R1592

REPORT 4

SECONDARY ALIPHATIC MONOAMINES

PROPERTIES, PRODUCTION, USES, EXPOSURE, AND TOXICOLOGIC, PHARMACOLOGIC, AND BIOLOGIC EFFECTS

Prepared for
The National Institute for Occupational
Safety and Health

Contract No. 210-79-0091

Prepared by

FRANKLIN RESEARCH CENTER
1320 Fenwick Lane
Silver Spring, Maryland 20910

November 30, 1979

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3

4. Title and Subtitle Report 4. Secondary Aliphatic Monoamines. Properties, Production, Uses, Exposure, and Toxicologic, Pharmacologic, and Biologic Effects	5. Report Date 79/11/30 6.
7. Author(s) Anonymous	8. Performing Organization Rept. No.
9. Performing Organization Name and Address Franklin Research Center, Silver Spring, Maryland	10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) 210-79-0091 (G)
12. Sponsoring Organization Name and Address	13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

Health hazards associated with workplace exposures to 20 priority compounds were identified. These compounds include: dimethylamine (124403), diethylamine (109897), methyl-n-butylamine (110689), diallylamine (124027), di-n-propylamine (142847), diisopropylamine (108189), n-ethyl-n-butylamine (13360639), n-methylcyclohexylamine (100607), n-ethylcyclohexylamine (5459938), dibutylamine (111922), diisobutylamine (110963), di-sec-butylamine (626233), diamylamine (2050922), diisoamylamine (544003), dicyclohexylamine (101837), dihexylamine (143168), diheptylamine (2470680), di-n-octylamine (1120485), di(2-ethylhexyl)amine (106207), and ditridecylamine (5910758). Chemical and physical properties of each compound were listed along with production and economic trends, uses, and environmental exposures. Biological effects were reviewed for dimethylamine, diethylamine, diisopropylamine, dibutylamine, diallylamine, and dicyclohexylamine. Industries and occupations where exposure to the priority group compounds identified by the National Occupational Hazard Survey occur were listed.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

NIOSH-Publication, NIOSH-Contract, Contract-210-79-0091, Amines, Agricultural-chemicals, Pesticides, Insecticides, Agricultural-workers, Detergent-industry, Metal-finishing, Oil-industry, Paint-manufacturing-industry, Petroleum-industry, Printing-industry

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
		52
	20. Security Class (This Page)	22. Price
		A04 14.95

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SYNOPSIS

This report presents the available scientific and technical information on the 20 priority compounds and identifies health hazards which may be associated with workplace exposure. Previous reports described the literature sources of nitrogenous compounds and the criteria used for selection of secondary aliphatic monoamines to serve as candidates for possible inclusion in a document.

Using those sources listed on page 1 of our report of September 20, 1979, this report expands the compound selection to include additional substitutions on the alkyl chain, such as halides, methoxy, and the benzene ring one or more carbons removed from the nitrogen atom. The additional compounds are included in Appendix II as Group D and Group T. Group D includes five drugs for which occupational exposure estimates exist: epinephrine, ephedrine, isoprenaline, phenylephrine, and methoxyphenamine.

In addition to Groups D and T the scope of this report includes a Priority Group of 20 secondary aliphatic monoamines. These were designated on the basis of toxicological and occupational hazard survey exposure data, and are produced in relatively large quantities for a multitude of uses. Nine additional groups of compounds are included in this scope. These compounds fall into discrete groups with common elements such as similar manufacturing processes, non-amine function, alkanol-amine function, etc. All compounds considered for inclusion in the scope of this report are presented in Appendix II.

The literature indicates important biological effects from exposure to Priority Group amines. Animal experimentation has shown that alkyl amines not only remove skin lipids but also break down the complex skin barrier to allow other materials to enter. Diethylamine has been shown to break down the red blood cell membrane. Hypoglycemia and a lowering of blood pressure has also been observed in animals. Heart lesions and arterial enzyme changes have been associated with diallyamine. Dicyclohexylamine is a suspected carcinogen and dimethylamine may be mutagenic.

Seven of the 20 amines considered in this report are identified in the National Occupational Hazard Survey. According to this survey, an estimated total of 741,882 people are exposed to these seven amines in their workplace. Dibutylamine, with an estimated exposure of 526,531 workers in 118 occcupations, exhibits the largest single exposure, and N-Ethyl-cyclohexylamine, with an estimated 252 workers in 4 occupations, exhibits the smallest exposure of the 7 reported priority compounds.

I. EXTENT OF EXPOSURE AND ENVIRONMENTAL DATA

Introduction

Each priority group compound discussed in this report is listed with three common index numbers, their Wiswesser line notation, their Chemical Abstract Service Ninth Collective Index name, and their standard abbreviation in Table I-1. The compounds in this table, as in most other tables within this report, are presented in order of increasing molecular weight and, in the case of isomeric compounds, in order of increasing molecular complexity (ie, "n-" before "iso-" before "sec-").

Chemical and Physical Properties

The chemical and physical properties of the 20 priority compounds have been compiled and are presented in Table I-2. By examining Table I-2 certain properties common to and characteristic of all the priority compounds can be recognized. These common properties include a relatively high pKa value that indicates the amines listed are strongly basic. This explains in part why secondary aliphatic amines act as strong irritants to the eyes, skin, and respiratory passages.

Another trait exhibited by the chemicals in Table I-2 is their characteristic fishy, ammoniacal ordor. This odor is most pronounced in the lower molecular weight amines, and tends to decrease in intensity with increasing molecular weight.

As indicated by their melting points, all of the amines in the priority group with less than seven carbons in their side-chains, with the exception of dimethylamine, exist as liquids at room temperature. Dimethylamine, the smallest secondary amine, exists as a gas in its pure form. The amines with seven or more carbons in their side-chains exist as solids or semi-solids at room temperature.

Of all the properties presented in Table I-2, excluding the pKa, those which are most closely related to the chemical health hazards posed by these compounds are the boiling point and vapor pressure. These two

properties together determine the volatility of a compound. When dealing with secondary amines that are known to give off irritating vapors, the volatility of the amine is of major concern. Because volatility is greater in chemicals with low boiling points and high vapor pressures, the lower molecular weight amines and the amines with branched side-chains pose a greater hazard of vapor-caused irritation.

Properties related to fire and explosion hazard include the flashpoint, auto-ignition temperature, and limits of flammability of chemical compounds. These properties, along with the National Fire Protection Association's "Fire Hazard Classifications" for flammability, reactivity with water and health-risk, (N00733), are presented in Table I-3. When one is dealing with compounds that liberate flammable or explosive vapors, vapor pressure and vapor density are properties that should also be considered. Compounds of this sort, which have high vapor pressures, pose a greater danger than those with low vapor pressures. Also, if the flammable/explosive vapor given off is dense, it has a tendency to migrate along ground level away from its source. If the vapor travels to a site of potential ignition, there is danger of flashback, resulting in a fire or explosion at the fumes' source.

Production and Economic Trends

The US manufacturers of 17 of the 20 priority compounds are listed in Table I-4, along with the compounds' known total production amounts for the past four years. The three compounds for which no US producer could be identified are diheptylamine, di-(2-ethylhexyl)amine, and ditridecylamine. The fact that no producers for these compounds were found in the sources used to prepare this table does not necessarily mean that these compounds are not produced in the United States. According to Chem Sources U.S.A. information on manufacturers identified by the text, "It should be recognized that this information is generally for volume producers of a particular product, and that there may be other producers who manufacture pilot or research quantitites and thus are not designated as a producer" (N00928). The compounds listed in the Directory of Chemical Producers "represent only chemicals produced in commercial quantities (ie, exceeding 1,000 pounds or. . . $1,000 in value annually)" (N00898).

Data on production quantities of specific compounds were collected from the Chemical Economics Handbook (N00904), the International Trade Commission's publication Synthetic Organic Chemicals, United States Production and Sales, 1977 (N00599), and the Amines section of the Kirk-Othmer Encyclopedia of Chemical Technology (N00807). Future additions to this section of Table I-4 will be made as soon as the 1978 edition of the ITC's Synthetic Organic Chemicals is available.

Four types of data have been accumulated thus far on the subject of distribution patterns. The geographic locations of the producing companies are included in the footnotes of Table I-4. (Note that the location given is that of the company's headquarters, and not necessarily that of the actual producing facility.) The known distributors of each priority group compound are listed in Table I-5. The types of industries utilizing some of the priority group compounds are identified by their standard industry codes in Table I-7. Finally, occupations in which human exposure to the priority amines occur are listed in Table I-8.

Uses

The known uses of 13 priority group compounds are compiled in Table I-6. Specific uses have not been identified for ECHA, DSBA, DIAA, DHA, D7A, DOA, and D13A. Of these compounds, D7A and D13A are listed in Chem Sources U.S.A. as not having "large-scale" US producers (N00928). It is expected that use information on the remaining five amines, which are known to be produced in the United States, will be obtained through industry contact, and during plant-site visits.

In Table I-6, types of uses are classified by a three symbol code. The first symbol indicates a general use classification. The data within the table is organized into groups of related uses. The classification scheme follows:

Group Symbols	Type of Use
A	Agricultural
C	Catalytic Agent
D	Dye, Paint, Ink, and Photographic
I	Intermediate (Used in Chemical Synthesis)
M	Metal Related
O	Oil, Petroleum, Petrochemicals, and Fuels
P	Pharmaceuticals and Cosmetics
R	Rubber Related
S	Solvents and Surfactants
T	Textile Related
V	Varnishes, Resins, Polymers, and Plastics
X	Antioxidant
Z	Miscellaneous

The second symbol indicates the use sub-classification. For example, a compound used as an intermediate in the manufacturing of a solvent would be symbolized by the code "IS".

The third symbol is necessary to eliminate ambiguities. For example, the code "IS" could also indicate that the compound was used as an intermediate in the preparation of a surfactant (as opposed to a solvent), thus the numeral 1, following "IS", has been assigned to the sub-sub-classification of solvent intermediate, and the numeral 2 to surfactant intermediate.

In cases where a use was identified by a general classification term (ie, "intermediate"), and where there are no ambiguities (ie, "catalyst for rubber"), an asterisk is found in place of a numeral, as the third symbol.

The Key to all of the use codes is located in the footnotes of Table I-6.

National Occupational Hazard Survey

Of the 20 compounds contained in the priority group, only 7 were addressed in the National Occupational Hazard Survey. The qualitative results of this survey, for these seven compounds, are compiled by two digit standard industry codes (SIC's) in Table I-7, and by three digit

occupational codes (OCC's) in Table I-8. Quantitative results for the seven amines surveyed are presented in Table I-9. It can be seen from Table I-9 that the primary source of exposure estimate input for DMA, DBA, and DCHA, was "generic" data. Additionally, "generic" data comprised a large part of the input for DEA and MCHA. In view of these facts, and due to the "soft" nature of "generic" data, if conclusions are to be drawn from the resulting exposure estimates, they should be drawn with extreme caution, preferably with the added insight of an actual, first-hand visit to the worksite where the exposure was initially observed.

Environment

The Russian literature reports an investigation of the air monoamine concentration in the vicinity of an amine production plant. Concentrations of amine were determined on the lee side of a factory and at fixed points in different urban areas. The highest concentrations of monoethylamine were found at distances of 1,000 meters and the higher mean diurnal concentration was found at a distance of 4,000 to 5,000 meters. Children living near the factory were compared for effects with those living 10 to 12 kilometers from the source of pollution. Incidence of several disease conditions and abnormalities in blood and urine chemistry were seen for children living near the factory (N00336, N00334, N00339).

Because of the ubiquitous occurrence of nitrites in food (vegetables such as celery), water, and human fluids such as saliva, along with a host of naturally occurring amines, a low level or backgound of nitrosoamines in man's environment is inescapable. Such low level exposure to nitrosoamines must have been present during the entire history of man.

Fine et al reported on the environmental distribution of both volatile and nonvolatile N-nitroso compounds in air and water. The authors developed a N-nitroso compound specific thermal energy analyzer interfaced to both a gas chromatograph and a high performance liquid

chromatograph. Sites in five cities were selected for air analyses: a site in Baltimore, MD, near a dimethyl hydrazine plant; in Belle, WV, near a chemical plant manufacturing dimethylamine; a similar site in Philadelphia, PA; on and around the Delaware bridge, in Wilmington, DE; and in an industrial park in Waltham, MA. Significant amounts of nitrosamines were found in Baltimore and in Belle, WV. No detectable levels were found in the other locations.

