HAZARDOUS CHEMICALS DESK REFERENCE

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N. IRVING SAX
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ELEMENTS

Element	Symbol	Atomic Number	Element	Symbol	Atomic Number
Actinium	Ac	89	Mercury	Hg	80
Aluminum	Al	13	Molybdenum	Mo	42
Americium	Am	95	Neodymium	Nd	60
Antimony	Sb	51	Neon	Ne	10
Argon	Ar	18	Neptunium	Np	93
Arsenic	As	33	Nickel	Ni	28
Astatine	At	85	Niobium	Nb	41
Barium	Ba	56	(Columbrium)		
Berkelium	Bk	97	Nitrogen	N	7
Beryllium	Be	4	Nobelium	No	102
Bismuth	Bi	83	Osmium	Os	76
Boron	B	5	Oxygen	O	8
Bromine	Br	35	Palladium	Pd	46
Cadmium	Cd	48	Phosphorus	P	15
Calcium	Ca	20	Platinum	Pt	78
Californium	Cf	98	Plutonium	Pu	94
Carbon	C	6	Polonium	Po	84
Cerium	Ce	58	Potassium	K	19
Cesium	Cs	55	Praseodymium	Pr	59
Chlorine	Cl	17	Promethium	Pm	61
Chromium	Cr	24	Protactinium	Pa	91
Cobalt	Co	27	Radium	Ra	88
Copper	Cu	29	Radon	Rn	86
Curium	Cm	96	Rhenium	Re	75
Dysprosium	Dy	66	Rhodium	Rh	45
Einsteinium	Es	99	Rubidium	Rb	37
Erbium	Er	68	Ruthenium	Ru	44
Europium	Eu	63	Samarium	Sm	62
Fermium	Fm	100	Scandium	Sc	21
Fluorine	F	9	Selenium	Se	34
Francium	Fr	87	Silicon	Si	14
Gadolinium	Gd	64	Silver	Ag	47
Gallium	Ga	31	Sodium	Na	11
Germanium	Ge	32	Strontium	Sr	38
Gold	Au	79	Sulfur	S	16
Halfnium	Hf	72	Tantalum	Ta	73
Helium	He	2	Technetium	Tc	43
Holmium	Ho	67	Tellurium	Te	52
Hydrogen	H	1	Terbium	Tb	65
Indium	In	49	Thallium	Tl	81
Iodine	I	53	Thorium	Th	90
Iridium	Ir	77	Thulium	Tm	69
Iron	Fe	26	Tin	Sn	50
Krypton	Kr	36	Titanium	Ti	22
Lanthanum	La	57	Tungsten (Wolfram)	W	74
Lawrencium	Lr	103	Uranium	U	92
Lead	Pb	82	Vanadium	V	23
Lithium	Li	3	Xenon	Xe	54
Lutetium	Lu	71	Ytterbium	Yb	70
Magnesium	Mg	12	Yttrium	Y	39
Manganese	Mn	25	Zinc	Zn	30
Mendelevium	Md	101	Zirconium	Zr	40

To Pauline and Grace
at our sides, as always

To Carol D. Wickell and William Mahn for their
professional assistance with this book.

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material assistance.

PREFACE

Reference works on hazardous materials seem to fall into two categories, the limited and the very detailed and comprehensive. The editors noted a need for a reference of moderate size which would serve the needs of many who must work with and evaluate the hazards of chemicals. This book was designed to fill that need.

To make the book useful, approximately 5000 materials were selected based upon their importance in industry, their toxicity or fire and explosion hazard, or upon widespread interest in the material. The actual entries were extracted from the 6th Edition of *Dangerous Properties of Industrial Materials*. The entries were shortened by removing citations to toxicity data and other less relevant information. The Toxic and Hazard Reviews, however, were mostly expanded and made more readable. The German Research Society's MAK values were added to assist in the design of safer workplaces.

Not only is it important to have specific data on hazardous materials but it is also important to convey information to employees handling the materials. For this reason, we have included five chapters of information on protective clothing, use of respirators, fire protection, storage and handling, and first aid. The primary purpose is to provide guidelines for managers and others responsible for maintaining a safety program. For example, major types of respirators and protective clothing are described and some explanation is given regarding recommendations for their use. The first aid chapter offers suggestions on what staff should be assigned responsibility in this area. The reader will need to consult other sources including government regulations, voluntary standards, and manufacturer literature for information regarding a specific chemical.

