ARMY DUGWAY PROVING GROUND UT
HANDBOOK FOR EVALUATING ECOLOGICAL EFFECTS OF POLLUTION AT DARC--ETC(U)
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UNCLASSIFIED DPG-HB-80-803
HANDBOOK

FOR EVALUATING ECOLOGICAL EFFECTS OF POLLUTION
AT DARCOM INSTALLATIONS

VOLUME 3

SPECIFIC EFFECTS OF POLLUTANTS IN
SPECIFIC ENVIRONMENTS

DECEMBER 1979

U.S. ARMY DUGWAY PROVING GROUND
Dugway, Utah 84022

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED
Handbook for Evaluating Ecological Effects of Pollution at DARCOM Installations, Volume 3, Specific Effects of Pollutants in Specific Environments

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Dugway, UT 84022

This handbook provides the DARCOM commander with a tool whereby he can respond quickly to a potential or actual pollution incident with a decisive program to evaluate the ecological effects of the pollution. To implement the procedures as set forth in the handbook, the commander will enlist the help of an environmental team composed of DARCOM scientists (or other suitable personnel) and individuals with limited ecological training (paraeconomists) who will do much of the manual labor. With a given volume, the team can perform the required functions.
Item 20 (con't)

The handbook covers the following areas in seven volumes of which this is Volume 3: (1) basic questions that need answering, (2) conducting the preliminary investigation of the problem, (3) determining the specific effects of a pollutant (the first three volumes are essentially library efforts), (4) terrestrial sampling, (5) aquatic sampling, (6) unexpected declines in animal populations and (7) handling data.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Concept</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCEPT</td>
<td>ii</td>
</tr>
<tr>
<td>USE OF THIS VOLUME</td>
<td>iii</td>
</tr>
<tr>
<td>FOREWORD</td>
<td>iv</td>
</tr>
<tr>
<td>CHECKLIST OF SPECIFIC EFFECTS OF POLLUTANTS</td>
<td></td>
</tr>
<tr>
<td>IN SPECIFIC ENVIRONMENTS</td>
<td></td>
</tr>
<tr>
<td>A. MEDIUM RECEIVING POLLUTANT</td>
<td>1</td>
</tr>
<tr>
<td>B. POTENTIAL TOXICITY</td>
<td>1</td>
</tr>
<tr>
<td>C. COMBINATION OF SUBSTANCES INVOLVING THE POLLUTANT AS ONE MEMBER</td>
<td>3</td>
</tr>
<tr>
<td>D. METABOLISM OF POLLUTANT</td>
<td>4</td>
</tr>
<tr>
<td>E. DISPERSION/DIFFUSION MODEL</td>
<td>4</td>
</tr>
<tr>
<td>F. COMBUSTION AND DEGRADATION PRODUCTS</td>
<td>7</td>
</tr>
<tr>
<td>G. SELECTED SOURCES OF INFORMATION FOR SPECIFIC EFFECTS OF POLLUTANTS IN SPECIFIC ENVIRONMENTS</td>
<td></td>
</tr>
<tr>
<td>A. SELECTED BIBLIOGRAPHIC REFERENCES</td>
<td>9</td>
</tr>
<tr>
<td>B. SELECTED COMPUTER BIBLIOGRAPHIC SEARCHES</td>
<td>11</td>
</tr>
</tbody>
</table>

APPENDIX

A. DISTRIBUTION LIST                                | A-1  |
CONCEPT

Before the sampling program is designed, it is prudent to model the fate of the pollutant in the environment for the following reasons: (1) to suggest the best indicator organisms and the best way to sample those organisms, (2) to ensure the most efficient placement of sampling stations and (3) to establish a schedule of sampling best suited for evaluating the environmental effects of the pollutant. The model can be a simple, verbal model such as, "The pollutant has a high potential for bioaccumulation in plants (plant uptake and concentration above ambient levels)" or be a complex, mathematical model such as those referenced below.

Although the following quotation applies to the laboratory techniques for obtaining toxicity data, the conditions covered are no less important when attempting to model the fate of the pollutant in the environment.

"The toxicity of a material is a property of that material, and can only be described by its effects upon a living organism. As a general principle, toxic materials are toxic to all living things, while the individual susceptibility of each species to the toxic material varies, as do the susceptibilities of the individual members within a species. Within a species, susceptibility varies with age, sex, state of health, rate of dosage, diet, etc. Therefore, toxicity data, to be useful, must include all the above and must be stated in terms of the specific test animal or organism used, the routes of administration of the toxic matter, and the time of exposure. Also a sufficient number of test animals or organisms must have been tested to rule out some of the variables listed above and to make the data statistically significant."