Water from the Mississippi River and three drinking water plants in New Orleans, LA, was analyzed using the thermal energy analyzer with the high performance liquid chromatograph. Extracts of nitrosated pesticides were compared in retention time with chromatogram peaks found in the drinking water. Several N-nitroso derivatives of pesticides gave peaks which matched those in the drinking water (N00787).

Tate and Alexander reported that secondary amines are generated in soil from added dialkyldithiocarbamates. The authors showed that little nitrate is needed to provide the nitrite as a precursor for nitrosamine formation. The concentrations used in this study were in the usage range of dimethyldithiocarbamate. This fungicide is used as a spray on vegetable and fruit crops (N00522).

Outdoor environmental chambers were designed to simulate a polluted atmosphere under realistic conditions of solar irradiation. Black plastic film covered the chamber, which was filled with particle free air at 20-40% relative humidity. Measured volumes of NO_2, O_2, NO and N_2 and samples of diethylamine and triethylamine were added. Some nitrous acid was formed. The mixture was allowed to react in the dark for 2 hours and then exposed to sunlight for 2 hours. Solar irradiation of the mixture resulted in severe photochemical smog. Diethylnitrosamine was rapidly formed in the dark from diethylamine. A small amount of diethylnitrosamine was also formed from triethylamine. Diethylnitrosamine was destroyed in sunlight. Other significant nitrogenous compounds formed in sunlight included dialkylnitramines, substituted amides, and small amounts of acetamide (N00581, N00806).

The Environmental Protection Agency reports the rural concentration of dimethylamine in air at a high value of 163.80 mg/m^3 (89 ppb). The odor recognition level is 1.10 mg/m^3 and the odor threshold is 0.09 mg/m^3 (0.047 ppm) (N00926).

Dimethylamine emission and ambient level goals were derived using the threshold limit value of 18 mg/m^3 (10 ppm). These emission level goals are adapted from the above EPA report and tabulate as follows:

Dimethylamine Emissions Level Goals Based on Ambient Factors

	Minimum Acute Toxicity Effluent		Ambient Level Goal	
	Based on Health Effects	Based on Ecological Effects	Based on Health Effects	Based on Ecological Effects
Air, mg/m^3 (ppm vol)	1.8×10^4 (10)		43 (0.024)	
Water, mg/l (ppm Wt)	2.7×10^5	1.0×10^3	248	500
Land, mg/g (ppm Wt)	5.4×10^2	2.0	0.5	1.0

II BIOLOGICAL EFFECTS

Introduction

The same reactive chemical properties which make aliphatic monoamines useful to industry make them reactive with environmental forces and with man and animals living in that environment. Until recently, the literature mainly described outward manifestations of exposure to secondary aliphatic monoamines such as eye, skin, and pulmonary irritation. However, Tainter in 1933, using one atropinized cat, reported a lowering of the blood pressure by dibutylamine. Recent literature reports significant physiological changes attributable to exposure to secondary aliphatic monoamines. Hypoglycemia has been attributed to diisopropyl and dicyclohexylamine exposure. Diethylamine is reported to interact with phospholipids in the erythroeyte membrane and may cause hemolytic activity. Alkyl amines remove lipids in the epidermal barrier and also alter skin structure. Diallylamine is associated with heart lesions and with arterial enzyme changes. It also causes a drop in blood pressure. Chromosome aberrations have been observed for dibutylamine and dicyclohexylamine. Dicyclohexylamine is also reported to be embryotoxic and to have gonadotrophic effects. The potential hazard to target organs in the body and the estimation of exposure levels associated with this risk need to be understood.

Secondary aliphatic monoamines react with water and acid to form bases and salts respectively. They react with acyl halides, anhydrides, and esters. With nitrous acid they form nitrosamines. (N00807)

The route of exposure to secondary aliphatic amines by workers is primarily through inhalation. The skin and eyes also serve as routes of entry into the body. In establishing workplace exposure limits, careful consideration must be given to individual human exposure risk. In a recent paper entitled "Variability in Target Organ Deposition Among Individuals Exposed to Toxic Substances Through Inhalation" the authors state that well controlled inhalation studies with laboratory animals reveal that about 2 percent of the animals in an exposure level group may receive more than three times the average organ dose of the total group.

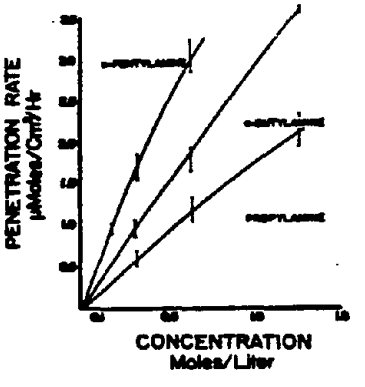
In exposures of man to substances distributed uniformly in the environment, a few percent of the individuals in an exposed population may receive more than five times the average dose. The organ dose of a substance at a specific time after inhalation will be related to the following parameters:

$$\text{Organ Dose} = \frac{(\text{amount inhaled}) \times (\text{fraction deposited}) \times (\text{uptake by target organ})}{\text{organ weight}}$$

The authors state "when establishing exposure control guidelines for substances in the environment by estimating average exposures of people, it is prudent to allow for a factor of 10 to account for the highest anticipated individual exposures." (N00540).

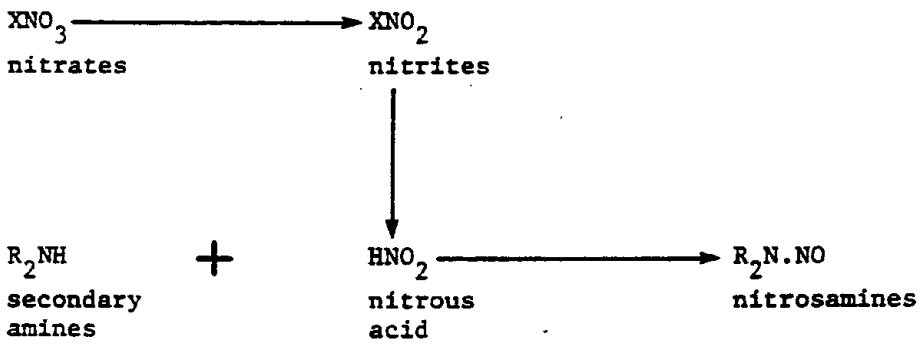
Literature on eye and skin effects caused by exposure to secondary aliphatic monoamines is very limited. Vinson discusses the role of the skin as an environmental barrier, a barrier associated with the epidermis. Alkyl amines have the ability to penetrate the barrier and alter its structure so that it is vulnerable to other chemical agents which normally would not penetrate intact skin. The longer the alkyl chain, the higher the permeability coefficient. The effect of amines on the skin barrier does not require water. Using rat skin Vinson showed that alkyl amines have the effect not only of removing skin lipids but of breaking down the complex structure of the barrier (N00536). When the protective mechanism of the skin barrier is affected, penetration not only by the alkyl amines but by other environmental pollutants is permitted.

The effect of concentration on penetration rates of amines through normal rat skin is shown below.



The literature on mutagenic, teratogenic, and carcinogenic testing of secondary aliphatic monoamines is scant and conflicting. The amines have not been shown to be carcinogenic; however, N-nitroso compounds are formed by reaction of nitrite and secondary amines in the presence of an acid. Nitrosation occurs readily with secondary amines of weak basicity and more slowly with strongly basic amines such as dimethylamine. (N00454)

Nitrosamines can be produced in foods and in the mammalian stomach, and also in the environment where amines are present. Factors that influence the rates of nitrosation include pH, temperature, catalysts, and inhibitors. Halides and thiocyanates accelerate nitrosation. (N00903, N00794). Nitrosamine formation is shown below.



Tomatis lists the nitrosamines of 5 amines in the priority group and some other groups among 111 compounds with sufficient evidence for consideration as a carcinogen. Tomatis states "In the presence of adequate experimental carcinogenicity data and in the absence of adequate human data, chemicals for which there is 'sufficient evidence' of carcinogenicity in test animals should be regarded for practical purposes as if they were carcinogenic to humans." (N00543)

Nitrosamine formation and toxicity are affected by various extrinsic factors. Ascorbic acid and Vitamin E inhibit nitrosamine formation (N00543, N00516, N00886). Vitamin E is also reported to protect rats from hepatotoxicity of preformed dimethylnitrosamine. (N00886) Ultraviolet or daylight causes a breakdown of the nitrosamine (N00571).

Commercially available secondary and tertiary aliphatic amines have recently been reported to be contaminated with corresponding nitrosamines. The concentrations in 28 samples of secondary aliphatic monoamines from various manufacturers ranged between 0.1 and 17.3 mg/kg and have been identified by gas chromatography and high-resolution mass spectrometry (N00078).

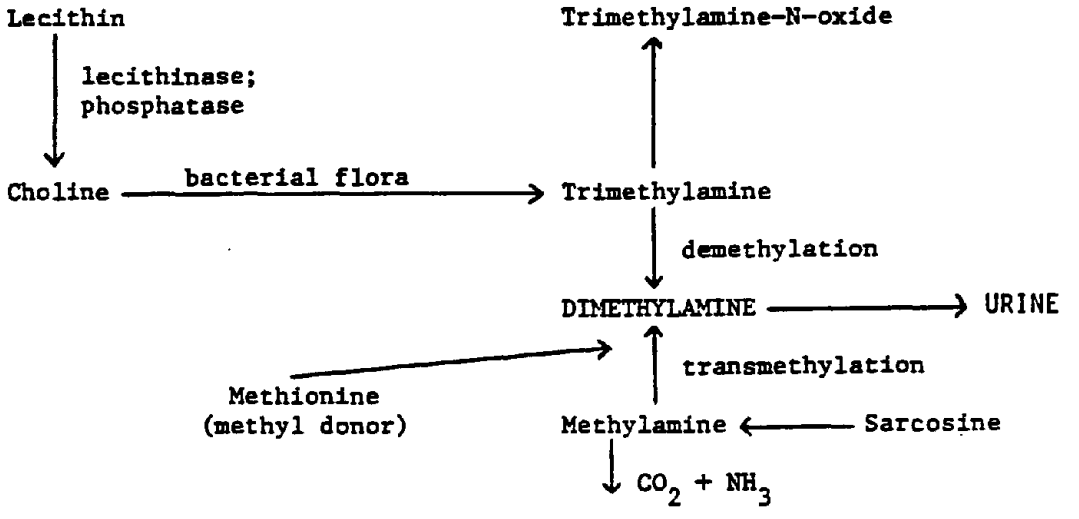
The following discussion of individual secondary aliphatic monoamines will be limited to those in the priority group for which significant references have been reviewed.

Biological Effects of Individual Amines

DIMETHYLAMINE

Dimethylamine is a secondary aliphatic monoamine which is found in the human body and normally excreted in the urine. It is derived from ingested choline and lecithin and depends on bacterial action in the small intestine for its formation (N00121). Asatoor injected radioactive methylamine into rats and produced dimethylamine, indicating that dimethylamine was produced by an N-methylation process commonly occurring in biological systems (N00121). Sterilization of the gut with neomycin sulfate reduced the urinary excretion of dimethylamine, indicating that most of the amine came from within (endogenous).

The metabolic pathway of DMA is shown below.



Asatoor and Simenhoff further showed that aliphatic amines are freely diffusible into body fluid and tissues, including cerebrospinal and brain fluid. Dimethylamine is present in significantly higher concentrations in the blood of uremic patients than in blood of normal subjects. 91.5 percent of 100 mg of ingested dimethylamine in a normal adult subject was excreted in the urine within 12 hours. (N00283, N00459, N00282, N00571)

Coon in 1970 exposed 15 rats, 15 guinea pigs, 3 albino rabbits, 3 squirrel monkeys, and 2 beagle dogs to 5 ppm continuously for 90 days in a Rochester type inhalation chamber. There were no signs of toxicity and all hematologic values were normal. Inflammatory changes were noted in the lungs of all species. The three rabbits and two of the three monkeys showed dilation of the bronchi (N00546).