Two cross reference indices are provided as Appendices to permit rapid location of a material if either a Chemical Abstract Service (CAS) number or a synonym for the material is the point of entry.

There is an average of three synonyms for each entry.

N. IRVING SAX
RICHARD J. LEWIS, SR.

INTRODUCTION

Entries in this book include basic chemicals, pesticides, dyes, detergents, lubricants, plastics, drugs, food additives, preservatives, ores, soaps, extracts from plant and animal sources, and industrial intermediates and waste products from production processes. Some of the information refers to materials whose composition is not precisely known. The chemical materials included are assumed to exhibit the reported toxic effect in their pure state unless otherwise noted. However, even in the case of a supposedly "pure" material, there is usually some degree of uncertainty as to its exact composition and the impurities which may be present. This possibility must be considered in attempting to interpret the data presented since the toxic effects observed could in some cases have been caused by a contaminant.

Excluded from our list are tradename products representing compounded or formulated proprietary mixtures available as commercial products. These exclusions are necessary because of difficulties in assessing the contribution of each component of a mixture to that material's total toxicity and because a product's formulation is often changed by varying the components, their concentration, or their purity. Commercial product tradenames as synonyms are included, particularly when they represent a single active chemical entity or a well-defined mixture of relatively constant composition. Radioactive materials are included but the effects reported are the chemically produced effects rather than the radiation effect.

For each material described the following data are provided when available: the material name, Hazard Rating (HR:), CAS number, RTECS number, molecular formula, molecular weight, selected properties including a description of the material (where necessary), synonyms, the U.S. Occupational Safety and Health Administration's (OSHA) air standards, the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values, the German Research Society's (MAK) values, U.S. Department of Transportation (DOT) classifications, and the Toxic and Hazard Review (THR). Each data type is described below.

1. *Name* The name of each material is selected to facilitate recognition of the material. In many cases no single name will be recognized by a majority of readers. Extensive cross-indexing by synonyms is provided to aid in locating an entry.

2. *HR:* is the hazard rating assigned to the material on a scale of 1 to 3 that briefly identifies the level of the toxicity as follows:

The number "3" indicates an LD_{50} below 400 mg/kg.
The number "2" indicates an LD_{50} of 400-4,000 mg/kg.
The number "1" indicates an LD_{50} of 4,000-40,000 mg/kg.

3. *CAS:* is the American Chemical Society's Chemical Abstracts Service Registry Number. It is a numeric designation assigned by the Chemical Abstracts Service and uniquely identifies a

specific chemical compound. This entry allows one to conclusively identify a material regardless of the name or naming system used.

4. *DOT:* indicates a four digit hazard code assigned by the U.S. Department of Transportation. This code is recognized internationally and is in agreement with the United Nations coding system. The code is used on transport documents, labels, and placards. It is also used to determine the regulations for shipping the material.

5. *RTECS:* is the accession number used by the Registry of Toxic Effects of Chemical Substances produced by the National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, 4676 Columbia Pkwy., Cincinnati, Ohio 45226. The RTECS data base contains toxicity data and related information for over 85,000 substances and is useful for locating published toxicity data.

6. *mf:* (molecular formula) or *af:* (atomic formula) designates the elemental composition of the material and is structured according to the Hill System (see *Journal of the American Chemical Society*, 22(8): 478-494, 1900) in which carbon and hydrogen (if present) are listed first, followed by the other elemental symbols in alphabetical order. The formula for compounds that do not contain carbon are ordered strictly alphabetically by element symbol. Compounds such as salts or those containing waters of hydration have molecular formulas incorporating the CAS dot-disconnect convention, in which the components are listed individually and separated by a period. The individual components of the formula are generally given in order of decreasing carbon atom count, and the component ratios given. A lower case "x" indicates that the ratio is unknown. A lower case "n" indicates a repeating, polymer-like structure.

7. *mw:* (molecular weight) is calculated from the molecular formula using standard elemental molecular weights (carbon = 12.01).

