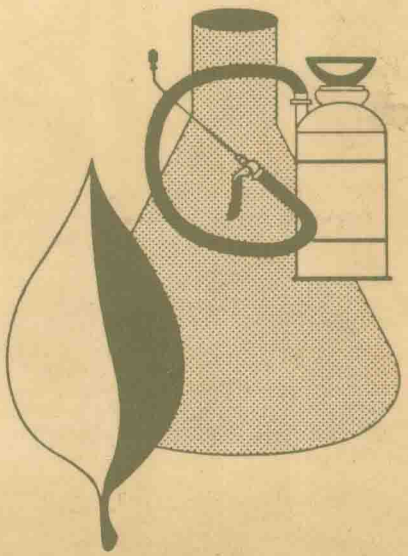
AGRICULTURAL CHEMICALS AND PESTICIDES

a Handbook of the Toxic Effects



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Agricultural Chemicals and Pesticides

A HANDBOOK OF THE TOXIC EFFECTS

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for the
U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Public Health Service
Centre for Disease Control
National Institute for Occupational Safety and Health

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PREFACE

A wide variety of agricultural chemicals and pesticides are used throughout the world and each year sees the development of new substances by agro-chemical manufacturers. These chemicals are developed for their biological activity and are used to achieve specific agricultural purposes, but they may also produce adverse biological effects on exposed humans and upon the environment.

This handbook provides toxicity data which should help with the provision of a safe working environment for those who use or are exposed to agricultural chemicals and pesticides. At the same time the data will be of use to all those concerned with the toxic effects of these substances on non-human species.

The data contained in this handbook were extracted from published literature and the cited references indicate that the substances were used or considered for use for agricultural purposes. Changing agricultural practices, the evolution of resistant pests and the intervention and recommendations of national and international agencies will, however, cause the mix of actual substances in use to change.

The Publisher

INTRODUCTION

This subfile was generated from the NIOSH Registry of Toxic Effects of Chemical Substances. It contains toxicity data on those substances and commercial mixtures identified in the literature as used or proposed for use in agriculture. THE READER IS CAUTIONED THAT SOME OF THESE SUBSTANCES ARE NOT IN CURRENT USE FOR AGRICULTURAL PURPOSES.

For those chemical substances selected, we have included the entire file entry: descriptors, molecular weight, molecular formula, synonyms, toxicity data, references, and pertinent occupational standards.

The purpose of this document is to assemble the above information in a way that will serve a variety of uses. The subfile will provide researchers and occupational health specialists with an introduction to the literature, thus facilitating their review of the potential hazard of a substance. Through the collection and presentation of the lowest reported doses that produce effects by several routes in various species, valuable information is made available to those who have responsibility for preparing safety data sheets of substances in the workplace. Through the use of this subfile, chemical and production engineers can identify the potential hazards which may be associated with chemical intermediates in the development of final products, and thus can facilitate the selection of substitutes or alternate processes which may be less hazardous.

In offering this subfile we recognize its limitations in achieving the purpose that we have set for it. First, it may not include all agricultural chemicals and pesticides. Such a goal can not be achieved without the full cooperation of the entire scientific community. Cooperation in the form of personal contributions will become increasingly imperative as the subfile becomes more complete.

The absence of a substance from this subfile does not imply that the substance is not used in agriculture. Rather, it signifies that toxicity data were not available or were not located in the literature at the time this subfile was assembled. It must be reemphasized that the inclusion of a substance in the subfile does not automatically mean that it must be avoided. In fact, there are in this subfile many substances which are valuable and are widely used to facilitate modern agricultural practices. A listing does mean, however, that the substance has the potential of being hazardous and, therefore, care must be exercised to prevent tragic consequences.

Second, no attempt has been made to resolve any questions about data that have been published. Of necessity, we rely on editing provided by the scientific community prior to any publication in scientific literature. Third, it is not the purpose of this subfile to quantitate the hazard through the use of the toxic concentration or dose that is presented with each substance. UNDER NO CIRCUMSTANCE CAN THE TOXIC DOSE VALUES PRESENTED WITH THESE CHEMICAL SUBSTANCES BE CONSIDERED AS BEING DEFINITIVE VALUES FOR DESCRIBING SAFE VERSUS TOXIC DOSES FOR HUMAN EXPOSURE. Concentrations of substances in the working environment which may be safely tolerated can be determined only by a critical evaluation of all available pertinent data by experienced investigators, data that include but are not limited to that listed in this subfile.

A critical evaluation of a chemical hazard involves much more than a determination of its toxic potency, no matter how complex the determination may be. A hazard evaluation must include such a determination, of course, but toxic potency and degree of hazard can not be considered synonymous. Indentifying and defining a chemical hazard must also include, among others, the evaluation of the amount and duration of exposure, the physical characteristics of the substance, the physical conditions under which exposure occurs, and the determination of the presence of other substances. All of these may significantly alter the toxic potency of a substance which, in turn, may alter the health of the person who may become exposed.

