



WORLD HEALTH ORGANIZATION  
INTERNATIONAL AGENCY FOR RESEARCH ON CANCER

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans

# Volume 7

## Some Anti-Thyroid and Related Substances, Nitrofurans and Industrial Chemicals

### Summary of Data Reported and Evaluation

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#### Anti-thyroid and Related Substances

Amitrole  
Ethylenethiourea  
Methylthiouracil  
Propylthiouracil  
Thioacetamide  
Thiouracil  
Thiourea  
Urethane

#### Nitrofurans

2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole  
*trans*-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)-vinyl]-1,3,4-oxadiazole  
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole  
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone  
1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone  
*N*-[4-(5-nitro-2-furyl)-2-thiazolyl]acetamide

#### Industrial Chemicals

Acetamide  
Benzene  
Diazomethane  
*ortho*- and *para*-Dichlorobenzene  
Ethyl Methanesulfonate  
Methyl methanesulfonate  
Polychlorinated biphenyls  
Vinyl chloride

# AMITROLE

VOL.: 7 (1974) (p. 31)

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Amitrole induced thyroid and liver tumours in both mice and rats following oral and/or subcutaneous administration. An increased incidence of liver-cell tumours in the trout has also been reported following oral administration, but this cannot be considered as conclusive until additional studies using properly controlled diets are reported. Limited skin-painting studies in mice gave no evidence of skin carcinogenicity.

### 5.2 Human carcinogenicity data

A single, small, cohort study raises the suspicion that amitrole may be carcinogenic to man, but the findings cannot be regarded as conclusive.

**Subsequent evaluations:** [Vol. 41 \(1986\)](#); [Suppl. 7 \(1987\)](#); [Vol. 79 \(2001\)](#)

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Last updated: 20 March 1998

# ETHYLENETHIOUREA

**VOL.:** 7 (1974) (p. 45)

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Ethylenethiourea (ETU) has been tested only by the oral route in rats, producing thyroid carcinomas. The reported increased incidence of liver-cell tumours in 2 strains of mice following oral administration awaits confirmation.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** [Suppl. 7 \(1987\)](#); [Vol. 79 \(2001\)](#)

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Last updated: 20 March 1998

# METHYLTHIOURACIL

VOL.: 7 (1974) (p. 53)

CAS No.: 56-04-2

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Methylthiouracil (MTU) administered to mice, rats and hamsters by the oral route produced thyroid tumours in all 3 species. It was similarly effective in rats following s.c. implantation. Kidney tumours were induced in female rats following oral administration. It enhanced the tumourigenic response of local application of 9,10-dimethyl-1,2-benzanthracene, producing cervicovaginal tumours in ovariectomized female rats. In rats and hamsters, combined treatment with <sup>131</sup>I and MTU, but not treatment with <sup>131</sup>I alone, increased the incidence of malignant thyroid tumours. There exists an inverse relationship between iodine content of the diet and MTU thyroid tumourigenicity.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 66: **Group 2B**); Vol. 79 (2001)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms for Methylthiouracil

- Alkiron
- Antibason
- Basecil
- Basethyrin
- 2,3-Dihydro-6-methyl-2-thioxo-4(1*H*)-pyrimidinone
- 2-Mercapto-4-hydroxy-6-methylpyrimidine
- 2-Mercapto-6-methyl-4-pyrimidone
- 2-Mercapto-6-methyl-pyrimid-4-one
- Metacil
- Methacil
- Methiacil
- Methicil
- Methiocil
- 6-Methyl-2-thio-2,4(1*H*,3*H*)-pyrimidinedione
- Methyl thiouracil
- Methyl-thiouracil
- 6-Methylthiouracil
- 6-Methyl-2-thiouracil
- 4-Methyl-2-thiouracil
- 4-Methyluracil
- MIU
- Muracil
- Orcanon
- Prostrumyl
- Strumacil

