PN-ABL-670
ISN 78104

# AGENCY FOR INTERNATIONAL DEVELOPMENT
# PPC/CDIE/DI REPORT PROCESSING FORM

**ENTER INFORMATION ONLY IF NOT INCLUDED ON COVER OR TITLE PAGE OF DOCUMENT**

1. Project/Subproject Number: 9365948

2. Contract/Grant Number: DPE-5948-C-00-5044-00

3. Publication Date: January 1987

4. Document Title/Translated Title:
Manuel for Preparation of Initial Environmental Evaluations (IEE) and Environmental Assessments (EA) of U.S.A.I.D. Projects for The Control of Vector-Borne Diseases

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6. Contributing Organization(s)
Vector Biology and Control Project
Medical Service Corporation International

7. Pagination: 94

8. Report Number: AR-045

9. Sponsoring A.I.D. Office: S&T/H

10. Abstract (optional - 250 word limit)

11. Subject Keywords (optional)
1.
2.
3.
4.
5.
6.

12. Supplementary Notes

13. Submitting Official: Robert W. Lennox, Sc.D.

14. Telephone Number: 703-527-6500

15. Today's Date: 6/25/92

DO NOT write below this line

16. DOCID

17. Document Disposition
DOCRD [ ] INV [ ] DUPLICATE [ ]

AID 590-7 (10/88)

PN-ABL-670

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VECTOR BIOLOGY & CONTROL

# Manual for Preparation of Initial Environmental Evaluations (IEE) and Environmental Assessments (EA) of U.S.A.I.D. Projects for The Control of Vector-Borne Diseases

by

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**AR-045**

Managed by Medical Service Corporation International
under contract to the U.S. Agency for International Development

TABLE OF CONTENTS

1.0 Introduction - Background and Purpose of this Document

2.0 Current Regulations Governing Environmental Considerations

2.1 Scope of Coverage and Definitions

2.2 Compliance with A.I.D. environmental Procedures With Reference to Vector Control

(a) Responsibility
(b) Guide to Compliance
(c) Environmental Examination (IEE)
(d) Environmental Assessment (EA)
(e) Environmental Impact Statement (EIS)
(f) Pesticide Procedures
(g) Endangered Species
(h) Monitoring and Evaluation Requirements
(i) Checks on Compliance
(j) Timing of Environmental Reviews
(k) Cost Considerations

3.0 Vector-borne Diseases Requiring Vector Control Interventions

4.0 Vector Control Activities Subject to USAID Environmental Review

4.1 Chemical Control

(a) Background
(b) Pesticides
(1) Policy and Rationale
(2) Selection of Pesticides
(3) Pesticide Applications in Vector Control Projects
(4) Insect Resistance to Pesticides
(5) Hazards Involved in the Use of Pesticides

4.2 Alternatives to Chemical Pesticides in Vector Control

(a) Biological Control
(1) Predators
(2) Parasites and Pathogens
(3) Fungi
(4) Protozoa
(5) Viruses

4.3 Physical Control

(a) Filling
(b) Deepening
(c) Drainage
(d) Water and Land Management
(e) Impoundments
(f) Construction Projects
(g) Environmentally Sensitive Habitats
(h) Man-Made vs. Natural Habitats

5.0 Training of Vector Control Personnel

6.0 Operational Examples of USAID Environmental Assessment Strategy

APPENDIX I - AID Environmental Procedures, 22 CFR Part 216.

APPENDIX II - Excerpts from: Environmental Assessment, Vector Control and Water and Sanitation Activities of Health Sector II Project, Honduras, 1988.

APPENDIX III - Excerpts from: Environmental Assessment of the Pakistan Malaria Control II Project Extension, 1988.

TABLE 1. Insecticides available for use in A.I.D.-supported vector control (V.C.) projects and registered for mosquito control by EPA (See Annex 2)

TABLE 2. Insecticides Used in Mosquito Control (WHO)

TABLE 3. Relative Costs of Pesticides Used for Indoor House Spraying

TABLE 4. Occurrence of Resistance in Selected Anophelines to Adulticides

TABLE 5. Status of Vector Resistance (Year of First Detection) to Pesticides in C. American Countries

FIGURE 1. Pesticide Intoxication Risk by Occupation on Type of Exposure.

FIGURE 2. Hazard Variables (toxicity, contamination, time)) of Pesticides.

ANNEX 1. Pesticide Law and Labeling; including sample insecticide label (Malathion)

ANNEX 2. Insecticides labeled for the Control of Adult and Larval Mosquitoes by Ground and Aerial APplication Methods (Rathburn)

ANNEX 3. Discussion Topics:
- 3A. Integrated Vector Control
- 3B. Selection of Pesticides
- 3C. Vector Resistance and Agriculture
- 3D. Availability of Alternative Insecticides

ANNEX 4. World Bank Guidelines for the Selection and Use of Pesticides

ANNEX 5. Hazards Involved in the Use of Pesticides

ANNEX 6. Field Methods for Measuring Blood Cholinesterase Activity

## 1.0 Introduction - Background and Purpose of this Document

This document was prepared in response to a request from the Office of Health of the Bureau of Science and Technology of A.I.D. as a guide for those concerned with environmental aspects of vector-borne disease control projects supported by USAID. Particular emphasis is placed on Guidelines for Compliance with regulations covering projects designed as interventions against such diseases as malaria, dengue, schistosomiasis, etc., involving the use of pesticides or environmental modifications directed against or affecting disease vector populations. Existing relevant documents [1,2,3] offer little detail on environmental implications or procedural direction for activities at the Mission level. Collectively, however, the referenced documents do provide pertinent information on legislation and Agency policies governing various environmental analyses, and have been incorporated and acknowledged in this document where appropriate. Also similarly included and referenced are published and unpublished (but released) documentation from the World Health Organization (WHO), U.S. Environmental Protection Agency (EPA), the Centers for Disease Control (CDC) and other sources.

This document attempts to anticipate and meet the needs of responsible officials for dealing with A.I.D.'s environmental policies, regulations and procedures as related to vector control projects. An effort is made to address the component activities of vector control operations e.g. pesticide applications, drainage projects, etc. to assure compliance with the regulations over the life of the project.

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[1] Environmental Assessment Guidelines Manual. A.I.D. Sept. 1974 (prepared by SER/ENGR) pp. 107 +61 pp. annexes.

[2] Programmatic Environmental Assessment (PEA) of Malaria Control Programs. 1980. 5 volumes:I-II (A-D): Scudder, H.I. and F.C. Roberts, Insect Control & Research, Inc. (Baltimore) for U.S.A.I.D. [reportedly 50 sets were distributed]

[3] A.I.D. Evaluation Assessments of Development Projects. June 1988. Occ. Paper No. 17. pp. 15.

## 2.0 Current Regulations Governing Environmental Considerations

### 2.1 Scope of Coverage and Definitions

The basic document governing A.I.D. environmental policy is "Reg. 216" (Appendix I)[4] which defines the general procedures to be used by A.I.D. to ensure that environmental factors and values are integrated into the Agency decision making process. These procedures also assign responsibility within the Agency for assessing the environmental effects of A.I.D.s actions. The present document is designed to interpret the provisions of Reg. 216 as they apply to the types of interventions likely to be employed in the control of vector-borne diseases, e.g., the use of insecticides, environmental modification to eliminate vector breeding sites (source reduction), and alternative methodology, e.g. biocontrol, where applicable. Although not vector control projects, per se, such projects as river basin development, new lands development, resettlement projects, penetration road building, irrigation or water management projects, etc. may have vector control implications making them subject to the provisions contained in Reg. 216.

The environmental procedures covered in Reg. 216 generally apply "to all new projects, programs or activities authorized or approved by A.I.D. and to substantive amendments or extensions of ongoing projects, programs or activities." Certain exemptions are allowed under Section 216.2(b) (international disaster assistance; other emergency circumstances; and circumstances involving exceptional foreign policy sensitivities.) Also, Section 216.2(b)(c) allows certain categorical exclusions, e.g., actions not having an effect on the natural or physical environment; actions in which A.I.D. has no knowledge or control over specific activities; and certain monitored and restricted research activities.

Unless excepted as provided in Section 2.16.2 (b), most vector control projects employing pesticides or habitat manipulations are subject to the environmental procedures and those officials with environmental responsibilities at the project level should consider the applicability of Reg. 216 to each project at all phases of design and development. Projects not designed for vector control but which have vector control implications should be equally considered.

Definitions pertinent to this document and detailed in Section 216.1(c) are:

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[4] Code of Federal Regulations, Title 22-Foreign Relations, Chapter II, Part 216-Environmental Procedures, 28 June, 1976. Published in: Federal Register, Vol. 41, No. 127-Wednesday, June 30, 1976. (22 U.S.C. 2381; 42 U.S.C. 4332) dated October 9, 1980.

CEQ Regulations. Regulations promulgated by the President's Council on Environmental Quality (CEQ).

Initial Environmental Examination (IEE). The first review of the reasonably foreseeable effects of a proposed action on the environment.

Threshold Decision. A formal Agency decision which determines, based on an IEE, whether a proposed Agency action is a major action significantly affecting the environment.

Environmental Assessment (EA). A detailed study of the reasonably foreseeable significant effect of a proposed action on the environment of a foreign country or countries.

Environmental Impact Statement (EIS). A detailed study of impacts, positive and negative, of a proposed A.I.D. action, including global considerations. A specific document having a definite format and content.

Project Identification Document (PID). An internal A.I.D. document which initially identifies and describes a proposed project.

Program Assistance Initial Proposal (PAIP). An internal A.I.D. document used to initiate and identify proposed non-project assistance (analogous to the PID).

Project Paper (PP). An internal document which provides a definitive description and appraisal of the project and particularly the plan of implementation.

Program Assistance Approval Document (PAAD). An internal document approving non-project assistance (analogous to PP).

Environment. The term environment, as used in these procedures means the natural and physical environment.

Significant Effect. A proposed action has a significant effect on the environment if it does significant harm to the environment.

Minor Donor. A.I.D. is a minor donor to a multidonor project when A.I.D. does not control the planning or design of the multidonor project and either (1) A.I.D.'s total contribution to the project is both less than $1,000,000 and less than 25 percent of the estimated project cost, or (ii) A.I.D.'s total contribution is more than $1,000,000 but less than 25 percent of the estimated project cost and the environmental procedures of the donor in control of the project are followed, but only if the A.I.D. Environmental Coordinator determines that such procedures are adequate.

## 2.2 Compliance with A.I.D. Environmental Procedures (Reg. 216) with Reference to Vector Control [5]

### (a) Responsibility

Each of the three A.I.D. Regional Bureaus has a Bureau Environmental Officer who is responsible for overseeing the implementation of the procedures at the USAID Mission level and for the clearance of projects for which environmental reviews are required. These officers work closely with their respective counterparts in the regional offices and USAID Missions. The Agency also has an Environmental Coordinator and General Counsel responsible for monitoring the review process and advising the A.I.D. Administrator on implementation problems and on general environmental issues. Highly technical assessments and the preparation of EA and EIS documents frequently require outside technical consultation.

The following dichotomous outline has been developed to assist environmental officers or others in interpreting the provisions of Reg. 216 and in making determinations as to the scope, applicability, and required procedures aimed at compliance, with special reference to vector control.