The National Institute for Occupational Safety and Health (NIOSH), under its criteria development program, conducts critical reviews of occupational hazards. The resulting criteria document for a particular hazard provides valid detailed support for the standard recommended by NIOSH to be used by the Department of Labor as a basis for its promulgation of a standard. As of the date of this publication, 63 criteria documents for recommended standards have been forwarded to the Department of Labor.

The concentrations of substances which have been determined by OSHA to provide a safe, healthy work environment for all persons are referenced in this subfile in the STANDARDS AND REGULATIONS sections of each substance listing. These standards may also include, as they are promulgated by the Department of Labor in response to recommendations of the criteria documentation program or as a result of the Standards Completion Program, methods for sampling and analysis; engineering control; appropriate personal protective equipment and clothing; emergency procedures; medical surveillance procedures; use of signs, labels, and placards to identify the hazardous substances; and the requirement for apprisement of the workers of the hazard to which they are exposed. In addition, many of the substances listed are regulated by the U.S. Environmental Protection Agency under provisions of the Federal Insecticide, Fungicide, and Rodenticide Act.

DETAILED FILE DESCRIPTION

Selection

1. *Substances Included* — For the purpose of this subfile the phrase "agricultural chemicals and pesticides" includes plant and animal growth regulators, fertilizers, veterinary antibiotics, algicides, fungicides, herbicides (weed and brush killers, defoliants, and desicants), bactericides, disinfectants, insecticides, insecticide adjuvants, insect attractants and repellants, chemosterilants, acaricides, nematocides, molluscicides, avicides, and rodenticides.

2. *Substances Excluded* — Excluded from the Registry and, therefore, from this publication are trade name products representing compounded or formulated proprietary mixtures available as commercial products. These exclusions are necessary because of difficulties in assessing the contribution to the toxicity by each component of the mixture and because the components of those formulations can be and are often changed by the producer by substitution of substances with different toxic effects or by changing the concentrations. Trade names are included in the subfile where they represent a single active chemical entity. Some listed substances may be impure commercial products of relatively constant composition and will be identified by definitions of composition rather than by a Chemical Abstracts Service Registry Number, or molecular formula. Radioactvie substances are now included but the effect reported is the chemically produced effect rather than the radiation effect.

Format

The subfile is made up of substances selected from the Registry of Toxic Effects of Chemical Substances. Each compound name is preceded by a seven character alphanumeric accession number consisting of two letters followed by five numerals. The number varies directly with the alphabetic sequence of the substance prime name in the Registry. Following the name of the substance are lines containing definitive descriptions of the substance, synonymous names, toxic dose information with references, and references to existing and recommended standards and to NIOSH's criteria for recommended standards. Reference CODEN abbreviations and respective titles are found at the end of the listing under Bibliographic References. Standard abbreviations are located on the inside of both covers for easy reference. A complete schematic entry is shown in Figure 1.

1. *Substance Prime Name.* The prime name of each substance in the Registry is derived from the nomenclature used by the American Chemical Society Chemical Abstracts Service (CAS) in the 8th Collective Index of Chemical Abstracts, which is in the inverted form. The names are modified by NIOSH for certain substances to provide convenience to the user in grouping substances of similar occupational pertinence, such as metallic salts. For each substance prime name, the reader will find the associated data listed in the order described below.

Some entries, however, appear as a chemical or descriptive name as published in the source from which the toxic data were derived. This is particularly true for those substances for which some aspects of their composition are in question, such as plant or animal extracts. These prime names are accompanied by a definition or description (DEF:) which may be a narrative including the source, a general statement of constituents, or other helpful information, with a reference.

The prime names and synonyms are ordered alphabetically by compound name, ignoring special characters such as numerals, Greek letters

and prefixes indicating substituent locations, and stereochemical or other structural features. These components are taken into account for secondary ordering in ascending numerical order and alphabetically within alphabetically similar substances.

When the line item is generated by a synonym, a cross reference is given to the sequence number which includes the available data.

2. *The Chemical Abstracts Service Registry Number,* (CAS:) is a designation which uniquely identifies a specific chemical compound. The value of such an entry is that it allows one to conclusively identify a substance regardless of the name or naming system used. The numbers used in this publication were derived from the Desk Top Analysis Tool* (DAT), the Chemical Abstracts Indexes, and various other sources, and may not reflect the currently assigned CAS number.

3. *The Molecular Weight,* (MW:) is calculated either from the molecular formula as presented in the DAT, from the reference source, or from the formula derived from the name of the compound.

4. *The Molecular Formula,* (MOLFM:) designates the elemental composition of the substance and is entered according to the rules presented in the DAT.

