

United States
Environmental Protection
Agency

Office of Research and
Development
Washington, DC 20460

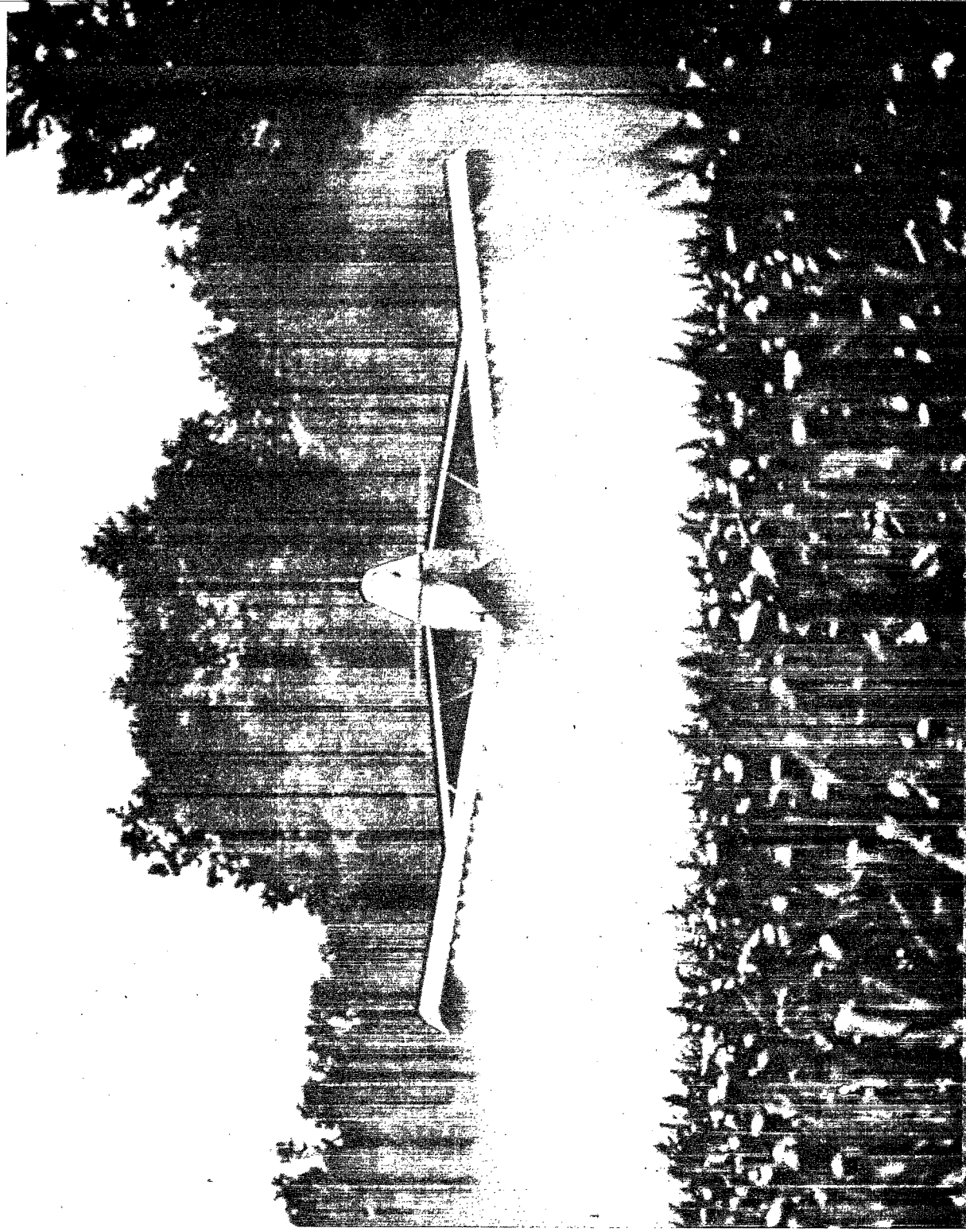
Office of International
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Washington, DC 20460

Office of Pesticides and
Toxic Substances
Washington, DC 20460

EPA/600/M-91/035
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Pesticide Usage Guidelines



EPA Technical Information Packages

This brochure is part of a series of information packages prepared by the United States Environmental Protection Agency (EPA). Aimed at the international community, the packages focus on key environmental and public health issues being investigated by EPA. The products highlighted within these packages provide a sound technical basis for decisions regarding the development of environmental policy, abatement activities, and pollution prevention. By pooling expertise in the areas of environmental science and technology, significant progress can be anticipated to ensure a habitable environment for all nations.