The first effort to identify data needs (Phase II, Volume I) will undoubtedly identify data gaps that must be filled in order to model the specific effects of the pollutants in the specific environment of the installation. Consequently, as part of the first installation visit effort, (phase III, Volume I) a literature survey will be conducted by the paraecologist under the general guidance of the environmental scientist. This survey will search the literature for information which could fill the above-mentioned data gaps.

USE OF THIS VOLUME

Volume 3 is divided into two parts: (1) a checklist of specific effects of pollutants in specific environments and (2) selected sources of information for specific effects of pollutants in specific environments. The team leader will review the checklist to establish the information he must have on the pollutant for modeling. He will then compare the information obtained during the first and second data-gathering efforts with that identified from the checklist to locate data gaps. The paraecologist will attempt to fill these data gaps from the literature.

The paraecologist will first contact the local technical libraries for the initial information sources listed in part 2. If they are available, the paraecologist will research these sources for the required information. He will copy the pages containing the desired information, as well as the pages explaining the use of the source. If the information is not available from these sources, computer bibliographic searches will be conducted. These searches can be conducted through most large university libraries which have computer terminals. The paraecologist will discuss these data gaps with the science reference librarian, who will use this information to establish the keywords, concepts, subject terms or other conditions of the search. The printout resulting from the search will list references that might contain the required information.

Once all printouts are received, the environmental scientists will select the pertinent citations and give these references to the paraecologist, who will go to the library and obtain copies. Some references may have to be obtained through interlibrary loan. When the references have been obtained, the paraecologist can search the references for the required information. He will relay the findings to the team leader.

1If current editions of the references are required but are not available, the ecology team at Dugway Proving Ground, Dugway, UT 84022 or Chemical Systems Laboratory, Edgewood Area, Aberdeen Proving Ground, MD 21010 may be alternate sources.
FOREWORD

This volume was prepared by David A. Gauthier and Dr. Carlos F. A. Pinkham. The following people have contributed written material to Volume 3:

Ryan E. Hoover, Computer Aided Reference Service, Marriott Library, University of Utah, Salt Lake City, UT 84112.


Dr. William Russell, DVM, Veterinarian for Tulsa Zoo, Tulsa, OK 74101.

The following people and organizations have contributed information used in Volume 3:

Dr. Lew Choules, U.S. Army Dugway Proving Ground, Dugway, UT 84022

Dr. Rex Eley, U.S. Army Engineer, Waterways Experiment Station, Vicksburg, MI 39180.


Lloyd A. Holly, U.S. Army Chemical Systems Laboratory, Edgewood, MD 21010.

Library Staff, Marriott Library, University of Utah, Salt Lake City, UT 84112.

Lester L. Miller, Jr., U.S. Army Chemical Systems Laboratory, Edgewood, MD 21010.

J. Gareth Pearson, U.S. Army Medical Bioengineering R & D Laboratory, Fort Dietrick, MD 21701

Dr. James M. Sontag, U.S. Department of Health Education and Welfare, Division of Cancer Cause and Prevention, Bethesda, MD 20014.

Technical Library Staff, U.S. Army Dugway Proving Ground, Dugway, UT 84022.
NOTE

The pronoun "he" is used in this volume as an impersonal pronoun which encompasses he and she and has no intent of personal reference or connection.
CHECKLIST OF SPECIFIC EFFECTS OF POLLUTANTS IN SPECIFIC ENVIRONMENTS

A. MEDIUM RECEIVING POLLUTANT

Land
  Surface
  Subsurface

Air

Water
  Surface
  Freshwater
    Lentic (lakes, ponds)
    Lotic (streams, rivers)
  Estuarine
  Marine
    Intertidal zone (shoreline)
    Neritic zone (shoreline to edge of continental shelf)

B. POTENTIAL TOXICITY

Man and other animals (Identify)

Toxic effects
  Acute  \( LD_{50}, LD_{LO}, LC_{50}, LC_{LO}, TD_{50}, TD_{LO} \) (L, Lethal; D, dosage; 50, 50% of test organisms; LO, lowest response level; C, concentration; T, toxic, debilitating but not lethal)
  Target organ(s)
  System effect
    Allergic or hypersensitive
  Chronic  \( LD_{50}, LD_{LO}, LC_{50}, LC_{LO}, TD_{50}, TD_{LO} \)
    Target organ(s)
    Systemic effect
    Allergic or hypersensitive

Special
  Neoplastigenic (produces tumors)
  Carcinogenic (produces malignant tumors)
  Mutagenic (produces genetic changes expressed in the offspring)
  Teratogenic (produces deformities during growth)
  Behavioral

