alpha-METHYLSTYRENE

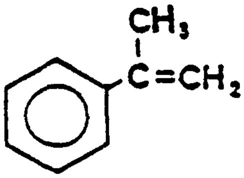
I. Chemical and Physical Information

A. Synonyms: α-Methylstyrene
Isopropenylbenzene
2-Phenylpropylene
1-Methylethenyl benzene
AMS

B. CAS No: 98-83-9

C. Molecular Formula: C_9H_{10}

D. Structural Formula:



E. Molecular Weight: 118.18

F. Physical Properties:

1. Physical State: Colorless liquid (Verschueren, 1977)
2. Melting Point: -23.2°C (Verschueren, 1977)
3. Boiling Point: 165.38°C (Hawley, 1981)
4. Flash Point: 53.9°C (Hawley, 1981)
5. Vapor Pressure: 2.3 mm Hg at 20°C and 4 mm Hg at 30°C (Verschueren, 1977)
6. Specific Gravity: 0.9062 at 25°C (Verschueren, 1977)
7. Refractive Index: 1.5359 at 25/25°C (Hawley, 1981)
8. Solubility in Water: 0.056 wt% at unspecified temperature (Santodonato et al., 1980)
9. Solubility in Organic Solvents: Soluble in ether, benzene, chloroform, acetone, carbon tetrachloride (Weast, 1984; TDB, 1985)
10. Log Octanol/Water Partition Coefficient: 3.36 (Leo, 1978; cited in ISHOW, 1985)
11. Other: Subject to polymerization by heat or catalyst; combustible (Hawley, 1981); pleasant, sweet, aromatic odor; low odor detection threshold - 0.008 ppm (Verschueren, 1977); 0.29 ppm (Amoore and Hautala, 1983).

February 28, 1986; rev. 11/30/87

II. Production/Use/Exposure/Environmental/Regulatory Data

A. Production

1. Manufacturing Process

α-Methylstyrene (AMS) is formed primarily as a byproduct of the manufacture of phenol from cumene. The process involves the oxidation of cumene to its peroxide followed by a cleavage reaction in an acidic medium to produce phenol, acetone, and AMS (Kirk-Othmer, 1983; Santodonato et al., 1980). AMS is also manufactured by the direct catalytic dehydrogenation of cumene.

AMS may also be produced by dehydrogenating ethyl toluene or by the ethylation and dehydrogenation of toluene (TDB, 1985).

2. Volume

The U.S. International Trade Commission (USITC) has reported the domestic production volume of AMS for the years 1980 through 1983 (USITC, 1981a-1984a), as follows:

Year	Production Volume (million lb)
1980	38.7
1981	35.5
1982	10.1
1983	47.5

The public portion of the Toxic Substances Control Act (TSCA) Chemical Substance Inventory (TSCA Inventory) reported the domestic production volume of AMS for 1977 to be between 34.2 and 192 million pounds (refer to Enclosure 1) (USEPA, 1985a). Of this reported volume, 10-50 million pounds were reported as produced for onsite use only.

As of January 1, 1985, the estimated annual domestic production capacity of AMS was reported to be 113 million pounds (SRI International, 1985).

For 1980 and 1982, the USITC reported AMS importation volumes of 22,046 and 2,238,969 pounds, respectively; no data were reported for 1981 or 1983 (USITC, 1981b-1984b).

3. Producers and Importers

Producers (USITC, 1984a; SRI International, 1985)

Allied Chemical Corp.
Frankford, PA

Amoco Chemicals Corp.
Texas City, TX

Chemical Exchange Co., Inc.
Baytown, TX

Clark Oil and Refining Corp.
Blue Island, IL

Georgia Gulf Corp.
Bound Brook, NJ
Plaquemine, LA

Shell Oil Company
Deer Park, TX

Texaco Chemical Company
El Dorado, KS

United States Steel Corp.
Haverhill, OH

The TSCA Inventory listed the following additional companies as producers of AMS during the period 1975-1982 (USEPA, 1985a):

Chevron U.S.A. Inc.
Richmond, CA

Dow Chemical Co., U.S.A
Midland, MI

Monsanto Co.
Alvin, TX
Texas City, TX

Union Carbide Corp.
Bound Brook, NJ
Ponce, PR

Importers

No importers were identified in the TSCA Inventory (USEPA, 1985a). The USITC does not identify importers.

4. Technical Product Composition

Commercial AMS is marketed as a minimum 99.3 wt% pure monomer inhibited with t-butylcatechol to prevent polymerization (Kirk-Othmer, 1983; Santodonato et al., 1980).

B. Use

Virtually all of the AMS produced is used in the formulation of specialty polymers and resins. It is widely used in the production of modified polyester and alkyd resin formulations. The primary demand for AMS in specialty resins is as an acrylonitrile-butadiene-styrene (ABS) additive; the resulting resin is useful in producing lightweight automotive products (Santodonato et al., 1980). As a copolymer in ABS and polystyrene, AMS increases the heat-distortion resistance of the product. In coatings and resins, AMS moderates reaction rates and improves product clarity (Kirk-Othmer, 1983).

Lower purity grades of AMS have a small number of end uses, including applications in musk oil fragrances and shoe soles (CEH, 1985).

Low-molecular-weight AMS polymers, which are viscous liquids, are used as plasticizers in paints, waxes, adhesives, and plastics (Santodonato et al., 1980).