Groups of 10 rats, 6 guinea pigs, and 2 rabbits, 5 mice and 1 monkey were given seven-hour daily exposures, five days a week for 18-20 weeks, to concentrations of either 183 or 97 ppm of dimethylamine. Corneal

injury was observed in the guinea pigs and rabbits after nine days of exposure. Central lobular fatty degeneration and necrosis of liver cells was found in rats, guinea pigs, rabbits and mice. Tubular degeneration of the testes was observed in the male rabbit at 183 ppm and in the male monkey at 97 ppm. (N00914)

A drop of a 5 per cent solution of dimethylamine in a rabbit's eye caused hemorrhages in the conjunctivae, corneal edema, and superficial opacities. Undiluted dimethylamine, placed on a rabbit's cornea, caused the cornea to become whitish blue and translucent and then white (N00873).

Visual disturbances in amine plant workers have been reported. These were characterized as a blue or gray vision with the view seen through a smokey haze. Dimethylamine was one of the chemicals implicated. Mellerio instilled one drop of pure dimethylamine into the eye of an anesthetized rabbit and lightly clamped the lids closed. After 5 minutes the eye was examined. The cornea became whitish blue and translucent. The reaction was reversible and was attributed to the Tyndall effect (light scattering) of denatured proteins (N00210). The eyes of workers chronically exposed to amines were examined in a large study. Slit lamp and ophthalmoscopic examinations of visual acuity and central and peripheral vision were carried out. No abnormalities were found. Details of this report will be obtained after translation of the article from German (N00568).

Differing test results for secondary aliphatic amines alone and with sodium nitrite in the various mutagenic test systems appear in the literature (N00140, N00473, N00470, N00232). Using the test for induction of DNA synthesis in mouse testes, dimethylamine in combination with sodium nitrite inhibited DNA replicative activity (N00543). With the direct bacterial assay employing four mutant strains of typhimurium (TA1530, TA1531, TA1532, TA1964) dimethylamine was negative. Dimethylamine was a weak mutagen in the microsomal mutagenesis assay with strain TA 1530 (N00473). It was found to be without mutagenic activity in the host mediated assay with S. typhimurium T1950. Couch and Friedman showed that treatment of mice with 2000 mg/kg of dimethylamine did not

increase the mutant frequency in S. typhimurium G46 (N00232). When dimethylamine and sodium nitrate were given together, a small but significant increase in mutant frequency above either compound alone was observed (N00232). Chromosome aberration tests with dimethylamine hydrochloride and dimethylnitrosamine showed chromosomal damage for dimethylnitrosamine only (N00472).

DIETHYLAMINE

Brieger and Hodes (1951) exposed rabbits to concentrations of diethylamine at 100 and 50 ppm, seven hours a day, five days a week for six weeks in a dynamic chamber. The liquid amine was volatilized and dispersed into the chamber. Air was sampled at approximately 1 liter of air per minute to monitor the concentration of diethylamine present. All rabbits survived. Pulmonary irritation and some degree of parenchymatous degeneration of liver and kidneys and corneal injury and edema of the eye were observed (N00094).

The Russian literature reports effects of low levels of diethylamine by continuous exposure over a 3 month period to male albino rats. The experimental methods used were not clearly described. Doses of 4.19, 0.37 and 0.05 mg/m^3 were used. In the second month of the experiment, 0.37 mg/m^3 produced cerebral cortex changes. Porphyrin metabolism was disturbed at 4.19 mg/m^3 and cholinesterase activity was increased at 0.37 mg/m^3. The concentration of diethylamine considered free of effects was 0.05 mg/m^3, which is used in Russia as the maximum permissible concentration in the air (N00338, N0039). Chronic exposure to the vapors of DEA at concentrations as low as 50 ppm in air caused conjunctival and pulmonary irritation in rats. Corneal erosion developed after 2 weeks of exposure (N00094).

An accidental squirt of diethylamine into the eye of a human resulted in intense pain, a swollen cornea with wrinkling of posterior surface, clouding, and infiltration of the stoma. Vision was impaired. After one month, astigmatism, impaired vision, and irregularity of the posterior surface of the cornea persisted. (N00873)

The Manufacturing Chemists Association, Chemical Safety Data Sheet SD-97 (1971) on diethylamine, reports on an accident case. MCA Accident Case History No. 1702 describes what happened when an employee removed the plug from a supposedly empty drum which had contained diethylamine. "He immediately suffered severe eye burns and intense lung irritation so that he was unable to breath although he struggled desperately to do so. He was quickly taken to the medical department and treated with oxygen and his eyes washed thoroughly with water. The primary concern in emergency treatment was his severe breathing difficulty. He was transferred to hospital where he later developed pneumonia and received treatment for severe eye burns. He was in a critical condition for several days." No follow-up on the patient was reported.

Contact of the bare skin with the liquid causes marked irritation. Contact with clothing wet with the liquid may result in destructive skin burns. Repeated skin contact may result in chronic irritation and sensitization may occur. Repeated or prolonged contact of the eye with vapors may result in edema of the eye, causing blurred and distorted vision (Chemical Safety Data Sheet SD 97, 1971).

The hemolytic activity of diethylamine salts was demonstrated in vitro using erythrocyte suspensions from dog blood. Hemolysis was caused by the interaction of amine cations with phospholipids in the erythrocyte membrane. Hemolytic activity was increased with increasing carbon chain length. Cephalin and lecithin release was increased by the presence of amine salts (N00433). Diethylamine is reported to have anticoagulant activity (N00392). Using the Ames Salmonella typhimurium microsomal test with tester strains TA1535 and TA100, the mutagenic activity of diethylamine was tested with and without metabolic activation. No increase in the number of mutants was found (N00235). Using induction of DNA synthesis in mouse testes, DNA was inhibited by sodium nitrite in combination with diethylamine. Diethylnitrosamine alone also inhibited DNA replicative activity (N00543).

DIISOPROPYLAMINE

Smyth and colleagues from the Mellon Institute of Industrial Research performed range finding tests on aliphatic amines. Inhalation tests were done in which rats were exposed to a vapor air mixture generated by passing 2.5 liters/min of dried air at room temperature through a fritted glass disc immersed to at least one inch in approximately 50 ml of test chemical in a gas-washing bottle. Inhalation of metered vapor concentrations was conducted using flowing streams of vapor prepared by proportioning pumps. These range finding tests are of limited value insofar as the concentrations were nominal and not analytically verified. Diisopropylamine at 1000 ppm produced death in two of six rats during a 4 hour exposure. A dose of 2000 ppm killed 5 of 6 rats. At 500 ppm no rats died. Saturated vapors at a pressure of 60 mmHg at 20 C was fatal to all animals in 5 minutes (N0062, N00418, N00060).

Severe irritation to the respiratory mucosa in several animal species resulted from inhalation of diisopropylamine vapors in concentrations ranging from 261 to 2,207 ppm. Animals were confined in a cylindrical steel chamber and exposed to a stream of air laden with the vapor of the amine. Liquid diisopropylamine was mechanically metered into the chamber at various rates. Rabbits, guinea pigs, rats and cats were subjected to inhalation of air containing various concentrations of the amine for varying periods of time, which ranged from a little less than 3 hours of continuous exposure (2,207 ppm) to 280 hours of discontinuous exposure (7 hours per day on 40 days) when the concentration was 261 ppm. Diisopropylamine in the air in the concentration of 261 ppm was a severe pulmonary irritant causing extensive injury to the epithelium and mucosa of the upper respiratory passage and bronchi of all species of animals. Hydropic degeneration and cloudy swelling of the corneal epithelium occurred when animals were exposed to 597 ppm. The lowest lethal concentration for the rabbit and guinea pig was 261 ppm, for the rat 597 ppm, and for the cat 2,207 ppm (less than 3 hours) (N00224).

Treon et al reported a temporary dimness of vision among men engaged in the distillation of diisopropylamine in a pilot plant operation. Haziness of vision, nausea and headache were reported. The mean concentration in the air of the pilot-plant was 100 to 200 mg/m^3. However, the concentration in the air near a drum was about 740 mg/m^3. Such concentrations persisted 5 to 10 minutes at a time, 2 or 3 times per day (N00224).

Hypoglycemia has been reported in workers exposed to the vapors of diisopropylamine. Diisopropylamine was found to decrease blood glucose levels of fasted, glucose-loaded or streptozotocin-diabetic rats and of fasted mice (N00110). Diisopropylamine caused temporary impairment of vision to humans after exposure to vapor concentrations as low as 25 to 50 ppm in air during distillation of the amine (N00873). Teschmann et al reported that injection of 12.5 mg of diisopropylamine hydrochloride decreased the blood pressure of patients with hypertension for 6 hours (N00572).

DIBUTYLAMINE

In 1923, Hanzlik injected subcutaneously 1 per cent aqueous solution of dibutylamine into white rats. The minimal fatal dose was 0.47 ml/kg. The minimal fatal dose for rabbits administered the same solution intravenously was 0.75 ml/kg, and by stomach intubation, 0.95 ml/kg. Exposure of white rats to vapors of dibutlyamine resulted in a lowest fatal concentration of 1:75,000. Exposure to the vapors of 2 and 5 ml placed on cotton under a bell jar killed 5 of 6 rats in 23 minutes. Smyth et al reports that inhalation of metered vapor concentrations of dibutylamine by 6 rats at a concentration of 250 ppm for 4 hours resulted in no deaths (N00062). Tainter in 1933 reported the lowering of blood pressure and reduction of pulse rate by dibutylamine (N00098).

Chromosome aberration tests in vitro were carried out on chinese hamster cells in culture. Nitrosamines were negative in this test; however, translocation type aberrations were produced by dibutylnitrosamine when microsome fractions of rat liver were added to

the test system (N00472). Chromosome aberration tests using analysis of sister chromatid exchanges (SCEs) showed induced SCEs and 1 or more chromosomal aberrations for dibutylamine (N00493).

DIALLYLAMINE

Early investigators reported the production of acute arterial lesions in rabbits injected intradermally with allylamine. It was further shown that intravenous injections of allylamines caused a great increase in capillary permeability and marked edema of blood vessel walls of the heart valves. Allylamine-induced myocardial necrosis mimics myocardial infarction in man (N00068, N00061).

Guzman et al studied the effects of diallylamine in rabbits, dogs, monkeys, and rats. Blood pressure determinations were done on a dog and the effect of sensitization on the ability of allylamines to produce heart lesions was studied. The authors found similar heart lesions produced by the mono-, di-, and triallylamines. The lesions were yellowish in color and varied in size from 1 mm to half the heart. Microscopic examination revealed interstitial fibrosis with areas of necrosis of muscle bundles. The heart size was increased. Repeated 7 hour exposures of rats to 200 ppm showed definite heart lesions after 4 exposures. The mean transaminase level in rats rose during the experiment to about twice control level. Injection into a dog with 10 mg/kg of diallyamine caused an immediate drop in blood pressure of 22 mm lasting 35 seconds and then increased to normal. There was no effect on blood pressure of rats exposed for prolonged periods of time. The authors concluded that diallylamine is detectable by odor at low concentrations and that operators working with this material have not revealed any untoward cardiovascular effects. Guzman et al recommended that air concentrations should not be greater than 20 ppm of diallylamine (N00089, N00088).

Allylamine was shown to produce arterial enzyme changes. Twenty-four female rats were intravenously injected with 7.5 mg of allylamine in saline three times a week for three weeks. There was a

significant decrease of aortic malate, lactate dehydrogenase, and ATPase activities and a rise in phosphomonoesterase. The results are the same general type as seen in preatherosclerotic arteries (N00279).

Boor found that monoamine oxidase inhibitors minimized the myocardial injury seen in rats given 11 mM of allylamine in drinking water for 3 weeks. Five monoamine oxidase inhibitors were given with allylamine in the drinking water. These were semicarbazide, hydoxylamine, molybdic acid, quinacrine, and hydrolazine. Semicarbazide and hydroxylamine almost totally prevented the cardiac lesions. Molybdic acid and quinacrine gave partial protection and hydrolazine had no effect. The role of the monoamine oxidase system in allylamine cardiotoxicity requires further study (N00320).