Routes of exposure
  Hair, feathers, etc
  Skin
  Mucous membrane (including eyes)
  Mouth
Mechanisms of exposure

Ingestion
  Grooming
  Contaminated Food
  Contaminated Water

Respiration

Absorption

Factors affecting individual or species susceptibility

Age
  Prenatal
  Neonatal (newborn to one month old)
  Juvenile
  Adult
  Aged

Sex
  Male
  Female

Condition
  Nutritional
  General health
  Other stress

Habitat
  Aerial
  Terrestrial
  Subterranean
  Aquatic
  Combination

Range
  Sedentary
  Local
  Migratory

Other
  Food habits
  Distribution of race or subspecies
  Seasonal variations (feeding, breeding, hibernation, etc)

Plants

Toxic effects

Acute
  Physical changes (visible changes; viz, death, stunted growth, chlorosis, etc)
  Chemical changes (metabolic, other nutritional factors)
  Genetic change (sterilization, decreased yield, delayed maturation, etc)

Chronic
  Physical
  Chemical
  Genetic (more likely as chronic effect)
Special
Neoplastigenic
Mutagenic
Teratogenic

Routes of Exposure
Leaves
Roots
Bark
Other (aerial roots, flowers, etc)

Mechanism of Exposure
Absorption (direct, indirect)
Respiration

Factors affecting individual or species susceptibility
Age
Physical characteristics
Texture (smooth, hairy, rough, etc)
Growth requirements
Nutrient requirements (including water)

Biological characteristics
Reproduction rate and cycle
Life span and cycle (deciduous, evergreen, annual, perennial)

Adaptability to environmental change

Condition
Nutritional
General health
Other stress

Habitat
Aerial
Terrestrial
Aquatic

Combination

Standards
Environmental Protection Agency (EPA)
Department of Transportation (DOT)
Occupational Safety and Health Act (USHA)
Department of the Army
State

C. COMBINATION OF SUBSTANCES INVOLVING THE POLLUTANT AS ONE MEMBER

Other substances present (identify)
Identify interaction, if any (synergistic, additive)
Toxicity of interaction
Known effects of interaction

\(^1\text{If the interaction produces a reactant different from either of the original substances, this reactant may be screened in the same manner as the original pollutant.}\)
Target organs
Systemic effects
Magnitude of effects

D. METABOLISM OF POLLUTANT

Biomagnification (concentration of the pollutant within the food chain)

Identify food chain
Degree of biomagnification at each trophic level
Organisms in the food chain most susceptible to the toxic effects
Degree of susceptibility (see item B)

Bioaccumulation (concentration of the pollutant above ambient levels within an individual)
Species which bioaccumulate the pollutant
Mechanisms of bioaccumulation
Levels of bioaccumulation above ambient concentration

E. DISPERSION/DIFFUSION MODELS

Physical characteristics of source
Chemical composition
Molecular weight

The term differs from that normally used which is "bioconcentration". However, the use of "concentration" in the standard definition of biomagnification and bioconcentration leads to confusion.

Appropriate land subsurface models can be found in Metry, A.A., "The fate of pollutants in subsurface environments". Journal of Environmental Sciences, 20:27-31, 1977. This is an abiotic model (biological processes are not included).


Appropriate biotic or abiotic water models can be obtained from U.S. Army Engineer Waterways Experiment Station, Environment Effects Laboratory, Vicksburg, MI 39180. They also can provide subsurface models. The Environmental Chemistry-Fate Modeling Section (E-35.21) of the American Society for Testing Materials, 1916 Rose St., Philadelphia, PA 19103 and The Office of Toxic Substances, 401 "M" St., S.W., Washington, DC 20460 are developing comprehensive water models.
Specific gravity
Normal atmospheric state (gas, liquid, solid)
Density in vapor, liquid, and solid state
Boiling, freezing, decomposition and flashpoint temperatures
Vapor pressure and volatility
Odor or appearance
Solubility in water and in other liquids
Viscosity
Surface tension
Size distribution of particles or droplets
Rates of decay

Characteristics of Source Emission
- Narrative description of source characteristics
- Geographical coordinates or map showing source locations
- Elevation above mean sea level
- Source dimensions (cross-sectional area, volume or stack diameter)
- Source height above ground level
- Total amount of material disseminated (source strength) or dissemination rate
- Concentration of material in soil solution
- Absorbed concentration of material
- Dissemination time (duration and time of day)
- Exit temperature, exit velocity, volumetric flow rate, average pore-water velocity