Pesticide Usage Guidelines discusses many commonly used pesticides, associated health and environmental concerns, safe labelling and application procedures, and residues in food. Brochures and associated support material are available on the following topics:

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| • Ensuring Safe Drinking Water ... EPA/600/M-91/012 | • Water Quality EPA/600/M-91/033 |
| • Mining Waste Management EPA/600/M-91/027 | • Risk Assessment EPA/600/M-91/034 |
| • Pesticide Waste Disposal EPA/600/M-91/028 | • Pesticide Usage Guidelines EPA/600/M-91/035 |
| • Air Quality Management EPA/600/M-91/029 | • Pollution Prevention EPA/600/M-91/036 |
| • Solid Waste Disposal EPA/600/M-91/030 | • Environmental Impact Assessments EPA/600/M-91/037 |
| • Hazardous Waste Management .. EPA/600/M-91/031 | • EPA Information Sources EPA/600/M-91/038 |
| • Small Community Wastewater Systems EPA/600/M-91/032 | • Environmental Management ... EPA/600/M-91/039 |

Each complete Technical Information Package (TIP) consists of a cover brochure as well as all of the documents highlighted within the body of the brochure. Generally, the cover brochures contain a section discussing the environmental issue, associated health and environmental effects, guidelines, sampling and analytical methods, as well as treatment and disposal technologies. Following this section, a bibliography is provided to identify other important sources and documents in the field. An attempt has been made to provide references that are readily available in technical libraries. Finally, a number of Office of Research and Development (ORD) technical experts followed by some additional EPA resources are listed to facilitate consultation and technical assistance. Document ordering information is provided on page 12.

Introduction

Pesticides are used to protect crops and stored grains, control household pests and nuisance insects, and eliminate vectors (organisms that carry pathogens from one host to another) of human and animal diseases. Accompanying the widespread use of these products, however, are occasional reports of pesticide poisoning. Causes of these incidents include transportation accidents, poor application practices, and inadvertent food contamination. In areas of intensive agricultural usage or newly irrigated tracts, overuse and careless handling of pesticides have often been observed.

Pesticide overapplication and improper disposal of pesticides, their containers, and contaminated articles can lead to human health and ecological problems. Lack of symptom recognition and poor access to emergency treatment can be fatal in cases of pesticide poisoning. While early symptom recognition and prompt emergency treatment can save the lives of exposed individuals, safe pesticide handling and disposal practices can sharply reduce health risks.

Pesticides Defined

Pesticides, chemicals used to kill pests (e.g., insects, weeds, fungi, rodents), must be recognized as toxic (poisonous) substances and must be handled carefully. Classes of pesticides are commonly named after the pest they help control (e.g., insecticides, herbicides, fungicides, rodenticides). The pesticide itself is known as

the active ingredient and usually has to be diluted for use because 1) physical properties of active ingredients are generally unsuitable for field use, 2) pesticides are highly toxic in the pure form, and 3) required doses are difficult to disperse at high concentrations. To facilitate dilution, a pesticide is mixed with inert (inactive) ingredients to produce a **formulation**. Some formulations include pesticides mixed with water or oil (wettable powders or emulsifiable concentrates), dry application (dusts or granules), and gas or vapor (fumigants, aerosols, pressurized sprays). Although the inert components of a formulation are considered to be inactive against pests, their potential risks to human health and the environment must be considered.

Major categories of pesticides include organochlorines, organophosphorus, carbamates, nitrochlorophenols, and bipyridyls. Examples of organochlorine compounds include endrin, dieldrin, lindane and toxaphene. Because most are persistent in the environment and may affect non-target wildlife, use of these insecticides is discouraged. Organophosphorus compounds include parathion (used against insects), diazinon (used against a wide variety of insects), and malathion. Carbamate pesticides include methomyl, propoxur and carbaryl. Carbaryl, the most commonly used agricultural insecticide, has little mammalian toxicity and does not leave residues in the environment. Nitrochlorophenols are used to prevent fungal attack on timber and as herbicides.