DICYCLOHEXYLAMINE

Dicyclohexylamine is a strong base. Infrared studies of dicyclohexylamine showed that this chemical exists under standard conditions as three rotational isomers in dymanic equilibrium. Depending on changes in temperature and pressure, solid dicyclohexylamine goes through several phase transitions. It is very reactive and will form salts with acid and soaps with fatty acids (N00399, N00220).

One gram of dicyclohexylamine dissolved in olive oil was injected into rabbits weighing 2 kg. Convulsions and death followed. An injection of 0.5 grams resulted in convulsions and temporary paralysis of the hindquarters. Dicyclohexylamine is readily absorbed through the skin (N00220). Russian literature reports occupational dermatoses in workers using oil soluble dicyclohexylamine salts. This was manifested by allergy and eczema (N00559). It also reports changes of central nervous system, myocardium, and hepatobiliary systems (N00565).

Dicyclohexylamine was administered subcutaneously to 111 mice and orally to 186 rats for a period of 12 months. Sarcomas at the site of injection were induced in 4 mice after 12 to 16 months of injection, and omental and hepatic tumors were induced in 2 rats (N00925).

Oral or intraperitoneal administration of 6.3 to 12.5 mg/kg of dicyclohexylamine decreased blood glucose levels of fasted, glucose-loaded or streptozotocin-diabetic rats and of fasted mice (N00110).

Dicyclohexylamine was tested in human leucocyte cultures and found to produce chromosomal aberrations. The majority of aberrations were gaps and breaks. Dicyclohexylamine salt and dicyclohexylamine nitrate were found to possess embryotoxic and gonadotoxic effects at 0.54 mg/kg (N00107).

Dicyclohexylamine is included on the NIOSH Suspected Carcinogen List (N00895).

TABLE I-1

NOMENCLATURE, MF, WLN, AND INDEX NUMBERS OF THE
PRIORITY GROUP COMPOUNDS
(In order of increasing Molecular Weights)

Common Name	CAS #	Chemical Abstracts Service Name (Ninth CI)	Abbreviation	Molecular Formula	Wiswesser Line Notation	Merck Index # (9th)	RTECS # (1979)	NOHS #
Dimethylamine	124-40-3	Methanamine, N-methyl	DMA	C2H7N	1M1	3215	IP8750000	26130
Diethylamine	109-89-7	Ethanamine, N-ethyl-	DEA	C4H11N	2M2	3081	HZ8750000	24680
Methyl-n-butylamine	110-68-9	1-Butanamine, N-methyl-	MBA	C5H13N	4M1	--	EO5250000	---
Diallylamine	124-02-7	2-Propen-1-amine, N-2-propenyl-	DALA	C6H11N	1U2M2U1	2930	UC6650000	---
Di-n-propylamine	142-84-7	1-Propanamine, N-propyl-	DPA	C6H15N	3M3	3363	JL9200000	A1132
Diisopropylamine	108-18-9	2-Propanamine, N-(1-methylethyl)-	DIPA	C6H15N	1Y1&MY1&1	3180	IM4025000	25850
N-Ethyl-n-butylamine	13360-63-9	1-Butanamine, N-ethyl-	EBA	C6H15N	4M2	--	---	---
N-Methylcyclohexylamine	100-60-7	N-Methylcyclohexylamine	MCHA	C7H15N	L6TJ AM1	--	---	---
N-Ethylcyclohexylamine	5459-93-8	N-Ethyl-cyclohexylamine	ECHA	C8H17N	L6TJ AM2	--	GX1225000	M1150
Dibutylamine	111-92-2	1-Butanamine, N-butyl-	DBA	C8H19N	4M4	3006	HR7780000	84285
Diisobutylamine	110-96-3	1-Propanamine, 2-methyl-N-(2-methylpropyl)	DIBA	C8H19N	1Y1&1M1Y1&1	--	TX1750000	---
Di-sec-butylamine	626-23-3	Di-sec-butylamine	DSBA	C8H19N	2Y1&MY2&1	--	---	---
Diamylamine	2050-92-2	1-Pentanamine, N-pentyl-	DAA	C10H23N	5M5	--	RZ9100000	---
Diisoamylamine	544-00-3	Diisopentylamine	DIAA	C10H23N	1Y1&2M2Y1&1	3177	---	---
Dicyclohexylamine	101-83-7	Cyclohexanamine, N-cyclohexyl-	DCHA	C12H23N	L6TJ AM- AL6TJ	3071	HY4025000	M1151
Dihexylamine	143-16-8	1-Hexanamine, N-hexyl-	DHA	C12H27N	6M6	--	IH6600000	---
Diheptylamine	2470-68-0	Diheptylamine	D7A	C14H31N	7M7	--	---	---
Di-n-octylamine	1120-48-5	Dioctylamine	DOA	C16H35N	8M8	--	JF9300000	---
Di(2-ethylhexyl)amine	106-20-7	1-Hexanamine, 2-ethyl-N-(2-ethylhexyl)-	D2EHA	C16H35N	4Y2&1M1Y4&2	--	IH6825000	---
Ditridecylamine	5910-75-8	Ditridecylamine	D13A	C26H55N	13M13	--	JP6650000	---

TABLE I-2

PHYSICAL AND CHEMICAL PROPERTIES OF PRIORITY GROUP COMPOUNDS

(In order of increasing Molecular Weight)

Substance	CAS #	Molecular Formula	Molecular Weight	Melting Point (C)	Boiling Point (C)	Density (20/4)	pK_a	Vapor Pressure (mmHg at 20 C)	Vapor Density (Air=1)	Water	Solubilities: alcohol	acetone	benzene	ether	Form at Standard Temperature and Pressure	Odor	Condensed Formula
Dimethylamine	124-40-3	C_2H_7N	45.09 *	-93	7.4	0.6804 (0/4)	10.732	1277	1.55	v	s	s	-	-	colorless gas	strong, fishy ammoniacal	$(CH_3)_2NH$
Diethylamine	109-89-7	$C_4H_{11}N$	73.14	-48	56.3	0.7056	10.11	195	2.52	v	*	s	-	-	colorless liquid	strong, ammoniacal	$(C_2H_5)_2NH$
Methyl-n-butylamine	110-68-9	$C_5H_{13}N$	87.17	FP:-75	91.1	0.7335	-	-	3.0	s	-	-	-	-	liquid	-	$CH_3NH(CH_2)_3CH_3$
Diallylamine	124-02-7	$C_6H_{11}N$	97.16	-88.4	111	0.7771	9.11	-	3.35	s	s	s	-	-	liquid	-	$(CH_2{:}CHCH_2)_2NH$
Di-n-propylamine	142-84-7	$C_6H_{15}N$	101.19	-39.6	109.4-10.4	0.7400	10.9	21	3.49	s	s	*	v	v	colorless liquid	ammoniacal	$(CH_3(CH_2)_2)_2NH$
Diisopropylamine	108-18-9	$C_6H_{15}N$	101.19	-61	84	0.7169	10.57	70	3.49	@	s	s	s	s	colorless liquid	pungent, ammonia-like	$((CH_3)_2CH)_2NH$
N-Ethyl-n-butylamine	13360-63-9	$C_6H_{15}N$	101.19	FP:-78	108-9	0.7398	-	18	3.5	i	*	*	*	*	colorless liquid	ammonia-like	$C_2H_5NH(CH_2)_2CH_3$
N-Methylcyclohexylamine	100-60-7	$C_7H_{15}N$	113.21	-8.5	149	0.86 (20 C)	-	11(40 C)	-	@	s	s	-	-	colorless to amber liquid	characteristic amine	$CH_3NHC_6H_{11}$
N-Ethylcyclohexylamine	5459-93-8	$C_8H_{17}N$	127.23	-	164	0.868 (0/0)	-	-	4.4	@	s	s	-	-	-	-	$C_2H_5NHC_6H_{11}$
Dibutylamine	111-92-2	$C_8H_{19}N$	129.25	-60to-59	159	0.7670	10.96	2	4.46	s	v	v	s	s	colorless liquid	mushy-ammonia	$(CH_3(CH_2)_3)_2NH$
Diisobutylamine	110-96-3	$C_8H_{19}N$	129.25	-73.5	139-40	0.74	10.91	10	4.46	@	s	s	s	s	colorless liquid	ammonia-like	$((CH_3)_2CHCH_2)_2NH$
Di-sec-butylamine	626-23-3	$C_8H_{19}N$	129.25	-	135	0.734 (20/20)	-	-	4.5	-	-	-	-	-	water-white liquid	characteristic amine	$(CH_3CH_2CH_3CH)_2NH$
Diamylamine	2050-92-2	$C_{10}H_{23}N$	157.30	-	202-3	0.7771	-	-	5.4	@	v	*	s	-	colorless liquid	-	$(CH_3(CH_2)_4)_2NH$
Diisoamylamine	544-00-3	$C_{10}H_{23}N$	157.30	-44	188	0.767	-	-	-	@	s	s	-	-	liquid	-	$((CH_3)_2CH(CH_2)_2)_2NH$
Dicyclohexylamine	101-83-7	$C_{12}H_{23}N$	181.33	-0.1	255.8	0.9123	10.7	-	6.25	@	s	s	-	s	colorless liquid	faint, fishy	$(C_6H_{11})_2NH$
Diheptylamine	1120-48-5	$C_{14}H_{31}N$	213.41	30	271	-	-	-	7.35	@	s	v	-	-	-	-	$(CH_3(CH_2)_6)_2NH$
Di-n-octylamine	1120-48-5	$C_{16}H_{35}N$	241.47	35.6	297-8	0.7960 (26/4)	-	-	-	i	v	v	-	-	-	-	$(CH_3(CH_2)_7)_2NH$
Di-(2-ethylhexyl)-amine	106-20-7	$C_{16}H_{35}N$	241.47	-	281.1	0.806 (20/20)	-	.01	-	@	-	s	-	s	-	-	$(CH_3(CH_2)_3(C_2H_5)CHCH_2)_2NH$
Ditridecylamine	5910-75-8	$C_{26}H_{55}N$	381.73	-	-	-	-	-	-	-	-	-	-	-	-	-	$(CH_3(CH_2)_{12})_2NH$

FP=Freezing Point

SOLUBILITY KEY
i=insoluble
@=slightly soluble
s=soluble
v=very soluble
*=infinitely soluble

ADAPTED FROM: H00733, H00807, H00891, H00896, H00897, and H00917

DOC05328/112879/HLL III

TABLE I-3

FIRE HAZARD PROPERTIES

(In order of increasing Molecular Weight)

Substance	CAS #	Flashpoint Open Cup F	Auto-ignition Temperature F	Limits of Flammability Lower (%)	Upper	Fire Hazard Classification Health/Flammability/Reactivity
Dimethylamine	124-40-3	0(25%)	806	2.8	14	3/4/0
Diethylamine	109-89-7	-15	594	1.8	10.1	2/3/0
Methyl-n-butylamine	110-68-9	35	-	-	-	3/3/0
Diallylamine	124-02-7	60	-	-	-	-
Di-n-propylamine	142-84-7	63	-	-	-	3/3/0
Diisopropylamine	108-18-9	30	755	-	-	3/3/0
N-Ethyl-n-butylamine	13360-63-9	64	-	-	-	3/3/0
N-Methylcyclohexylamine	100-60-7	86(CC)	-	-	-	-
N-Ethylcyclohexylamine	5459-93-8	86	-	-	-	3/3/0
Dibutylamine	111-92-2	125	-	1.1	-	3/2/0
Diisobutylamine	110-96-3	85	-	-	-	3/3/0
Di-sec-butylamine	626-23-3	75	-	-	-	3/3/0
Diamylamine	2050-92-2	124	-	-	-	3/2/0
Diisoamylamine	544-00-3	-	-	-	-	-
Dicyclohexylamine	101-83-7	210	-	-	-	3/1/0
Dihexylamine	143-16-8	220	-	-	-	2/1/0
Diheptylamine	2470-68-0	-	-	-	-	-
Di-n-octylamine	1120-48-5	-	-	-	-	-
Di-(2-ethylhexyl)-amine	106-20-7	270	-	-	-	3/1/0
Ditridecylamine	5910-75-8	-	-	-	-	-

KEY

HEALTH HAZARD CODES

3- Materials which on short exposure could cause serious temporary or residual injury even if prompt medical treatment were given.