C. Occupational Exposure

The National Occupational Hazard Survey (NOHS), conducted by the National Institute for Occupational Safety and Health (NIOSH) from 1972 to 1974, estimated that 25,018 workers in 1,999 plants were potentially exposed to AMS in the workplace (NIOSH, 1976). These estimates were derived from observations of the actual use of the compound, the use of tradename products known to contain the compound, and generic products suspected of containing the compound (3%, 96%, and 1% of total estimate, respectively). The industries with the largest number of exposed workers were heavy construction contractors, miscellaneous business services, and paper and allied products (refer to Enclosure 2). The occupational groups with the largest number of exposed workers were construction laborers (excluding carpenters' helpers), automobile mechanics, and heavy equipment mechanics (refer to Enclosure 3).

AMS was not included in the National Occupational Exposure Survey conducted by NIOSH from 1980 to 1983 (NIOSH, 1984).

The NIOSH Tradename Ingredient Data Base of NOHS listed AMS as a constituent of 15 products used in industrial applications (NIOSH, 1976). The concentration of AMS in the products ranged from 1-99%: six products contained 1-5% AMS, seven contained 14-50%, and two were composed of 99% AMS (refer to Enclosure 4).

Recommended workplace exposure limits for airborne concentrations of AMS have been established by the American Conference of Governmental Industrial Hygienists (ACGIH, 1984). The 8-hour time-weighted average (TWA) threshold limit value is 50 ppm (240 mg/m^3), and the short-term (15-minute) exposure limit is 100 ppm (485 mg/m^3).

At one facility, Samimi and Falbo (1982) monitored the levels at which production workers were exposed to the principal monomers, including AMS, used in the production of styrene-based polymers. Samples were taken at several locations: Reactors A and B, which were open for the preliminary stages of the process; Reactors C and D, which were closed systems; and the unloading docks where the monomers were received into the plant. The results of exposure to AMS were summarized as follows:

Time-Weighted Average Concentration of AMS Monomer in the Breathing Zones of Workers at Various Job Sites

Job Site	Number of Samples	TWA Concentration of AMS (ppb)	
		Mean	Range
Reactor A	11	15	ND[a]-40
Reactor B	9	116	ND-583
Reactor C	13	8	ND-56
Reactor D	6	23	9-52
Unloading Docks	11	98	ND-360

[a]ND = Not detectable (< 1 ppb).

Time-Weighted Average Concentration of AMS Monomer in the Atmosphere of Various Workplaces

Job Site	Number of Samples	TWA Concentration of AMS (ppb)	
		Mean	Range
Reactor A	8	21	ND[a]-122
Reactor B	6	19	6-34
Reactor C	6	2	ND-9
Reactor C (lower level)	9	ND	--
Reactor D	10	ND	--
Unloading Dock	18	4	ND-452

[a]ND = Not detectable (< 1 ppb).

The authors attributed these low values (ppb) to highly efficient engineering controls, including the employment of closed system polymerization processes and continuous ventilation of reactor enclosures.

Cocheo et al. (1983) studied the volatile pollutants produced during several rubber goods manufacturing processes. None of the processes studied utilized AMS as a raw material. However, AMS was detected in the ambient air in the extrusion area of an electrical cable insulation plant. The concentration of AMS in the 10 samples analyzed ranged from 0 to 5 $\mu g/m^3$.

The ability of workers to detect exposure potential to industrial chemicals, including AMS, has been summarized by Amoore and Hautala (1983). For AMS, the geometric mean for odor threshold, as reported in the literature, was 0.29 ppm. Odor thresholds are defined on the basis of the percentage of workers able to recognize the presence of a specific chemical in the air. Verschueren (1977) reported an odor threshold value of 0.008 ppm with 100% recognition at 0.156 ppm. In an early study involving limited exposure to AMS, Wolf et al. (1956) reported that the odor was not detectable at levels below 10 ppm. Regardless, the odor threshold is quite low, and likely provides adequate warning of its presence (HAZARDLINE, 1985).

D. Consumer Exposure

No specific information was found on consumer exposure to AMS. However, it has been reported (Kirk-Othmer, 1983) that AMS is a product of the outgassing of polystyrene insulation materials. Therefore, consumers may be exposed via inhalation to AMS mobilized from these materials.

E. Environmental Data

Relative to its primary application in the manufacture of polymers and resins, AMS may be released to the environment via emissions from vents on process equipment, storage tank losses, miscellaneous leaks and spills, process wastewaters, and solid process wastes (Santodonato et al., 1980). The identification of methylstyrenes (not specified) in oxy-acetylene and oxy-ethylene flames suggests combustion sources as possible environmental sources of AMS. Pfäffli et al. (1978) identified AMS as a product of the thermal degradation of polystyrene, with 0.12 ± 0.02 mg AMS at 350°C and 0.07 ± 0.01 mg AMS at 500°C released from 100 mg of polystyrene.

No information was found on ambient environmental concentrations of AMS. Available information suggests that AMS is not photoreactive in sunlight and that hydrolysis is not expected to occur in the environment (Santodonato et al., 1980). AMS is subject to oxidation in air; thus, commercial AMS must be stabilized.

The log octanol/water partition coefficient of AMS is 3.36, which may indicate a potential to bioconcentrate. In trace quantities AMS is soluble in water; it will evaporate relatively rapidly and is expected to partition to the atmosphere (Santodonato et al., 1980).