- Thimecil
- Thiomecil
- 2-Thio-6-methy1-1,3-pyrimidin-4-one
- 6-Thio-4-methyluracil
- Thiomidil
- Thioryl
- 2-Thio-4-oxo-6-methy1-1,3-pyrimidine
- Thiothyron
- Thiuryl
- Thyreostat
- Thyril
- Tiotiron

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Last updated: 20 March 1998

# PROPYLTHIOURACIL

VOL.: 7 (1974) (p. 67)

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Propylthiouracil produced thyroid tumours in mice, rats, hamsters, and guinea-pigs following oral administration, the only route tested. In mice, pituitary adenomas were also observed.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluations:** [Suppl. 7 \(1987\)](#); [Vol. 79 \(2001\)](#)

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Last updated: 20 March 1998

# THIOACETAMIDE

**VOL.:** 7 (1974) (p. 77)

**CAS No.:**62-55-5

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Thioacetamide is carcinogenic to mice and rats following oral administration, the only route tested. It induced liver-cell tumours in mice and liver-cell and bile duct tumours in rats. No carcinogenic effects were observed in hamsters following its oral administration.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 72: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms for Thioacetamide

- Acetothioamide
- Ethanethioamide
- TAA

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Last updated: 20 March 1998

# THIOURACIL

VOL.: 7 (1974) (p. 85)

CAS No.: 141-90-2

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Thiouracil increased the incidence of liver-cell tumours in mice and produced thyroid tumours in several strains of rats following oral administration, the only route tested. Studies in cats, dogs and monkeys were inadequate in group size and duration to allow evaluation of carcinogenicity. The study in fish reported did not demonstrate a significant carcinogenic effect.

### 5.2 Human carcinogenicity data

No adequate case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluations:** Suppl. 7 (1987) (p. 72); [Vol. 79 \(2001\) \(p. 127\)](#)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms for Thiouracil

- Antagothyroid
- Deracil
- 2,3-Dihydro-2-thioxo-4(1*H*)-pyrimidinone
- 6-Hydroxy-2-mercapto-pyrimidine
- 2-Mercapto-4-hydroxypyrimidine
- 2-Mercapto-4-pyrimidinol
- 2-Mercapto-4-pyrimidone
- 2-Mercapto-pyrimid-4-one
- 2-Thio-4-oxo-1,3-pyrimidine
- 2-Thio-2,4-(1*H*,3*H*)-pyrimidinedione
- 2-Thio-1,3-pyrimidin-4-one
- 2-Thiouracil
- 6-Thiouracil
- TU
- 2-TU

# THIOUREA

**VOL.:** 7 (1974) (p. 95)

**CAS No.:** 62-56-6

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Thiourea produced liver, thyroid and Zymbal gland tumours in rats following oral administration. Intraperitoneal injection followed by oral administration also led to the formation of Zymbal gland tumours in rats.

Oral and s.c. administration to mice did not produce thyroid tumours; however, the experiment using the s.c. route was inadequate. An increased incidence of liver-cell tumours in trout was reported, but this result cannot be considered as conclusive until additional studies using properly controlled diets are reported.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluations:** Suppl. 7 (1987) (p. 72: **Group 2B**); [Vol. 79 \(2001\)](#)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms for Thiourea

- Thiocarbamide
- 2-Thiourea
- THU

# URETHANE

**VOL.:** 7 (1974) (p. 111)

**CAS No.:** 51-79-6

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Urethane has been shown to be carcinogenic in mice, rats and hamsters following administration by the oral, inhalation, subcutaneous or intraperitoneal routes, producing, among others, lung tumours, lymphomas, hepatomas, melanomas and vascular tumours. It is an initiator for skin carcinogenesis in mice both when given orally and topically. It was also shown to enhance the leukaemogenic effect of X-irradiation. It is carcinogenic in single dose experiments and following prenatal exposure. Neonatal and infant mice are more susceptible to cancer induction by urethane than are adult mice.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 73: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms

- Ethyl carbamate
- Ethyl ester of carbamic acid
- Ethylurethan
- Ethyl urethan
- Ethyl urethane
- Leucothane
- Pracarbamin
- Urethan

# 2-AMINO-5-(5-NITRO-2-FURYL)-1,3,4-THIADIAZOLE

**VOL.:** 7 (1974) (p. 143)

**CAS No.:** 712-68-5

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole is carcinogenic in rats following oral administration, the only species and route tested. It produced mammary carcinomas and forestomach papillomas.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 57: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms

- 5-Amino-2-(5-nitro-2-furyl)-1,3,4-thiadiazole
- ASA-140
- Furidazina
- Furidiazina
- Furidiazine
- NF-475
- 2-(5-Nitro-2-furyl)-5-amino-1,3,4-thiadiazole
- 5-(5-Nitro-2-furyl)-2-amino-1,3,4-thiadiazole
- Ph/778
- Triafur

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Last updated: 19 March 1998

# ***trans*-2-[(DIMETHYLAMINO)METHYLIMINO]-5-[2-(5-NITRO-2-FURYL)VINYL]-1,3,4-OXADIAZOLE**

**VOL.:** 7 (1974) (p. 147)

**CAS No.:** 25962-77-0

## **5. Summary of Data Reported and Evaluation**

### **5.1 Animal carcinogenicity data**

*trans*-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole is carcinogenic in rats following oral administration, the only species and route tested. It produced mammary and intestinal tract carcinomas.

### **5.2 Human carcinogenicity data**

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 62: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

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Last updated: 19 March 1998

# 2-(2-FORMYLHYDRAZINO)-4-(5-NITRO-2-FURYL)THIAZOLE

**VOL.:** 7 (1974) (p. 151)

**CAS No.:** 3570-75-0

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole is carcinogenic in mice, rats and hamsters following oral administration, the only species and route tested. In mice it produced mainly stomach and pulmonary tumours and lymphocytic leukaemias. In rats it produced mainly mammary, renal, hepatic and gastrointestinal tract tumours and lymphocytic leukaemias; in hamsters it produced mainly forestomach and urinary bladder tumours.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 63: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms

- AS-17665
- FNT
- Formic acid 2-[4-(5-nitro-2-furyl)-2-thiazolyl]hydrazide
- 2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazol
- Nefurthiazole
- Nifurthiazol
- Nifurthiazole

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Last updated: 19 March 1998

# 5-(MORPHOLINOMETHYL)-3-[(5-NITROFURFURYLIDENE)-AMINO]-2-OXAZOLIDINONE

VOL.: 7 (1974) (p. 161)

## dl-Form

CAS No.: 139-91-3

## l-Form

CAS No.: 3795-88-8

## dl-Form hydrochloride

CAS No.: 13146-28-6

## 4. Comments on Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone is carcinogenic in rats following oral administration of its hydrochloride. It produced mainly mammary carcinomas and lymphoblastic lymphomas. No other species or routes of administration were tested.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 67: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms for the dl-Form

- Altabactina
- Altafur
- Biofurin
- Donafur
- F-150
- Furaldone
- Furaldone tartrate
- Furalton
- Furamidone
- Furasol
- Furazol INE
- Furazolin
- Furazoline
- Furfural Piper
- Furitale
- Furlate
- Furlidon
- Furmethonol
- Furmetox
- Fur-Novo