Public Health Concerns

Human exposure to pesticides may occur by way of oral, dermal, or inhalation contact; the resulting toxicity may be acute (rapid poisoning produced by a single or few exposures) or chronic (effects produced by long-term exposure). Metabolism and kinetics play a significant role in the expression of the ultimate toxicity of a given pesticide. Some pesticides are activated by metabolism while others are deactivated. The risk of adverse effects can be reduced by reducing exposure. Depending on use and disposition, a very toxic compound may ultimately be less harmful than a relatively non-toxic one. Pesticides should be labeled according to their hazard class and the usage instructions on the label should reflect their toxicity.

The label on the pesticide container and/or the manufacturer's data sheet that accompanies the pesticide should contain: 1) the name of the pesticide, 2) the name of the manufacturer, 3) a registration number, 4) the pesticide's ingredients, 5) the type of formulation, 6) the net contents of the package, 7) date of manufacture, 8) the degree of hazard and antidote or first aid measures for treatment of poisoning, 9) particular application of the pesticide, 10) directions for use, 11) warning and cautionary statement, 12) storage information and 13) container and residual pesticide disposal information. For complete labeling requirements as well as additional usage guidance, readers should contact the appropriate government agency in their country.



Pesticide Effects on the Human Body

Often, pesticides inhibit or alter the action of certain key enzymes. In this way, exposure to pesticides can cause damage to a number of organs within the body. Organophosphorus compounds, for example, inhibit an enzyme in red blood cells, plasma, the brain and other organs. Other pesticides, (e.g., chloro/nitro compounds) can stimulate metabolism and cause unusually high body temperatures to be suffered.

Pesticide Residues in Food

Although significant societal benefits have been associated with the use of agricultural pesticides, human dietary exposure to these chemicals continues to be a concern. Regulatory efforts throughout the world have attempted to protect consumers from the potential dangers of pesticide residues. Varying technological capabilities and economic situations, however, necessitate a wide range of regulatory approaches internationally (Johnson, 1989).

To regulate pesticide residues, a legal limit known as the maximum residue limit (MRL) is developed for each pesticide. The MRL is the maximum level of residue that is legally permitted to remain in or on a crop in commerce. This limit is used to provide reasonable assurance that no adverse effects to the consumer will result over a lifetime of dietary exposure. Although strict adherence to MRLs may not be feasible for some countries facing dire economic pressures, those countries relying on

food export profits may wish to monitor for and comply with these levels to maintain credibility as responsible exporters.

- *IRIS Database* —The Integrated Risk Information System (IRIS) contains summaries of chronic human health risk information that represents EPA consensus opinion on the potential adverse health effects for approximately 500 chemicals and other agents. The IRIS risk information includes summary sections on potential non-cancer effects resulting from oral and inhalation exposure (oral reference dose and inhalation reference concentration, respectively) and summaries of carcinogenicity risk information. IRIS is a useful initial resource for hazard identification and dose-response information and for directing the user to the underlying data on which the information is based. Other information in IRIS includes summaries of EPA Drinking Water Health Advisories and EPA regulations. See pages 10-11 for information on accessing IRIS.

- World Health Organization document number WHO/PCS/90.1, 1990, *The WHO Recommended Classification of Pesticides by Hazard, and Guidelines to Classification 1990 - 1991* —This document contains pesticide classification tables as well as guidelines to classification. Toxicity values for active ingredients as well as information on formulations and mixtures is presented. The document is available on request from: Division of Environmental

Health, World Health Organization, 1211 Geneva 27, Switzerland.

- EPA/625/4-89/024 *Risk Assessment, Management and Communication of Drinking Water Contamination* — This publication provides concentration levels (standards and health advisories) judged safe for the presence of pesticides in drinking water.

Guidelines for the Usage of Pesticides

It is important when selecting a pesticide to choose one that is approved for usage at local, regional and/or national level and then to use it in accordance with the instructions given on the label and/or manufacturer's safety data sheet. Table 1 provides a summary of various control measures used to prevent or lessen the damage caused by pests.