Little information was found on the biodegradability of AMS. AMS has been identified in the sewage of a synthetic rubber factory by Ilyaletdinov et al. (1983). Isolated from the same sewage were several bacterial strains, two of which were identified as <u>Bacillus</u> <u>cereus</u> and <u>Pseudomonas</u> <u>aeruginosa</u>. The authors reported the decomposition of AMS and the increase in biomass of each of the active cultures, grown on synthetic medium with AMS as the sole source of carbon.

F. Regulatory Status

AMS was scored for biological effects and exposure potential by the TSCA Interagency Testing Committee (ITC) in 1983 (ITS, 1985). The ITC reviews chemicals in commerce for potential designation to the Environmental Protection Agency for consideration for industry-required testing for toxicological and/or environmental health effects. AMS was not selected for further study by the ITC as a result of the scoring activity.

The Occupational Safety and Health Administration (OSHA) has established a permissible exposure ceiling limit of 100 ppm (480 mg/m^3) for AMS (OSHA, 1983). OSHA and NIOSH have established 5000 ppm (24.0 g/m^3) as the concentration of AMS that is immediately dangerous to life or health (Sittig, 1981). Employers are required to provide potentially exposed employees with adequate ventilation; respiratory, eye, and face protective equipment; and accessible medical services, sanitation, and first aid.

Under the Hazardous Materials Transportation Act, administered by the Department of Transportation, AMS is regulated as a flammable liquid under Section 49 CFR 172.102 (USDOT, 1984). Consequently, international transporters of AMS are required to conform to certain labeling and packaging requirements.

Due to its combustibility, AMS is regulated as an ignitable hazardous waste (Waste No. D001), not otherwise specified, under the Resource Conservation and Recovery Act (RCRA). Generators and transporters of hazardous waste, as well as owners and operators of waste treatment, storage, and disposal facilities, are subject to minimum standards that define acceptable management practices. As a result of its inclusion under RCRA, AMS is also regulated under Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act, with a reportable quantity of 100 pounds for releases of AMS from vessels and facilities (HAZARDLINE, 1985; USEPA, 1985b).

III. Toxicological Effects

A. Human Data

1. Acute: No specific information was found on the systemic acute toxicity of AMS. The results of limited exposure of human subjects to AMS were summarized by Wolf et al. (1956) as follows:

AMS (ppm)	Type and Degree of Response
600 or more	Very strong odor; strong eye and nasal irritation
200	Objectionably strong odor
100	Strong odor but tolerated without excessive discomfort
50	Detectable odor but no irritation
Less than 10	Odor not detectable

The "comfort" level of AMS to humans is well below the "no effect" level of 200 ppm determined in animal experiments.

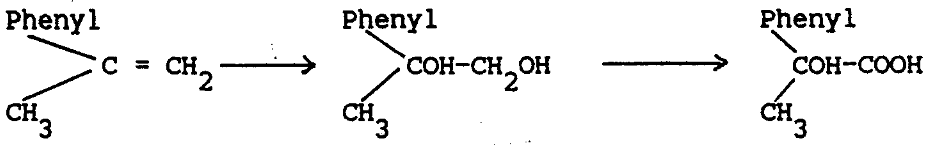
2. <u>Epidemiological Evidence/Case Reports</u>: Putalova (1979) conducted a clinical study of 102 workers in various butadiene-α-methylstyrene rubber factories. The workers were exposed for 7-10 years to vapors of AMS, butadiene, isopropylbenzene, benzene and other chemicals used in the manufacture of butadiene-α-methylstyrene copolymer rubber. Forty-eight percent of the workers suffered from abnormal hepatobiliary functions, including liver disturbances and dyskinesia.

   Demchenko (1978) studied the effect of exposure to AMS on the functional state of the respiratory system of synthetic rubber production workers. In a group of 76 workers exposed to AMS and doing hard manual labor, higher consumption and utilization of oxygen were found as compared to a control group.

3. <u>Chemical Disposition</u>: Aizvert (1979) studied the skin absorption and excretion kinetics of AMS in humans. Undiluted pure AMS penetrated the unimpaired skin well and was absorbed at a rate of 19.5 mg/cm^2/hour. The absorption rate of AMS from aqueous solutions was in the range of 0.048 to 0.256 mg/cm^2/hr depending on the temperature and

concentration of the solution. The kinetics of excretion of the AMS metabolites, atrolactic acid and 2-phenyl-2-hydroxypropanol, was found to be a first-order process. No rate constants were given. The author compared these results with his results obtained from inhalation exposure of volunteers and reported a lower rate of metabolism from the skin route with the amount of metabolites excreted in the urine about one-third that obtained with the inhalation route.

Bardodej and Bardodejova (1970) studied the biotransformation of AMS in humans exposed for an 8-hour period to unspecified levels of the compound by inhalation. Based on their observation that atrolactic acid is present in the urine of exposed individuals, the authors proposed the following partial biotransformation scheme for AMS:



α-Methylstyrene   2-Phenyl-2-hydroxypropanol   Atrolactic acid

Aizvert (1974, 1975) studied the excretion of atrolactic acid in humans exposed to AMS. The urine of workers exposed to AMS by inhalation at atmospheric concentrations in the range of 2-27 mg/m^3 contained 0.5-2.4 mg% atrolactic acid (Aizvert, 1974). The duration of exposure was not specified. Following exposure at 0.02-4.0 mg/L, 26.2% of AMS was excreted as atrolactic acid (Aizvert, 1975). Atrolactic acid was not found in the urine of individuals exposed to AMS at atmospheric levels of 0.005 mg/L (Aizvert, 1974).