### (b) Guide to Compliance with Reg. 216

1a Project, program or activity involves: (i) international disaster assistance; (ii) other emergency circumstances; (iii) circumstances involving exceptional foreign policy sensitivities. Exempt from procedures [2/6.2(b)(1)(i,ii,iii)]. See 2a, below.

1b A new project, program or activity or a substantive amendment or extension of an ongoing project, program or activity approved by A.I.D. and without exemptions of 1a, above. Procedures apply [216.2]. See 3a, below.

2a Project, program or activity is exempted under (i) international disaster assistance....determination shall be made either by the Assistant Administrator having responsibility for the program, project or activity, or by the Administrator, where authority to approved financing has been reserved by the

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5 Materials in this section abstracted from Reg. 216 (Annex 1) and "A.I.D. Evaluation Assessments of Development Projects" (op. cit.)

Administrator. The determination shall be made after consultation with CEQ regarding the environmental consequences of the proposed program, project or activity. A formal, written determination is not needed [216.2(b)(2)].

2b Project, program or activity is exempted for reasons other than international disaster assistance, i.e., (ii) other emergency circumstances or (iii) exceptional foreign policy sensitivities. A formal, written determination, including a statement of the justification, is needed [216.2(b)(2)].

3a Class of action (listed in 216.2(c)(2) meets the criteria for which an IEE, EA or EIS generally is not required: (i) the action does not have an effect on the natural or physical environment; (ii) A.I.D. does not have knowledge of or control over, and the objective of the A.I.D. in furnishing assistance does not require, either prior to implementation of specific activities, knowledge of or control over, the details of the specific activities that have an effect on the physical and natural environment for which financing is provided by A.I.D.; (iii) Research activities which may have an affect on the physical and natural environment, but will not have a significant effect as a result of limited scope, carefully controlled nature and effective monitoring.

NOTE: Examples of classes of actions not subject to the procedures include (i) education, TA, or training programs; (ii) controlled experimentation for research of small size and carefully monitored; (iii) analyses, studies, research workshops; (iv) projects in which A.I.D. is a minor donor, etc. It should be noted that the Procedures require exceptions even to actions so excluded, e.g., "under education -- construction of facilities would require consideration. Also, 216.2(c)(3) places responsibility for determining the extent to which the action fits the categorical exclusion test. The determination is made in writing and submitted with the PID, PAIP or comparable document. This determination, which must include a brief statement supporting application of the exclusion shall be reviewed by the Bureau Environmental Officer in the same manner as a Threshold Decision under 216.3(a) of

the procedures. It must also be noted that the procedures set forth in 216.3 apply to any project, program or activity included even in exclusion categories if at any time in the design, review or approval of the activity it is determined that the project, program or activity, or aspect or component thereof, is subject to the control of A.I.D. and may have a significant effect on the environment.

3b Class of action (listed in 216.2(3)(d) has been determined generally to have a significant effect on the environment and an EA or EIS as appropriate is required. Examples of such classes of action include: (i) programs of river basin development; (ii) irrigation or water management projects;(iii) agricultural land leveling; (iv) drainage projects, etc. Pesticides are a special category under 216.2(e) to which the exemptions of 216.2(b)(1) and the categorical exclusions of 216.2(c)(2) are not applicable to the assistance for the procurement or use of pesticides.

Once a particular action has been tracked and applicability of Reg. 216 determined, the following guidelines are provided to aid in the interpretation of environmental procedures aimed at compliance with Reg. 216.3.

(c) Initial Environmental Examination (IEE) [see 216.3(a)(1)]

The initial IEE includes a preliminary study to identify "foreseeable effects of a proposed action on the environment." The study is usually undertaken by USAID Mission in-house staff (e.g., the Mission's environmental officer) or the project designers. Based on the findings, a statement recommending either a negative" or "positive" threshold decision is submitted to the Bureau Environmental Officer. The Bureau Environmental Officer then reviews the statement and either accepts or rejects the recommendation.

A "negative" threshold decision means that the project will not have a significant effect on the environment. A "positive" determination means the opposite and would require project designers to follow the procedures for conducting an Environmental Assessment or preparing an Environmental Impact Statement, whichever is appropriate.

(d) Environmental Assessment (EA) [See 216.3(a)(4) and 216.6]

An environmental assessment is defined as "a detailed study of the reasonable foreseeable significant effects, both beneficial

and adverse, of a proposed action on the environment of a foreign country or countries." The purpose of the study is to identify the mitigation measures (i.e., environmental safeguards) that should be incorporated into the design of the project to offset or mitigate negative effects on the environment.

Reg. 216 specifies that as part of the preparation for the study, a detailed scope of work should be prepared and circulated through a "scoping process". In practice, this involves holding "scoping sessions" (i.e., meeting to solicit responses from relevant A.I.D. personnel and contractors as well as non-A.I.D. personnel in the host country, including "representatives of host country governments, public and private institutions"). At the discretion of the Bureau Environmental Officer, written comments may also be solicited from other U.S. Federal agencies. The final scope of work must take into considerations issues and suggestions raised during the scoping sessions and must be approved by the Bureau Environmental Officer.

Recommendations from the study are subsequently included and submitted for review as an integral part of the Project Paper or equivalent document, after clearance by the Bureau Environmental Officer. Subsequently, the Project Paper or equivalent document is subject to standard A.I.D. review procedures.

(e) Environmental Impact Statement (EIS) [See 216.3(a)(4) and 216.7]

Environmental impact statements serve the same purpose as environmental assessment studies except that they focus on examining potential environmental effects in a wider context i.e., "on the United States, the global environment or areas outside the jurisdiction of any nation". The procedures for preparing environmental impact statements are identical to those for conducting environmental assessments. However, there are two additional provisions. First, if the A.I.D. Administrator deems it necessary, formal public hearings may be held in the United States to discuss draft scopes of work for the environmental studies. Second, environmental impact statements must be reviewed and cleared by the Agency's Environmental Coordinator and the General Counsel.

(f) Pesticide Procedures [See 216.3(b)]

Reg. 216 stipulates factors that must be considered in an initial environmental examination (IEE) and, if necessary, an environmental assessment (EA), or environmental impact statement (EIS) and the conditions under which the use of pesticides in A.I.D. projects may be permitted.

(g) Endangered Species [See 216.5]

The scope of work for an IEE, EA, and EIS, and environmental impact statement should also determine whether an activity under investigation will have adverse effects on endangered or threatened species and their habitats.

(h) Monitoring and Evaluation Requirements [See 216.3(a)(8)]

The design of any project for which an EA or EIS is required must include provisions for data collection and analysis that would indicate "any changes in environmental quality--positive or negative--during their implementation." The data collected would be used to evaluate the environmental impact of the project and to alert USAID Missions of any unexpected development during project implementation that might adversely affect the environment. An EA or EIS would be required if the adverse effect is significant. An example might be the necessity to change from a microbial mosquito larvicide to a chemical larvicide during the course of a project.

(i) Checks on Compliance

A.I.D.'s system for reviewing projects assures compliance with Reg. 216 in two ways:

(1) Approval for funding a project is conditional on the Bureau Environmental Officer's (for initial environmental examinations and environment assessments) or Environmental Coordinator's (for environmental impact statements) concurrence with the USAID Mission's decisions concerning how environmental issues should be addressed in the environmental reviews and in the project's design.

(2) The procedures stipulated by Reg. 216 not only are required by A.I.D. policy but also by U.S. law; therefore, noncompliance could present a legal problem for the Agency.

Problems that may arise over how to interpret Reg. 216 are usually resolved before a project's design is finalized. For example, if a Bureau Environmental Officer has grounds to reject an application for a "categorical exclusion," USAID Missions would usually concede and arrange for an initial environmental examination to be conducted and reviewed prior to final authorization of the project. However, if for some reason an environmental review cannot be fully completed prior to final authorization for a project, Reg. 216 allows for "appropriate covenants or conditions precedent" to permit obligations of funds for project components that have been reviewed, while withholding funding for those components still under investigation.

(j) Timing of Environmental Reviews

Experience has taught most USAID Missions to initiate the environmental review process early in the project identification stage. This approach allows the Missions not only to comply with Reg. 216, but also sufficient time to conduct an environmental assessment, if necessary, and to allow project designers to incorporate its recommendations concerning mitigation measures into the project design. Thus the environmental assessments can be as effectively used as other project feasibility studies (i.e., as inputs to project design work).

A.I.D.'s system for implementing Reg. 216 serves three purposes. First, it provides general guidance for the Agency in its efforts to comply with U.S. law governing A.I.D.'s development activities; second, it mandates USAID Missions and project designers to review and resolve environmental issues presented by a project; third; through scoping sessions, it encourages communication between A.I.D., the host country, and the public on the issues.

(k) Cost Considerations

While few USAID Missions question the value of designing environmentally sound projects, many are reluctant to spend more than the minimum necessary for environmental analyses. Nonetheless, proponents of environmental assessments argue that the cost of initial examinations is usually minimal, and experience indicates that the cost of environmental assessments is not excessive--usually approximating 1 percent or less of the total A.I.D. investment in the project. Costs of environmental assessments can be minimized by: (1) timing fieldwork for environmental studies to coincide with that for other feasibility studies; (2) using in-house A.I.D. expert staff and (3) including local experts in study teams.

3.0 Vector-borne Diseases Requiring Vector Control Interventions

Of more than 100 "tropical diseases" caused by viruses, fungi, bacteria, protozoa and helminths, some of the most troublesome are so-called vector-borne diseases requiring various methods and degrees of control of the invertebrate vector (carrier) to effectuate either precipitous or long-range management of the disease from the standpoint of public health.

The most common vector-borne diseases with which USAID mission's contend are: malaria, vectored by anopheline mosquitoes; arboviruses (arthropod-borne viruses--e.g., dengue, yellow fever, encephalitides, etc.), vectored by aedine and culicine mosquitoes; and/or schistosomiasis vectored by fresh water snails; and Guinea worm disease, for which copepods (crustaceans) serve as intermediate hosts. These diseases are listed as top priorities

in national health programs in nearly every tropical country where they occur. Other important vector-borne diseases requiring vector control interventions include onchocerciasis, vectored by black flies of the genus Simulium; Chagas' disease, vectored by triatomine bugs ("kissing" bugs); African human trypanosomiasis (sleeping sickness), vectored by tsetse flies of the genus Glossina; and lymphatic filariasis, vectored by mosquitoes of several genera (e.g. Culex, Aedes, Mansonia, Anopheles).

Because malaria, arboviruses and/or schistosomiasis are the vector-borne diseases most frequently requiring USAID-assisted projects, these diseases are emphasized in this document.

The snail vectors of schistosomiasis and the developmental stages of the mosquito vectors of malaria and arboviruses are aquatic. Thus, vector control projects are often designed to eliminate or manipulate aquatic habitats through water management (drainage, filling, etc.) other projects are designed to reduce contact between humans and infective adult mosquitoes. In either case there are often physical alterations to the environment or large-scale applications of pesticides potentially impacting on the environment. Although other options might be considered (e.g. use of parasites or predators of the vectors, exclusion by screening, personal protection, etc.) these would by their nature have little negative impact on the environment. At any rate, Reg. 216 provides guidelines for all types of interventions--chemical or physical--and should be reviewed as early as possible in project planning for guidance in compliance with environmental regulations.