5. *Synonyms,* (SYN:) This line is devoted to synonyms for the prime name substance listed. All synonyms found will be listed following "SYN:" according to the same rules presented for ordering the substance on the first line. Each name will be separated by an asterisk. Synonyms are other chemical names, trade names, common or generic names, or codes.

6. *Toxic Dose Data,* (TXDS:) (See Figure 2.) All of the entries in the toxic dose data section contain information entered as follows: the first line starts with the notation "TXDS:" immediately followed by the toxic dose information. The notations indicate, in sequence, the route of exposure; the species of animal studied; the type of dose; the amount of substance per body weight or concentration per unit air volume and, where applicable, the duration of exposure; a descriptive notation for the type of effect reported; and, lastly, the reference source from which the information was extracted. Only the first toxic dose data line is identified by "TXDS:". Each element of this toxic dose data line is discussed below.

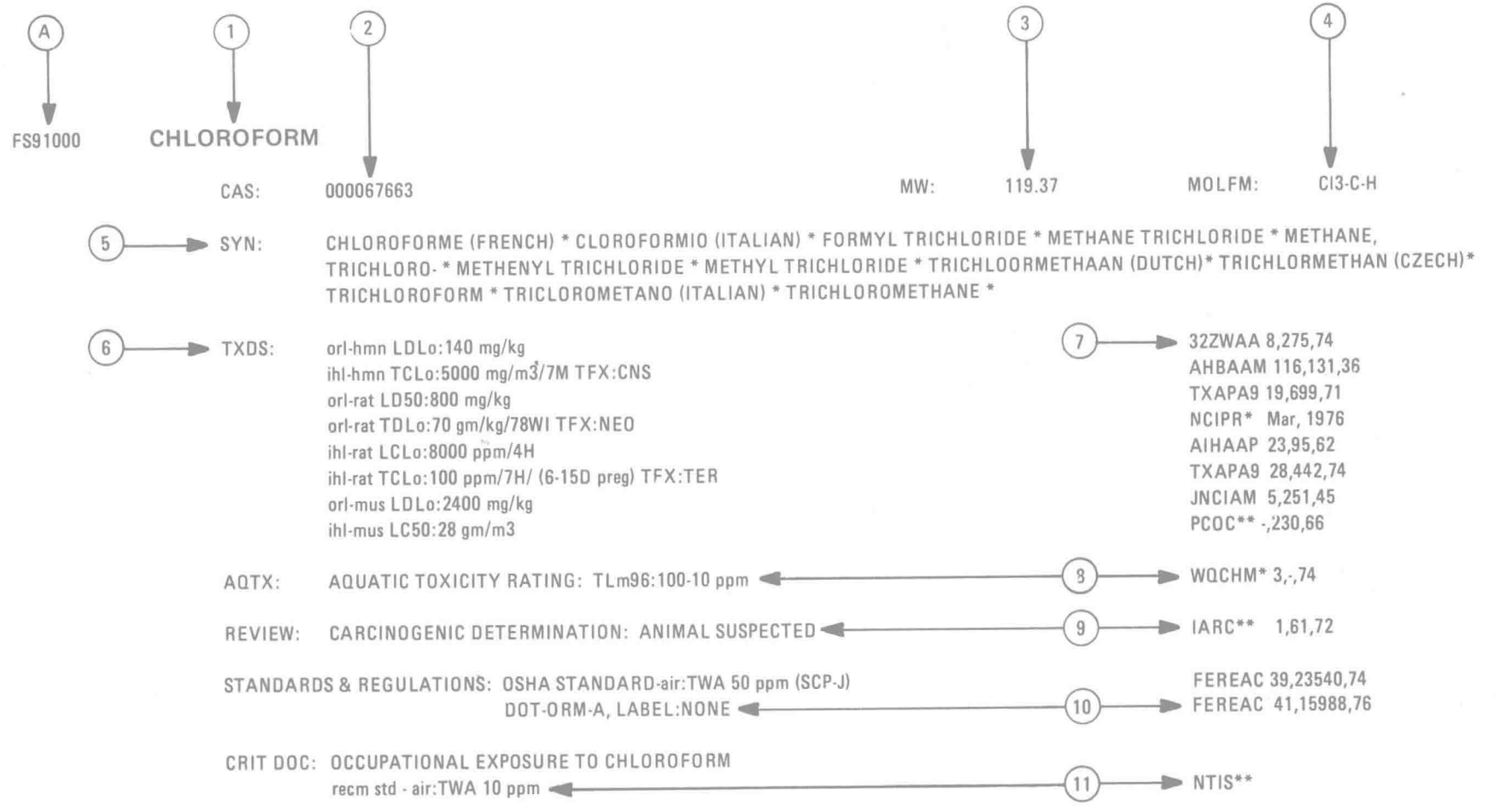
a. *Qualifying Toxic Dose.* All toxic doses appearing in the Registry are derived from reports of the toxic effects produced by individual substances. A toxic effect is defined as any noxious effect on the body — reversible or irreversible; any tumor — benign or malignant; any mutagenic or teratogenic effect which includes fetal resorption or other disturbances to a normal gestation; or death which has been reported to have resulted from exposure to a substance via the respiratory tract, skin, eye, mouth, or any other route. For humans the toxic effect is any effect that was reported in the source reference. There is no qualifying limitation as to the duration of exposure or for the quantity or concentration of the substance, nor is there a qualifying limitation with respect to the circumstances that resulted in the exposure. Regardless of the absurdity of the circumstances that were involved in a toxic exposure, it is assumed that the same circumstances could recur. The qualifying symptomatology for animals cannot be elucidated with any practicality; therefore, more objective signs of toxic effects must be relied upon. The production of tumors (neoplastigenesis), benign or malignant (carcinogenesis); the production of changes in the offspring, whether transmissible (mutagenesis) or not (teratogenesis); and death are the criteria that are used as the toxic effects for animal data. There is no limitation with respect to the duration of exposure, nor the quantity or concentration of the dose of the substance reported to have caused these effects.