8. *PROP:* (Properties) are selected to be useful for evaluating the hazard of a material and designing proper storage and use procedures. A definition of the material is included where necessary. The physical description of the material may include the form, color and odor to aid in positive identification. When available, the boiling point, melting point, density, vapor pressure, vapor density, and refractive index are given. The flash point, autoignition temperature, and lower and upper explosive limits are included to aid in fire protection and control. An indication is given of the solubility or miscibility of the material in water and common solvents.

9. *SYN(S)* (synonyms) for the material are listed alphabetically. Synonyms include other chemical names, common or generic names, foreign names (with the language in parentheses), or codes. Some synonyms consist in whole or in part of registered trademarks. These trademarks are not identified as such.

The reader is cautioned that some synonyms, particularly common names, may be ambiguous and refer to more than one material.

10. *OSHA PEL:* (Permissible Exposure Limits) are the air concentrations to which workers can be exposed for a normal 8-hour day, 40-hour work week without ill effects as defined by the U.S. Occupational Safety and Health Administration (OSHA), Department of Labor. These standards may also include the notation "CL" indicating a ceiling limit which must not be exceeded, or "Pk" indicating the maximum short time peak allowed above the ceiling value. These limits are found in 29 CFR (Code of Federal Regulations) 1910.1000. The CFR regulations also contain detailed requirements for control of some substances and special regulations for carcinogenic substances. Additional information is available from OSHA, Technical Data Center, U.S. Department of Labor, Washington, D.C. 20210.

11. *ACGIH TLV:* are the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists (ACGIH). The TLV represents a time weighted average (TWA) air concentration to which workers can be exposed for a normal 8-hour day, 40-hour work week without ill effects. The notation "CL" indicating a ceiling limit which must not be exceeded. The notation "skin" indicates that the material penetrates intact skin, and skin contact should be avoided even though the TLV concentration is not exceeded. STEL indicates a short-term exposure limit which is a 15-minute time-weighted average which should not be exceeded. Biological Exposure Indices (BEI) are, according to the ACGIH, set to provide a warning level "...of biological response to the chemical, or warning levels of that chemical or its metabolic product(s) in tissues, fluids, or exhaled air of exposed workers..."

The latest annual TLV list is contained in the publication *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment and Biological Exposure Indices with Intended Changes.* The values in this document should be consulted for future trends in recommendations. The ACGIH TLV's are adopted in whole or in part by many countries and local administrative agencies throughout the world. As a result, these recommendations have a major impact on the control of workplace contaminant concentrations. The ACGIH may be contacted for additional information at 6500 Glenway Ave., Cincinnati, Ohio 45211, USA.

12. *DFG MAK:* are the German Research Society's MAK value. Those materials which are classified as to workplace hazard potential by the German Research Society are noted on this line. The MAK values are also revised annually and discussions of materials under consideration for MAK assignment are included in the annual publication together with the current values. *BAT:* indicates Biological Tolerance Value for a Working Material which is defined as, "...the maximum permissible quantity of a chemical compound, its metabolites, or any deviation from the norm of biological parameters induced by these substances in exposed humans." *TRK:* values are Technical Guiding Concentrations for workplace control of carcinogens. For additional information, write to Deutsche Forschungsgemeinschaft (German Research Society), Kennedyallee 40, D-5300 Bonn 2, Federal Republic of Germany. The publication *Maximum Concentrations at the Workplace and Biological Tolerance Values for Working Materials* can be obtained from Verlag Chemie GmbH, Buchauslieferung, P.O. Box 1260 /1280, D-6940 Weinheim, Federal Republic of Germany, or Verlag Chemie, Deerfield Beach, Florida.

13. *DOT Classification:* is the hazard classification according to the U.S. Department of Transportation (DOT) or the International Maritime Organization (IMO.) This classification gives an indication of the hazards expected in transportation, and serves as a guide to the development of proper labels, placards, and shipping instructions. The basic hazard classes include compressed gases, flammables, oxidizers, corrosives, explosives, radioactive materials, and poisons. Although a material may be designated by only one hazard class, additional hazards may be indicated by adding labels or by using other means directed by DOT. Many materials are regulated under general headings such as "pesticides" or "combustible liquids" as defined in the regulations. These are not noted here as their specific concentration or properties must be known for proper classification. Special regulations may govern shipment by air. This information should serve *only as a guide* since the regulation of transported materials is carefully controlled in most countries by federal and local agencies. Because of frequent changes to regulations, it is recommended that the reader contact the applicable agency for information about the current standards for a particular material. United States transportation regulations are found in 40 CFR, Parts 100 to 189. Contact the U.S. Department of Transportation, Materials Transportation Bureau, Washington, D.C. 20590.