## 4.0 Vector Control Activities Subject to USAID Environmental Review

### 4.1 Chemical Control

#### (a) Background

A.I.D.'s policy of Integrated Pest Management (IPM) derives largely from agricultural requirements[6], but in general, encompasses the use of pesticides in public health programs for protection of human health, primarily the control of insect vectors of malaria and other vector-borne diseases. In public health programs the term Integrated Vector Control (IVC) is the equivalent of IPM in agriculture (see Annex 3A).

The concept of integrated programs involves employing a wide range of biological, cultural, mechanical and chemical techniques to keep target pests or vectors below damaging levels to prevent sole reliance on chemical pesticides while maintaining maximum protection to the environment.

The integrated approach is hardly a new concept in vector control (particularly involving mosquitoes) in that mosquito control measures have historically included any one or a combination of techniques aimed at: (1) eliminating mosquito-producing habitats; (2) control of larvae by habitat alterations, predation or chemicals, and (3) chemical control of adult mosquitoes--usually in that order with adulticiding a last choice.

Increasing ecological and environmental impact of control measures, and increasing problems of insecticide resistance emphasize the need for "integrated" control programs and the development of alternative means of control. Thus, there is much current activity involving the development, testing and use of biocontrol (selective use of predators, parasites and pathogens), Insect Growth Regulator (IGR compounds), monomolecular films and genetic techniques. In spite of the commitment and intent, the use of alternative methodology in vector control programs is in its infancy. However, the policies of USAID, WHO, PAHO, federal and local agencies, etc., do indeed reflect a commitment to integrated programs.

The various methods of vector control--chemicals, physical, alternatives, etc.--are discussed in the following section under the appropriate headings with special reference to environmental consideration.

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[6] A.I.D. Agricultural Pest Management Guideline, Draft 3, 13 December 1987.

(b) Pesticides

(1) Policy and Rationale

Effective vector control requires the use of both chemical and non-chemical means. While every effort should be made to develop alternatives to chemicals, pesticides remain essential to the control of disease vectors. Thus, the judicious use of existing compounds and the search for new compounds can be expected to continue.

There are a number of ways to classify pesticides (insecticides), some of which are: (1) by use and target--e.g., malathion may appear as an ultra-low volume (ULV) adulticide, a larvicidal wettable powder (WP), a larvicidal emulsifiable concentrate (EC), or an acaricidal dust; (2) by life stage targeted, e.g., adulticides, larvicides, ovicides; (3) by taxonomic entity, e.g., insecticides (insects), acaricides (mites and ticks) herbicides (weeds); (4) by the chemical class to which compounds belong (chlorinated hydrocarbons, organophosphates, carbamates, etc; (5) by mode of action, e.g. stomach poisons, contact poisons, etc.; (6) intended action (e.g. fumigants, residual sprays, etc.).

Vector control draws on all of these classifications depending upon context. However, insecticide regulations are based on use, and the specific use of a given pesticide formulation is the basis for the pesticide label which is the practical expression of the law. Use and formulation affect every aspect of efficacy -- as well as the environmental regulations -- from transport, storage, handling, to the methods of application, habitat restrictions, human safety requirements, to the likelihood of resistance, etc. (Annex 1). A sample label is appended to Annex 1.

(2) Selection of Pesticides

Selection of the proper pesticide should begin with a thoughtful analysis of the objectives of the control program and of the possible ways to achieve that objective. For example:

- What is the target species? All pest control begins with a correct determination of the species or group requiring control

- What habitat(s) will be affected by application of the pesticide using the proposed formulation, rates, frequency etc.?

- What is the current breeding level and biotic potential of the target population -- and at what threshold will the population require an intervention?

- Are there other control options available (source reduction, biocontrol, physical control, personal protection, e.g. vaccine or preventive and prophylactic drugs, etc.) - and if so, would they be efficacious and affordable in the present situation?

The judicious use of pesticides to supplement, not supplant, other methods of control is the aim of current Agency policy. If it is determined that a pesticide is to be used, the exact placement in the control system should be plotted and the following factors addressed:

Legality: What pesticide formulations are registered by the USEPA and/or acceptable to USAID under Reg. 216 for the specific task at hand?

Effectiveness: Which of the acceptable and available pesticides are best suited for the job in terms of expected results?

Insect Resistance: Is the target species known to have resistance or levels of tolerance to the pesticide? Is a monitoring system in place to determine baseline susceptibility of the species to the pesticide and to detect changes during the project?

Storage and Disposal: Are storage and disposal facilities for pesticides and empty containers available, adequate, and under proper supervision?

Personnel: Are properly trained personnel available for handling and applying the pesticides of choice? Are they supervised by trained personnel? Are training and retraining programs in place?

Addressing such considerations as posed by the foregoing questions for the specific pesticide(s) and formulation(s) proposed for the specific pest(s) in the specific target area(s) will assure a sound approach to "doing the right thing in the right place at the right time".

Once a pesticide formulation has been selected and identified for use in a vector control program, a more focused appraisal is offered by Reg. 216.3 (b)(1)(i) which lists factors to be considered, but not necessarily limited to the following:

a. The USEPA registration status of the requested pesticide.

b. The basis for selection of the requested pesticide.

c. The extent to which the proposed pesticide use is part

of an integrated pest management program.

d. The proposed method or methods of application, including availability of appropriate application and safety equipment.

e. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use and measures available to minimize such hazards.

f. The effectiveness of the pesticide for the proposed use.

g. Compatibility of the proposed pesticide with target and nontarget ecosystems.

h. The conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

i. The availability and effectiveness of other pesticides or nonchemical control methods.

j. The requesting country's ability to regulate or control the distribution, storage, use and disposal of the requested pesticide.

k. The provisions made for training of users and applicators, and

l. The provisions made for monitoring the use and effectiveness of the pesticide.

The strict adherence to the guidelines under Reg. 216 in terms of documentation and procedures will almost certainly assure compliance with the purpose and intent of USAID environmental regulations.

(3) Pesticide Applications in Vector Control Projects

Relatively few of the vast numbers of pesticides developed and marketed since the advent of synthetic organic compounds (developed since World War II) have found application in vector control projects, particularly in USAID-supported projects in developing countries. This is due largely to the need for highly specific compounds and formulations required for domiciliary and peri-domiciliary mosquito adulticiding and the direct application of mosquito larvicides to aquatic habitats near human habitation or activity as opposed to agricultural application to field crops in sparsely populated and open areas. Cultural, social, economic, and safety factors associated with such a visible application of pesticides directly affecting the human population have all contributed to constraints in pesticides selection for public

health uses. This subject is more fully discussed in Annex 4A and 4D.

EPA-approved pesticides available for use in USAID-supported vector-borne disease control are listed in Table 1. The principle uses include: (1) adulticiding of interior surfaces (mainly walls) of domiciles with residual compounds (e.g., malathion, fenitrothion, propoxur) allowing protection for several months, thus minimizing treatment to two or three times per year; (2) adulticides used as space sprays in peri-domiciliary situations to precipitously reduce mosquito populations -- e.g., very low dosages of malathion, naled, etc. as ultra-low-volume (ULV) or low volume sprays or fog applied by truck-mounted or airplane spray equipment (aerial applications are used mainly to cover large areas specifically in emergency disease control situations); (3) larviciding mosquito habitats producing vector species <u>within flight range</u> of the human population targeted for protection under the project. In every case, the purpose and desired result is the minimization of vector-human contact to interrupt the transfer of disease agents (protozoa of malaria; viruses of dengue, yellow fever, or encephalitis; worms of filariasis or onchocerciasis; etc.).

While a policy might embrace alternatives to the use of vector control in disease control to satisfy ecological and environmental interests -- for some diseases, e.g., dengue and encephalitis, there is no currently available alternative to vector control. Thus, insecticides continue to be necessary (See Annex 3D).

Insecticidal compounds used in mosquito control as larvicides, residual sprays or aerosols, compiled from WHO documents, are included in Table 2 with the WHO hazard rating for each compound. Those compounds most likely to be used in vector control projects abroad, and the relative costs of the more applicable compounds are given in Table 3. Insecticides labeled by U.S. EPA for the control of adult and larval mosquitoes by ground and aerial application methods have recently been extensively reviewed by Rathburn and a copy of his report is appended as Annex 2.

(4) <u>Insect Resistance to Pesticides</u>

Consideration of the use of chemical control of insect pests must include the concept of insecticide resistance. Since most normal populations of insects represent a large gene pool, they contain individuals that vary widely in their susceptibility to insecticides. As a result, putting selective pressure on a population with a toxic chemical leads to survival of those individuals <u>tolerant</u> to the chemical. Continued selective pressure causes a shift of the gene pool with the result that <u>resistance</u> develops in most of a population. As pesticide resistance becomes more widespread (Tables 4 & 5), whether through heavy agricultural spraying (see Annex 3c) of the same compounds used in vector

control or related compounds, or by improper use of vector control pesticides, an understanding of resistance and its problems become essential to effective vector control.

Resistance of insects to insecticides is defined as the ability of an insect population to withstand a poison which was generally lethal to earlier populations. In general, two types of resistance occur in insects:

Physiological resistance: The ability through physiological processes to withstand a toxicant (e.g. by differences in the permeability of the insect exoskeleton to insecticides or the storage of insecticides in body tissues such as fat).

Some biochemical mechanisms for the development of resistance are so general in scope that cross-resistance develops between similar or virtually unrelated pesticides.

Behavioral resistance: This type of resistance is reflected in the ability of the insect to avoid lethal contact with the insecticide through protective habits or behavior, such as anopheline mosquitoes resting outdoors rather than on treated interior wall surfaces. Such resistance is also believed to be genetic with the resistance-conferring behavioral traits being selected in a similar manner.

Resistance to insecticides has been reported in many species of insects. Among arthropods of public health importance, this phenomenon was first noted among culicine mosquitoes in Italy in 1946 and 1947. By 1958, 35 species of insects of public health importance were reported to be resistant to organochlorines and 4 were resistant to organophosphates. By 1971, there were reported to be 104 species resistant to organochlorines and 18 resistant to organophosphates. In 1984, 171 species of insects and mites of medical/veterinary importance were reported to be resistant to one or more classes of insecticides. Since that time, resistance has continued to appear.

In some areas, such as parts of California, because of widespread resistance to multiple compounds, chemical control of mosquitoes is no longer practical except through the use of larvicidal oils. Because of its impact on our ability to control vector populations, public health workers should periodically test susceptibility of insect species to the insecticides used in control programs. It is particularly important to have a baseline level of susceptibility of a species to a new insecticide before changing chemicals.

In many parts of the world, the widespread use of a particular insecticide in agriculture has led to resistance in species of public health importance. For example, in Central America, the widespread use of DDT to control agricultural insects has exposed

malaria mosquitoes to this insecticide, eliminating the susceptible individuals, and gradually developing a strain of Anopheles resistant to this chemical. This situation led to the failure of malaria control programs based on killing adult Anopheles by residual spraying of homes with the affected insecticide. Examples of malaria vectors resistant to various compounds in at least some parts of their range are listed in Tables 4 & 5.

Kits for determining resistance to insecticides in mosquito adults and larvae, flies, fleas, lice, bedbugs, and other arthropods of public health importance have been developed by the World Health Organization (WHO).

These kits can be purchased from the WHO and used to determine susceptibility levels to an insecticide before changing to a new compound[7]. The drawback to the use of these kits is that resistance to space sprays cannot be determined by using them. Field bioassay, even with problems of standardization of technique, remains the only practical means for space spray susceptibility evaluation.

