# Rapid Guide to Hazardous Chemicals in the Workplace

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# Introduction

There are many reference books available with information on the hazards of materials in the workplace. They are often complex, technical, and expect the reader to draw sophisticated conclusions based on the information presented.

This book, on the other hand, fills the need for a rapid reference to hundreds of the most frequently encountered hazardous materials. Each entry was selected because its dangerous properties have prompted regulation by government agencies, or consideration by standard-setting groups. The hazardous properties of each material are clearly and concisely stated.

Each of the nearly 700 materials has a recommended safe workplace air concentration or other workplace control recommendation. The U.S. Occupational Safety and Health Administration's (OSHA), the American Conference of Governmental Industrial Hygienists' (ACGIH), and the German Research Society's (MAK) values are listed as they apply to each entry. These recommendations constitute the most comprehensive set of workplace air level guides and are presented in one place for the first time in this book.

For assessment of transport hazards, the U.S. Department of Transportation (DOT) hazard class number and description are included. This information serves as an index to the transportation regulations of the United States and most international shipments. The hazard class number is in most cases an internationally agreed upon United Nations number. These values are useful guides to the control of workplace atmospheres, but are not the complete solution. The danger from a substance may arise from contact hazards which cause irritation, skin corrosion and burns, allergenic reactions or skin penetration leading to toxic effects in the body. Other dangers arise from the hazards of fire and explosion. Many substances present storage problems because they are incompatible with other commonly encountered chemicals. The hazards are not disclosed by the various numerical standards, but are clearly and concisely disclosed in the Toxic and Hazard Reviews (THR) which are the focal point of each entry. These reviews disclose the various types and degrees of dangerous or harmful effects reported in the literature, condensed into a compact, understandable paragraph. The THRs are designed to quickly define and clarify the hazard profile of a given substance.

The final section of each entry contains a physical description of the material and gives useful physical and flammability properties. This information can aid in the identification of unknown materials and in the design and selection of the proper storage and handling facilities.

This "guide" is designed to afford easy access to information on the adverse properties of commonly encountered industrial materials. A book of this size cannot hope to present all the data necessary to completely assess the proper use of these substances. The information provided should allow a quick assessment of the relative hazards of the material and the types and nature of the hazards likely to be encountered. The reference codes included with each entry refer to sources of additional information which should be consulted for technical details.

Many publications on hazardous materials attempt to provide information on all aspects of hazardous material control. It is our belief that such subjects as fire control, first aid, and the selection and use of personal protective equipment and respirators should not be treated as briefly as would be required by this format. Decisions on such crucial matters must be made with careful consideration of specific workplace conditions. It is hoped that the information in this book will stimulate sufficient action to provide safer work environments.

The standards and recommended air concentrations are set by various mechanisms which vary in frequency of change. While the current values at time of publication are listed, the reader is cautioned to *verify* the data with the appropriate agency before undertaking major control efforts based on the data given here. Many substances are under test for carcinogenic activity. When a positive finding is reported, the recommended or mandatory control values can change rapidly. Transportation regulations change in detail as transport experience dictates.

We have strived for perfection in our presentation, but recognize that perfection is rarely achieved. Please bring any errors or suggestions to our attention for review.

THE EDITORS



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# How to Use This Book

Each entry consists of four sections:

1. identifying information
2. standards and recommendations
3. toxic and hazard reviews (THR's)
4. physical properties

## 1. *Identifying Information*

Section 1 contains the index name used to alphabetize the entry. The molecular formula immediately follows the name. The number to the far right is the hazard rating (HR). This rating varies from 3 indicating the highest hazard potential to 1 indicating the lowest hazard potential. Since the materials were selected for their importance in the design of a safe workplace, the majority, as expected, carry a rating of 3.

Since chemicals are often known by several widely recognized names (synonyms) a few useful synonyms are included to aid in their identification. They are listed with each entry and alphabetized in Appendix I. If a name is not located in the entries, it may be a synonym for an entry and listed in Appendix I, with reference to the entry name.

The line following the synonyms contains three reference codes which facilitate identification of the material. The codes are also useful in searching for additional data in computerized data bases and large reference works which contain cross indexes by these codes. The first code is identified by "CAS" and is the code assigned to the material by the Chemical Abstracts Service of the American Chemical Society. This code is becoming a universal "social security number" for chemical entities. It should be used whenever possible in describing a substance to avoid the confusion and ambiguity caused by multiple synonyms for the same chemical.

The second entry is identified by "NIOSH" and is the accession number used by the Registry of Toxic Effects of Chemical Substances (RTECS) produced by the National Institute for Occupational Safety and Health, 4676 Columbia Pkwy., Cincinnati, Ohio 45226. The RTECS contains toxicity data and related information for over 75,000 substances and is useful for locating published toxicity data.