2- Materials which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.

FLAMMABILITY CODES

4- Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.

3- Liquids and solids that can be ignited under almost all ambient temperature conditions.

2- Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.

1- Materials that must be preheated before ignition can occur.

REACTIVITY CODES

0- Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.

ADAPTED FROM: M00733, M00896, and M00917

DOC0523B/112879/HLL III

TABLE I-4

PRODUCERS OF PRIORITY GROUP COMPOUNDS
(In order of increasing Molecular Weight)

Common Name	CAS #	Producer Code																Production Quantities (in Tons)			
		ABB	ALB	AMS	APC	APG	ASI	DUC	GAF	IMS	IMX	LAC	PAT	SHC	UCC	UCL	VCI	1975	1976	1977	1978
Dimethylamine	124-40-3					X		X	X	X	X					X			80000	36000	
Diethylamine	109-89-7			X		X	X						X		X		X	7	7000	6200	
Methyl-n-butylamine	110-68-9		X																small		
Diallylamine	124-02-7													X					500		
Di-n-propylamine	142-84-7				X								X				X		17000		
Diisopropylamine	108-18-9			X		X	X						X		X		X		1406		
N-Ethyl-n-butylamine	13360-63-9												X						1000		
N-Methylcyclohexylamine	100-60-7	X	X																		
N-Ethylcyclohexylamine	5459-93-8	X	X																		
Dibutylamine	111-92-2												X				X		3000		
Diisobutylamine	110-96-3		X										X				X		18000		
Di-sec-butylamine	626-23-3																X				
Diamylamine	2050-92-2		X										S				S		20		
Diisoamylamine	544-00-3											D									
Dicyclohexylamine	101-83-7	X															X		1500		
Dihexylamine	143-16-8												X				X				
Diheptylamine	2470-68-0																				
Di-n-octylamine	1120-48-5		X																		
Di-(2-ethylhexyl)-amine	106-20-7																				
Ditridecylamine	5910-75-8																				

	A B B	A L B	A M S	A P C	A P G	A S I	D U C	G A F	I M S	I M X	L A C	P A T	S H C	U C C	U C L	V C I

PRODUCER CODE KEY

ABB: Abbott Laboritories, Chemical and Agricultural Division (North Chicago, IL)
ALB: The Ames Laboratories, Inc. (Milford, CT)
AMS: Union Oil Company of California, Amsco Division (Schaumberg, IL)
APC: Air Products and Chemicals, Inc., Specialty Gas Department (Allentown, PA)
APG: Air Products and Chemicals, Inc., Chemicals Group (Allentown, PA)
ASI: Ashland Chemical Co., Industrial Chemicals & Solvents Div. (Columbus, OH)
DUC: E.I. DuPont De Nemours & Co., Chemicals, Dyes & Pigments Dept. (Wilmington, DE)
GAF: GAF Corporation, Chemical Products (New York, NY)
IMS: Sobin Chemicals Inc. (Boston, MA)
IMX: International Minerals & Chemicals Corporation, Chemicals Group, Industrial Chemicals Division (Des Plains, IL)
LAC: Lachat Chemicals, Inc. (Mequon, WI)
PAT: Pennwalt Corporation, Organic Chemicals and Plastics (New York, NY)
SHC: Shell Chemical Company, Chemical Sales (Houston, TX)
UCC: Union Carbide Corporation, Chemicals and Plastics (New York, NY)
UCL: Union Carbide Corporation, Linde Division, National Specialty Gas Office (South Plainfield, NJ)
VCI: Virginia Chemicals Inc. (Portsmouth, VA)

SYMBOL KEY

D=Developmental Producer
S=Suspected Producer
X=Large Scale Producer
(1,000 lbs or $1,000 per annum)

ADAPTED FROM: H00599, H00898, H00904, and H00928

DOC0491B/112879/HLL III

TABLE I-5

DISTRIBUTORS OF PRIORITY GROUP COMPOUNDS

DISTRIBUTOR CODE

Common Name	CAS #	ACO	ADA	ALM	AME	APC	APH	ATO	BAS	BCL	BKC	BRI	CDC	CLB	CPL	CSA	CSI	CTR
Dimethylamine	124-40-3			X	X			X	X	X							X	X
Diethylamine	109-89-7	X		X	X		X	X		X	X	X	X			X	X	X
Methyl-n-butylamine	110-68-9		X	X					X						X			
Diallylamine	124-02-7			X				X			X				X		X	X
Di-n-propylamine	142-84-7	X		X				X	X	X			X		X		X	X
Diisopropylamine	108-18-9	X		X				X		X	X				X			X
N-Ethyl-n-butylamine	13360-63-9			X		X			X						X			
N-Methylcyclohexylamine	100-60-7			X				X	X						X		X	
N-Ethylcyclohexylamine	5459-93-8							X	X						X			
Dibutylamine	111-92-2			X				X	X	X	X						X	X
Diisobutylamine	110-96-3			X		X		X	X						X		X	X
Di-sec-butylamine	626-23-3	X						X	X						X			X
Diamylamine	2050-92-2									X							X	
Diisoamylamine	544-00-3																	
Dicyclohexylamine	101-83-7			X			X	X	X	X	X		X		X		X	X
Dihexylamine	143-16-8			X				X							X		X	X
Diheptylamine	2470-68-0																	
Di-n-octylamine	1120-48-5			X				X							X			X
Di-(2-ethylhexyl)-amine	106-20-7								X					X				
Ditridecylamine	5910-75-8								X									

Common Name	EAC	EKO	EMD	FIS	FRF	GRL	GSC	HAC	HAV	HST	ITC	KNK	LAC	LAP	MAL	MAT	MCB
Dimethylamine	X	X	X	X			X							X	X	X	X
Diethylamine	X	X	X	X		X	X	X			X		X	X	X		X
Methyl-n-butylamine			X		X							X	X				
Diallylamine			X						X			X	X				X
Di-n-propylamine	X	X	X	X			X					X	X				X
Diisopropylamine	X	X	X	X			X					X	X		X		X
N-Ethyl-n-butylamine												X	X				
N-Methylcyclohexylamine			X														
N-Ethylcyclohexylamine			X									X	X				
Dibutylamine	X		X	X		X							X		X		X
Diisobutylamine			X	X	X							X	X				
Di-sec-butylamine	X	X	X	X								X					
Diamylamine	X				X							X					
Diisoamylamine		X		X									X				
Dicyclohexylamine	X	X	X	X			X					X	X		X		X
Dihexylamine		X	X	X								X					
Diheptylamine				X								X					
Di-n-octylamine		X	X	X	X							X	X				
Di-(2-ethylhexyl)-amine										X		X					X
Ditridecylamine													X				

Common Name	MOB	MON	PWB	POS	ROB	SAP	SIG	SSI	SUO	THC	TOY	TRI	TWD	VCI	VWR	WOR
Dimethylamine			X		X					X	X	X			X	
Diethylamine			X				X	X	X		X	X			X	X
Methyl-n-butylamine			X			X						X				
Diallylamine												X				
Di-n-propylamine			X	X					X			X				X
Diisopropylamine			X						X		X	X			X	X
N-Ethyl-n-butylamine			X			X								X		
N-Methylcyclohexylamine			X	X								X				
N-Ethylcyclohexylamine			X									X		X		
Dibutylamine			X				X		X			X			X	
Diisobutylamine			X						X			X				X
Di-sec-butylamine			X													
Diamylamine			X											X		X
Diisoamylamine												X				
Dicyclohexylamine	X	X	X				X		X			X				
Dihexylamine			X						X			X				
Diheptylamine			X											X		
Di-n-octylamine			X			X						X	X			
Di-(2-ethylhexyl)-amine			X											X		
Ditridecylamine			X													

A A A A A A A B B B B C C C C C C E E E F F G G H H H I K L L M M M M M P P R S S S S T T T T V V W
C D L M P P T A C K R D L P S S T A K M I R R S A A S T N A A A A C O O W O O A I S U H O R W C W O
O A M E G H O S L C I C B L A I R C O D S F L C C V T C K C P L T B B N B S B P G I O C Y I D I R R

DISTRIBUTOR CODE KEY

ACO: Accurate Chemicals & Scientific Corp.
ADA: Adams Chemical Company
ALM: Aldrich Chemical Company, Inc.
AME: American Research Products Co.
APC: Air Products and Chemicals Inc., Chemicals Group
APH: Apache Chemicals, Inc.
ATO: Atomergic Chemetals Corp.
BAS: BASF Wyandotte Corp., Intermediate Chemicals Dept.
BCL: Bio-Clinical Laboratories, Inc.
BKC: J.T. Baker Chemicals, Co.
BRI: Brinkmann Instruments, Inc.
CDC: Chemical Dynamics Corporation
CLB: Columbia Organic Chemicals Co., Inc.
CPL: Chemical Procurement Labs, Inc.
CSA: Chemsampco, Inc., Sub. Albany International Corp.
CSI: Chem Services, Inc. (Small Quantities Only)
CTR: Chemtech Research, Inc.
EAC: Eastern Chemical, Division of Guardian Chemical Corporation
EKO: Eastman Organic Chemicals, Eastman Kodak Company
EMD: EM Laboratories, Inc.
FIS: Fisher Scientific Company
FRF: Fairfield Chemical Company
GRL: GLS Chem. Co., Div. Great Lakes Terminal & Transport Corporation
GSC: Gallard Schlesinger Chemical Mfg. Corp.
HAC: HACH Chemical Co., Fine Chemicals Division
HAV: Haven Chemical, Div. of Haven Industries, Inc.,
Specialty Organic Chemicals Dept.
HST: American Hoechst Corp.
ITC: Intsel Corp.
KNK: I.C. N/K & K, Life Sciences Group
LAC: Lachat Chemicals, Inc.
LAP: La Pine Scientific Company
MAL: Mallinckrodt, Inc., Science Products Division,
Plastic Products
MAT: Matheson Gas Products
MCB: MC & B Manufacturing Chemists
MOB: Mobay Chemical Corporation
MON: Monsanto
PWB: Pfaltz & Bauer, Inc., Div. of Aceto Chem. Co.
POS: Polysciences, Inc.
ROB: Roboco Chemicals, Inc.
SAP: Sapon Laboratories
SIG: Sigma Chemical Co.
SSI: Simmler, Inc.
SUO: Supelco, Inc.
THC: Thomas-Hayward Chemical Co.
TOY: Toyomenka (America) Inc.
TRI: Tridom Chemicals, Inc.
TWD: Trans World Chemicals, Inc.
VCI: Virginia Chemicals Inc.
VWR: VWR Scientific
WOR: Worth Chemical Corp.