Many genetic, biological, and operational factors lead to development of (or loss of) resistance in a population, and courses of action that might be affected by or contribute to increased resistance in a vector population should be avoided when selecting an insecticide for project application.

A further discussion on resistance as related to insecticide selection appears in Annex 3B, and on vector resistance and agriculture in Annex 3C.

(5) Hazards Involved in the Use of Pesticides

Reg. 216 covering pesticide procedures includes examination of potential hazards to the human environment as an integral part of the review system and should be considered early in the review process. Once a decision is made to approve a planned pesticide use, the Project Paper (PP) shall include, to the extent practicable, provisions designed to mitigate potential adverse effects of the pesticide.

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7 In addition to the kits, a series of unpublished WHO documents "Instructions for determining the susceptibility of public health pests to pesticides," a catalogue of related materials can be ordered from the Division of Vector Biology and Control, World Health Organization 1211 Geneva 27, Switzerland.

While various situations under Reg. 216 (A.I.D. involvement; registration status of the pesticide by USEPA for similar uses; use restrictions, etc.) determine the course and level of action required of USAID, as well as the responsibilities of the host country in detailing specifics of hazard management (storage, handling, container disposal, etc.) -- it is apparent that each proposed use and formulation must be individually evaluated. Reg. 216 is the basic guideline, supplemented by specific label instructions and the "scoping" process.

While a clear USAID policy on the handling of pesticide hazards, apart from those regulations in Reg. 216 seems to be lacking for public health uses -- the agency does have established policies regarding safe handling of pesticides in agricultural projects drawn heavily from two sources: (1) Guidelines for Selection and Use of Pesticides in Bank Financed Projects and the Procurement when Financed by the Bank (known as the World Bank Guidelines, which the agency helped develop and endorsed in 1985) and (2) The International Code of Conduct on the Distribution and Use of Pesticides (1986. Food and Agriculture Organization). Since USAID policy concerning pesticide safety is derived largely from the World Bank Guidelines and on which much of Reg. 216 application to public health pesticide use is based, Section B (Handling, Storage and Application Safety) from the World Bank Guidelines is appended as Annex 4 to this document. During the period of the global malaria eradication strategy, CDC played a lead role in conjunction with WHO in the area of insecticide technology, including hazard management aspects. Because of the specific applicability of CDC's pesticide safety activities to public health projects, a chapter from "Insecticides for the Control of Insects of Public Health Importance" (CDC 1981) is reproduced in Annex 5, summarizing pesticide safety.

When organophosphate (OP) compounds, such as malathion and fenitrothion are used it is imperative to periodically measure cholinesterase depression in staff handling such pesticides. The standard WHO-approved field methods for measuring blood cholinesterase activity are described in Annex 6.

Figure 1 diagrams relative risks of pesticide intoxication by occupation and type of exposure. Figure 2, depicts in equation form the various factors influencing the hazards of pesticide use in terms of the variables (toxicity, contamination, time of exposure). For example, dilution, protective clothing, and short exposure time collectively offset much of the risk of using a pesticide of relatively high mammalian toxicity.

## 4.2 Alternatives To Chemical Pesticides in Vector Control

In recent years several classes of "non-chemical" compounds have found their way into vector control programs and some have become viable alternatives to conventional pesticides, especially

in integrated programs. The most successful of these compounds have been those directed against mosquito larvae in distinctive aquatic habitats. Especially worthy of mention are the Insect Growth Regulator (IGR) compounds, principally methoprene, that interfere with the normal physiological processes of specific organisms disrupting molting or metamorphosis; and the monomolecular film (Arosurf MSF) which is a highly refined hydrocarbon with formulation and safety advantages over conventional petroleum oils. Although sometimes thought of more as a biological control agent, the bacterial compound Bacillus thuringiensis var. israelensis (B.t.i.) is more chemical than biological in that it is formulated as a chemical, applied as a chemical and evaluated as a chemical and must be ingested by mosquito larvae to be effective. These formulations are not bacteria, per se, but rather crystals derived from spores produced by laboratory cultured bacteria. Thus, for practical purposes, B.t.i. formulations are usually included among listings of chemical larvicides. However, in this document, B.t.i. is discussed under bacteria in the biological control section which follows.

(a) Biological Control

With the exception of the use of larvivorous fish, all approaches to the efficacious control of vector mosquitoes by biological means must be considered as new technology in various stages of development[6]. Even with larvivorous fish, which have generally shown a high degree of biocontrol success, there remains a need to find species which are adapted to survival under local conditions and in temporary habitats.

Although biological control agents alone are not expected to be 100 percent effective, it is important to determine how they may be used to supplement other control tactics in an IPM program. Other than time proven larvivorous fish, the following groups of organisms are considered to have potential in mosquito control, at least under certain, rather specific conditions.

(1) Predators

Turbellaria. Certain species of flatworms appear to hold potential for control of immature mosquitoes. They are readily mass produced and produce semidormant eggs. Dugesia dorotocephala has been shown to be effective against a number of Florida pest mosquitoes including Ae. taeniorhynchus, Ps. columbiae, and Cx. nigripalpus. However, this species is adversely affected by high salt concentrations.

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[6]The material in this section is derived basically from "Integrated Pest Management for Mosquitoes in Florida" unpublished work document, May 1982, pp. 48-56. (Office of Entomology, Dept. of HRS, Jacksonville)

Toxorhynchites (mosquito larvae). Those species of predatory Toxorhynchites offer potential in the control of treehole and container-breeding mosquitoes. Tests with Tx. rutilus in New Orleans have shown the females to be extremely fastidious in the selection of oviposition sites. This predatory genus has potential in biocontrol if species can be found which are more catholic in their choice of containers for oviposition.

(2) Parasites and Pathogens

Nematodes. The mermithid Romanomermis culicivorax has a wide host range and is readily mass produced. Under favorable conditions, laboratory produced populations have become established in the field and continued to recycle. Drying, salinity and temperature are limiting factors in infectivity and establishment of the species. Another species, Octomyomermis muspratti, is tolerant of pollution, salinity, and dessication, and has potential for dispersal by infected adult mosquitoes. However, the species characterized by asynchronous egg hatching, is difficult to mass produce.

Bacteria. Both Bacillus thuringiensis var. israelensis (B.t.i.) (serotype H-14) and Bacillus sphaericus (strain 1593). are steadily becoming more established as larvicides in mosquito control activities. B.t.i. is, in effect, a biological insecticide which does not recycle in mosquito populations and therefore must be continuously reapplied as needed. Advantages of B.t.i. include a lack of activity against nontarget organisms and effectiveness against a wide range of mosquito species.

B. sphaericus (strain 1593) also kills mosquitoes by means of a toxin or toxins, produced during vegetative growth as well as during sporulation. Concentrations of the toxin are much higher in spores. Most Culex species are susceptible to B. sphaericus while Aedes and Anopheles vary in susceptibility from species to species and, in Anopheles, even between strains of the same species. B. sphaericus spores are active in polluted waters, have long residual activity, and in certain habitats show potential for recycling, but its effectiveness is reduced by excessive suspended particulates.

(3) Fungi

A number of fungi are being investigated for activity against mosquito larvae. New mosquito pathogenic strains of Metarhizium anisopliae have been found which are infectious for a wide range of species. Conidia adhere to the perispiracular valves of larvae, germinate and penetrate the cuticle. Death results from obstruction of the spiracles or possibly from toxins. Recycling does not occur and mass production techniques are yet to be developed.

The aquatic fungus Lagenidium giganteum can grow as a saprophyte or as a parasite of mosquito larvae. The mosquito is killed when the infectious zoospores penetrate the cuticle and form an extensive mycelium throughout the hemocoel. This fungus has excellent potential because of its broad mosquito host range and ability to recycle.

Other facultative fungal parasites of mosquitoes include species of Culicinomyces. These fungi have a wide mosquito host range and produce conidia on mosquito cadavers thereby recycling in the aquatic environment. They may also be disseminated by adult mosquitoes.

Fungi of the genus Coelomomyces which infect mosquitoes are obligately heteroecious and require copepods as intermediate hosts. Thus, they are likely to have limited efficacy. Knowledge of the host specificity of Coelomomyces spp. is still rather limited, but the possibility of introduction and establishment of exotic species should be explored.

(4) Protozoa

The most common protozoan parasites of mosquitoes are the microsporidia. Two species, Vavraia culicis and Nosema algerae have been studied rather extensively. Neither species results in extensive larval mortality, but both in decrease longevity and fecundity in adult mosquitoes. In field tests they show little ability to recycle, which limits their usefulness. Another group of microsporidia, the Amblysoporidae, are currently being studied. This family contains species which are dimorphic in development and can be transovarially transmitted for one generation in some species and for multiple generations in others. They have not been transmitted horizontally and it is possible that an intermediate host may be required. They have the advantages of being lethal to mosquito larvae and being transovarially transmitted.

(5) Viruses

A fairly large number of viruses have been reported from mosquitoes. The Baculovirus group offers the most promise for biocontrol potential because of generally high inefectivity and pathogenicity. Viral pathogens are generally difficult to mass produce and work in vector control lags behind similar work for control of agricultural pests.

(6) Genetic Control

Genetic control programs have been successful against several economically important pests including the screwworm,

fruit flies, pink bollworm, and codling moth and research has demonstrated the applicability of the theory and principal to a variety of other pest species. Common to success has been mass production, sterilization by radiation or chemical and release of sterilized insects. Other genetic mechanisms such as translocations, inversions, compound chromosomes, hybrid sterility, cytoplasmic incompatibility and others are being investigated for their applicability to control programs.

Research on genetic control in mosquitoes has been restricted to disease-bearing species in the genera Anopheles, Culex and Aedes. These groups can be sterilized by radiation and chemicals. Small scale field trials have demonstrated that these sterile male mosquito can compete in nature and induce sterility in wild females. Where experiments were run with small populations in relatively isolated areas, population reduction occurred. Where experiments involved small to large areas without isolation, migration tended to hinder reduction. Current research involving sterility is promising.

## 4.3 Physical Control (Source Reduction)

Physical control, as used in this document, refers to all commonly employed methods of mosquito control other than chemical or biological. Physical methods include mainly those which involve the physical or mechanical alteration of topography in the management of water. Elimination or reduction of mosquito breeding sites by these methods is often termed "source reduction" or physical larval control (PLC). All source reduction methods require some manipulation of the environment, and should be examined for possible negative (or positive) effects on the environment (Appendix II). While physical control techniques are effective--they may not always be feasible for environmental, economic, cultural or other reasons.

Source reduction methods most commonly used include filling, deepening, draining, ditching, water level management, shoreline maintenance, management of vegetation, and others in selected situations.* Impoundments, reservoirs, irrigation systems, navigational dredging, natural wetlands, and the presence of endangered species present special problems in mosquito control by physical means.

A brief description of the more common physical control methods used in vector control is given below, and their nature is such that environmental impact (positive or negative) must always be considered.

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* A convenient reference is "Manual on Environmental Management for Mosquito Control" WHO Offset Publ. No. 66, Geneva 1982: pp. 283

(a) Filling - The placing of soil and similar compacting materials into water-holding depression.