4. <u>Biochemical Effects</u>: Sergeta et al. (1977) studied ornithine carbamoyl transferase (OCT) levels in workers at a synthetic rubber plant. An unspecified higher level of the enzyme was found in exposed healthy workers and in exposed workers showing initial signs of nervous disorders.

   Bravve (1974) studied hematological changes and levels of vitamin B_{12} in the serum of workers at a synthetic rubber plant. Hematological investigation of workers employed for 1-5 years (Group 1) or for 5-14 years (Group 2) indicated the following:

   - The level of vitamin B_{12} dropped to 61% and 35% of control values in workers in Groups 1 and 2, respectively.

   - Several changes in the erythrone system were reported, including a rise in average erythrocyte diameter and percent macrocytes, and a drop in normocytes. No further details were available in the English abstract of this Russian paper.

5. <u>Carcinogenicity/Chronic</u>: No information was found in the information sources searched.

6. <u>Teratogenicity and Reproductive Effects</u>: No information was found.

B. <u>Animal Data</u>

1. <u>Acute</u>: The acute systemic toxicity data on AMS are summarized in Table 1.

Table I. Acute Toxicity of AMS in Laboratory Animals

Species	Strain	Route	No./Sex	Dose	Effects	Reference
Rat	White	Orl (gavage)	20/M	—	LD_{50}: 4.9 g/kg Post-mortem examination of the animals revealed slight liver abnormality and kidney effect of questionable significance	Wolf et al. (1956)
Rat	—[a]	Ihl	-/-	3000 ppm[b]	Lowest lethal concentration	Wolf et al. (1956)
Guinea pig	—	Ihl	-/-	3000 ppm[b]	Lowest lethal concentration	Wolf et al. (1956)

[a] Not specified
[b] No. of 7-hr exposures = 3–4; duration of experiment = 3–4 days.

Two drops of undiluted liquid AMS applied to the conjunctival sac of the right eye of an unspecified number of white rabbits caused slight conjunctival irritation but no corneal injury (Wolf et al., 1956). Repeated applications (10-20) of undiluted AMS to the ear and shaved abdominal skin of an unspecified number of white rabbits over 2-4 weeks caused moderate-to-marked irritation and slight necrosis (Wolf et al., 1956).

2. Chemical Disposition: Bardodej and Bardodejova (1970) observed atrolactic acid in the urine of an unspecified number of dogs and rats dosed orally with unspecified levels of AMS. The authors proposed that atrolactic acid is formed from AMS via 2-phenyl-2-hydroxypropanol, as shown previously (see p. 11).

   Aizvert (1975) studied the biotransformation of AMS in albino rats and guinea pigs. When AMS was administered orally and subcutaneously, for 1-3 days, at doses ranging from 5 to 100 mg/kg, atrolactic acid is excreted with urine in the amount of 15.6% in guinea pigs and 9.6% in rats. Daily atrolactic acid excretion in the urine of rats and guinea pigs was also determined following 5-hr inhalation exposures at concentrations of 0.005, 0.02, 0.05, 0.2, 2.0, and 4.0 mg/L. Except for the lowest exposure concentration, the atrolactic acid excretion was proportional to the AMS concentration in the air and lasted from 1 to 5 days following the exposure. Following exposure equivalent to the maximum permissible concentration of 5.0 mg/m^3 no atrolactic acid was found in the urine.

3. Biochemical Effects: Solov'ev (1974) studied the effect of AMS on the brain metabolism of rats. The animals were exposed by inhalation to AMS at atmospheric levels of 0.05 mg/L, 4-5 hours daily for 6 months. The observed effects

included accumulation of high levels of ammonia, decreased total protein nitrogen and protein amide nitrogen, and increased glutamine formation. Other effects observed in the brain included decreased tissue respiration and glycogen levels, increased glycolysis, and uncoupling of oxidative phosphorylation.

Solov'ev and Barashkova (1978) studied the effect of AMS on the content of free amino acids in rat brain. The animals were exposed by inhalation to AMS at atmospheric levels of 3-5 mg/L, 6 hours/day for 6 days. There was an increase in levels of γ-aminobutyric acid, lysine, histidine, and aspartate. There was a decrease in levels of valine, methionine, and tyrosine.

Klimina (1974) studied the effect of AMS on acetylcholine levels in rats. A single inhalation exposure to AMS at an atmospheric concentration of 3-5 mg/L (length of exposure not specified) decreased the acetylcholine level of the blood, kidneys, and liver.

4. <u>Prechronic</u>: Mirzoyan and Zhakenova (1972) applied AMS (30%, solvent not specified) to rabbit skin daily for 20 days. The observed effects included inflammation, hyperemia, edema, desquamation and sensitization. Thickening of the epidermal layer and hyperkeratosis were also observed.

5. <u>Carcinogenicity/Chronic</u>: No information was found on the carcinogenic potential of AMS.