- *Handbook on the Use of Pesticides in the Asia-Pacific Region*, Manila, Philippines, November 1987 — This document provides basic technical information and data necessary for evaluating pesticide procurement and use. The handbook briefly reviews the following subjects: 1) pest problems and their control practices, particularly with respect to pesticide use; 2) major pesticides used on crops and pests, together with information on relevant industry and market trends; 3) significant environmen-

Table 1.
Summary of Available Pest Control Measures

Control Measures	Pest Types		
	<u>Insects</u>	<u>Weeds</u>	<u>Pathogens*</u>
Biological control	Use of available predators and parasites	Used for some perennial weeds	Not feasible at present
Plant resistance	Used sparingly	Not available	Used widely
Cultural methods	Synchronous planting of non-susceptible crops; trap crops (which lure specific pests); sanitation	Removal of weeds	Synchronous planting; trap crops; sanitation
Mechanical and physical methods	Use of insect traps; use of extremes of temperature, sound, etc.	Hand weeding; inter-row cultivation	Crop burning
Chemical methods	Use of insecticides	Use of herbicides	Use of fungicides
Integrated pest management	Widely used against insects	Used sparingly	Used sparingly

*Plant "pathogens" are microorganisms (bacteria, fungi, and viruses) that live on and cause disease in host plants.

tal and other concerns related to pesticide use; 4) information sources and a directory of international organizations involved with pesticides and pest management. To order copies of this publication, contact the Information Office, Asian Development Bank, P.O. Box 789, 1099 Metro Manila, Philippines.

Control

Regulation of pesticides can help protect against adverse human and environmental health effects while not denying society access to benefits of pesticide use. Registration enables authorities to exercise control over quality, use levels, efficacy claims, labeling, packaging and advertising, and helps ensure that the interests of end-users are well protected. Data required for registration include chemical and physical properties, effectiveness, toxicity for assessment of human health hazards, and prediction of environmental effects.

Application of Pesticides

Hand spraying is probably the most common application method for insecticides and herbicides in developing nations. Machine sprayers, usually drawn by a tractor, are particularly useful for spraying trees or large areas of land. Aerial application is effective at covering large areas of land.

To avoid being poisoned after applying pesticides, the hands and face should be washed thoroughly with soap and clean water prior to eating food, chewing, or smoking. If a nozzle

becomes blocked, blowing it clear by mouth should never be attempted. Instead, the nozzle should be removed and blown clear with the pressure release valve of the pump. Blocked nozzles can also be cleaned using either a thin grass stem or stick or with soap and water.

When spraying a crop with a pesticide of moderate or low toxicity, the applicator should wear an overall (a protective outer garment), boots, and a brimmed hat (if the crop is high). If the applicator is spraying a pesticide of high toxicity, he should wear rubber or plastic gloves, a rubber or plastic apron, and a pair of glasses. When spraying inside buildings, the applicator should wear an overall, boots, a brimmed hat and a pair of eyeglasses.

Individuals charged with handling concentrated pesticides (e.g., a "mixer" or person who is bagging pesticides) must take extra care. They should wear an overall, gloves, boots, aprons, and a respirator or clean cloth over their mouths and noses. For mixing highly toxic pesticides, a respirator containing a cartridge (replaced at least on a daily basis) and glasses are required.

The goal of the overall is to cover 85% of the skin associated with the trunk and other parts of the body. A scarf is needed if the head and neck are not covered. The lower legs and feet should be protected with boots. To protect the hands and arms, gloves need to extend to within 5 centimeters of the elbow.

The pesticide applicator must always hold the wand away from the body and never spray

into the wind (although it is best to spray on windless days). The worker should spray to one side and avoid walking through freshly sprayed areas. Leaking equipment must be repaired immediately. Should dermal exposure occur, the applicator must wash drops of pesticide off the skin immediately. When possible, the applicator should wash between pump charges.

Similar procedures must be exercised when spraying buildings. The applicator must always 1) hold the wand away from the body (especially when spraying upper walls and eaves), 2) stand to avoid spray drift from door and window drafts, and (3) spray slowly and systematically. Some of the various methods for application of pesticides are listed in Table 2.

Upon terminating pesticide application for the day, the worker should wash himself and his clothes with clean water. Work clothes contaminated during the pesticide application process should be washed separately from normal household laundry. Personnel assigned the task of mixing pesticide formulations should use a long paddle (rather than stirring with only the hands), stir slowly enough to avoid splashing, pour carefully, and properly dispose of empty containers. Baggers should always 1) weigh the pesticide carefully, 2) put the pesticide in the bag gently to avoid dust, 3) avoid contaminating the outside of the bag, 4) put the bag on a clean surface for closure, and 5) keep the surrounding area clean.