(b) Deepening - The modification of impoundments to increase the slope of the shoreline, thus reducing shallow margins associated with mosquito breeding. Often, deepening and filling are used in conjunction, i.e., deepening a reservoir and using the soil to build up the marginal rim. This technique is especially useful in situations of fluctuating water levels.

(c) Drainage - this widely used method involves open ditching, use of subsurface drains or even pumping to remove standing water. Each technique has a specific application, and its use depends on the size of the area to be drained, the terrain, soil type, economic feasibility, etc.

(c) Water and Land Management - This category might be more a reflection of a vector control response than to a vector control intervention owing to such activities as irrigation, "borrow pit" use, collection of waste water, etc. by others. However, there are many examples of water and shoreline management for vector control goals, the most notable being the water management system of the Tennessee Valley Authority.

(e) Impoundments - many problems of reservoir mosquito production can be "built out" in the planning stages by proper clearing, basin preparation, mechanisms for managing pool levels and proper shoreline maintenance.

(f) Construction Projects - Reservoirs, irrigation systems, "borrow pits", diked spoils areas, etc. are activities that are generally not aimed at vector control but may be conducive to large scale production of mosquito larvae, thus requiring a vector control consideration during construction and maintenance periods. Such activities are covered under Reg. 216 as previously stated.

(g) Environmentally sensitive habitats - Areas designated as natural wetlands, areas known to be environmentally sensitive for any reason, or to contain endangered species require very special attention under Reg. 216. If disease control intervention using vector control should be absolutely necessary - then special consideration should be given to the use of alternative methodology not affecting such sensitive areas (see Appendix II).

(h) Man-made vs. Natural Habitats. While many mosquito habitats are naturally occurring (undisturbed marshes, swamps, springs, estuaries, spring-fed ponds, lakes, water-containing tree cavities, pooled stream water, etc.)--as many, if not more, with sometimes greater consequences are man-made (poorly maintained drainage ditches and structures, "borrow pits", reservoirs, irrigation structures and systems, spoils areas, domestic containers, etc.).

Notwithstanding the source of mosquito breeding habitats, natural or man-made, most can be mitigated, often without the use of pesticides and without damage to the environment. In most man-made situations involving manipulation of water and land in construction of reservoirs, irrigation projects, drainage projects, airports or roads, etc., the opportunity exists to "build out" potential problem situations even in the design stage by "building in " water control structures or mechanisms such as flash boards, dikes, pumping stations, proper reservoir basin preparation, shoreline maintenance practices, sump systems, etc.

For example, reservoirs can be properly cleared and water levels managed to prevent anophelism (malaria prevention); water supplies and waste water system can be controlled or designed in housing projects to lessen the production of domestic Aedes and Culex (vectors of yellow fever, dengue, filariasis); irrigation water flow can be designed or controlled to lessen floodwater mosquito production (arbovirus vectors); dikes and pumps can be used to keep "wet places wet" and "dry places dry", both sound mosquito control practices, etc.

Thus, in reviewing the various physical control options, the opportunity exists to consider vector control alternatives for each project activity in terms of economic, social, cultural and environmental efficacy.

## 5.0 Training of Vector Control Personnel

If in the environmental procedures it is determined that A.I.D. approved activities require mitigation by training of in-country personnel, such plans would be incorporated in the appropriate documents. For example, Reg. 216.3(b), in dealing with potential hazards of pesticide use, states..." the Initial Environmental Examination will include an evaluation of the user hazards associated with the proposed USEPA restricted uses (pesticides) to ensure that the implementation plan which is contained in the Project Paper incorporates provisions for making the recipient government aware of these risks and providing, if necessary, such technical assistance as may be required to mitigate these risks." In many cases the most effective mitigating factor would be training in the safe use and monitoring of pesticides in the human and natural environment.

The nature and extent of training to ensure environmental procedures compliance should be tailored to a specific activity, but should always be considered in environmental as well as technical terms.

Examples of training activities as related to the use of pesticides in terms of environmental considerations are provided by the following sample paragraphs taken from a 1988 Environmental Assessment of the USAID Pakistan Malaria Control Project Extension:

### Provision for Training of Malaria Control Insecticide Users

Specialized preservice and in-service refresher courses for senior and mid-level provincial and urban health officers (malaria staff and general health staff working on malaria) are provided regularly by NIMRT in Lahore. The courses offered are designed to meet the current malaria control program needs. Preservice courses include 12-14 week courses for physicians, malaria superintendents and entomologists, and 10 week courses for junior field supervisors. A part of the curriculum is instruction in insecticide application technologies, formulations, safe use practices and the use of cholinesterase test kits. In addition, a USAID-financed 3-day workshop is given annually for entomologists, malaria superintendents and health education officers in each province, the subject being safe use of insecticides. The objective is to give refresher training to these trainers, who will in turn give instructions to all malaria supervisors who will serve as spray squad leaders.

When spraymen and mixers are employed for the spraying season each year, they are given a one week training period by the malaria supervisors who will be their squad leader. This training includes proper mixing and spraying techniques, and safety precautions to protect employees as well as

householders.

Safety Training. In 1988 as in previous years, workshops were held in each Province on the safe use of pesticides. All Assistant Entomologists and CD officers involved in malaria control attended the workshops. Participants were expected to pass safety information on to each Malaria Supervisor. In this way, safety procedures were reinforced throughout the malaria control program system.

## 6.0 Operational Examples of USAID Environmental Assessment Strategy

To strengthen the understanding and interpretation of environmental regulatory aspects of these guidelines, two excerpts from two recent Environmental Assessments (Honduras 1988 and Pakistan 1988) conducted by the Vector Biology and Control Project (VBC) on behalf of AID and the respective missions are appended as an integral part of this manual (Appendices II and III). In each case, the excerpts include the extracted Table of Contents to illustrate the coverage, scope, applicability and general procedures involved in an environmental assessment related to vector control projects. A second entity, in each case includes a more detailed excerpt detailing criteria review activities necessary to the completion of the respective environmental assessments.

Appendix II (Environmental Assessment, Vector Control and Water and Sanitation Activities of the Health Sector II Project, Honduras, June 1988) illustrates environmental regulatory procedures related to most aspects of a mosquito control intervention program including adulticiding, larviciding, land control, etc. Appendix III (Environmental Assessment of the Pakistan Malaria Control II Project Extension, August 1988) illustrates a more focused activity dealing with hazard management of pesticides (transport, storage, disposal, etc.) used in a large malaria control program.

Although the Honduras (Appendix II) and Pakistan (Appendix III) represent different regions, situations and technical considerations, similarities can be seen in the mechanics of completing an environmental assessment in the area of vector-borne disease control.

**TABLE 1**

Insecticides available for use in A.I.D.-Supported Vector Control (VC) Projects and Registered for Mosquito Control by EPA (See Annex 2)

| Insecticide | Most Common Use in VC Projects | Viable Alternatives |
|---|---|---|
| Adulticides: | | |
| Malathion | Intradomiciliary residual spray against anopheline vectors of malaria | Selection from the list of a compound not previously used in a specific program meeting the criteria of Annex 1. |
| Propoxur | | |
| Fenitrothion | | |
| Bendiocarb | | |
| Malathion | Ground or air ULV | Selection from listed compounds and consideration of other formulations as fogs or sprays by ground or air consistent with labeling. |
| Naled | Ground ULV | |
| Fenthion | Ground ULV | |
| Chlorpyriphos | Ground ULV | |
| Resmethrin/ Pipelonyl butoxide (Pbo) | Ground ULV | |
| Pyrethrin/Pbo | Ground ULV | |
| Larvicides: | | |
| Temephos | Ground Hand Application | Selection of various formulations (emulsifiables, granular, flowable concentrates, wettable powder, pellets, sand granules, etc.) from the list and alternative methods of application (pressure equipment, vehicle mounted equipment, aerial equipment, etc.) consistent with labeling. |
| Chlorpyriphos | Ground Hand Application | |
| Fenthion | Ground Hand Application | |
| Malathion | Ground Hand Application | |
| Methoprene (IGR) | Ground Hand Application | |
| B.t.i. (bacteria) | Ground Hand Application | |
| Arosurf® (monomolecular film) | Ground Hand Application | |
| Oils | Ground Hand Application | |

TABLE 2

INSECTICIDES USED IN MOSQUITO CONTROL (WHO)

Key: Acute Hazard Unlikely AHU — Highly Hazardous IB
Moderately Hazardous II — Slightly Hazardous III
Not Applicable N/A

| WHO Class Hazard | Compound | | Larvicide | Residual Spray | Aerosol |
|---|---|---|---|---|---|
| AHU | bioresmethrin | (PY) | | | X |
| II | *bendiocarb | (C) | | X | |
| AHU | chlorphoxim | (OP) | X | X | |
| II | *chlorpyrifos | (OP) | X | | X |
| II | DDT | (OC) | | X | |
| AHU | deltamethrin | (PY) | X | X | X |
| IB | dichlorvos | (OP) | | X | X |
| AHU | *diflubenzuron | (IGR) | X | | |
| II | *fenitrothion | (OP) | X | X | X |
| IB | *fenthion | (OP) | X | | X |
| AHU | jodfenphos | (OP) | X | | X |
| II | lindane (gamma HCH) | (OC) | | X | |
| III | *malathion | (OP) | X | X | X |
| AHU | *methoprene | (IGR) | X | | |
| II | *naled (Dibrom) | (OP) | | | X |
| AHU | *permethrin | (PY) | X | X | X |
| II | phoxim | (OP) | X | | |
| III | pirimiphos-methyl | (OP) | X | X | X |
| II | *propoxur | (C) | | X | X |
| III | *resmethrin | (PY) | | | X |
| AHU | *temephos (Abate) | (OP) | X | | |
| AHU | B.t.i. | | X | | |
| N/A | fuel oil | | X | | |
| NA | larvicidal oil | | X | | |
| N/A | monomolecular layers | | X | | |
| IB | Paris Green | | X | | |

*Most likely to be used in projects supported by USAID.
' Extracted from: W.H.O. 1986. The WHO Recommended classification of presticides by hazard and guidelines to classification 1986/1987. VBC 86.1

TABLE 3

**RELATIVE COSTS OF PESTICIDES USED FOR INDOOR HOUSE SPRAYING: INCREASED LABOR COSTS (2X) FOR OP AND C COMPOUNDS NOT INCLUDED**

| Insecticide (Type) | Dosage[1] a.i. $g/m^2$ | Applications[1] per year | Cost US$/kg | Relative Costs of Insecticides (DDT=1) |
|---|---|---|---|---|
| DDT (OC) | 2.0 | 2 | 1.50 | 1.0 |
| Malathion (OP) | 1-2.0 | 4 | 3.50 | 4.6 |
| Fenitrothion (OP) | 1-2.0 | 4 | 5.50 | 7.3 |
| Propoxur (C) | 1-2.0 | 4 | 16.00 | 21.0 |
| Bendiocarb (C) | 0.4 | 4 | 50.00 | 26.6 |

[1] World Health Organization/Vector Biology and Control/82.841

TABLE 4

OCCURRENCE OF RESISTANCE IN SELECTED ANOPHELINES TO ADULTICIDES[a]

| Species | Organochlorines | | Organophosphates | | | Carbamates (some) | Pyrethroids (some) |
|---|---|---|---|---|---|---|---|
| | DDT | HCH | Malathion | Fenitrothion | Other | | |
| **Anopheles** | | | | | | | |
| **Africa** | | | | | | | |
| gambiae | + | + | | | | | |
| arabiensis | + | + | + | | | | + |
| funestus | + | + | + | | | | |
| **Asia and Near East** | | | | | | | |
| pharoensis | + | + | + | + | + | + | |
| sacharovi | + | + | + | + | + | + | + |
| stephensi | + | + | + | + | + | + | |
| minimus | + | + | | | | | |
| sundiacus | + | + | | | | | |
| culicifaces | + | + | + | + | | + | + |
| **Americas** | | | | | | | |
| albimanus | + | + | + | + | | + | |
| darlingi | + | | | | | | |
| pseudopunctipennis | + | + | + | + | | + | + |

[a]Existence of resistance in some populations does not indicate that resistance exists in all populations throughout the geographic range of the species (e.g., An. darlingi exhibits resistance in Colombia, but not in other areas of South America). Therefore, this table records that resistance has developed in some populations and may develop in others.