We accepted claims by the authors that the neoplastic effects were reported in accordance with recognized classification schemes. Thus, if the effects were characterized as being carcinogenic, mutagenic, or teratogenic by the author, those reported classifications were entered in the Registry. A substance is listed according to the following rules:

(1) A neoplastigen (NEO) is a substance that produces a benign tumor, a tumor that cannot definitely be classified as carcinogenic, or tumors produced in a study where the results are equivocal because of poor study design.

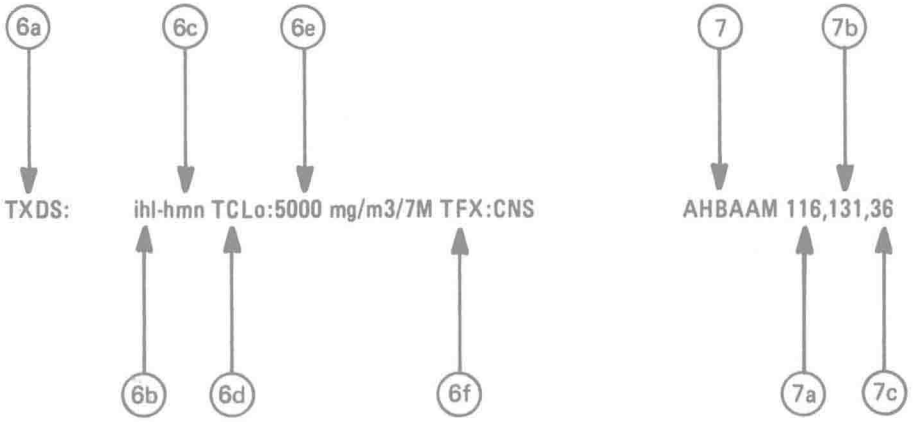
(2) A substance is considered a carcinogen (CAR) if it was reported to have produced a

*Desk Top Analysis Tool for the Common Data Base (6 volumes) 1968: NTIS**PB 179-900.



A. SEQUENCE NUMBER IN THIS LISTING.
1. PRIME NAME OF COMPOUND, SEE 1 IN TEXT BELOW.
2. CHEMICAL ABSTRACTS REGISTRY NUMBER, WHICH IS A NUMBER ASSIGNED TO THIS COMPOUND SO THAT IT MAY BE UNIQUELY IDENTIFIED, SEE 2 IN TEXT BELOW.
3. MOLECULAR WEIGHT OF THIS COMPOUND, SEE 3 IN TEXT BELOW.
4. MOLECULAR FORMULA OR ELEMENTAL FORMULA OF THIS COMPOUND, SEE 4 IN TEXT BELOW.
5. SYNONYMS, COMMON NAMES, TRADE NAMES, AND OTHER CHEMICAL NAMES, SEE 5 IN TEXT BELOW.
6. TOXIC DOSE LINE, SEE 6 IN TEXT BELOW. ALSO SEE FIGURE 2.
7. THIS IS THE REFERENCE TO THE ORIGINAL ARTICLE OR SOURCE FROM WHICH THE TOXIC DATA WAS DERIVED, SEE 7 IN TEXT BELOW.
8. AQUATIC TOXICITY RATING IS A RELATIVE TOXICITY TO AQUATIC LIFE, SEE 8 IN TEXT BELOW.
9. REVIEW OF THIS COMPOUND, SEE 9 IN TEXT BELOW.
10. STANDARDS AND REGULATIONS ENTRIES INDICATE A STANDARD FOR THIS SUBSTANCE HAS BEEN PROMULGATED BY A FEDERAL AGENCY, SEE 10 IN TEXT BELOW.
11. A CRITERIA DOCUMENT SUPPORTING A RECOMMENDED STANDARD HAS BEEN PUBLISHED BY NIOSH, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, SEE 11 IN TEXT BELOW.