- Germicina
- Ibifur
- Medifuran
- Megafur
- (+/-)-5-Methyl morpholino-3-[amino(5-nitrofurfurylidene)]-2-oxazolidinone
- 5-Morpholinomethyl-3-(5-nitrofurfurylideneamino)-2-oxazolidinone
- 5-(N-Morpholinomethyl)-3-(nitrofurfurylideneamino)-2-oxazolidinone
- (+/-)-5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone
- 5-(4-Morpholinomethyl)-3-(5-nitrofurfurylideneamino)-2-oxazolidinone
- 5-(4-Morpholinomethyl)-3-(5-nitro-2-furfurylideneamino)-2-oxazolidinone
- 5-(4-Morpholinylmethyl)-3-[(5-nitro-2-furanyl)methylene]-amino-2-oxazolidinone
- Nitrofuraltadone
- 3-(5-Nitro-2-furfurylideneamino)-5-(4-morpholinomethyl)-2-oxazolidinone
- N-(5-Nitro-2-furfurylidene)-3-amino-5-(N'-morpholinylmethyl)-2-oxazolidinone
- Neofuran
- NF 260
- Nifadone
- Nitraldone
- Nitrofur
- Nitrofurmethone
- Otifuril
- Polival
- Sepsinol
- Sistogram
- Spectrafur
- Ultrafur
- Unifur
- Valsyn
- Viofural

# 1-[(5-NITROFURFURYLIDENE)AMINO]-2-IMIDAZOLIDINONE

VOL.: 7 (1974) (p. 181)

CAS No.: 555-84-0

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone is carcinogenic in rats following oral administration, the only species and route tested. It produced mammary carcinomas and lymphoblastic lymphomas.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 67: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms

- Nifuradene
- NF-246
- Nifuradine
- *N*-(5-Nitro-2-furfurylidene)-1-amino-2-imidazolidinone
- *N*-(5-Nitro-2-furfurylideneamino)-2-imidazolidinone
- Oxafuradene
- Oxifuradene
- Oxyfuradene
- Renafur

# ***N*-[4-(5-NITRO-2-FURYL)-2-THIAZOLYL]ACETAMIDE**

**VOL.:** 7 (1974) (p. 185)

**CAS No.:** 531-82-8

## **5. Summary of Data Reported and Evaluation**

### **5.1 Animal carcinogenicity data**

*N*-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide (NFTA) is carcinogenic in mice, rats (independent of the crystalline form) and hamsters following oral administration, the only route tested. It produced generalized lymphosarcomas and forestomach tumours in mice; mainly mammary carcinomas, salivary gland carcinomas, lung carcinomas and transitional-cell carcinomas of the renal pelvis in rats; and, in hamsters, urinary bladder carcinomas and forestomach tumours. Two dogs given NFTA orally developed gall-bladder adenomas.

### **5.2 Human carcinogenicity data**

No case reports or epidemiological studies were available to the Working Group.

**Previous evaluation:** [Vol. 1 \(1972\)](#)

**Subsequent evaluation:** Suppl. 7 (1987) (p. 67: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### **Synonyms**

- 2-Acetamido-4-(5-nitro-2-furyl)thiadiazole
- 2-Acetamido-4-(5-nitro-2-furyl)thiazole
- 2-Acetylamino-4-(5-nitro-2-furyl)thiazole
- Furathiazole
- Furium
- Furothiazole
- NFTA
- *N*-[4-(5-Nitro-2-furanyl)-2-thiazolyl]acetamide
- *N*-[4-(5-Nitro-2-furyl)thiazol-2-yl]acetamide

# ACETAMIDE

VOL.: 7 (1974) (p. 197)

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Acetamide is carcinogenic in rats following oral administration, the only species and route tested, producing benign and malignant liver tumours.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** [Suppl. 7 \(1987\)](#); [Vol. 71 \(1999\)](#)

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Last updated: 13 April 1999

# BENZENE

VOL.: 7 (1974) (p. 203)

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Benzene has been tested only in mice by subcutaneous injection and skin application. The data reported do not permit the conclusion that carcinogenic activity has been demonstrated.

### 5.2 Human carcinogenicity data

It is established that exposure to commercial benzene or benzene-containing mixtures may result in damage to the haematopoietic system. A relationship between such exposure and the development of leukaemia is suggested by many case reports, and this suggestion is strengthened by a case-control study from Japan.