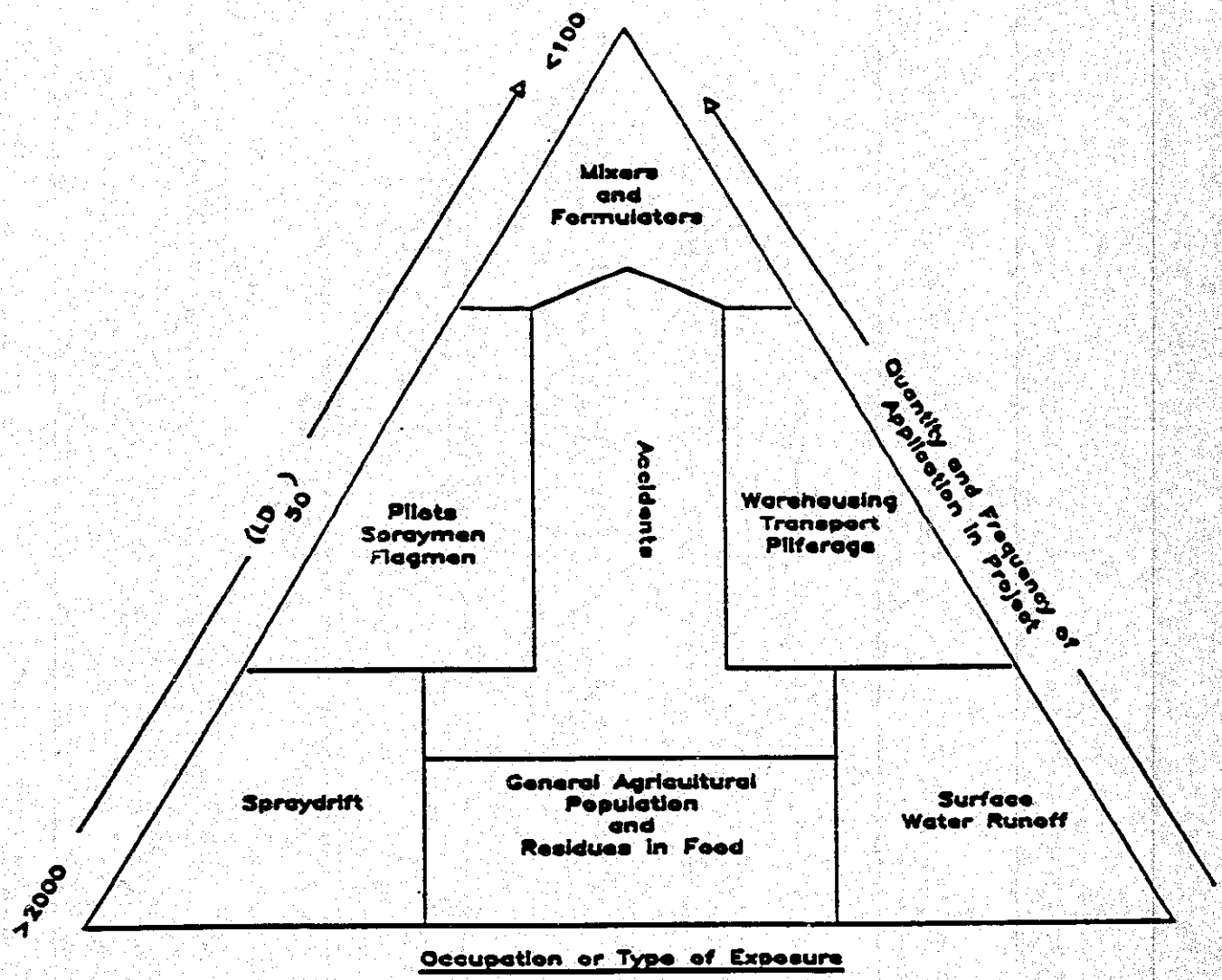
Source: Brown, A.W.A. 1986. Insecticide Resistance in Mosquitoes: A Pragmatic Review. J. Am. Mosq. Control Assoc. 2(2): 123-140.

TABLE 5

STATUS OF VECTOR RESISTANCE (YEAR OF FIRST DETECTION) TO PESTICIDES IN CENTRAL AMERICAN COUNTRIES

| Country | Persons performing tests | No. of tests per year | Vector species | Stage | Malathion | Propoxur | Fenthion | Temephos | Deltamethrin | Dieldrin | HCH | DDT | Dursban | Fenitrothion | Bayteroid | Bendiocarb | Chlorpyrifos | Pirimiphosmethyl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Costa Rica | 7 | ? | Ae. aegypti | L | - | | | | - | | | - | | | | | | |
| | | | An. albimanus | A | - | 1979 | | | - | - | | 1974 | | | | | | |
| El Salvador | 5 | 280-300 | Ae. aegypti | L | | | 1965 | | | - | 1974 | - | | | | | | |
| | | | An. albimanus | A | | 1974 | | | | 1960 | | 1960 | | | | | | |
| Guatemala | 13 | 200-300 | Ae. aegypti | L | - | | | - | | - | - | 1973 | - | - | | | | |
| | | | An. albimanus | A | - | 1981 | | | 1980 | 1964 | | 1964 | | 1979 | - | 1985 | 1980 | - |
| | | | An. pseudopunctipennis | A | | | | | - | | | 1980 | | - | | | - | |
| | | | An. vestitipennis | A | | - | | | | | | 1979 | | - | | | - | |
| Honduras | 3 | 50 | Ae. aegypti | L | | | | - | | - | 1973 | 1968 | | | | | | |
| | | | " | A | | | | | | | | 1968 | | 1984 | | | | |
| | | | An. albimanus | A | | 1973 | | | + | | | 1970 | | 1980 | | | | |
| Mexico | 50 | 12 | An. albimanus | A | 1982 | 1982 | - | | 1982 | | | 1964 | | 1982 | | | - | |
| | | | An. aquasalis | A | | | | | | | | | | | | | - | |
| | | | An. pseudopunctipennis | A | | | | | | 1967 | | 1972 | | | | | | |
| | | | An. quadrimaculatus | A | | | | | | | | 1964 | | | | | | |
| | | | An. vestitipennis | A | | | | | | | | 1976 | | | | | | |
| | | | Cimax lectularius | A | 1973 | 1973 | | | | 1973 | 1973 | 1973 | | | | | | |
| Nicaragua | 8 | 20 | An. albimanus | A | 1980 | 1979 | | | 1985 | | | 1965 | | 1985 | | 1982 | 1978 | |
| | | | An. pseudopunctipennis | A | | | | | - | | | | | | | | | |
| | | | Ae. aegypti | L | | | + | | | | | | | | | | | |
| | | | Ae. aegypti | A | + | | | | | | | | | | | | | |
| Panama | 12 | 50 | Ae. aegypti | L | - | | - | - | | 1973 | | | | | | | | |
| | | | An. albimanus | A | 1981 | - | | | | | | 1971 | | - | | | | |
| | | | An. apicimacula | A | | | | | | | | - | | | | | | |
| | | | An. pseudopunctipennis | A | | | | | | | | - | | | | | | |
| | | | An. punctimacula | A | | - | | | | | | 1980 | | | | | | |

FIGURE 1




Comparison of the risks of various occupations, and through other means of exposure, to pesticide intoxication in relation to the quantities and toxicities of pesticides used in pest/vector control programs.

FIGURE 2. HAZARD VARIABLES (TOXICITY, CONTAMINATION, TIME) OF PESTICIDES
FROM: PLESTINA, R. 1984. PREVENTION, DIAGNOSIS AND TREATMENT OF INSECTICIDE POISONING. WHO/VBC/84.889.GENEVA, 71 PP.

where:

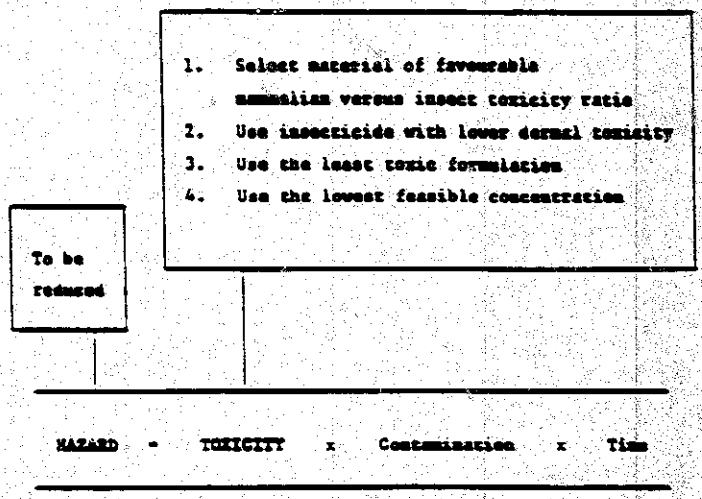
Hazard = risk of poisoning

Toxicity = ability to cause damage

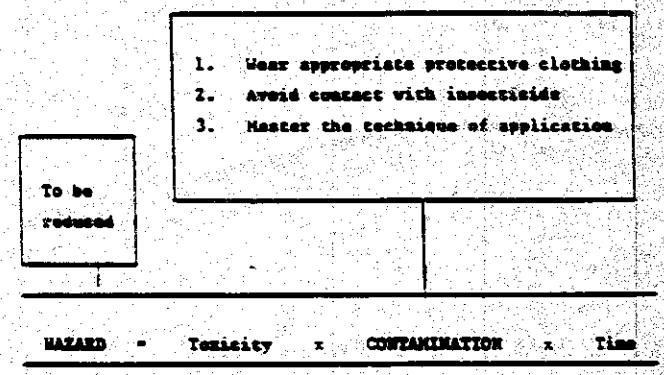
Contamination = prerequisite for entering body

Time = duration of contact with insecticide

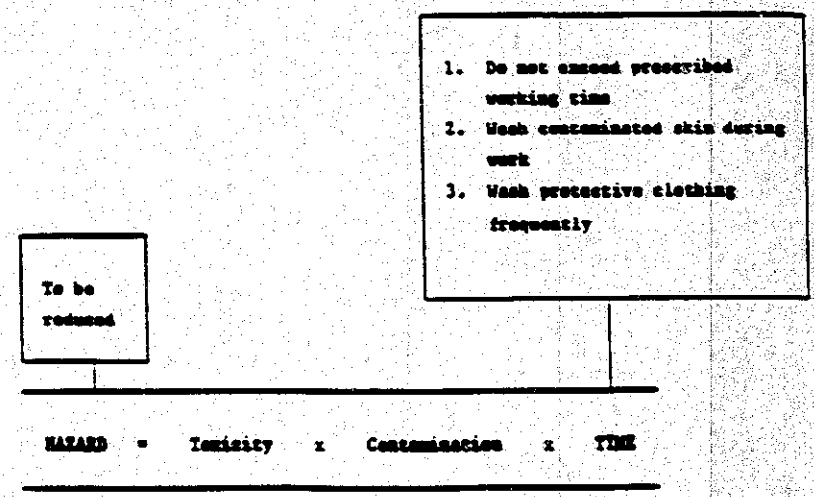
If any of the three variables on the right side of equation is zero, hazard is also zero. However, since the toxicity variable can never be zero, all insecticides having some degree of toxicity can be reduced by selecting the most appropriate insecticide. For example, a compound may be of relatively high mammalian toxicity but presents little hazard if it is used in a very diluted form or in a formulation that makes absorption difficult by any route.