Receptor Parameters
- Narrative description of different receptors (flora and fauna) vulnerable to source emissions
- Geographical coordinates and distribution
- Elevation of receptors relative to source
- Toxicological values and physical response of receptors for various effects such as no damage or effects, mild damage or incapacitation, and lethal dose or dosage levels
- Breathing rate of mammals or description of population and activities performed
- Protection that may be available through low ventilation structures, etc
- Detoxification (time vs response) factors and population immunization levels
- Hydrodynamic dispersion coefficient
- Bulk density of dry soil
- Soil water-content fraction

Meteorological Parameters
- Hourly surface weather observations to include:
  - Wind direction
  - Windspeed
  - Cloud cover

The engineers responsible for the design of the operation are the best sources of this information.
Cloud height
Visibility and obstructions to vision
Temperature
Relative humidity
Precipitation types and amounts
Meteorological data tabulations
  Wind direction occurrence frequencies
  Frequency and duration of persistent wind directions
  Windspeed occurrence frequencies
  Frequency and duration of persistent wind speeds
Atmospheric turbulence measurements
  Standard deviation of wind azimuths as a function of windspeed
  Standard deviation of vertical wind angles as a function of windspeed
Vertical profiles of temperature
Height of surface mixing layer
Cloud heights and cover by time of day
Solar radiation
Air temperature means and extremes
Relative humidity means and extremes
Precipitation type, frequency, amounts, rates and extremes
Site Characteristics
  Significant terrain features or topographical map
  Vegetative cover and characteristics
  Background atmospheric pollutants
  Watershed drainage patterns
Aquatic data for specific area
  pH
  Alkalinity
  Hardness
  Dissolved oxygen
  BOD (biochemical oxygen demand)
  Chlorides
  Sulfates
  Heavy metals
  Nutrients (carbon, nitrogen, phosphorus)
  Conductivity
  Suspended solids
Cross-sections of body of water
Flow regime
  Flow rate through cross-sections of water
  Tidal flow
  Density of tidal water
  Characteristics of salt wedge in estuary (leading edge of salt water flowing beneath lighter fresh water during flood tide)
Temperature variation through cross-section of water
Location of riffles, pools, backwaters, etc
Annual or seasonal trends in above categories

F. COMBUSTION AND DEGRADATION PRODUCTS

Receiving Medium (see item A above)
Conditions of receiving medium affecting combustion or degradation
Moisture content
Temperature
pH
Other reactants present (see item E above)
Sunlight
Oxygen level
Biological activities
Identify combustion and degradation products
Residence time (half-life) for pollutant and its combustion or degradation products
Information in items B through D above
A. SELECTED BIBLIOGRAPHIC REFERENCES


The 1976 edition of the Registry of Toxic Effects, formerly known as the Toxic Substances List, has been prepared in compliance with the requirements of Section 20(a) (6) of the Occupational Safety and Health Act of 1970, Public Law 91-596, and includes the original list (1971) and all subsequent publications. This revision contains 82,908 lists of chemical substances, including 5,228 new chemical compounds not in the 1975 edition. The U.S. Department of Labor's Occupational Safety and Health Standards (OSHA); and data on carcinogenesis, mutagenesis, teratogenesis, human toxic effects, OSHA Standards and recommended standards from NIOSH Criteria Documents are included for many compounds.

The registry serves as a single source document for basic toxicity information as well as for such other data as chemical properties and information necessary for the preparation of safety directives and hazard evaluations for chemical substances for which standards have not been recommended or promulgated.


A single source for quick, up-to-date, concise, hazard-analysis information on approximately 13,000 common industrial and laboratory materials. The hazard analyses include a toxic hazard rating or toxicology paragraph, a fire hazard rating; and explosion hazard rating and a disaster hazard rating, to give some idea of the hazards produced when quantities of a material become involved in disasters such as fire, explosion or flood.


Although pesticides form a restricted family of compounds, they constitute a major source of potential problems on military installations. Furthermore, this reference is one of the few comprehensive documents with toxicity data on wildlife. The chemicals chosen are
ones to which wildlife are either often exposed or most susceptible. Most are widely used or represent common families of chemicals applied to forests, rangeland, aquatic habitats or agricultural areas. Acute toxicity data and a list of the common symptoms observed are presented for each pesticide. For some, particularly those likely to be applied repeatedly or to persist long after application, the results of 30-day repeated oral toxicity or feeding tests are also included.


This report is compilation and analysis of the results of nearly 10 years of testing the lethal dietary toxicities of pesticidal and industrial chemicals to young bobwhites, Japanese quail, ring-necked pheasants and mallards.