FIGURE 1. AN EXAMPLE OF A TYPICAL ENTRY IN THE AGRICULTURAL CHEMICALS/PESTICIDES SUBFILE



6a. AN ACRONYM WHICH STANDS FOR "TOXIC DOSE."
6b. THIS IS AN ABBREVIATION FOR THE ROUTE OF ADMINISTRATION OR ENTRY OF THIS SUBSTANCE. SEE TABLE II FOR OTHER ROUTES OF ENTRY USED IN THE LIST.
6c. THIS IS AN ABBREVIATION FOR THE SPECIES. SEE TABLE III FOR THE OTHER SPECIES USED IN THE LIST.
6d. THIS IS THE TYPE OF DOSE REPORTED. SEE 6d IN TEXT BELOW.
6e. THIS IS THE DOSE WHICH CAUSED THE TOXIC EFFECT. SEE 6e IN TEXT BELOW.
6f. THE FIRST PART OF THIS NOTATION, "TFX," IS AN ACRONYM WHICH STANDS FOR "TOXIC EFFECTS." THE LAST PART OF THIS NOTATION REFERS TO THE ORGAN SYSTEM AFFECTED BY THE DOSE ADMINISTERED. SEE TABLE V BELOW.
7. THIS IS A CODE DENOTING THE REFERENCE FROM WHICH THE TOXIC DATA WAS DERIVED. THE REFERENCE FOR THIS CODE MAY BE FOUND IN THE BIBLIOGRAPHY. SEE 7 IN TEXT BELOW.
7a. VOLUME NUMBER OF THE REFERENCE.
7b. PAGE NUMBER OF THE REFERENCE.
7c. THESE TWO DIGITS STAND FOR THE YEAR OF PUBLICATION, I.E., 1936.

FIGURE 2. A TYPICAL TOXIC DOSE LINE FROM THE AGRICULTURAL CHEMICALS/PESTICIDES SUBFILE

(THIS FIGURE IS A FURTHER EXPLANATION OF ITEM 6 IN FIGURE 1)

malignant tumor or one that metastasized to other parts of the body.

The report of the lowest total dose administered over the shortest time to produce the toxic effect was given preference, although some editorial license was taken in order that additional references might be cited for the user. In contrast to the constraining criteria for dose quantity used in previous editions, no restrictions are placed on the amount of a substance producing death in an experimental animal nor on the time period over which the dose was given. By law, however, a toxic effect must be produced for the dose published. Therefore, terms suggesting that a toxic or lethal effect may exist at quantities greater than those tried cannot be used. Table I presents a guide for the reader's evaluation of acute lethal doses administered by different routes to animals relative to the expected acute lethal effects in humans.

b. *Route of Exposure or Administration.* Although many exposures to substances in the industrial community occur by way of the respiratory tract or skin, most exposures reported in the published literature concern studies of experimental animals in which the test substances were introduced primarily through the mouth by pills, in food, in drinking water, or by intubation directly into the stomach.

For purposes of developing information concerning the relative toxicity of substances, studies in which oral administration is reported are always listed. Because of the importance of information dealing with the effects of respiratory exposure, any studies concerning toxic effects of exposure by inhalation are also listed. However, inhalation studies are generally not as useful for purposes of comparing the toxic potency of different substances because of the limited number of studies reported and because of the wide variability of test programs that are employed in this field of study. Skin absorption studies, as available, are also reported. The abbreviations and definitions of the various routes of exposure used in the Registry are found in Table II.

c. *Species Exposed.* Since the effects in humans are of primary concern, we have indicated, when available, whether the results were observed in man, woman, child or infant. If no such distinction was made in the reference, the term "human" is used. Results of studies on rats or mice are the most frequently reported and hence provide the most useful data for comparative purposes. The species and abbreviations used are listed alphabetically in Table III.

d. *Description of Exposure.* In order to better describe the administered dose reported in the literature, six abbreviations are used. These terms indicate whether the dose caused death (LD) or other toxic effects (TD) and whether it was administered as a lethal concentration (LC) or toxic concentration (TC) in the inhaled air. In general, the term "Lo" is used where the number of subjects studied was not a significant number from the population or the calculated percentage of subjects showing an effect was listed as 100. The definition of terms is as follows:

TDLo-Toxic Lose Low—the lowest dose of a substance introduced by any route other than inhalation over any given period of time and reported to produce any toxic effect in humans or to produce carcinogenic, teratogenic, mutagenic, or neoplastigenic effects in humans or animals.