   Wolf et al. (1956) exposed rats, guinea pigs, rabbits, and rhesus monkeys to AMS vapors for 7 hours/day, 5 days/week for up to 212 days (in the high dose groups of rats and guinea pigs, the experiment lasted only 3-4 days). The concentrations employed ranged from 200 to 3000 ppm for rats and guinea pigs, and were 200 and 600 ppm for rabbits and monkeys. Further details and results of repeated AMS vapor inhalation are given in Table 2. Growth depression and increase in liver and kidney weights were observed. Some rabbits in the high-dose group died after 152 exposures. No ill effects were observed in monkeys following 149 exposures at 600 ppm. No ill effects were observed in any of the species after 139 exposures at 200 ppm over a period of 197 days. Gerarde (1960) noted that an important negative finding in this investigation was the lack of any evidence of injury to the blood-forming tissues.

Makar'eva (1972) studied the effect of chronic AMS exposure on leukopoiesis and functional state of leukocytes in rats and rabbits. Twenty-one rats and 8 rabbits were exposed (route unspecified) for 3 months to average AMS concentrations of 0.59 ± 0.09 mg/L (100 times higher than permissible) with functional measurements taken during the exposure period. This resulted in a decrease of osmotic stability of leukocytes, and glycogen and peroxidase content in the neutrophils.

6. <u>Teratogenicity and Reproductive Effects</u>: In a 4-month inhalation study by Serebrennikov and Ogleznev (1978), female rats exposed to AMS at the maximum permissible concentration showed increased embryonal mortality (33.3%), as compared to 7.5% in the controls. The frequency of malformations (teratogenesis) also increased to 21.0%, as compared to 3.0% in controls. The type of malformations were not indicated in the English abstract of this Russian paper.

Table 2. Results of Repeated Vapor Inhalation on Animals Exposed to a-Methyl Styrene

Animal Species	Average Vapor Concentrations ppm	mg/L	Sex	7-Hr Exposures, No.	Duration of Experiment, Days	Effects*			
Rat	3,000	14.49	Both	3-4	3-4				M+++
	800	3.86	Both	28	38	G+;	Lw+;	Kw+	
	600	2.90	Both	149	212		Lw+;	Kw+	
	200	0.97	Both	139	197			No effect	
Guinea pig	3,000	14.49	Both	3-4	3-4				M+++
	800	3.86	Both	27	38	G+;	Lw+;	Kw+	
	600	2.90	Both	144	212		Lw+		
	200	0.97	Both	139	197			No effect	
Rabbit	600	2.90	Both	152	212	G+;			M+
	200	0.97	Both	139	197			No effect	
Rhesus monkey	600	2.90	F	149	212			No effect	
	200	0.97	Both	139	197			No effect	

*G = growth depression
w = weight increase
L = liver
K = kidney
M = mortality

The intensity of response is noted as follows:
+ = slight
++ = moderate
+++ = severe

[a] Adapted from Wolf et al. (1956)

C. Genotoxicity

AMS was tested for its ability to induce sister-chromatid exchanges (SCE's) in human lymphocytes (Norppa and Vainio, 1983). Lymphocytes from whole blood of a healthy male donor were treated for 48 hours with the test compound at concentrations ranging from 0.33 to 10 mM. AMS showed a positive effect only at the 0.33 mM level; however, it did not double the mean number of SCE's/cell over the corresponding control cultures.

D. Structure-Activity Relationships

Methylated styrenes and styrene are known to induce SCE's in human whole-blood lymphocyte cultures without exogenous metabolic activation systems (Norppa and Vainio, 1983). Since these compounds are not direct mutagens, they are perhaps converted into reactive metabolites in vitro. Styrene analogs (2-phenylethanol and ethylbenzene) without a double bond in the side-chain show negative or weak effects in SCE induction. This suggests that these compounds are not themselves effective mutagens and are not converted into reactive species in the test system; the reactive metabolites are derived from the conversion of the vinyl group of styrene and methylated styrenes and are styrene-7,8-oxides.

The testing status of related compounds, currently being studied by the National Toxicology Program, is summarized in Table 3.

IV. Nomination Source

A. Source: Environmental Protection Agency (USEPA, 1984)

B. Recommendation: Toxicological evaluation
Genetic toxicology
Subchronic

Table 3. NTP Testing Status of Compounds Related to AMS[a]

Chemical	CAS Number	Genotoxicity	Carcinogenicity	Other
Methyl Styrene[b]	98-83-9	-Selected for <u>Salmonella</u> -On test for chromosomal aberrations and sister chromatid exchanges in CHO cells	—	—
Styrene	100-42-5	-Negative in <u>Salmonella</u> -On test for sex-linked recessive lethal mutations in <u>Drosophila</u> -On test for chromosomal aberrations and sister chromatid exchanges in CHO cells	-Equivocal in gavage bioassay; increased incidence of lung adenomas and carcinomas in mice; however, convincing evidence for carcinogenicity in mice and rats is lacking -Nominated for inhalation carcinogenesis studies	—
Styrene oxide	96-09-3	-Positive in mouse lymphoma	-Report of gavage bioassay in preparation by Frederick Cancer Research Foundation	-Inhalation teratology study: 16% maternal mortality; reduced maternal body weight; reduced liver weight; increased lung and kidney weight; reduced number of pregnancies -Inhalation teratology study: 79.2% maternal mortality at 50 ppm, 16.7% at 15 ppm; reduced weight gain at 50 ppm; increased lung weight. Fetal effect: reduced weight
Vinyl toluene	25013-15-4	-Negative in <u>Salmonella</u> -Positive in mouse lymphoma -On test for chromosomal aberrations and sister chromatid exchanges in CHO cells	-Histology phase of inhalation bioassay in progress	-Dominant lethal test, no reproductive effects, reduced kidney and testes weights