Pilots must also take precautions to avoid contact with pesticides as much as possible.

Table 2.
Application of Pesticides

Pesticides are applied in many different ways using many types of application equipment, as is shown below:

<u>Equipment/technique</u>	<u>Purpose</u>
1. Spraying with stirrup pumps (wetable powders (WP))	- indoor residual spraying for malaria control - outdoor for crops
2. Spraying with hand compression pump (WP and emulsifiable concentrations (EC))	- spraying insecticides on crops - residual insecticides on walls - spraying larvicides (kill insect larvae)
3. Knapsack sprayer (WP & EC)	- larviciding for public health
4. Dust blower (dusts & powders)	- larviciding - agriculture crop dusting
5. Thermal fogging	- to kill adult insects & for ULV ("ultra-low volume" or small quantities of highly concentrated pesticides) application
6. Aerial	- ULV or dust applications

Ventilators should be closed while spraying and the pilot should avoid flying back through the pesticides or over sprayed areas.

Public Protection

Pesticide users must strive to protect other people and their property (e.g., animals) from exposure. Pesticides and food should never be transported in the same vehicle. Any pesticide spillage should be cleaned thoroughly with large amounts of water. All pesticides must be stored safely away from children, animals, and anyone who might misuse them. Pesticides must be stored in clearly labeled (preferably the original) containers. The containers should be kept in a safe storehouse that is well-vented and can be closed off to prevent unwanted entry. The storehouse should be located away from populated areas, on well-drained land, and away from domestic water supplies. It should be constructed with non-combustible material, and have a leakproof floor and emergency exits.

Environmental Protection

Many human disease vectors are controlled by spraying or treating surface waters with insecticides. Additionally, herbicides are often applied to water in tropical areas to control

aquatic weeds. Other avenues for pesticide contamination of water include: 1) discharges of surplus pesticide after spraying operations, 2) water used for washing spraying equipment, 3) spraying of crops planted close to water bodies, 4) accidental spillage of pesticide formulations, 5) run-off, leakage and erosion from treated soil, 6) fall-out of pesticides from polluted air, and 7) indiscriminate aerial application of pesticides to soils/crops.

Within the last decade, groundwater contamination by agricultural chemicals has been documented throughout the United States. The widespread occurrence of pesticides in groundwater together with the toxicity of many of these chemicals have caused concern over the potential for adverse health effects from chronic exposure via contaminated drinking water. Groundwater is the only source of drinking water in many rural areas. Significant contamination may occur because of the extensive use of agricultural chemicals and the shallow depths of aquifers.

The agricultural practices most likely to affect groundwater quality are pesticide selection and application rate, nitrogen fertilizer application rate, and crop rotation. Use of less persistent and less mobile compounds can reduce the potential for groundwater contamination.

Pesticide application rates directly influence the amount available for leaching (movement of substances with water through the soil). Crop rotations usually reduce the need for application of insecticides and may reduce the need for herbicides.

The processes affecting movement of pesticides into groundwater include plant uptake, volatilization (evaporation) to the atmosphere, chemical or microbial degradation (breakdown), adsorption by the soil, and transport by water. The amount of a chemical that is stored, transformed, or transported is controlled by 1) the amount and properties (such as solubility and persistence) of the chemical, 2) soil properties, 3) timing and intensity of precipitation, and 4) hydrogeologic conditions.

- *Revised Guidelines on Environmental Criteria for the Registration of Pesticides*, Food and Agriculture Organization of the United Nations, Rome, December 1989 — Assessment of effects on the environment is an integral part of the process of pesticide development and registration. This document discusses the need to include exposure considerations, physical/chemical properties, fate and mobility in the environment, and effects on the environment in the pesticide registration process.