The third code is identified by "DOT" and is the U.S Department of Transportation hazard code. 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.

## 2. *Standards and Recommendations*

The four possible entries in this section are:

*OSHA:* which is followed by the Permissible Exposure Limit (PEL) 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 value 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.

*ACGIH:* which is followed by the Threshold Limit Value (TLV) of the American Conference of Governmental Industrial Hygienists (ACGIH). The TLV also represents an air concentration to which workers can be exposed for a normal 8-hour day, 40-hour work week without ill effects. The notation "skin" indicates that the material penetrates intact skin, and skin contact should be avoided even though the TLV concentration is not exceeded. 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." These values should be consulted for future trends in recommendations since 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.

*MAK:* which is followed by the German Research Society's (MAK) value. Those materials which are classified as to carcinogenic 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. 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.

*DOT:* which is followed by 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. 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. U.S. 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.

### 3. *Toxic and Hazard Reviews (THR's)*

This section contains a summary of the toxic properties of the material. Acute immediate effects such as irritation, corrosion, or lethal action are reported in concise language. Chronic or delayed health effects are noted including cancer, reproductive, or allergenic effects. Where possible the specific organ systems or body surfaces affected are listed. Toxic or hazardous decomposition products are identified. An assessment is given of flammable and explosive properties. Incompatible materials and instabilities are listed to guide in the safe storage and use of materials. A list of the elements used to keep this and the following section to manageable size are found on the inside covers of the book. The chemical formulas appear on pages xv–xviii.

### 4. *Physical Properties*

This section gives a physical description of the material in terms of form, color and odor to aid in positive identification. Here are listed the physical properties which are used for determination of hazard potential and assessment of correct storage and handling practices. 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.

# Key to Abbreviations

ACGIH - American Conference of Governmental Industrial Hygienists
alc - alcohol
ALR - allergenic effects
amorph - amorphous
anhyd - anhydrous
approx - approximately
aq - aqueous
atm - atmosphere
autoign temp - autoignition temperature
bp - boiling point
BPR - blood pressure effects
b range - boiling range
bz - benzene
C - Centigrade
CARC - carcinogenic effects
carc(s) - carcinogen(s)
CAS - Chemical Abstracts Service
cc - cubic centimeter
CC - closed cup
CL - ceiling concentration
CNS - central nervous system effects
COC - Cleveland Open Cup
compd(s) - compound(s)
conc - concentration, concentrated
contg - containing
corr - corrosive
cryst - crystal(s), crystalline
CUM - cumulative effects
CVS - cardiovascular effects
d - density
D - day
decomp - decomposition
deliq - deliquescent
dil - dilute
DOT - Department of Transportation
EPA - Environmental Protection Agency
ETA - equivocal tumorigenic agent
eth - ether
exper - experimental (animal)
expl - explosive
expos - exposure
eye - administration into eye (irritant)

EYE - systemic eye effects
(F) - Fahrenheit
fbr - fibroblasts
fp - freezing point
flamm - flammable
flash p - flash point
g/L - grams/Liter
GI - gastrointestinal
GIT - gastointestinal tract effects
g/L - grams per liter
glac - glacial
GLN - glandular effects
gran - granular, granules
H, hr - hour
hexag - hexagonal
hmn - human
HOH - water
HR: - hazard rating
htd - heated
htg - heating
IARC - International Agency for Research on Cancer
ims - intramuscular
incomp - incompatible
inhal - inhalation
insol - insoluble
intox - intoxication
ipr - intraperitoneal
IRR - irritant effects (systemic)
irr - irritant, irritating, irritation
itr - intratracheal
ivn - intravenous
kg - kilogram (one thousand grams)
L - liter
lel - lower explosive limit
liq - liquid
m- - meta
m3 - cubic meter(s)
M - minute(s)
mem - membrane
μ, u - micron
mg - milligram(s)
mg/M3 - milligrams per cubic meter
misc - miscible
mL - milliliter
MLD - mild irritation effects
mm - millimeter(s)
MMI - mucous membrane effects
mo(s) - month(s)
mod - moderately
MOD - moderate irritation effects
mol - mole