Table 3. NTP Testing Status of Compounds Related to AMS[a,b] (continued)

Chemical	CAS Number	Genotoxicity	Carcinogenicity	Other
Divinylbenzene	1321-74-0	-Negative in Salmonella in two independent studies	—	—
Ethylbenzene	100-41-4	-Negative in Salmonella -On test in mouse lymphoma -Negative for chromosomal aberrations and sister chromatid exchanges in CHO cells.	—	-Inhalation teratology study: incresed maternal liver weight at 960 ppm; reduced number of live fetuses/litter at 100 and 960 ppm -Inhalation teratology study: reduced pregestation body weight; increased liver, kidney, and spleen weight; fewer pregnancies; reduced fetal length; increase in fetal ribs -Dominant lethal test: inadequate results

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[a] NTP CHEMTRACK (1986).

[b] AMS has been nominated for genetic toxicology and subchronic testing (see Section IV).

C. Rationale: Very high production
Limited in vitro data

D. Priority: None given

E. Date of Nomination: July 1984

V. Chemical Evaluation Committee Review

A. Date of Review: October 23, 1985

B. Recommendations:
- In-depth toxicological evaluation
- Short-term in vivo reproductive toxicity assay
- In vitro cytogenetics

C. Priority: Low

D. NTP Chemical Selection Principle(s): 3, 8

E. Rationale/Remarks:
- High production
- Potential for toxicity based on in vitro data

VI. Board of Scientific Counselors Review

A. Date of Review: October 23, 1985

B. Recommendations:
- In-depth toxicological evaluation
- Short-term in vivo reproductive toxicity assay
- In vitro cytogenetics

C. Priority: Low

D. Rationale/Remarks:
- High production
- Lack of toxicity data

VII. Executive Committee Review

A. Date of Review: August 24, 1987

B. Decision: Selected as an NTP FY 1987 priority chemical for in-depth toxicological evaluation

VIII. Information Sources

This report was prepared by a multidisciplinary team of scientists and technicians. Dr. Satish Bhalla was the principal author.

The information resources used in preparing this review include the automated data bases listed below, journal articles, general reference materials, and contractor/agency reports.

ON-LINE DATA BASES SEARCHED

MEDLARS

CHEMLINE	
RTECS	
TDB	
MEDLINE	1983-Present
TOXLINE	1966-Present
TOX 76	1976-1980
TOX 65	1940-1975
CANCERLIT	1963-Present
CANCERPROJ	1978-1981
EXPRESS	1984-Present

DIALOG

AGRICOLA	1970-Present
AQUALINE	1960-Present
BIOSIS PREVIEWS	1969-Present
CA SEARCH	1967-Present
CHEMICAL EXPOSURE	1974-Present
CIN (Chemical Indust. Notes)	1974-Present
CLAIMS/U.S. PATENT ABSTRACTS	1950-Present
CONFERENCE PAPERS INDEX	1973-Present
CRGS (Chemical Regulations and Guidelines) System)	1982-Present
EMBASE	1974-Present
ENVIROLINE	1971-Present
ENVIRONMENTAL BIBLIOGRAPHY	1974-Present
FEDERAL REGISTER ABSTRACTS	1977-Present
FEDERAL RESEARCH IN PROGRESS	1976-Present
GPO	
LIFE SCIENCES COLLECTION	1978-Present
NTIS	1970-Present
OCCUPATIONAL SAFETY AND HEALTH	1972-Present
PTS PROMT	1972-Present
PTS F&S INDEXES	1972-Present
POLLUTION ABSTRACTS	1970-Present
SCISEARCH	1974-Present

CIS

OHMTADS
SPHERE, CESARS, DERMAL, ENVIROFATE, GENETOX, and ISHOW

BRS

KIRK-OTHMER	1978-Present

INFOLINE

LABORATORY HAZARD BULLETIN	1981-Present
CURRENT AWARENESS IN BIOLOGICAL SCIENCES	1983-Present
CHEMICAL HAZARDS IN INDUSTRY	1984-Present
WORLD SURFACE COATING ABSTRACTS	1976-Present

OTHERS

CECATS	
CURRENT AWARENESS	
DIDS	1950-Present
EMIC	1940-Present
ETIC	
EPACASR	
FSTA (Food Science and Technology Abstracts)	1969-Present
IPA (International Pharmaceutical Abstracts)	1970-Present
ITS	
METADEX	1966-Present
NOES	
NOHS	
NTP CHEMTRACK	
STORET	
TSCA INVENTORY	
HAZARDLINE	1983-Present
OSHA MONITORING DATA BASE	
WORLD TEXTILES	1970-Present

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98-83-9   8TH COLLECTIVE INDEX NAME:
          STYRENE, .ALPHA.-METHYL-