14. *THR* Under this heading the reader will find both a brief summary of the toxicity and a discussion of the symptoms caused by exposure. Materials incompatible with an entry are listed

here. Fire and explosion hazards are briefly summarized in terms of flash points and upper and lower explosive limits. Where feasible, fire-fighting materials and methods are discussed. A material with a flash point of 100°F or less is flammable and dangerous; if the flash point is from 100° to 200°F, it is combustible and of moderate hazard; if it is above 200°F, the material is combustible and of low fire hazard.

CONTENTS

SECTION I

1

SAFE STORAGE AND HANDLING OF CHEMICALS

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Chemicals stored properly present a minimum of hazards. A flammable chemical retains its hazardous properties when stored in a safety can, but its likelihood of becoming involved in a fire is minimal simply because of the "designed in" safety features of a safety can. Likewise, a toxic chemical is harmless as long as its storage prevents inhalation, ingestion, or contact. The recent Hazard Communication Standard has placed greater importance on good storage than ever before because good storage is one of the first measures that any employer can take to protect workers from exposure to hazards.

The first step in organizing the storage of chemicals is to take an inventory of the chemicals. All too frequently, chemical storerooms resemble kitchen pantries. In a chemical storeroom, a forgotten container of a chemical may deteriorate on the shelf to something with a completely different chemical identity. Not only can this change in identity ruin a chemical experiment or procedure, it can also present an immediate hazard.

A tape recorder can be used to take your own chemical inventory. The identity of each chemical and the condition of the container, as well as its location, can be recited into the tape recorder. This eliminates the necessity of moving or picking up potentially dangerous containers to read their labels. Afterwards, with reference materials available, the hazard of each chemical can be accessed and proper safe handling and storage procedures established. A chemical storage area should be identified with a sign along with other important signs such as "No Smoking," "Fire Extinguisher," "Safety Shower," etc.

Typically, storage of chemicals involves the basic container, usually the original shipping container, and transfer containers. The basic container ranges from large tanks or drums to cans, bottles, and paper sacks. Transfer containers can be cans, pails, bottles, etc. Handling and storage guidelines for these containers are frequently found on the original shipping container and by referring to the Material Safety Data Sheet (MSDS) that should accompany each shipment. Before handling and storage procedures for a chemical can be established, its hazards must be known. If in doubt, put the container in a safe, secure location until a proper determination of its hazards can be made.

STORAGE BY HAZARD CLASS

Chemicals should not be stored alphabetically. If all sodium compounds are stored together, then strong oxidizers like sodium chromate might be stored next to strong

reducers like sodium dithionite, and an accidental mixture could be devastating. Instead, chemicals should be stored by their respective hazard classes. That is, flammables should be stored with flammables, acids with acids, etc. The following table gives a list of hazard classes and storage guidelines.

Hazard Class	*Storage Guidelines*	*Storage Color*	*Examples*
Flammable	Store in flammable liquid storage area	red	ethanol, mineral spirits, gasoline
Flammable	Store in flammable liquid storage area but separate from other flammables	red with white stripes	benzoyl peroxide, sodium metal, lithium aluminum hydride
Reactive	Store separately and away from flammable and combustible materials	yellow	ammonium nitrate, sodium chlorate, hydrogen peroxide
Reactive	Store separately and away from flammable and combustible materials but separate from other reactive chemicals	yellow with white stripes	acrylamide, sodium dithionite, sodium hypophosphite, hydrazine
Contact	Store in corrosion-proof area	white	hydrochloric acid, iodine, titanium tetrachloride
Contact	Store in corrosion-proof area but separate from other contact hazards	white with black stripes	chlorosulfonic acid, sodium hydroxide
Health	Store in secured area	blue	sodium cyanide, mercury compounds, carbon tetrachloride
Moderate	Substances which are suitable for general storage area	orange	sodium chloride, dextrose, monoethanol amine

The above color-coded storage system was developed by J. T. Baker Chemical Co. Other chemical companies such as Fisher Scientific Co. and Mallinkrodt Chemical Co. have developed similar storage systems.