mp - melting point
MSK - musculo-skeletal effects
mumem - mucous membrane(s)
MUT - mutagen
mw - molecular weight
N - nitrogen
NaOH - sodium hydroxide
NaPCP - sodium pentachlorophenate
NEO - neoplastic effects
NIOSH - National Institute for Occupational Safety and Health
nonflamm - nonflammable
NOx - oxides of nitrogen
NTP - National Toxicology Program
O - oxygen
o- - ortho
OC - open cup
ocu - ocular
OSHA - Occupational Safety and Health Administration
p- - para
par - parenteral
petr eth - petroleum ether
pg - picogram (one trillionth of a gram)
pk - peak concentration
pmol - picomole
PNS - peripheral nervous system effects
POx - oxides of phosphorous
ppb - parts per billion (v/V)
pph - parts per hundred (v/V) (percent)
ppm - parts per million (v/V)
ppt - parts per trillion (v/V)
PROP - properties
PSY - psychotropic effects
PUL - pulmonary system effects
rbt - rabbit
refr - refractive
resp - respiratory
rhomb - rhombic
S, sec. - second(s)
scu - subcutaneous
SEV - severe irritation effects
SKN - systemic skin effects
slt - slight
sltly - slightly
sol - soluble
soln - solution
solv(s) - solvent(s)
spont - spontaneous(ly)
subl - sublimes
susp - suspected
SYS - systemic effects
TC - toxic concentration


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TCC - Taglibue closed cup
TD - toxic dose
tech - technical
temp - temperature
TER - teratogenic effects
TFX - toxic effects
THR - toxic and hazard review
TLV - threshold limit value
tox - toxic, toxicity
uel - upper explosive limits
μg, ug - microgram (one millionth of a gram)
ULC - underwriters laboratory classification
μmol, umol - micromole
unk - unknown
UNS - toxic effects unspecified in source
vap d - vapor density
vap press - vapor pressure
visc - viscosity
W - week(s)
Y - year(s)
% - percent(age)
> - greater than
< - less than
⇐ - equal to or less than
⇒ - equal to or greater than

# Chemical Formulas

$Ag_2O$ - silver oxide
Al - aluminum
$AlCl_3$ - aluminum chloride
$BF_3$ - boron trifluoride
$B_2O_3$ - boron oxide
$BO_x$ - boron oxides
$Br_2$ - bromine gas
$BrF_3$ - bromine trifluoride
$CaCl_2$ - calcium chloride
$Ca(CN)_2$ - calcium cyanide
$CaO_x$ - calcium oxides
$Ca(OCl)_2$ - calcium oxychloride
$CCl_4$ - carbon tetrachloride
$Cd(OH)_2$ - cadmium hydroxide
CdO - cadmium oxide
$C_6H_6$ - benzene
$CHCl_3$ - chloroform
$CH_3OH$ - methanol
$Cl_2$ - chlorine gas
$ClO_2$ - chlorine oxide
$ClF_3$ - chlorine trifluoride
CN - cyanide
CO - carbon monoxide
$CoO_x$ - cobalt oxides
$CO_2$ - carbon dioxide
$COCl_2$ - phosgene
$CrO_3$ - chromium trioxide
$Cr_2O_3$ - chromium oxide
$CS_2$ - carbon bisulfide
$Cs_2O$ - cesium oxide
$CuFeS_2$ - copper iron sulfide
EtOH - ethanol
$F_2$ - fluorine gas
$Fe_2O_3$ - iron oxide
$F_2O_2$ - fluorine oxide
$H_2$ - hydrogen gas
HCHO - formaldehyde
HCl - hydrochloric acid
HF - hydrofluoric acid
$HgF_2$ - mercuric fluoride
HI - hydriodic acid
$HNO_3$ - nitric acid
$H_2O_2$ or HOOH - hydrogen peroxide
HOAc - acetic acid
HOCl - hypochlorous acid
$H_2S$ - hydrogen sulfide
$H_2SO_4$ - sulfuric acid
$H_2SO_3$ - sulfurous acid
$H_2S_2O_3$ - thiosulfuric acid
$IF_7$ - iodine heptafluoride
$KClO_3$ - potassium chlorate
$K_2CrO_4$ - potassium chromate
KHC - potassium carbide
KOH - potassium hydroxide
LiH - lithium hydride
LiOH - lithium hydroxide
$Mg(C_2H_5)_2$ - magnesium ethyl
MgO - magnesia
$Na_2C_2$ - sodium carbide
$NaClO_3$ - sodium perchlorate
NaK - sodium-potassium alloy
$NaN_3$ - sodium nitride
$NaNO_3$ - sodium nitrate
$Na_2O$ - sodium oxide
$Na_2O_2$ - sodium peroxide
NaOBr - sodium oxybromide
NaOCl - sodium oxychloride
NaOH - sodium hydroxide
$NF_3$ - nitrogen fluoride
$NH_3$ - ammonia
$NH_4^+$ - ammonium radical
$NH_4NO_3$ - ammonium nitrate
$NH_4OH$ - ammonium hydroxide
$N_2O_4$ - NOx; oxides of nitrogen
NOCl - nitrosyl chloride
$NO_x$ - nitrogen oxides
$O_2$ - oxygen gas
$O_3$ - ozone
$OF_2$ - oxygen fluoride
$OsO_4$ - osmium tetraoxide
$PCl_3$ - phosphorus trichloride