          9TH COLLECTIVE INDEX NAME:
          BENZENE, (1-METHYLETHENYL)-

          CHEVRON U.S.A. INC            (000976C)
          P.O. BOX 1272
          RICHMOND REFINERY
          RICHMOND                       CA  94802
               MANUFACTURER
               1977 PRODUCTION OF 1 MILLION TO TEN MILLION POUNDS

          DOW CHEMICAL COMPANY U.S.A.   (001024G)
          MICHIGAN DIVISION
          809 E. MAIN STREET
          MIDLAND                        MI  48640
               MANUFACTURER
               1977 PRODUCTION OF 1 MILLION TO TEN MILLION POUNDS

          MONSANTO CO.                  (002043M)
          ATTN: PHILLIP E. BRUBAKER
          BOX 1311
          TEXAS CITY                     TX  77590
               MANUFACTURER
               1977 PRODUCTION OF 100,000 TO 1,000,000 POUNDS

          MONSANTO COMPANY              (002060B)
          ATTN: GORDON E DAVENPORT
          P.O. BOX 711
          ALVIN                          TX  77511
               MANUFACTURER
               PRODUCED SITE LIMITED
               1977 PRODUCTION OF TEN MILLION TO FIFTY MILLION POUNDS

          U.S. STEEL CORP.              (003295Q)
          ATTN: S.J. DEMSKI
          BOX 127
          IRONTON                        OH  45638
               MANUFACTURER
               1977 PRODUCTION OF TEN MILLION TO FIFTY MILLION POUNDS

          UNION CARBIDE CARIBE          (003325P)
          P.O. BOX 3168 - PONCE PLANT
          PONCE                          PR
               MANUFACTURER


          UNION CARBIDE CORPORATION     (003334Y)
          RIVER ROAD
          BOUND BROOK                    NJ  08805
               MANUFACTURER
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[illegible] CHEMICALS CORPORATION   (0033742)
2800 FARM ROAD
TEXAS CITY                           TX  77590
     MANUFACTURER
     PRODUCED SITE LIMITED


ALLIED CHEMICAL CORPORATION          (0034376)
MARGARET & BERMUDA STREETS
PHILADELPHIA                         PA  19137
     MANUFACTURER


SHELL OIL COMPANY                    (0043341)
P.O. BOX 100
DEER PARK                            TX  77536
     MANUFACTURER


GEORGIA-PACIFIC CORP-PLAQUEMI        (006219W)
HWY 405
PLAQUEMINE                           LA  70764
     MANUFACTURER
     1977 PRODUCTION OF TEN MILLION TO FIFTY MILLION POUNDS

GETTY REFINING & MARKETING           (0063899)
P.O. BOX 1121
EL DORADO                            KS  67042
     MANUFACTURER
     1977 PRODUCTION OF 1 MILLION TO TEN MILLION POUNDS

CLARK OIL & REFINING CORP.           (007072B)
ATTN: ROBERT H. BRUGGINK
131ST AND KEDZIE AVENUE
BLUE ISLAND                          IL  60406
     MANUFACTURER
     1977 PRODUCTION OF 1 MILLION TO TEN MILLION POUNDS

CHEMICAL EXCHANGE CO., INC.          (007333H)
[illegible] BAKER ROAD
[illegible]N                         TX  77520
     MANUFACTURER
     [illegible] PRODUCTION OF 100,000 TO 1,000,000 [illegible]
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National Occupational Hazard Survey

PROJECTED NUMBERS BY INDUSTRY 07/23/85

CAS #	HAZ	DESCRIPTION
000090839	M1533	METHYLSTYRENE, ALPHA-

SIC CODE	DESCRIPTION	ESTIMATED PLANTS	ESTIMATED PEOPLE	ESTIMATED EXPOSURES
15	GENERAL BUILDING CONTRACTORS	73	1,813 **	1,813
16	HEAVY CONSTRUCTION CONTRACTORS	63	6,254 ***	6,254
25	FURNITURE AND FIXTURES	23	464 ***	464
26	PAPER AND ALLIED PRODUCTS	46	3,971 ***	3,971
28	CHEMICALS AND ALLIED PRODUCTS	206	2,760 ***	4,007
30	RUBBER AND PLASTICS PRODUCTS, NEC	24	47 ***	47
31	LEATHER AND LEATHER PRODUCTS	13	13 ***	13
33	PRIMARY METAL INDUSTRIES	11	287 ***	287
34	FABRICATED METAL PRODUCTS	203	581 ***	891
37	TRANSPORTATION EQUIPMENT	35	287 ***	287
48	COMMUNICATION	45	91 ***	91
55	AUTOMOTIVE DEALERS & SERVICE STATIONS	794	3,175 ***	3,175
72	PERSONAL SERVICES	355	710 **	710
73	MISCELLANEOUS BUSINESS SERVICES	109	4,565 ***	4,565
TOTAL		1,999	25,018 ***	26,575