Additional References

- Brattstin, L.B. *et al.* "Insecticide Resistance: Challenge to Pest Management and Basic Research." *Science* 231 (1986): 1255-1260.
- Codex. "Guide to Codex Recommendations Concerning Pesticide Residues. Part 1. General Notes and Guidelines." The Hague, Codex Alimentarius Commission (Report CAC/PRI-1984), 1984.
- CSA. "Cancer Risk of Pesticides in Agricultural Workers. Report by the Council on Scientific Affairs." *Journal of the American Medical Association* 260 (1988): 959-966.
- ESCAP. "Development/Environment Trends in Asia and the Pacific: A Regional Overview." Economic and Social Commission of Asia and the Pacific, 1983.
- FAO. "Report of the FAO Panel of Experts on Integrated Pest Control, September 1967." Rome, Food and Agriculture Organization of the United Nations, 1967.
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- FAO. "Prevention of Post-Harvest Food Losses." Rome, Food and Agriculture Organization of the United Nations, 1985.
- FAO. "Guidelines on Good Labelling Practice for Pesticides." Rome, Food and Agriculture Organization of the United Nations, 1985.
- FAO. "International Code of Conduct on the Distribution and Use of Pesticides." Rome, Food and Agriculture Organization of the United Nations, 1986.
- FAO/WHO. "Pesticide Residues in Food." Report on the 1975 Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues (WHO Technical Report Series, No. 592; FAO Plant Production and Protection Series, No. 1).
- Johnson, E. "Pesticide Residues." Chapter 11, pp. 253-281. International Food Regulation Handbook. Ed. R.D. Middlekauff and P. Shubik. New York: Marcel Dekker, Inc., 1989.
- Lewis, R., *et al.* "Measurement of Atmospheric Concentrations of Common Household Pesticides." *Environmental Monitoring Assessment*, 10 (1988): 59-73.
- Mills, P.A. "Pesticide Residue Content." *Journal of the Association of Official Analytical Chemists* 73, No. 5 (1990): 657-660.
- Morgan, D.P. "Minimizing Occupational Exposure to Pesticides: Acute and Chronic Effects of Pesticides on Human Health." *Residue Reviews*, 75 (1980): 97-102.
- U.S. EPA. "Pesticide Fact Sheets." United States Environmental Protection Agency. 1985-1986. OPTS. Washington, D.C.
- WHO. "Public Health Impact of Pesticides Used in Agriculture." World Health Organization, 1990.



Inappropriate application of pesticides has been linked with reduced populations of predatory birds.

Photo by S.C. Delaney

Pesticide Contact List

<u>Project Area</u>	<u>Contact</u>	<u>FAX</u>
Bioassays	Richard Siefert	218-720-5539
Disposal Methods	Paul des Rosiers	202-260-3861
Disposal of Small Quantities	James E. Smith, Jr.	513-569-7566
Ecological Research	Phillip Larsen	503-757-4601
Exposure Assessment	Matthew Lorber	202-260-1722
Food Chain Contamination	Craig McFarlane	503-757-4601
Groundwater Modeling	Robert Carsel	404-546-3340
Human Health Effects	Elaine Grose	919-541-1440
Incineration	Donald Oberacker	513-569-7549
Land Treatment	John Matthews	405-332-2256
Microbiology	Charles Hendricks	503-757-4601
Monitoring	Andy Bond	919-541-7588
Risk Assessment	Herman Gibb	202-260-0106
Sampling and Analysis	Robert Lewis	919-541-4609
Stabilization	Carlton Wiles	513-569-7879
Surface Water Modeling	Robert Ambrose, Jr.	404-546-3340
Toxicology	Robert Menzer	904-934-9201
Treatment Technologies	Glenn Shaul	513-569-7408

Additional Opportunities for Obtaining Technical Information

PESTICIDE INFORMATION NETWORK (PIN)

PIN contains a compilation of pesticide monitoring projects performed by government agencies and private institutions. Files currently available through PIN are:

- The Pesticide Monitoring Inventory
- The Restricted Use Products File
- The Chemical Index

To access PIN, FAX requests for information to 703-305-5919. For additional information, write:

Office of Pesticides and Toxic Substances
U.S. Environmental Protection Agency
401 M Street, S. W. (TS-788)
Washington, D.C. 20460

INTEGRATED RISK INFORMATION SYSTEM (IRIS)

For general information on IRIS, contact:

IRIS User Support Unit
Environmental Criteria and Assessment Office
U.S. Environmental Protection Agency
26 W. Martin Luther King Drive
Cincinnati, OH 45268
Telephone: 513-569-7254

Access to the on-line version of IRIS, which is updated monthly, is available via the National Library of Medicine's (NLM) International MEDLARS Centers. One of the data services of the MEDLARS Centers

is TOXNET and IRIS is part of TOXNET. For information on the NLM MEDLARS Centers, contact:

Director for International Programs
National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20894 USA

For additional information on TOXNET, contact:

Specialized Information Services Division
National Library of Medicine
Attn.: IRIS Representative
8600 Rockville Pike
Bethesda, MD 20894
Telephone: 301-496-6531 or 301-496-1131
(Ask for IRIS Representative)

Alternatively, updated diskettes of IRIS can be purchased from the National Technical Information Service (NTIS) on a quarterly basis. For information on the NTIS purchase of diskettes, contact:

Stu Wiseman, Federal Computer Products Center
National Technical Information Service
U.S. Department of Commerce
5828 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4807

INTEGRATED RISK INFORMATION SYSTEM (cont.)