ADAPTED FROM: H00898 and H00928

BOC0492B/112879/HLL III

TABLE I-6

USES OF PRIORITY GROUP COMPOUNDS
(In order of increasing Molecular Weight)

USE CODES

Compound Abbrev.	AA1	AA2	AA3	AA4	AA5	CC*	CD1	CD2	CR*	CV*	DD1	DD2	DD3	DD4	IA1	IA2	IA3	ID*	II*	IM1	IM2
DMA	X	X		X	X				X		X			X			X		X		
DEA											X					X			X		
MBA																			X		
DALA																			X		
DPA						X			X								X		X		
DIPA						X											X		X	X	X
EBA																			X		
MCHA																	X	X	X		
ECHA																					
DBA						X								X	X			X	X	X	X
DIBA																			X		
DSBA																					
DAA																					
DIAA																					
DCHA		X					X	X		X									X		
DHA																					
D7A																					
DOA																					
D2EHA															X			X			
D13A																					

Compound Abbrev.	IO*	IP1	IP2	IP3	IR1	IR2	IS1	IS2	IT1	IT2	IV*	IZ1	IZ2	IZ3	IZ4	IZ5	MM1	MM2	MM3	MM4
DMA						X	X									X			X	X
DEA			X	X	X						X							X	X	X
MBA																				
DALA																				
DPA		X	X		X															
DIPA						X											X			
EBA																				
MCHA		X				X			X			X	X		X					
ECHA																				
DBA					X	X							X					X		
DIBA																				
DSBA																				
DAA																		X	X	
DIAA																				
DCHA																	X	X		
DHA																				
D7A																				
DOA																				
D2EHA													X							
D13A																				

Compound Abbrev.	OO1	OO2	OO3	PP*	RR*	SO*	SS1	SS2	SS3	SS4	SV*	TT1	TT2	VV1	VV2	VV3	XO1	XO2	XR*	ZZ1	ZZ2	ZZ3	ZZ4
DMA				X	X		X		X			X							X		X		
DEA				X	X			X				X			X	X							
MBA																							
DALA																							
DPA																							
DIPA																							
EBA																							
MCHA							X													X			
ECHA																							
DBA					X								X			X							
DIBA																							
DSBA																							
DAA					X	X				X	X												
DIAA																							
DCHA			X											X			X	X	X		X	X	
DHA																							
D7A																							
DOA																							
D2EHA																							
D13A																							

USE CODE KEY

A Group: Agricultural Uses
AA1: Pesticide
AA2: Insecticide
AA3: Fungicide
AA4: Herbicide
AA5: Pesticide Propellant

C Group: Catalyst Uses
CC*: "Catalyst"
CD1: Paint Catalyst
CD2: Ink Catalyst
CR*: Rubber Catalyst
CV*: Varnish Catalyst

D Group: Dye, Paint, Ink, and Photographic
DD1: Dye
DD2: Paint
DD3: Printing Ink
DD4: Photographic Chemical

I Group: Intermediates (Used in Chemical Synthesis)
IA1: Insecticide Intermediate
IA2: Fungicide Intermediate
IA3: Herbicide Intermediate
ID*: Dyestuff Intermediate
II*: "Intermediate"
IM1: Corrosion Inhibitor Int.
IM2: Ore Flotation Intermediate
IO*: Motor Fuel Stabilizer Int.
IP1: Pharmaceutical Int.
IP2: Medicinal Intermediate
IP3: Antimalarial Intermediate
IR1: Rubber Processing Chem. Int.
IR2: Rubber Accelerator Int.
IS1: Solvent Intermediate
IS2: Surfactant Intermediate
IT1: Textile Softener Int.
IT2: Textile Finishing Resin Int.
IV*: Epoxy Resin Curing Agent Int.
IZ1: Optical Brightener Int.
IZ2: Emulsifier Intermediate
IZ3: Chelating Agent Int.
IZ4: Antioxidant Intermediate
IZ5: Rocket Fuel Intermediate

M Group: Metal Related
MM1: Vapor Phase Corrosion Inhibitor
MM2: Corrosion Inhibitor
MM3: Ore Flotation Agent
MM4: Electroplating

O Group: Oil, Petroleum, Petrochemicals, and Fuels
OO1: Petroleum Chemicals
OO2: Crude Oil Emulsion Breaker
OO3: Used Motor Oil Refining

P Group: Pharmaceuticals and Cosmetics
PP*: Pharmaceuticals

R Group: Rubber Related
RR*: Rubber Processing

S Group: Solvents and Surfactants
SO*: Oil Solvent
SS1: Solvent
SS2: Selective Solvent
SS3: Surfactant
SS4: Cellulose Ester Solvent
SV*: Resin Solvent

T Group: Textile Related
TT1: Textile Specialties
TT2: Textile Finishing Agent

V Group: Varnishes, Resins, Pol and Plastics
VV1: Plasticizer
VV2: Resins
VV3: Polymerization Inhibitor

X Group: Antioxidants
XO1: Lubricating Oil Antioxidar
XO2: Fuel Antioxidant
XR*: Rubber Antioxidant

Z Group: Miscellaneous
ZZ1: Acid Acceptor
ZZ2: Detergents
ZZ3: Extractants
ZZ4: Brake Fluid Additives
ZZ5: Acid Gas Absorbent
ZZ6: Dehairing Agent

ADAPTED FROM: H00807, H00896, and H00917

DOC0524B/112979/ELL III

TABLE I-7

WORKER EXPOSURE TO PRIORITY GROUP AMINES
IDENTIFIED BY THE NATIONAL OCCUPATIONAL HAZARD SURVEY
-Compiled by two digit standard industry codes (SIC's)-

SIC CODE	DESCRIPTION	CAS # 101-83-7	108-18-9	109-89-7	111-92-2	124-40-3	142-84-7	5459-93-8
07	Agriculture services and hunting		X		X			
09	Fisheries				X			
13	Oil and gas extraction		X		X			
15	General building contractors		X	X	X	X		
16	Heavy construction contractors		X	X	X	X		
17	Special trade contractor		X	X	X	X		
19	Ordnance and accessories		X		X			
20	Food and kindred products		X	X	X	X		
21	Tobacco manufactures				X			
22	Textile mill products		X		X			
23	Apparel and other textile products		X		X			
24	Lumber and wood products	X	X		X			
25	Furniture and fixtures		X		X			
26	Paper and allied products		X	X	X	X		
27	Printing and publishing		X		X			
28	Chemicals and allied products	X	X	X	X	X	X	X
29	Petroleum and coal products		X		X			X
30	Rubber and plastics products, NEC	X	X	X	X	X		
31	Leather and leather products		X		X	X		
32	Stone, clay, and glass products		X	X	X	X		
33	Primary metal industries		X	X	X	X		X
34	Fabricated metal products		X	X	X	X		
35	Machinery, except electrical		X	X	X	X		
36	Electrical equipment and supplies		X	X	X	X		
37	Transportation equipment		X	X	X	X		
38	Instruments and related products		X		X	X		
39	Miscellaneous manufacturing industries		X	X	X	X		
41	Local and interurban passenger transit	X	X		X			
42	Trucking and warehousing		X		X			
44	Water transportation		X		X			
45	Transportation by air		X	X	X	X		
46	Pipe line transportation		X		X			
48	Communication		X		X			
49	Electric, gas, and sanitary services		X		X			
50	Wholesale trade		X	X	X			
52	Building materials and farm equipment						X	
53	Retail general merchandise		X		X			
55	Automotive dealers & service stations		X		X			
58	Eating and drinking places				X			
59	Miscellaneous retail stores				X			
60	Banking				X			
65	Real estate				X			
70	Hotels and other lodging places				X			
73	Miscellaneous business services			X	X	X		
75	Auto repair, services, and garages				X			
76	Miscellaneous repair services				X			
79	Amusement & recreation services, NEC				X			
80	Medical and other health services		X	X	X	X		
89	Miscellaneous services		X					

Dicyclohexylamine.. (101-83-7)
Diisopropylamine.. (108-18-9)
Diethylamine.. (109-89-7)
Dibutylamine.. (111-92-2)
Dimethylamine.. (124-40-3)
Di-n-propylamine.. (142-84-7)
N-Ethylcyclohexylamine.. (5459-93-8)

TABLE I-8

WORKER EXPOSURE TO PRIORITY GROUP AMINES

IDENTIFIED BY THE NATIONAL OCCUPATIONAL HAZARD SURVEY

-Compiled by three digit occupational codes (OCC's)-

OCC CODE PE	Description	CAS # 101-77-9	109-89-7	110-18-9	111-92-2	112-40-3	114-42-8	5459-78
006	Aeronautical and astronautical engineers				X			
010	Chemical engineers			X	X	X		
012	Electrical and electronic engineers				X			
013	Industrial engineers				X	X		
014	Mechanical engineers				X			
023	Engineers, N.E.C.				X			
044	Biological scientists			X	X			
045	Chemists	X	X	X	X	X		X
056	Personnel and labor relations workers		X					
075	Registered nurses				X			
076	Therapists				X			
080	Clinical laboratory technologists and technicians			X		X		
141	Adult education teachers				X			
150	Agriculture and biological technicians, except			X			X	
151	Chemical technicians	X	X	X	X	X	X	X
152	Draftsmen				X			
153	Electrical and electronic engineering technicians				X			
154	Industrial engineering technicians		X					
155	Mechanical engineering technicians				X			
162	Engineering and science technicians, N.E.C.		X	X	X	X		
173	Technicians, N.E.C.				X			
183	Designers				X			
190	Painters and sculptors				X			
220	Office managers, N.E.C.		X					
231	Sales managers and department heads, retail		X					
245	Managers and administrators, N.E.C.		X	X	X	X		X
280	Salesmen and sales clerks, N.E.C.		X					
305	Bookkeepers				X			
314	Counter clerks, except food				X			
323	Expediters and production controllers		X		X			
325	File clerks				X			
332	Mail handlers, except post office		X					
344	Duplicating machine operators		X					
345	Key punch operators		X					
355	Office machine operators, N.E.C.		X					
360	Payroll and timekeeping clerks		X					
372	Secretaries, N.E.C.				X			
374	Shipping and receiving clerks		X		X			
381	Stock clerks and storekeepers		X		X			
391	Typists		X		X			
394	Miscellaneous clerical workers		X					
395	Not specified clerical workers		X					
404	Boilermakers		X		X			
~~410~~	~~Bricklayers and stonemasons~~		X	X	X	X		

411	Brickmasons and stonemasons, apprentices				X	
412	Bulldozer operators		X			
413	Cabinetmakers				X	
415	Carpenters		X	X	X	X
420	Carpet installers		X			
421	Cement and concrete finishers		X	X	X	X
422	Compositors and typesetters		X		X	
424	Cranemen, derrickmen, and hoistmen		X		X	
430	Electricians		X		X	
431	Electrician apprentices		X		X	
433	Electric power linemen and cablemen		X		X	
436	Excavating, grading, and road machine operators		X		X	
440	Floor layers, exc, tile setters				X	
441	Foremen, N.E.C.	X	X	X	X	X
442	Forgemen and hammermen		X			
443	Furniture and wood finishers				X	
445	Glaziers		X		X	
446	Heat treaters, annealers, and temperers		X			
452	Inspectors, N.E.C.				X	
454	Job and die setters, metal		X			
461	Machinists		X		X	
470	Air conditioning, heating, and refrigeration		X		X	
471	Aircraft		X	X	X	X
472	Automobile body repairmen		X		X	
473	Automobile mechanics	X	X		X	
481	Heavy equipment mechancis, incl. diesel		X	X	X	X
482	Household appliance and accessory installers		X		X	
485	Radio and television		X		X	
491	Mechanic, exc. auto. apprentices				X	
492	Miscellaneous mechanics and repairmen		X	X	X	
495	Not specified mechanics and repairmen	X	X	X	X	X
502	Millwrights				X	
503	Molders, metal			X	X	X
510	Painters, construction and maintenance				X	
514	Pattern and model makers, exc. paper		X		X	
520	Plasterers				X	
522	Plumbers and pipe fitters		X		X	
525	Power station operators				X	
530	Pressmen and plate printers, printing		X		X	
533	Rollers and finishers, metal		X		X	
534	Roofers and slaters				X	
535	Sheetmetal workers and tinsmiths		X	X	X	X
536	Sheetmetal apprentices				X	
545	Stationary engineers		X	X	X	
552	Telephone installers and repairmen		X		X	
554	Telephone linemen and splicers				X	
560	Tile setters				X	
561	Tool and die makers		X		X	
563	Upholsterers				X	
571	Specified craft apprentices, N.E.C.				X	
575	Craftsmen and kindred workers, N.E.C.				X	
601	Asbestos and insulation workers				X	
602	Assemblers		X	X	X	X
604	Bottling and canning operatives			X		
610	Checkers, examiners, and inspectors; manufact		X	X	X	X
612	Cutting operatives, N.E.C.		X		X	
615	Dry wall installers and lathers				X	
621	Filers, polishers, sanders, ans buffers		X		X	
622	Furnacemen, smeltermen, and pourers		X		X	
623	Garage workers and gas station attendants		X		X	
626	Heaters, metal		X			
633	Meat cutters and butchers, manufacturing			X		X
634	Meat wrappers, retail trade				X	