This book provides a list of trade-name products, together with their ingredients; addresses and telephone numbers of companies for use when descriptions of products are not available; sample formulas of many types of products, with an estimate of the toxicity of each formula; toxicological information, including an appraisal of toxicity of individual ingredients and recommendations for treatment and supportive care.

(6) Environmental Protection Agency (EPA) proposed regulation for Regulation of Discharge of Hazardous Substances into Waterways. The complete list, regulatory information and toxicity data, can be found in the January 9, 1976, issue of the Environment Reporter, Vol 6, No. 37.

The proposed regulations (40CFR116) would designate 306 substances as hazardous and would limit their discharge under Section 311 of the Federal Water Pollution Control Act (40FR59959, December 30, 1975). These proposed regulations also establish categories of hazard and define penalties for discharge.


An excellent general source for chemical and physical data on inorganic and organic compounds. New editions are published annually.

Appendix E of this reference provides an excellent annotated listing of chemical information centers and systems. Appendix D provides a useful discussion of systems that can be used to identify or assess the hazard associated with chemicals.

B. SELECTED COMPUTER BIBLIOGRAPHIC SEARCHES

These searches are available at most universities at a minimal cost through computer retrieval services. Most searches can be obtained through three retrieval systems: DIALOG, ORBIT and MEDLARS, which together cover approximately 70 data bases, which in turn give access to thousands of journals, reports, conferences and books containing millions of articles. The most useful data bases of these retrieval systems are shown in Table 1 and described below. The printed references can include abstracts or descriptors, depending on the specific data base. The team leader is responsible for determining the specific data bases to be accessed.

The above data bases cover unclassified documents. In most cases they will provide the necessary information. However, if a search for classified documents is indicated, the Defense Documentation Center (DDC), Cameron Station, Alexandria, VA 22314 is the best source. It also lists unclassified DOD documents.
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<sup>a</sup>Approximate number of citations
<sup>b</sup>DIALOG data base
<sup>c</sup>ORBIT data base
<sup>d</sup>MEDLARS data base

(continued)
On-line and off-line searches result in the same information. On-line searches provide the references immediately but are more expensive and may be limited in the number of references printed; off-line searches are inexpensive, unlimited in the number of references cited and are mailed to the requestor within a few days. The choice of which search to use will be the responsibility of the team leader, based on the urgency of the situation.

File Descriptions:

AGRICOLA (NAL/CAIN)

CAIN is the cataloging and indexing data base of the National Agricultural Library (NAL). This massive file provides comprehensive coverage of worldwide journal and monographic literature on agricultural and related subjects.

APTIC

APTIC is a computerization of Air Pollution Abstracts covering all aspects of air pollution, its effects, prevention and control.

ASFA

Aquatic Sciences and Fisheries Abstract is a comprehensive data base on life sciences of the seas and inland waters, as well as related legal, political and social topics.

BIOSIS

BIOSIS contains world wide citations from both BIOLOGICAL ABSTRACTS and BIORESEARCH INDEX. BIOLOGICAL ABSTRACTS includes accounts of original research from nearly 8,000 primary journal and monograph titles. BIORESEARCH INDEX includes additional citations from symposia, reviews, preliminary reports, semipopular journals, selected institutional and government reports, research communications, and other secondary sources.

CAB ABS

A comprehensive file of agricultural information containing all records in 22 journals published by the Commonwealth Agricultural Bureaux, Great Britain.

CANCERLINE

CANCERLINE is the National Cancer Institute's on-line data base dealing with cancer therapy and chemical, physical and viral
carcinogenesis. References are obtained from Cancer Therapy Abstracts and Carcinogenesis Abstracts.

CANCERPROJ

The CANCERPROJ data base contains summaries of on-going cancer research projects being conducted by cancer scientists in many countries. The data for the project descriptions are processed by the Current Cancer Research Projects Analysis Center (CCRESPAC) of the International Cancer Research Data Bank (ICRDB) Program. This center is at the Smithsonian Science Information Exchange (SSIE) in Washington, D.C.

CIS INDEX

The Congressional Information Service Index covers publications emanating from the work of committees and subcommittees of the U.S. Congress: hearings, reports, committee prints, and other documents. Public laws are added annually. Cross-disciplinary coverage includes public services programs, raw materials and consumer products, industry technology, legal questions, national and international government policies and events, conservation and the full range of issues and topics of legislative concern.

CHEMCON/ CHEM 7071

This is the computer-readable file corresponding to the printed Chemical Abstracts. It provides access to the world's scientific and technical literature for chemistry, chemical engineering, and chemical aspects of the life sciences. Coverage includes journal articles, patent specifications, reviews, technical reports, monographs, conference proceedings, symposia, dissertations and books.

COMP DISS ABS

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