$P_2O_3$ - phosphorus trioxide
$P_2O_5$ - phosphorus pentoxide
$PO_x$ - oxides of phosphorus
$Rb_2C_2$ - rubidium carbide
$SCl_2$ - sulfur chloride
$SiO_2$ - silica
$SO_2$ - sulfur dioxide
$SO_x$ - sulfur oxides
2, 3, 7, 8-TCDD - dioxin
TeO - tellurium oxide
$Tl(NO_3)_3$ - thallium nitrate
$Tl_2O$ - thallous oxide
$VO_x$ - vanadium oxides
$ZnCl_2$ - zinc chloride
$ZnCrO_4$ - zinc chromate
$ZnCr_2O_7$ - zinc dichromate
ZnO - zinc oxide

# Chemical Formulas

acetic acid - $HOAc$
aluminum - $Al$
aluminum chloride - $AlCl_3$
ammonia - $NH_3$
ammonium - $NH_4^+$
ammonium hydroxide - $NH_4OH$
ammonium nitrate - $NH_4NO_3$
benzene - $C_6H_6$
boron oxide - $B_2O_3$
boron oxides - $BO_x$
boron trifluoride - $BF_3$
bromine gas - $Br_2$
bromine trifluoride - $BrF_3$
cadmium hydroxide - $Cd(OH)_2$
cadmium oxide - $CdO$
calcium chloride - $CaCl_2$
calcium cyanide - $Ca(CN)_2$
calcium oxides - $CaO_x$
calcium oxychloride - $Ca(OCl)_2$
carbon bisulfide - $CS_2$
carbon dioxide - $CO_2$
carbon monoxide - $CO$
carbon tetrachloride - $CCl_4$
cesium oxide - $Cs_2O$
chlorine gas - $Cl_2$
chlorine oxide - $ClO_2$
chlorine trifluoride - $ClF_3$
chloroform - $CHCl_3$
chromium oxide - $Cr_2O_3$
chromium trioxide - $CrO_3$
cobalt oxides - $CoO_x$
copper iron sulfide - $CuFeS_2$
cyanide - $CN$
dioxin - 2, 3, 7, 8-TCDD
ethanol - $EtOH$
fluorine gas - $F_2$
fluorine oxide - $F_2O_2$
formaldehyde - $HCHO$
hydriodic acid - $HI$
hydrochloric acid - $HCl$
hydrofluoric acid - $HF$
hydrogen gas - $H_2$
hydrogen peroxide - $H_2O_2$ or $HOOH$
hydrogen sulfide - $H_2S$
hypochlorous acid - $HOCl$
iodine heptafluoride - $IF_7$
iron oxide - $Fe_2O_3$
lithium hydride - $LiH$
lithium hydroxide - $LiOH$
magnesia - $MgO$
magnesium ethyl - $Mg(C_2H_5)_2$
mercuric fluoride - $HgF_2$
methanol - $CH_3OH$
nitric acid - $HNO_3$
nitrogen fluoride - $NF_3$
nitrosyl chloride - $NOCl$
nitrogen oxides - $NO_x$
nitrogen oxide - $N_2O_4$
osmium tetraoxide - $OsO_4$
oxides of phosphorus - $PO_x$
oxygen gas - $O_2$
oxygen fluoride - $OF_2$
ozone - $O_3$
phosgene - $COCl_2$
phosphorus pentoxide - $P_2O_5$
phosphorus trichloride - $PCl_3$
phosphorus trioxide - $P_2O_3$
potassium carbide - $KHC$
potassium chlorate - $KClO_3$
potassium chromate - $K_2CrO_4$
potassium hydroxide - $KOH$
rubidium carbide - $Rb_2C_2$
silica - $SiO_2$
silver oxide - $Ag_2O$
sodium carbide - $Na_2C_2$
sodium hydroxide - $NaOH$
sodium nitrate - $NaNO_3$
sodium nitride - $NaN_3$
sodium oxide - $Na_2O$
sodium oxybromide - $NaOBr$
sodium oxychloride - $NaOCl$

sodium perchlorate - $NaClO_3$
sodium peroxide - $Na_2O_2$
sodium potassium alloy - NaK
sulfur chloride - $SCl_2$
sulfur dioxide - $SO_2$
sulfur oxides - $SO_x$
sulfuric acid - $H_2SO_4$
sulfurous acid - $H_2SO_3$
tellurium oxide - $TeO_2$
thallium nitrate - $Tl(NO_3)_3$
thallous oxide - $Tl_2O$
thiosulfuric acid - $H_2S_2O_3$
vanadium oxides - $VO_x$
zinc chloride - $ZnCl_2$
zinc chromate - $ZnCrO_4$
zinc dichromate - $ZnCr_2O_7$
zinc oxide - ZnO

# Contents





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