535 Metal platers		X	X		X	
640 Mine operatives, N.E.C		X		X		
641 Mixing operatives	X	X	X	X	X	
642 Oilers and greasers, exc. auto		X		X		
643 Packers and wrappers, except meat and produce		X	X	X	X	
644 Painters, manufactured articles		X	X	X	X	
645 Photographic process workers		X				
650 Drill press operatives		X		X		
651 Grinding machine operatives		X				
652 Lathe and milling machine operatives		X		X		
653 Precision machine operatives, N.E.C.		X				
656 Punch and stamping press operatives		X				
660 Riveters and fasteners				X		
662 Sawyers		X		X		
664 Shoemaking machine operatives				X		
665 Solders				X		
666 Stationary firemen		X		X		
671 Knitters, loopers, and toppers		X				
672 Spinners, twisters, and winders		X		X		
674 Textile operatives, N.E.C.		X				
680 Welders and flame-cutters		X	X	X	X	
681 Winding operatives, N.E.C.		X		X		
690 Machine operatives, miscellaneous specified	X	X	X	X	X	
692 Machine operatives, not specified		X	X	X	X	
694 Miscellaneous operatives		X	X	X	X	
695 Not specified operatives		X	X	X	X	
706 Fork lift and tow motor operatives		X	X	X	X	
713 Railroad switchmen		X				
715 Truck drivers		X		X		
750 Carpenters' helpers				X		
751 Construction laborers, exc. carpenter' helper		X	X	X	X	
753 Freight and material handlers		X	X	X	X	
755 Gardeners and groundskeepers, exc. farm		X		X	X	
760 Longshoremen and stevedores		X				
762 Stock handlers			X	X	X	
764 Vehicle washers and equipment cleaners		X		X		
770 Warehousemen, N.E.C.		X		X		
780 Miscellaneous laborers		X	X	X	X	
785 Not specified laborers		X	X	X	X	
902 Cleaners and charwomen		X	X	X	X	
903 Janitors and sextons		X		X		
950 Housekeepers, exc. private household				X		
962 Guards and watchmen		X				
Dicyclohexylamine						
Diisopropylamine						
Diethylamine						
Dibutylamine						
Dimethlyamine						
Di-n-propylamine						
N-Ethylcyclohexylamine						

DOC0529B/112879/HLL III

TABLE I-9

NOHS QUANTITATIVE EXPOSURE SUMMARY

Common Name	NOHS #	Estimated People Exposed	Source of Exposure Estimate ACT	TRN	GEN	Number of Occupations
Dimethylamine	26130	37,196	11	1	88	36
Diethylamine	24680	67,643	49	6	45	40
Di-n-propylamine	A1132	18,018	100	0	0	2
Diisopropylamine	25850	91,398	3	97	1	99
N-Ethylcyclohexylamine	M1150	252	0	67	33	4
Dibutylamine	84285	526,531	0	0	100	118
Dicyclohexylamine	M1151	844	0	43	57	7

DOC0008X/112679/HLL III

TABLE II-1

LD 50 (mg/kg) AND LC 50 (ppm) VALUES OF

PRIORITY GROUP COMPOUNDS

Common Name	CAS #	Oral (Rat) LD 50	Oral (Mouse) LD 50	Oral (Guinea Pig) LD 50	Oral (Rabbit) LD 50	Dermal (Rabbit) LD 50	IPR (Mouse) LD 50	SCU (Mouse) LD 50	Inhale LC 50 (Rat) -4 hour-	Reference(s)
Dimethylamine	124-40-3	698	316	240	240	-	-	-	--	
Diethylamine	109-89-7	540	649	-	-	.82 ml/kg	-	-	4000	N 88,329,927
Methyl-n-butylamine	110-68-9	420	-	-	-	1.26 ml/kg	-	-	--	N 62
Diallylamine	124-02-7	650	516	-	-	356	187	-	--	N 62,88
Di-n-propylamine	142-84-7	930	-	-	-	1.25 ml/kg	-	-	--	N 62
Diisopropylamine	108-18-9	700	-	-	-	-	-	-	--	N 88
N-Ethyl-n-butylamine	13360-63-9	-	-	-	-	-	-	-	--	
N-Methylcyclohexylamine	100-60-7	520	-	-	-	-	-	-	--	Abbott Data
N-Ethylcyclohexylamine	5459-93-8	590	-	-	-	.75 ml/kg	-	-	--	N 62
Dibutylamine	111-92-2	360	-	-	-	1.01 ml/kg	-	-	--	N 927
Diisobutylamine	110-96-3	258	629	620	-	-	-	-	--	N 869,927
Di-sec-butylamine	626-23-3	-	-	-	-	-	-	-	--	
Diamylamine	2050-92-2	.27 ml/kg	-	-	-	.35 ml/kg	-	-	--	N 62
Diisoamylamine	544-00-3	-	-	-	-	-	-	-	--	
Dicyclohexylamine	101-83-7	373	-	-	-	-	-	135	--	N 927
Dihexylamine	143-16-8	380	-	-	-	170	-	-	--	N 88
Diheptylamine	2470-68-0	200-400	-	-	-	-	-	-	--	N 891
Di-n-octylamine	1120-48-5	-	-	-	-	-	-	-	--	
Di-(2-ethylhexyl)-amine	106-20-7	1640	-	-	-	1.19 ml/kg	800	-	--	N 420,927
Ditridecylamine	5910-75-8	9.85 ml/kg	-	-	-	3.54 ml/kg	-	-	--	N 62

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APPENDIX I

Progress Report on the 21 Areas of Concern Identified in the Contract Modification

1. Data contained in the Registry of Toxic Effects of Chemical Substances

The July 1979 microfiche edition of RTECS (N00927) was searched for all 20 priority group compounds. Postings were found for all but five of the amines. The amines with no postings are EBA, MCHA, DSBA, DIAA, and D7A. From the CODENS listed in the microfiche postings, an effort to obtain a copy of each RTECS citation was undertaken.

In the process of acquiring and examining original citations, a number of discrepancies between RTECS postings and original data have been discovered. These discrepancies are being reported to appropriate NIOSH personnel.

2. Production Quantities

Information obtained to date on production quantities is presented in Table I-4. As mentioned in the text, production figures for 1978 will be added as soon as they are available. It is hoped that the known data on this area of concern, as well as on the third area of concern, will be expanded upon through industry contacts and plant-site visits.

3. Companies Manufacturing

All known manufacturers of the priority group amines are presented in Table I-4, along with the city and state of their headquarters. As mentioned in the text, US producers have not been identified for D7A, D2EHA, and D13A.

4. Distribution Patterns

Information on distribution patterns has been presented in the following four forms: location of producers' headquarters, known distributors, types of industries using the compounds, and occupations of

individuals exposed to the amines. Data has also been accumulated on Department of Transporation, International Air Transport Association, and Coast Guard shipping regulations and the types of containers in which the priority compounds are shipped.

5. SIC Codes Affected

SIC codes affected by the priority group amines have been identified by means of the National Occupational Hazard Survey and are presented in Table I-7. More investigations of the users of these amines are planned.

6. Trends in Use and Production

Investigations into future trends are in progress; however, sources appear to be quite limited at this time.

7. Chemical and Physical Properties

Chemical and Physical properties are presented in Table I-2. Sources utilized to prepare this table may be found in the table's footnotes. Additions to this table will be made as the information becomes available; however, all standard references have been exhausted for this purpose.

8. Additional Pertinent Toxicity Data

Additional toxicity data is turning up as tree searches identify new references, but for the most part this new data consists of nonstandard toxicity testing results.

9. Pertinent Epidemiology

Beyond the National Occupational Hazard Survey, the results of which are reported in Tables I-7, -8 and -9, very little epidemiological information has been found. The search for this type of information continues.

10. Pertinent Case Studies

A limited number of pertinent case studies have turned up in the literature, and these are presented in Section II of this report, "Biological Effects."

11. TOX-TIPS from the Smithsonian

The search of TOX-TIPS is underway, but thus far no applicable information has been obtained.

12. Use Information

Uses of the priority group compounds have been identified from standard references and producers' technical data sheets. This information is presented in Table I-6.

13. NIOSH Information

NIOSH Project Plans and Health Hazard Evaluations have been searched and little usable information has been obtained. (For current NIOSH research, see point 19 below.)

14. OSHA Information

Many initial steps have been taken to obtain OSHA information on the priority group compounds. At present, a request has been made for compliance findings and related information in OSHA's Management Data System Computer. The OSHA carcinogen classifications of the priority group compounds will be reported as soon as updated classification information is available.

15. Relevent Information from the Bureau of Labor Statistics

Pertinence and applicability of worker exposure data in the Bureau of Labor Statistics' (BLS) database was evaluated during a visit to the Office of Supplemental Data Systems. It was determined that the information in BLS's computers was of little or no value, for the following reasons:

1. The bases input source is the initial report of a workman's compensation application. This form is filled out either by the workers themselves, their supervisors, a records secretary, or occasionally an examining physician; therefore the data reported tends to be sketchy and nonstandardized.

2. In addition, the data are drawn from the records of individual states, and the systems utilized by different states tend to differ widely in content and sophistication.

3. Finally, the accession index of the BLS database is set up under a very general classification scheme. Thus it is not possible to extract information specifically about the priority compounds. The closest accessible classification term is, "Chemicals and Chemical Compounds, NEC".

16. Relevent Information from the EPA

Contacts have been established within the EPA and assorted materials have been obtained. Work is continuing in this area of concern.

17. Relevent Information from the Department of Commerce

Information is being extracted from the Commerce Department's Statistical Abstract of the United States; work is continuing in this area of concern.

18. Status of Materials on National Toxicology Program (and the National Cancer Institute's Carcinogenesis Testing Program)

None of the priority group compounds appear in the Draft FY '80 NTP Toxicity Testing list. Also, none of the priority amines appear in the NCI Carcinogenesis Testing Program's list of Chemicals on Standard Protocol.

19. NIOSH's Occuptional Safety and Health Current Research File

Information has been requested on a current, ongoing research project, Mechanisms of Toxicity of Industrial Chemicals, being conducted by H. Plotnick, NIOSH Division of Biomedical and Behavioral Science. This file continues to be monitored for any new developments.

20. Popular Press Activities

No postings have been found on the priority group compounds, and on amines in general, in the following databases: 1. Systems Development

Corporation's INDEX File, which contains entries from the following newspapers: The Chicago Tribune, The Detroit News, The Houston Post, The New Orleans Picayune, The San Francisco Chronicle, The Los Angeles Times, and The Washington Post (1976 to present.) 2. Lockheed's Magazine Index File, which covers 370 popular magazines (1977 to present). 3. Lockheed's National Newspaper Index File, which contains entries from The Christian Science Monitor, The New York Times, and The Wall Street Journal (1979 to present).

21. Additives and Contaminants in Commercial Products

At present we are trying to determine the most effective ways to obtain this information.