Some chemicals with multiple hazards fit into different storage classes. Phenol, for example, is flammable, toxic, and corrosive. The storage class it is put in depends upon the most likely hazard found in your workplace. If sources of ignition are present, perhaps it should be stored as a flammable. On the other hand, if contact is possible, it should be stored as a contact hazard, but separate from oxidizers like nitric acid. If the possibility of human contact is minimal, its storage as a toxic substance becomes less important.

LABELING

For safe handling and storage, all containers of chemicals should be properly labeled and the information on the label should also be found on the Material Safety Data Sheet. Take care to preserve the label on the original container, and if the contents are

ACETONE

DANGER!

EXTREMELY FLAMMABLE. HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION.

Keep away from heat, sparks, flame. Avoid contact with eyes, skin, clothing. Avoid breathing vapor. Keep in tightly closed container. Use with adequate ventilation. Wash thoroughly after handling.

EFFECTS OF OVEREXPOSURE: Contact with skin has a defatting effect, causing drying and irritation. Overexposure to vapors may cause irritation of mucous membranes, dryness of mouth and throat, headache, nausea and dizziness.

FIRST AID PROCEDURES: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If contacted, immediately flush eyes with plenty of water for at least 15 minutes. Flush skin with water. If swallowed, if conscious, immediately induce vomiting.

Consult MSDS for further hazardous information and instructions. CAS NO. [67-64-1]

A label designed in an ANSI format.

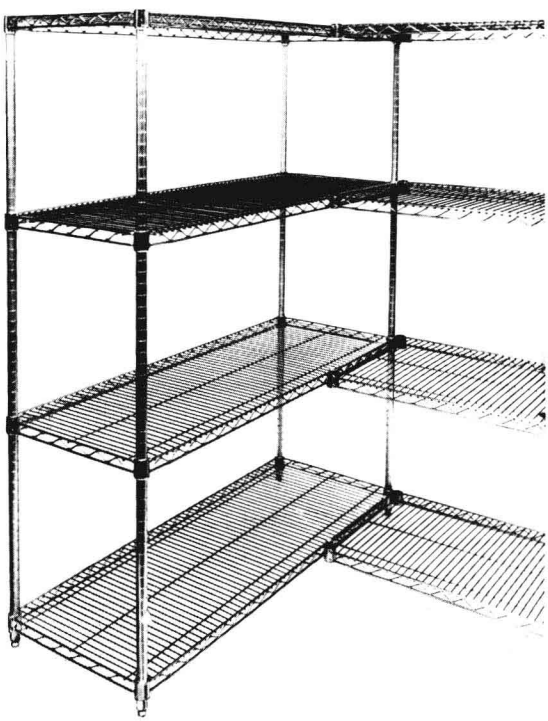
"In plant" container labels.

transferred to a secondary container, it also must be labeled, provided it is used during different work shifts or stored on a shelf. Various labeling systems are available. Some are based upon the NFPA rating system of 0 (least) to 4 (extreme) and others are based on the ANSI format which contains written statements of warnings, precautions, storage guidelines, first aid, etc. Sax uses a rating of 0 (least) to 3 (extreme).

The recent Hazard Communication Standard has very specific requirements with respect to labeling containers. Make certain that the label on the original shipping container contains the same information supplied on the MSDS. This should include the name of the manufacturer, the hazards of the chemical, and the organs affected. The statement "Harmful if Inhaled" is not sufficient according to the Standard. Instead, the label should say why it is harmful, such as, "causes lung damage." The labeling requirements for secondary or "in plant" containers is less strict. However, containers can no longer be left unlabeled or identified with a simple name. These new labeling requirements should eliminate the questions "What's in that can?" or "Where should it be put?" Instead, the questions will be "What is it?" "Will it harm me?", and "How and where should it be stored?" If you still have casually placed containers in your facilities that are poorly identified, you have a problem that must be corrected immediately.

SHELVING

A chemical storeroom is equipped with shelving to hold various sized bottles and containers of chemicals. Check to make certain that the weight of the chemicals does not exceed the manufacturer's weight limitations and that the shelves are securely attached to prevent them from falling over. To stop containers from "creeping" off the shelf, a lip is frequently installed along the front edge. This is of particular importance in areas of



Open-type shelving permits free circulation of air.