TCLo-Toxic Concentration Low—the lowest concentration of a substance in air to which humans or animals have been exposed for any given period of time that has been reported to produce any toxic effect in humans or to produce a carcinogenic, teratogenic, mutagenic, or neoplastigenic effect in animals or humans.

LDLo-Lethal Dose Low—the lowest dose of a substance other than LD50 introduced by any route other than inhalation over any given period of time in one or more divided portions and reported to have caused death in humans or animals.

LD50-Lethal Dose Fifty—A calculated dose of a substance which is expected to cause the death of 50% of an entire defined experimental animal population, as determined from the exposure to the substance, by any route other than inhalation, of a significant number from that population. Other lethal dose percentages, such as LD1, LD10, LD30, LD99, may be published in the scientific literature for the specific purposes of the author. Such data would be published in the list if these figures, in the absence of a calculated lethal dose (LD50), were the lowest published in the article.

LCLo-Lethal Concentration Low—the lowest concentration of a substance in air, other than LC50, which has been reported to have caused

death in humans or animals. The reported concentrations may be entered for periods of exposure which are less than 24 hours (acute) and greater than 24 hours (subacute and chronic).

LC50-Lethal Concentration Fifty—a calculated concentration of a substance in air, exposure to which for a specified length of time is expected to cause the death of 50% of an entire defined experimental animal population as determined from the exposure to the substance of a significant number from that population.

e. *Units of Dose Measurement.* As is found in almost all experimental toxicology, the doses given are expressed in terms of the quantity administered per unit body weight or quantity per skin surface area, or quantity per unit volume of the respired air. In addition, where available, the duration of time over which the dose was administered is also listed. The dose, whether it was reported in terms of weight, surface area, or volume, is entered in terms of units of weight.

Milligrams (one thousandth of a gram) per kilogram (mg/kg) are preferred, but in some cases, because of dose size and its practical presentation in the file, grams per kilogram (gm/kg), micrograms (one millionth of a gram) per kilogram (ug/kg), or nanograms (one billionth of a gram) per kilogram (ng/kg) are used. Volume measurements of dose were converted to weight units by appropriate calculations, assuming all liquids to have a density of one gram per milliliter.

All body weights have been converted to kilograms (kg) for uniformity. For those references in which the dose was reported to have been administered to an animal of unspecified weight or a given number of animals in a group (e.g., feeding studies) without weight data, the weights of the respective animal species were assured to be those found in Table III and the dose is listed on a per kilogram body weight basis. Assumptions for daily food and water intake are found in Table III to allow approximating doses for humans and species of experimental animals where the dose has been expressed as a concentration in food or water. The values presented are selections which are reasonable for the species and convenient for dose calculations.

All concentrations of a gaseous substance in air are listed preferably as parts of vapor or gas per million parts of air by volume (ppm). However, parts per hundred (pph or per cent), parts per billion (ppb), or parts per trillion (ppt) may be used for convenience of presentation. If the substance is a solid or a liquid, the concentrations are listed preferably as milligrams per cubic meter (mg/m^3) but may, as applicable, be listed as micrograms per cubic meter (ug/m^3), nanograms per cubic meter (ng/m^3), or picograms (one trillionth of a gram) per cubic meter (pg/m^3) of air. For those cases in which other measurements of contaminants are used, such as fibers or particles, the measurement is spelled out.

Where the duration of exposure is available, time is presented as indicated in Table IV. In all cases the total duration of exposure appears first after the kilogram body weight and slash followed by descriptive data; e.g., 10 mg/kg/3WI means ten milligrams per kilogram body weight administered over a period of three weeks, intermittently in a number of separate, discrete doses. Other notations of time duration are found on the inside of both back and front covers. This description is intended to provide the reader with enough information for an approximation of the experimental conditions which can be further clarified by studying the article cited.

f. *Frequency of Exposure.* Frequency of exposure to the test substance varies depending on the nature of the experiment. For the purpose of the Registry, frequency of exposure is given only in the case of an inhalation experiment.

g. *Duration of Exposure.* For assessment of neoplasic effect, the testing period should be the life-span of the animal, or until statistically valid calculations can be obtained regarding tumor incidence. In the TXDS line the *total* toxic dose causing the carcinogenic effect is given. The duration of exposure is included to give some indication of the testing period during which the animal was exposed to the toxic dose reported.

h. *Notations Descriptive of the Toxicology.* The toxic dose line thus far has indicated the route of entry, the species involved, the description of the dose, and the amount of the dose. The next entry found on this line when a toxic exposure (TD or TC) has been listed is the term "TFX:" (Toxic Effect). Following "TFX:" will be one of the notations found in Table V. These notations will indicate the organ system affected

or will indicate in the case of animal experiments special effects that the substance produced, e.g., CAR = carcinogen. No attempt was made to be definitive in reporting the effect because such definition requires much detailed qualification and is beyond the scope of the publication at this time. The selection of the dose was based, first, on the lowest dose producing an effect and, second, on the latest study published.