The hazard will also be considerably reduced, even if a toxic compound is used, if the compound is applied by an experienced operator, properly equipped and properly protected. It is known that poisonings among professionals are rare.




The longer the working time the higher the risk involved, provided that other variables remain unchanged.




This also means that a chemical of relatively low mammalian toxicity may present a hazard when it is used in concentrated form, and handled frequently by non-professionals who are poorly equipped and unprotected.

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# APPENDIX I

## Environmental Procedures

These Procedures have been revised based on experience with previous ones agreed to in settlement of a law suit brought against the Agency in 1975. The Procedures are Federal Regulations and therefore, it is, imperative that they be followed in the development of Agency programs.

In preparing these Regulations, some interpretations and definitions have been drawn from Executive Order No 12114 of January 4, 1979, on the application of the national Environmental Policy Act (NEPA) to extraterritorial situations. Some elements of the revised regulations on NEPA issued by the President's Council on Environmental Quality have also been adopted. Examples are: the definition of significant impact, the concept of scoping of issues to be examined in a formal analysis, and the elimination of certain AID activities from the requirement for environmental review.

In addition, these procedures: 1) provide advance notice that certain types of projects will automatically require detailed environmental analysis thus eliminating one step in the former process and permitting early planning for this activity; 2) permit the use of specially prepared project design considerations or guidance to be substituted for environmental analysis in selected situations; 3) advocate the use of indigenous specialists to examine pre-defined issues during the project design stage; 4) clarify the role of the Bureau's Environmental Officer in the review and approval process and 5) permit in certain circumstances, projects to go forward prior to completion of environmental analysis.

Note that only minimal clarification changes have been made in those sections dealing with the evaluation and selection of pesticides to be supported by AID in projects or of a non-project assistance activity.

**INTERNATIONAL DEVELOPMENT COOPERATION AGENCY**
**Agency for International Development**

**22 CFR Part 216**

**Environmental Procedures**

**§ 216.1 Introduction.**

(a) *Purpose.* In accordance with Sections 118(b) and 621 of the Foreign Assistance Act of 1961, as amended, (the FAA) the following general procedures shall be used by A.I.D. to ensure that environmental factors and values are integrated into the A.I.D. decision making process. These procedures also assign responsibility within the Agency for assessing the environmental effects of A.I.D.'s actions. These procedures are consistent with Executive Order 12114, issued January 4, 1979, entitled Environmental Effects Abroad of Major Federal Actions, and the purposes of the National Environmental Policy Act of 1970, as amended (42 U.S.C. 4371 et seq.) (NEPA). They are intended to implement the requirements of NEPA as they effect the A.I.D. program.

(b) *Environmental Policy.* In the conduct of its mandate to help upgrade the quality of life of the poor in developing countries, A.I.D. conducts a broad range of activities. These activities address such basic problems as hunger, malnutrition, overpopulation, disease, disaster, deterioration of the environment and the natural resource base, illiteracy as well as the lack of adequate housing and transportation. Pursuant to the FAA, A.I.D. provides development assistance in the form of technical advisory services, research, training, construction and commodity support. In addition, A.I.D. conducts programs under the Agricultural Trade Development and Assistance Act of 1954 (Pub. L. 480) that are designed to combat hunger, malnutrition and to facilitate economic development. Assistance programs are carried out under the foreign policy guidance of the Secretary of State and in cooperation with the governments of sovereign states. Within this framework, it is A.I.D. policy to:

(1) Ensure that the environmental consequences of A.I.D.-financed activities are identified and considered by A.I.D. and the host country prior to a final decision to proceed and that appropriate environmental safeguards are adopted;

(2) Assist developing countries to strengthen their capabilities to appreciate and effectively evaluate the potential environmental effects of proposed development strategies and projects, and to select, implement and manage effective environmental programs;

(3) Identify impacts resulting from A.I.D.'s actions upon the environment, including those aspects of the biosphere which are the common and cultural heritage of all mankind; and

(4) Define environmental limiting factors that constrain development and identify and carry out activities that assist in restoring the renewable resource base on which sustained development depends.

(c) *Definitions.*—(1) *CEQ Regulations.* Regulations promulgated by the President's Council on Environmental Quality (CEQ) (Federal Register, Volume 43, Number 230, November 29, 1978) under the authority of NEPA and Executive Order 11514, entitled Protection and Enhancement of Environmental Quality (March 5, 1970) as amended by Executive Order 11991 (May 24, 1977).

(2) *Initial Environmental Examination.* An Initial Environmental Examination is the first review of the reasonably foreseeable effects of a proposed action on the environment. Its function is to provide a brief statement of the factual basis for a Threshold Decision as to whether an Environmental Assessment or an Environmental Impact Statement will be required.

(3) *Threshold Decision.* A formal Agency decision which determines, based on an Initial Environmental Examination, whether a proposed Agency action is a major action significantly affecting the environment.

(4) *Environmental Assessment.* A detailed study of the reasonably foreseeable significant effects, both beneficial and adverse, of a proposed action on the environment of a foreign country or countries.

(5) *Environmental Impact Statement.* A detailed study of the reasonably foreseeable environmental impacts, both positive and negative, of a proposed

41

A.I.D. action and its reasonable alternatives on the United States, the global environment or areas outside the jurisdiction of any nation as described in § 216.7 of these procedures. It is a specific document having a definite format and content, as provided in NEPA and the CEQ Regulations. The required form and content of an Environmental Impact Statement is further described in § 216.7 infra.

(6) *Project Identification Document (PID).* An internal A.I.D. document which initially identifies and describes a proposed project.

(7) *Program Assistance Initial Proposal (PAIP).* An internal A.I.D. document used to initiate and identify proposed non-project assistance, including commodity import programs. It is analogous to the PID.

(8) *Project Paper (PP).* An internal A.I.D. document which provides a definitive description and appraisal of the project and particularly the plan or implementation.

(9) *Program Assistance Approval Document (PAAD).* An internal A.I.D. document approving non-project assistance. It is analogous to the PP.

(10) *Environment.* The term environment, as used in these procedures with respect to effects occurring outside the United States, means the natural and physical environment. With respect to effects occurring within the United States see § 216.7(b).

(11) *Significant Effect.* With respect to effects on the environment outside the United States, a proposed action has a significant effect on the environment if it does significant harm to the environment.

(12) *Minor Donor.* For purposes of these procedures, A.I.D. is a minor donor to a multidonor project when A.I.D. does not control the planning or design of the multidonor project and either: (i) A.I.D.'s total contribution to the project is both less than $1,000,000 and less than 25 percent of the estimated project cost, or (ii) A.I.D.'s total contribution is more than $1,000,000 but less than 25 percent of the estimated project cost and the environmental procedures of the donor in control of the planning of design of the project are followed, but only if the A.I.D. Environmental Coordinator determines that such procedures are adequate.

**§ 216.2 Applicability of procedures.**

(a) *Scope.* Except as provided in § 216.2(b), these procedures apply to all new projects, programs or activities authorized or approved by A.I.D. and to substantive amendments or extensions of ongoing projects, programs, or activities.

(b) *Exemptions.* (1) Projects, programs or activities involving the following are exempt from these procedures:

(i) International disaster assistance;

(ii) Other emergency circumstances; and

(iii) Circumstances involving exceptional foreign policy sensitivities.

(2) A formal written determination, including a statement of the justification therefore, is required for each project, program or activity for which an exemption is made under paragraphs (b)(1) (ii) and (iii) of this section, but is not required for projects, programs or activities under paragraph (b)(1)(i) of this section. The determination shall be made either by the Assistant Administrator having responsibility for the program, project or activity, or by the Administrator, where authority to approve financing has been reserved by the Administrator. The determination shall be made after consultation with CEQ regarding the environmental consequences of the proposed program, project or activity.

(c) *Categorical Exclusions.* (1) The following criteria have been applied in determining the classes of actions included in § 216.2(c)(2) for which an Initial Environmental Examination, Environmental Assessment and Environmental Impact Statement generally are not required:

(i) The action does not have an effect on the natural or physicial environment;

(ii) A.I.D. does not have knowledge of or control over, and the objective of A.I.D. in furnishing assistance does not require, either prior to approval of financing or prior to implementation of specific activities, knowledge of or control over, the details of the specific activities that have an effect on the physicial and natural environment for which financing is provided by A.I.D.;

(iii) Research activities which may have an affect on the physicial and natural environment but will not have a significant effect as a result of limited scope, carefully controlled nature and effective monitoring.

(2) The following classes of actions are not subject to the procedures set forth in § 216.3, except to the extent provided herein:

(i) Education, technical assistance, or training programs except to the extent such programs include activities directly affecting the environment (such as construction of facilities, etc.);

(ii) Controlled experimentation exclusively for the purpose of research and field evaluation which are confined to small areas and carefully monitored;

(iii) Analyses, studies, academic or research workshops and meetings;

(iv) Projects in which A.I.D. is a minor donor to a multidonor project and there is no potential significant effects upon the environment of the United States, areas outside any nation's jurisdiction or endangered or threatened species or their critical habitat;

(v) Document and information transfers;

(vi) Contributions to international, regional or national organizations by the United States which are not for the purpose of carrying out a specifically identifiable project or projects;

(vii) Institution building grants to research and educational institutions in the United States such as those provided for under Section 122(d) and Title XII of Chapter 2 of Part I of the FAA (22 USCA §§ 2151 p. (b) 2220a. (1979));

(viii) Programs involving nutrition, health care or population and family planning services except to the extent designed to include activities directly affecting the environment (such as construction of facilities, water supply systems, waste water treatment, etc.)

(ix) Assistance provided under a Commodity Import Program when, prior to approval, A.I.D. does not have knowledge of the specific commodities to be financed and when the objective in furnishing such assistance requires neither knowledge, at the time the assistance is authorized, nor control, during implementation, of the commodities or their use in the host country.