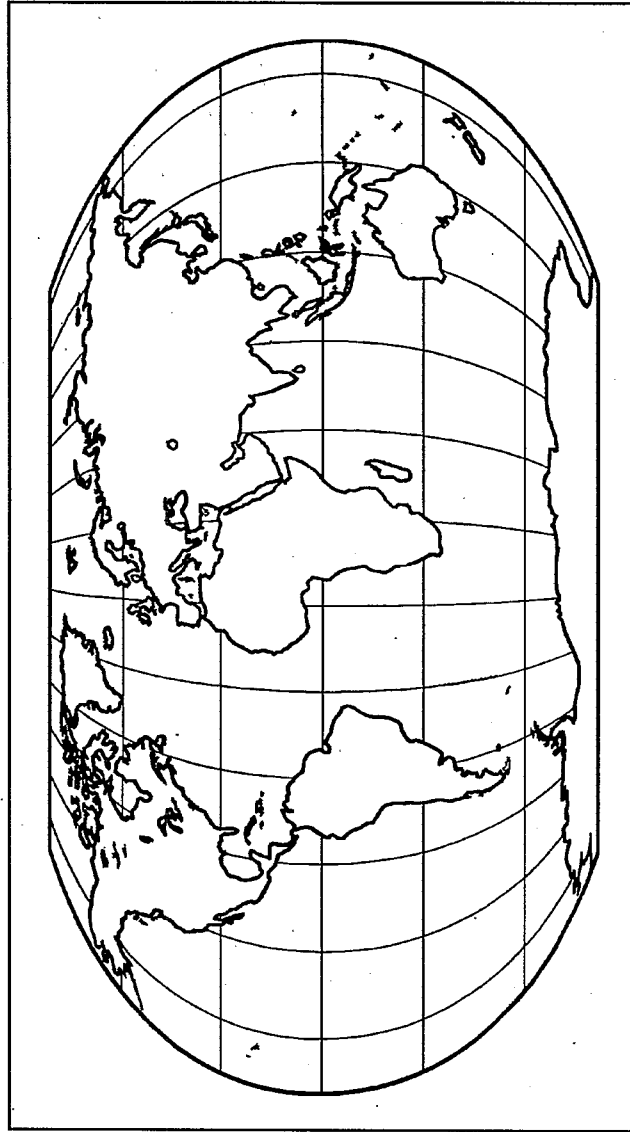
EPA also provides, quarterly, diskette copies of IRIS to both the World Health Organization (WHO) and the Pan American Health Organization (PAHO). These organizations will provide copies of the latest IRIS entry for specific requested chemicals.

For IRIS information from WHO, contact:

Dr. Michel Gilbert
International Programme on Chemical Safety
Division of Environmental Health
World Health Organization
1211 Geneva
27-Switzerland
Telephone: 41-22-9-13574

For IRIS information from PAHO, contact:

Senor Jose Luis Lima Leal
Servicios de Informacion
Centro Panamericano de Ecologia Humana y Salud
Organizacion Panamericana de la Salud
Apartado Postal 37-473
06696 Mexico, D.F. MEXICO
Telephone: 721-643-44