7. *Cited Reference.* The final entry of the TXDS line is the reference from which the toxic dose information was extracted. All references from which information has been gathered are and must be publicly available. No governmental classified documents have been used for source information. All references have been given a unique six-letter CODEN* character code which identifies periodicals and serial publications as well as individual published works. The CODEN references are found in the Bibliographic References section of this volume. For those references for which no CODEN was found, the corresponding six-letter code includes asterisks (*) in the last one or two positions following the first four or five letters of an acronym for the publication title. In this manner, all acronyms will be found in alphabetical order. Following the CODEN designation (for most entries) will be the number of the volume, followed by a comma; the page number of the first page of the article, followed by a comma; the last two numbers indicating the year. In a special situation where contributors have provided information on their unpublished studies in accordance with the criteria described herein, the first three letters of the last name, the initials of the first and middle name along with a number sign (#), and the date of the letter supplying the information will be found. Any other designation found will be explained with its reference code in the Bibliography.

8. *Aquatic Toxicity* ratings were extracted from *Water Quality Characteristics of Hazardous Materials* by Dr. W. Hahn and Paul Jensen, Texas A & M University, 1974. The format for this line is "Aquatic Toxicity Rating: TLm96..... ppm" where TLm96 is defined as the 96-hour static or continuous flow standard protocol. Because of the lack of standardization and the wide variety of species investigated, ratings are used to give an indication of the toxicity of substances to aquatic life.

*CODEN for Periodical Titles, Chemical Abstracts Service, Columbus, Ohio 43210

9. *Reviews.* This section supplies additional information to enable the reader to make knowledgeable evaluations of potential chemical hazards. There are two types of reviews: the Threshold Limit Values, which are recommended limits proposed by the American Conference of Governmental Industrial Hygienists (ACGIH) based on a consensus, and the International Agency for Research on Cancer (IARC) monograph reviews, which are published by the United Nations.

a. *Threshold Limit Value* (TLV). The TLV is an upper limit (ceiling) or time-weighted average concentration of a substance recommended by the ACGIH for control of occupational exposures. This concentration may be designated as a ceiling (CL), time-weighted average concentration (TWA), or a notation indicating that there is a potential hazard from exposure to skin. These TLVs were taken from *Documentation of the Threshold Limit Values for Substances in Workroom Air* (third edition, 1971), its supplement, or from documentation which appears in the ACGIH annual reports. "(SKN)" in an entry indicates that even though the air concentration may be below the limit value, significant additional exposure to the skin may be dangerous.

b. *Cancer Reviews.* In the International Agency for Research on Cancer (IARC) monographs, suspected environmental carcinogens are examined and summaries of available data with appropriate references are presented. Sections of these reviews are synonyms, physical and chemical properties, uses and occurrence, and biological data relevant to the evaluation of carcinogenic risk to humans. This current series of eleven monographs includes an evaluation of approximately 300 substances.

The specific format for this data line can be seen in Figure 1. The cancer review data line indicates that some carcinogenicity data pertaining to a chemical has been reviewed by the IARC committee. The committee's conclusion is summarized in two words. The first word indicates whether the data pertains to humans or to animals. The second word indicates the results of the determination as either "positive, suspected, indefinite, or negative."

The cancer review reflects only the conclusion

made by the IARC committee based on the data available for the committee's evaluation. Hence, it is to be expected that in some cases there is disagreement between the IARC determination and the carcinogenicity information in the toxicity data lines for the substance.

10. *Standards and Regulations.* This section contains notations indicating that the substance is regulated by an Agency of the United States Government. The heading of these reference lines is "Standards and Regulations" followed either by "OSHA," "EPA," or "DOT." "OSHA" refers to standards promulgated under section six of the Occupational Safety and Health Act of 1970. "EPA" refers to Worker Protection Standards for Agricultural Pesticides promulgated under the Federal Insecticide, Fungicide, and Rotenticide Act. "DOT" refers to substances regulated for shipment by the Department of Transportation.

If the entry following OSHA is "air," then this is an air contaminant standard. TWA or CL refers to either time-weighted average or ceiling value. For some substances, TWA, CL, and Pk (peak) values are given in the standard. In those cases, all three are listed. Finally, some entries may be followed by the designation "(skin)." This designation indicates that the compound may be absorbed by the skin and, even though the air concentration may be below the limit, significant additional exposure through the skin may be possible. The FEREAC reference is to the volume, page, and year of the *Federal Register*.

Standards Completion Program — The entry "(SCP)" indicates that a draft technical standard has been developed for the substance under the joint NIOSH/OSHA Standards Completion Program. A draft technical standard includes requirements for apprising employees of all hazards to which they are exposed, acceptable personal protective equipment, engineering control procedures, air sampling and analytical procedures medical surveillance, and recordkeeping. Copies of the draft technical standards are available for review in each of the NIOSH and OSHA Regional Offices. The letter entry following SCP, for example "(SCP-A)," refers to the set of draft standards which were prepared concurrently.