** USE FIRST STANDARD DEVIATION COLUMN, EMPLOYEE TABLE

*** USE SECOND STANDARD DEVIATION COLUMN, EMPLOYEE TABLE

ENCLOSURE 2
NOHS

National Occupational Hazard Survey

PROJECTED NUMBERS BY OCCUPATION 07/23/85

CAS #	HAZ	DESCRIPTION
000098839	M1533	METHYLSTYRENE, ALPHA-

OCC CODE	DESCRIPTION	ESTIMATED PLANTS	ESTIMATED PEOPLE		ESTIMATED EXPOSURES
010	CHEMICAL ENGINEERS	5	15	***	15
013	INDUSTRIAL ENGINEERS	30	30	***	30
023	ENGINEERS, N.E.C.	30	120	***	120
045	CHEMISTS	68	324	***	324
075	REGISTERED NURSES	45	91	***	91
151	CHEMICAL TECHNICANS	135	224	***	292
154	INDUSTRIAL ENGINEERING TECHNICIANS	5	20	***	20
162	ENGINEERING AND SCIENCE TECHNICIANS, N.E.C.	30	120	***	120
233	SALES MANAGERS. EXCEPT RETAIL TRADE	104	1,872	***	1,872
245	MANAGERS AND ADMINISTRATORS, N.E.C.	202	618	***	685
323	EXPEDITERS AND PRODUCTION CONTROLLERS	30	60	***	60
392	WEIGHERS	43	129	***	129
415	CARPENTERS	30	90	***	90
430	ELECTRICIANS	30	300	***	300
441	FOREMEN, N.E.C.	87	220	***	220
473	AUTOMOBILE MECHANICS	802	3,238	***	3,238
481	HEAVY EQUIPMENT MECHANICS, INCL. DIESEL	139	2,300	***	2,300
495	NOT SPECIFIED MECHANICS AND REPAIRMEN	30	330	***	330
530	PRESSMEN AND PLATE PRINTERS, PRINTING	11	22	***	22
535	SHEETMETAL WORKERS AND TINSMITHS	73	1,813	***	1,813
602	ASSEMBLERS	7	112	***	112
610	CHECKERS. EXAMINERS. AND INSPECTORS; MANUFACT	30	150	***	150
630	LAUNDRY AND DRY CLEANING OPERATIVES, N.E.C.	355	710	***	710
641	MIXING OPERATIVES	173	1,153	***	1,355
644	PAINTERS. MANUFACTURED ARTICLES	155	310	***	619
664	SHOEMAKING MACHINE OPERATIVES	13	13	***	13
690	MACHINE OPERATIVES. MISCELLANEOUS SPECIFIED	201	1,919	***	2,324
692	MACHINE OPERATIVES. NOT SPECIFIED	33	538	***	1,042
694	MISCELLANEOUS OPERATIVES	106	626	***	626
706	FORK LIFT AND TOW MOTOR OPERATIVES	11	33	***	33
751	CONSTRUCTION LABORERS, EXC. CARPENTER' HELPER	63	6,254	***	6,254
770	WAREHOUSEMEN. N.E.C.	30	690	***	690
903	JANITORS AND SEXTONS	57	576	***	576
TOTAL		*	25,018	***	26,575

* ESTIMATED PLANTS NOT ADDITIVE BY OCCUPATION
** USE FIRST STANDARD DEVIATION COLUMN. EMPLOYEE TABLE
*** USE SECOND STANDARD DEVIATION COLUMN. EMPLOYEE TABLE

ENCLOSURE 3
NOHS

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M1533     METHYLSTYRENE, ALPHA-

   0009408  CELLO CHEMICAL CO$8200 FISHER AVE$BALTIMORE, MD  21222

        0082644     CELLO SPRAY BUFF SYSTEM                                                  02 %

        0577201     CELLOTHANE                                                               03 %

   0080289  PENNSYLVANIA INDUS CHEMICAL$PO BOX 240$CLAIRTON, PA  15025

        0493369     PICCO 6100 70VMP                                                         04 %

        0493372     PICCODIENE 2215                                                          05 %

        0945119     PICCODIENE 275-74A RESIN                                                 04 %

   0126540  THIELE-ENGDAHL INC$714 DIVISION ST$ELIZABETH, NJ  07201

        0126598     TOPLACQUER AJM-6809                                                      32 %

   0182079  INMONT CORP$ROUTE 17 & GREGG STREET$LODI, NJ  07644

        0616626     836 POLY STYRENE                                                         20 %

   0235925  UPACO ADHESIVES INC$MONUMENTAL ADHESIVES DIV$3 E SPITBROOK RD$PO BOX 1207$NASHUA,  NH

        0471316     SLC-8029                                                                 33 %

   0277967  AMOCO CHEMICALS CORP$200 E RANDOLPH DR$CHICAGO,  IL   60601

        6020098     AMOCO RESIN 18-290                                                       99 %

   0290596  BORG-WARNER CORP$MARBON CHEMICAL DIV$200 S MICHIGAN AVE$CHICAGO, IL  60604

        0641540     2650 CYCOL                                                               23 %

        0641542     CYCOLOX800                                                               24 %

   0359629  THIOKOL CHEMICAL CORP$PO BOX 517$MOSS POINT, MS  39563

        0360467     TP-680                                                                   99 %

   0905445  NEVILLE CHEMICAL$432 W TURKEYFOOT LAKE$AKRON, OH  44319

        0905444     CUMAR W 2 1/2                                                            01 %

   1014470  HERCULES INC$810 NORTHLAND TOWERS WEST$SOUTHFIELD,  MI   48075

        6012548     PICCO 6120-3                                                             14 %

   6000235  HERCULES INC$INDUSTRIAL CHEMICAL DIV$120 STATE ST$CLAIRTON,  PA   15025

        6009330     PICCOTEX 120                                                             50 %
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ENCLOSURE 4
NOHS

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