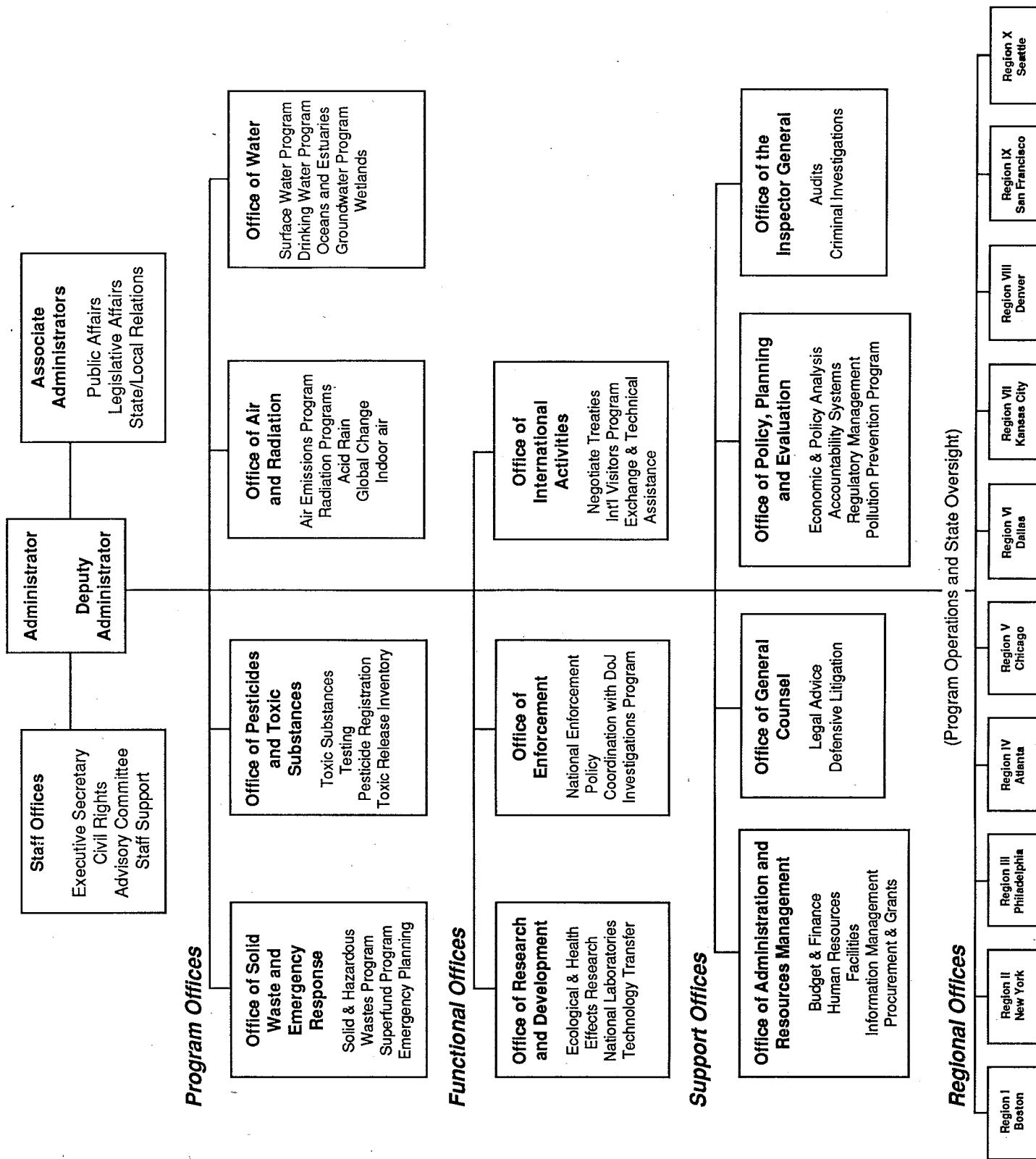
Ordering Technical Documents

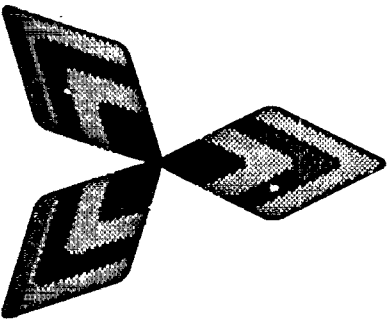
The EPA documents mentioned in the Technical Information Package brochures can be ordered at no charge (while supplies are available) from the Center for Environmental Research Information (CERI). Once the CERI inventory is exhausted, clients will be directed to the National Technical Information Service (NTIS) where documents may be purchased. Orders can be placed by mail, phone, or FAX. To order documents, have the document number or the EXACT title ready. The journal articles listed in the *Additional References* section may be ordered from the U.S. National Focal Point of INFOTERRA.

CENTER FOR ENVIRONMENTAL RESEARCH INFORMATION (CERI)	NATIONAL TECHNICAL INFORMATION SERVICE (NTIS)
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