**Subsequent evaluation:** [Vol. 29 \(1982\)](#); [Suppl. 7 \(1987\)](#)

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Last updated: 19 March 1998

# DIAZOMETHANE

**VOL.:** 7 (1974) (p. 223)

**CAS No.:** 334-88-3

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Limited studies indicate that diazomethane is carcinogenic in mice and rats, the only species tested. In mice it increased the incidence of lung tumours following skin application; and exposure to the gas induced lung tumours in rats.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 61: **Group 3**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonym

- Azimethylene

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Last updated: 19 March 1998

# ***ortho-* AND *para*-DICHLOROBENZENE**

**VOL.:** 7 (1974) (p. 231)

## **5. Summary of Data Reported and Evaluation**

### **5.1 Animal carcinogenicity data**

No adequate studies on which to base an evaluation of carcinogenicity were available to the Working Group.

### **5.2 Human carcinogenicity data**

One report has suggested an association between leukaemia and exposure to dichlorobenzenes, but this is insufficient evidence from which to assess the carcinogenic risk of this compound.

**Subsequent evaluations:** [Vol. 29 \(1982\)](#); [Suppl. 7 \(1987\)](#); [Vol73 \(1999\)](#)

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Last updated: 30 September 1999

# ETHYL METHANESULFONATE

**VOL.:** 7 (1974) (p. 245)

**CAS No.:**62-50-0

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

Ethyl methanesulfonate is carcinogenic in mice and rats following subcutaneous or intraperitoneal injection, the only species and routes tested. It produced mainly lung and kidney tumours in both species. It is carcinogenic following administration of a single dose.

### 5.2 Human carcinogenicity data

No case reports or epidemiological studies were available to the Working Group.

**Subsequent evaluation:** Suppl. 7 (1987) (p. 63: **Group 2B**)

For definition of Groups, see [Preamble Evaluation](#).

### Synonyms

- EMS
- Ethyl ester of methanesulfonic acid
- Ethyl ester of methylsulfonic acid
- Ethylmethanesulfonate
- Ethylmethane sulfonate
- Ethyl methane sulfonate
- Ethyl methansulfonate
- Methanesulfonic acid ethyl ester
- "Half-Myleran"
- NSC 26805

# POLYCHLORINATED BIPHENYLS (PCBs)

VOL.: 7 (1974) (p. 261)

## 5. Summary of Data Reported and Evaluation

### 5.1 Animal carcinogenicity data

A limited number of PCBs have been tested. Kanechlor 500 and Aroclor 1254 are carcinogenic in mice inducing benign and malignant liver-cell tumours following oral administration, the only route tested. In rats, Kanechlor 500, 400 and 300 induced multiple hyperplastic liver nodules following oral administration.

### 5.2 Human carcinogenicity data

In the absence of epidemiological studies the available case report does not allow an evaluation to be made.

**Subsequent evaluations:** [Vol. 18 \(1978\)](#); [Suppl. 7 \(1987\)](#)

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Last updated: 19 March 1998

# VINYL CHLORIDE

**VOL.:** 7 (1974) (p. 291)

## 5.1 Animal carcinogenicity data

Vinyl chloride monomer (VCM) is carcinogenic in mice and rats following exposure by inhalation. The tumours in mice were mainly lung tumours, mammary carcinomas and angiosarcomas (malignant haemangioendotheliomas) of the liver. Angiosarcomas of the liver and other organs, Zymbal gland carcinomas and nephroblastomas occurred in exposed rats. Preliminary studies have suggested that VCM also produces subcutaneous angiosarcomas in the offspring of rats that have been exposed during pregnancy.

## 5.2 Human carcinogenicity data

In view of the extreme rarity of angiosarcoma of the liver in the general population, the observation of 16 cases in workers exposed to vinyl chloride monomer during the polymerization process is evidence of a causal relationship.

**Subsequent evaluation:** [Vol. 19 \(1979\)](#); [Suppl. 7 \(1987\)](#)

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Last updated: 19 March 1998