APPENDIX II

TABLES A-1, A-2, AND A-3

TABLE A-1

GROUP D COMPOUNDS

Common Name	Synonym	CAS #	MF
Epinephrine	Adrenalin	51-43-4	C9H13NO3
Phenylephrine	Neo-Synephrine	59-42-7	C9H13NO2
Methoxyphenamine	Methoxyphenadrine	93-30-1	C11H17NO
Phenylpropylmethylamine	Phenpromethamine	93-88-9	C10H15N
Synephrine	Oxedrine	94-07-5	C9H13NO2
Adrenalone	Adrenone	99-45-6	C9H11NO3
Mephentermine	Mephine	100-92-5	C11H17N
Phenmetrazine	Oxazimedrine	134-49-6	C11H15NO
Protokylol	Caytine	136-70-9	C18H21NO5
Ephedrine	Ephedrin	299-42-3	C10H15NO
Pholedrine	Isodrine	370-14-9	C10H15NO
Isoxsuprine	-	395-28-8	C18H23NO3
Nylidrin	Nilidrine	447-41-6	C19H25NO2
Dioxyethedrine	-	497-75-6	C11H17NO3
Epinine	Deoxyepinephrine	501-15-5	C9H13NO2
Isoetharine	Isoctarine	530-08-5	C13H21NO3
Methamphetamine	-	537-46-2	C10H15N
Metaproterenol	Orciprenaline	586-06-1	C11H17NO3
Bamethan	Butedrine	3703-79-5	C12H19NO2
Isoprophenamine	Chlorprenaline	6933-90-0	C11H16ClNO
Isoproterenol	Isoprenaline	7683-59-2	C11H17NO3
Ethylphenylephrine	-	10128-36-6	C10H15NO2
Salbutamol	Albuterol	18559-94-9	C13H21NO3
Hydroxyephrine	-	-	C10H15NO2

TABLE A-2

GROUP T COMPOUNDS

Common Name	Ninth CI Chemical Abstracts Service Name	CAS #	MF
(+)-Methamphetamine chloride	Benzeneethanamine, N,.alpha.-dimethyl-, hydrochloride, (S)-	51-57-0	C10H15N.ClH
o-Chloro-N-methylbenzylamine	Benzenemethanamine, 2-chloro-N-methyl-	94-64-4	C8H10ClN
Benzylisopropylamine	Benzenemethanamine, N-(1-methylethyl)-	102-97-6	C10H15N
Dibenzylamine	Benzenemethanamine, N-(phenylmethyl)-	103-49-1	C14H15N
p-Chloro-N-methylbenzylamine	Benzenemethanamine, 4-chloro-N-methyl-	104-11-0	C8H10ClN
Dimethoxyethylamine	Ethanamine, 2-methoxy-N-(2-methoxyethyl)-	111-95-5	C6H15NO2
2,2-Dimethoxyethyl(methyl)amine	Ethanamine, 2,2-dimethoxy-N-methyl-	122-07-6	C5H13NO2
Methylisooctenylamine	5-Hepten-2-amine, N,6-dimethyl-	503-01-5	C9H19N
Benzylidenebenzylamine	Benzenemethanamine, N-(phenylmethylene)-	780-25-6	C14H13N
Bis(2-chloroethyl)amine hydrochloride	Ethanamine, 2-chloro-N-(2-chloroethyl)-, hydrochloride	821-48-7	C4H9Cl2N.ClH
Methoxymethylamine	Methanamine, N-Methoxy	1117-97-1	C2H7NO
N-Benzylidene cyclohexylamine	Cyclohexanamine, N-(phenylmethylene)-	2211-66-7	C13H17N
N-Benzylbutylamine	Benzenemethanamine, N-butyl-	2403-22-7	C11H17N
Methyl-N-octylamine	1-Octanamine, N-methyl-	2439-54-5	C9H21N
tert-Butylbenzylamine	Benzenemethanamine, N-(1,1-dimethylethyl)-	3378-72-1	C11H17N
N-Benzylidene ethylamine	Ethanamine, N-(phenylmethylene)-	6852-54-6	C9H11N
N-Benzylidene-1-methylethylamine	2-Propanamine, N-(phenylmethylene)-	6852-56-8	C10H13N
Benzylethylamine	Benzenemethanamine, N-ethyl-	14321-27-8	C9H13N
N-Chloro-2-propylamine	2-Propanamine, N-chloro-	26245-56-7	C3H8ClN
3-Chloro-N-methylbenzylamine	Benzenemethanamine, 3-chloro-N-methyl-	39191-07-06	C8H10ClN
N-Hydroxy-2-proplyamine sulfate	2-Propanamine, N-hydroxy-, sulfate (2:1) (salt)	64611-86-5	C3H9NO.1/2H2O4S

TABLE A-3

SECONDARY ALIPHATIC MONOAMINES CONSIDERED FOR INCLUSION
(Listed by Ascending Chemical Abstracts Registry Number)

Common Name	CAS Name	CAS #	Molecular Formula
4-Hydroxyproline	L-Proline, 4-hydroxy-, trans-	51-35-4	C05H09NO3
Propylenimine	Propylenimine	75-55-8	C03H07N
Methylacetamide (N)	Acetamide, N-methyl-	79-16-3	C03H07NO2
N-Methylcyclohexylamine	N-Methylcyclohexylamine	100-60-7	C07H15N
Dicyclohexylamine	Cyclohexanamine, N-cyclohexyl-	101-83-7	C12H23N
Methylurethane	Carbamic acid, methyl-, ethyl ester	105-40-8	C04H09NO2
1-Hexanamine, 2-ethyl-N-(2-ethylhexyl)-	1-Hexanamine, 2-ethyl-N-(2-ethylhexyl)-	106-20-7	C16H35N
Sarcosine	Glycine, N-methyl-	107-97-1	C03H07NO2
Diisopropylamine	2-Propanamine, N-(1-methylethyl)-	108-18-9	C06H15N
Methylpiperidine (2)	Piperidine, 2-methyl-	109-05-7	C06H13N
Methyl aminoethanol (N)	Ethanol, 2-(methylamino)-	109-83-1	C03H09NO
Diethylamine	Ethanamine, N-ethyl-	109-89-7	C04H11N
Divinylenimine	Divinylenimine	109-97-7	C04H05N
Methyl-n-butylamine	1-Butanamine, N-methyl-	110-68-9	C05H13N
Ethanol, 2- (ethylamino)	Ethanol, 2- (ethyl amino)-	110-73-6	C04H11NO
Piperidine	Piperidine	110-89-4	C05H11N
Morpholine	Morpholine	110-91-8	C04H09NO
Diisobutylamine	1-Propanamine, 2-methyl-N-(2-methylpropyl)	110-96-3	C08H19N
Diisopropanolamine	2-Propanol, 1-1'-iminobis-	110-97-4	C06H15NO2
Diethanolamine	Ethanol, 2,2'-iminobis-	111-42-2	C04H11NO2
Dibutylamine	1-Butanamine, N-butyl-	111-92-2	C08H19N
Diethylamine, 2,2'-dimethoxy-	Diethylamine, 2,2'-dimethoxy-	111-95-5	C06H15NO2
Amines, N-octadecyl-1-octadecanamine	1-Octadecanamine, N-octadecyl-	112-99-2	C36H75N
N-Methylformamide	N-Methylformamide	123-39-7	C02H05NO
Succinimide	2,5-Pyrrolidinedione	123-56-8	C04H05NO2
Diallylamine	2-Propen-1-amine, N-2-propenyl-	124-02-7	C06H11N
Dimethylamine	Methanamine, N-methyl	124-40-3	C02H07N
Rhodanine	4'-Thiazolidinone, 2-thioxo-	141-84-4	C03H03NOS2
Acetyl ethanolamine (N)	Ethanolamine, N-acetyl-	142-26-7	C04H09NO2
Glycine, N-carboxymethyl	Glycine, N-(carboxymethyl)-	142-73-4	C04H07NO4
Di-n-propylamine	1-Propanamine, N-propyl-	142-84-7	C06H15N
Dihexylamine	1-Hexanamine, N-hexyl-	143-16-8	C12H27N
Proline (1)	L-Proline	147-85-3	C05H09NO2
Ethylene imine	Aziridine	151-56-4	C02H05N
Propylhydroxylamine	1-Propanol, 3-amino-	156-87-6	C03H09NO
4-Hexenylamine, N,1,5-trimethyl	4-Hexenylamine, N,1,5-trimethyl-	503-01-5	C09H19N
2,6-Dimethylpiperidine	2,6-Dimethylpiperidine	504-03-0	C07H15N
Hexylamine, N,1-dimethyl	Hexylamine, N,1-dimethyl	540-43-2	C08H19N
Acetyl glycine	Glycine, N-acetyl-	543-24-8	C04H07NO3
Diisopentylamine	Diisopentylamine	544-00-3	C10H23N
Butyrolactam	2-Pyrrolidione	616-45-5	C04H07NO
Ethyl urethane	Carbamic acid, N-ethyl, ethyl ester	623-78-9	C05H11NO2
N-Methylethylamine	Ethanamine, N-methyl-	624-78-2	C03H09N
Methylisobutylamine	1-Propanamine, N,2-dimethyl-	625-43-6	C05H13N
Ethyl-acetamide (N)	Acetamide, N-ethyl-	625-50-3	C04H09NO
Formaldehyde-acetamide	Acetamide, N-(hydroxymethyl)-	625-51-4	C03H07NO2
Diacetamide	Diacetamide	625-77-4	C04H09NO2
Di-sec-butylamine	Di-sec-butylamine	626-23-3	C08H19N
Methylpiperidine (3)	Piperidine, 3-methyl-	626-56-2	C06H13N
Methylpiperidine (4)	Piperidine, 4-methyl-	626-58-4	C06H13N
Methyl n-propylamine	Propylamine, N-methyl-	627-35-0	C04H11N
Ethyl-formamide (N)	Formamide, N-ethyl-	627-45-2	C03H07NO
Diglycolamine	Diglycolamine	929-06-6	C04H11NO2
Dioctylamine	Dioctylamine	1120-48-5	C16H35N
Didecylamine	Didecylamine	1120-49-6	C20H43N
N-Methylpropanamide	N-Methylpropanamide	1187-58-2	C04H09NO
Diamylamine	1-Pentanamine, N-pentyl-	2050-92-2	C10H23N
Diheptylamine	Diheptylamine	2470-68-0	C14H31N
Amines, N-dodecyl-1-dodecanamine	1-Dodecanamine, N-dodecyl-	3007-31-6	C24H51N
N-Ethylcyclohexylamine	N-Ethyl-cyclohexylamine	5459-93-8	C08H17N
Ethylcetylamine	Ethylcetylamine	5877-76-9	C18H39N
Ditridecylamine	Ditridecylamine	5910-75-8	C26H55N
N-Tert-butylisopropylamine	N-Tert-butylisopropylamine	7515-80-2	C07H17N
N-Ethyl-n-butylamine	1-Butanamine, N-ethyl-	13360-63-9	C06H15N
Amines, N-hexadecyl-1-hexadecamine	Amines, N-hexadecyl-1-hexadecamine	16724-63-3	
Amines, N-tetradecyl-1-tetradecanamine	Amines, N-tetradecyl-1-tetradecanamine	17361-44-3	
N-Ethyl-2-methyl-2-propen-1-amine	Allylamine, N-ethyl-2-methyl	18328-90-0	C06H13N
Diethylamine, 1-methyl-	Diethylamine, 1-methyl-	19961-27-4	C05H13N
Ethylpropylamine	Ethylpropylamine	20193-20-8	C05H13N
1-Butanamine, N-propyl-	1-Butanamine, N-propyl-	20193-21-9	C07H17N
Butylamine, N-isobutyl-	Butylamine, N-isobutyl-	20810-06-4	C08H19N
N-Ethyl-sec-butylamine	N-Ethyl-sec-butylamine	21035-44-9	C06H15N
Diisooctylamine	Diisooctylamine	28454-70-8	C16H39N
3,5-Dimethylpiperidine	3,5-Dimethylpiperidine	35794-11-7	C07H15N
N-Amyl-n-butylamine	1-Pentanamine, N-butyl-	39536-61-3	C09H21N
Amines, dicoco alkylmethyl	Amines, dicoco alkylmethyl-	61788-62-3	
Amines, dicoco alkyl	Amines, dicoco alkyl-	61789-76-2	
Amines, bis (hydrogenated tallow alkyl)	Amines, bis (hydrogenated tallow alkyl)-	61789-79-5	
Amines, di-C 14-18 -alkylmethyl	Amines, di-C 14-18 -alkylmethyl-	67700-99-6	
Amines, di-C 14-18 -alkyl	Amines, di-C 14-18 -alkyl-	68037-98-9	
Amines, di-C 12-18 -alkyl	Amines, di-C 12-18 -alkyl-	68153-95-7	
Amines, di-C 16-22 -alkyl	Amines, di-C 16-22 -alkyl-	68439-74-7	
Amines, di-C 12-18 -alkylmethyl	Amines, di-C 12-18 -alkylmethyl-	68439-75-8	
Amines, di-C 13 -branched alkyl	Amines, di-C 13 -branched alkyl-	68513-50-8	
Amines, di-C 8-20 -alkylmethyl	Amines, di-C 8-20 -alkylmethyl-	68526-68-1	
Amines, di-C 12-15 -alkylmethyl	Amines, di-C 12-15 -alkylmethyl-	68526-69-2	
Amines, dicoya alkyl	Amines, dicoya alkyl-	68783-23-3	
Amines, ditallow alkyl	Amines, ditallow alkyl-	68783-24-4	
Amines, dimethyltallow	Amines, dimethyltallow	68814-69-7	