The information following the DOT notation for each substance has been obtained from the Department of Transportation (DOT) concerning (a) the hazard class, (b) the label(s) required, and (c) the proper shipping name(s) as specified for transportation. For transportation purposes, a hazardous material means a substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce and which has been so designated.

The basic hazard classes include compressed gases, flammables, oxidizers, corrosives, explosives, radioactive materials, and poisons.

11. *NIOSH Criteria Documents.* The next line of a toxic substance entry will indicate that a NIOSH criteria document for recommendation of a health standard is available at the time of printing. This line will start with "CRIT DOC:" followed by the title of the document and the source for the reference in terms consistent with the Bibliography. The reference citation is the National Technical Information Service, U.S. Department of Commerce document number from which paper copy or microfiche copy may be ordered.

TABLES

TABLE I

GUIDELINES FOR EVALUATING ACUTE* DOSAGES DIFFERENTIATING RELATIVELY TOXIC FROM NONTOXIC SUBSTANCES TAKING INTO CONSIDERATION THE ROUTE OF ADMINISTRATION TO EXPERIMENTAL ANIMALS AND THE DOSE CAUSING DEATH**

SPECIES	Routes of Administration								
	Oral Rectal Intraduodenum Intracervix	24-Hour Inhalation Maximum		Skin	Parenteral Intraperitoneal Intrapleural	Parenteral Subcutaneous Intradermal Implant	Parenteral Intravenous Intramuscular Ocular Intracerebral Intratracheal Intraplacental Intravaginal Intrarenal	Other	Unreported
	mg/kg	ppm	mg/m³	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Hamster, Frog, Gerbil	2,500	5,000 (0.5%)	1,000	1,400	1,000	5,000	750	1,000	2,500
Rat, Mouse, Squirrel, Mammal, unspecified	5,000***	10,000 (1%)	2,000	2,800	2,000	10,000***	1,500	2,000	5,000
Rabbit, Guinea Pig, Chicken, Pigeon, Quail, Duck, Turkey, Bird	10,000	20,000 (2%)	4,000	2,800***	4,000	20,000	3,000	4,000	10,000
Dog, Monkey· Cat, Pig, Cattle, Domestic Animals: Sheep, Goat, Horse	10,000	20,000 (2%)	4,000	5,600	4,000	20,000	3,000	4,000	10,000

*Applies to those substances for which acute or short term toxicity characterizes the response, e.g., fast-acting substances, irritants, narcosis-producing substances and most drugs. Does not apply to substances whose characteristic response results from prolonged exposures, e.g., silica, lead, benzene, carbon disulfide, carcinogens. Concentrations more appropriately characterizing the toxicity of long- or slow-acting substances are derived from non-acute toxicity studies.

**Calculated from experimental data (Stokinger).

***From Hine and Jacobson, AIHAAP 15, 141, 54.

TABLE II

ROUTES OF ADMINISTRATION TO, OR EXPOSURE OF, ANIMAL SPECIES TO TOXIC SUBSTANCES

Route	Abbreviation	Definition
Intraarterial	iat	administration into the artery
Intraaural	ial	administration into the ear
Intracerebral	ice	administration into the cerebrum
Intracervical	icv	administration into the cervix
Intradermal	idr	administration within the dermis by hypodermic needle
Intraduodenal	idu	administration into the duodenum
Inhalation	ihl	inhalation in chamber, by cannulation, or through mask
Implant	imp	placed surgically within the body — location described in reference
Intramuscular	ims	administration of dose into the muscle by hypodermic needle
Intraplacental	ipc	administration into the placenta
Intrapleural	ipl	administration of dose into the pleural cavity by hypodermic needle
Intraperitoneal	ipr	administration into the peritoneal cavity
Intrarenal	irn	administration into the kidney
Intraspinal	isp	administration into the spinal canal
Intratracheal	itr	administration into the trachea
Intravaginal	ivg	administration into the vagina
Intravenous	ivn	administration of dose directly into the vein by hypodermic needle
Ocular	ocu	administration directly onto the surface of the eye or into the conjunctival sac
Oral	orl	per os, intragastric, feeding introduction with drinking water
Parenteral	par	administration into the body through the skin. Reference cited is not specific concerning the route used. Could be ipr, scu, ivn, ipl, ims, irn, or ice
Rectal	rec	administration of dose by way of rectum to the rectum or colon in form of enema, suppository
Skin	skn	application to the intact skin, dermal, cutaneous
Subcutaneous	scu	administration under the skin
Unreported	unk	dose, but not route, is specified in the reference