(x) Support for intermediate credit institutions when the objective is to assist in the capitalization of the institution or part thereof and when such support does not involve reservation of the right to review and approve individual loans made by the institution;

(xi) Programs of maternal or child feeding conducted under Title II of Pub. L. 480;

(xii) Food for development programs conducted by food recipient countries under Title III of Pub. L. 480, when achieving A.I.D.'s objectives in such programs does not require knowledge of or control over the details of the specific activities conducted by the foreign country under such program;

(xiii) Matching, general support and institutional support grants provided to private voluntary organizations (PVOs) to assist in financing programs where A.I.D.'s objective in providing such financing does not require knowledge of or control over the details of the specific activities conducted by the PVO;

(xiv) Studies, projects or programs intended to develop the capability of recipient countries to engage in development planning, except to the extent designed to result in activities directly affecting the environment (such as construction of facilities, etc.); and

(xv) Activities which involve the application of design criteria or standards developed and approved by A.I.D.

(3) The originator of a project, program or activity shall determine the extent to which it is within the classes of actions described in paragraph (c)(2) of this section. This determination shall be made in writing and be submitted with the PID, PAIP or comparable document. This determination, which must include a brief statement supporting application of the exclusion shall be reviewed by the Bureau Environmental Officer in the same manner as a Threshold Decision under § 216.3(a)(2) of these procedures. Notwithstanding paragraph (c)(2) of this section, the procedures set forth in § 216.3 shall apply to any project, program or activity included in the classes of actions listed in paragraph (c)(2) of this section, or any aspect or component thereof, if at any time in the design, review or approval of the activity it is determined that the project, program or activity, or aspect or component thereof, is subject to the control of A.I.D. and may have a significant effect on the environment.

(d) *Classes of Actions Normally Having a Significant Effect on the Environment.* (1) The following classes of actions have been determined generally to have a significant effect on the environment and an Environmental Assessment or Environmental Impact Statement, as appropriate, will be required:

(i) Programs of river basin development;

(ii) Irrigation or water management projects, including dams and impoundments;

(iii) Agricultural land leveling;

(iv) Drainage projects;

(v) Large scale agricultural mechanization;

(vi) New lands development;

(vii) Resettlement projects;

(viii) Penetration road building or road improvement projects;

(ix) Powerplants;

(x) Industrial plants;

(xi) Potable water and sewerage projects other than those that are small-scale.

(2) An Initial Environmental Examination normally will not be necessary for activities within the classes described in § 216.2(d), except when the originator of the project believes that the project will not have a significant effect on the environment. In such cases, the activity may be subjected to the procedures set forth in § 216.3.

(e) *Pesticides.* The exemptions of § 216.2(b)(1) and the categorical exclusions of § 216.2(c)(2) are not applicable to assistance for the procurement or use of pesticides.

**§ 216.3 Procedures.**

(a) *General Procedures*—(1) *Preparation of the Initial Environmental Examination.* Except as otherwise provided, an Initial Environmental Examination is not required for activities identified in § 216.2(b)(1), (c)(2), and (d). For all other A.I.D. activities described in § 216.2(a) an Initial Environmental Examination will be prepared by the originator of an action. Except as indicated in this section, it should be prepared with the PID or PAIP. For projects including the procurement or use of pesticides, the procedures set forth in § 216.3(b) will be followed, in addition to the procedures in this paragraph. Activities which cannot be identified in sufficient detail to permit the completion of an Initial Environmental Examination with the PID or PAIP, shall be described by including with the PID or PAIP: (i) an explanation indicating why the Initial Environmental Examination cannot be completed; (ii) an estimate of the amount of time required to complete the Initial Environmental Examination; and (iii) a recommendation that a Threshold Decision be deferred until the Initial Environmental Examination is completed. The responsible Assistant Administrator will act on the request for deferral concurrently with action on the PID or PAIP and will designate a time for completion of the Initial Environmental Examination. In all instances, except as provided in § 216.3(a)(7), this completion date will be in sufficient time to allow for the completion of an Environmental Assessment or Environmental Impact Statement, if required, before a final decision is made to provide A.I.D. funding for the action.

(2) *Threshold decision.* (i) The Initial Environmental Examination will include a Threshold Decision made by the officer in the originating office who signs the PID or PAIP. If the Initial Environmental Examination is completed prior to or at the same time as the PID or PAIP, the Threshold Decision will be reviewed by the Bureau Environmental Officer concurrently with approval of the PID or PAIP. The Bureau Environmental Officer will either concur in the Threshold Decision or request reconsideration by the officer who made the Threshold Decision, stating the reasons for the request. Differences of opinion between these officers shall be submitted for resolution to the Assistant Administrator at the same time that the PID is submitted for approval.

(ii) An Initial Environmental Examination, completed subsequent to approval of the PID or PAIP, will be forwarded immediately together with the Threshold Determination to the Bureau Environmental Officer for action as described above.

(iii) A Positive Threshold Decision shall result from a finding that the proposed action will have a significant effect on the environment. An Environmental Impact Statement shall be prepared if required pursuant to

§ 216.7. If an impact statement is not required, an Environmental Assessment will be prepared in accordance with § 216.6. The cognizant Bureau or Office will record a Negative Determination if the proposed action will not have a significant effect on the environment.

(3) *Negative Declaration.* The Assistant Administrator, or the Administrator in actions for which the approval of the Administrator is required for the authorization of financing, may make a Negative Declaration, in writing, that the Agency will not develop an Environmental Assessment or an Environmental Impact Statement regarding an action found to have a significant effect on the environment when (i) a substantial number of Environmental Assessments or Environmental Impact Statements relating to similar activities have been prepared in the past, if relevant to the proposed action, (ii) the Agency has previously prepared a programmatic Statement or Assessment covering the activity in question which has been considered in the development of such activity, or (iii) the Agency has developed design criteria for such an action which, if applied in the design of the action, will avoid a significant effect on the environment.

(4) *Scope of Environmental Assessment or Impact Statement*—(i) *Procedure and Content.* After a Positive Threshold Decision has been made, or a determination is made under the presticide procedures set forth in § 216.3(b) that an Environmental Assessment or Environmental Impact Statement is required, the originator of the action shall commence the process of identifying the significant issues relating to the proposed action and of determining the scope of the issues to be addressed in the Environmental Assessment or Environmental Impact Statement. The originator of an action within the classes of actions described in § 216.2(d) shall commence this scoping process as soon as practicable. Persons having expertise relevant to the environmental aspects of the proposed action shall also participate in this scoping process. (Participants may include but are not limited to representatives of host governments, public and private institutions, the A.I.D. Mission staff and contractors.) This process shall result in a written statement which shall include the following matters:

(*a*) A determination of the scope and significance of issues to be analyzed in the Environmental Assessment or Impact Statement, including direct and indirect effects of the project on the environment.

(*b*) Identification and elimination from detailed study of the issues that are not significant or have been covered by earlier environmental review, or approved design considerations, narrowing the discussion of these issues to a brief presentation of why they will not have a significant effect on the environment.

(*c*) A description of (*1*) the timing of the preparation of environmental analyses, including phasing if appropriate, (*2*) variations required in the format of the Environmental Assessment, and (*3*) the tentative planning and decision making schedule; and

(*d*) A description of how the analysis will be conducted and the disciplines that will participate in the analysis.

(ii) These written statements shall be reviewed and approved by the Bureau Environmental Officer.

(iii) *Circulation of Scoping Statement.* To assist in the preparation of an Environmental Assessment, the Bureau Environmental Office may circulate copies of the written statement, together with a request for written comments, within thirty days, to selected federal agencies if that Officer believes comments by such federal agencies will be useful in the preparation of an Environmental Assessment. Comments received from reviewing federal agencies will be considered in the preparation of the Environmental Assessment and in the formulation of the design and implementation of the project, and will, together with the scoping statement, will be included in the project file.

(iv) *Change in Threshold Decision.* If it becomes evident that the action will not have a significant effect on the environment (i.e., will not cause significant harm to the environment), the Positive Threshold Decision may be withdrawn with the concurrence of the Bureau Environmental Officer. In the case of an action included in § 216.2(d)(2), the request for withdrawal shall be made to the Bureau Environmental Officer.

45

(5) *Preparation of Environmental Assessments and Environmental Impact Statement.* If the PID or PAIP is approved, and the Threshold Decision is positive, or the action is included in § 216.2(d), the originator of the action will be responsible for the preparation of an Environmental Assessment or Environmental Impact Statement as required. Draft Environmental Impact Statements will be circulated for review and comment as part of the review of Project Papers and as outlined further in § 216.7 of these procedures. Except as provided in § 216.3(a)(7), final approval of the PP or PAAD and the method of implementation will include consideration of the Environmental Assessment of final Environmental Impact Statement.

(6) *Processing and Review Within A.I.D.* (i) Initial Environmental Examinations, Environmental Assessments and final Environmental Impact Statements will be processed pursuant to standard A.I.D. procedures for project approval documents. Except as provided in § 216.3(a)(7), Environmental Assessments and final Environmental Impact Statements will be reviewed as an integral part of the Project Paper or equivalent document. In addition to these procedures, Environmental Assessments will be reviewed and cleared by the Bureau Environmental Officer. They may also be reviewed by the Agency's Environmental Coordinator who will monitor the Environmental Assessment process.

(ii) When project approval authority is delegated to field posts, Environmental Assessments shall be reviewed and cleared by the Bureau Environmental Officer prior to the approval of such actions.

(iii) Draft and final Environmental Impact Statements will be reviewed and cleared by the Environmental Coordinator and the Office of the General Counsel.

(7) *Environmental Review After Authorization of Financing.* (i) Environmental review may be performed after authorization of a project, program or activity only with respect to subprojects or significant aspects of the project, program or activity that are unidentified at the time of authorization. Environmental review shall be completed prior to authorization for all subprojects and aspects of a project, program or activity that are identified.

(ii) Environmental review should occur at the earliest time in design or implementation at which a meaningful review can be undertaken, but in no event later than when previously unidentified subprojects or aspects of projects, programs or activities are identified and planned. To the extent possible, adequate information to undertake deferred environmental review should be obtained before funds are obligated for unidentified subprojects or aspects of projects, programs or activities. (Funds may be obligated for the other aspects for which environmental review has been completed.) To avoid an irreversible commitment of resources prior to the conclusion of environmental review, the obligation of funds can be made incrementally as subprojects or aspects of projects, programs or activities are identified; or if necessary while planning continues, including environmental review, the agreement or other document obligating funds may contain appropriate convenants or conditions precedent to disbursement for unidentified subprojects or aspects of projects, programs or activities.

(iii) When environmetal review must be deferred beyond the time some of the funds are to be disbursed (e.g. long lead times for the delivery of goods or services), the project agreement or other document obligating funds shall contain a covenant or covenants requiring environmental review, including an Environmental Assessment or Environmental Impact Statement, when appropriate, to be completed and taken into account prior to implementation of those subprojects or aspects of the project, program or activity for which environmental review is deferred. Such convenants shall ensure that implementation plans will be modified in accordance with environmental review if the parties decide that modifications are necessary.

(iv) When environmental review will not be completed for an entire project, program or activity prior to authorization, the Initial Environmental Examination and Threshold Decision required under § 216.3(a)(1) and (2) shall identify those aspects of the project, program or activity for which

environmental review will be completed prior to the time financing is authorized. It shall also include those subprojects or aspects for which environmental review will be deferred, stating the reasons for deferral and the time when environmental review will be completed. Further, it shall state how an irreversible commitment of funds will be avoided until environmental review is completed. The A.I.D. officer responsible for making environmental decisions for such projects, programs or activities shall also be identified (the same officer who has decision making authority for the other aspects of implementation). This deferral shall be reviewed and approved by the officer making the Threshold Decision and the officer who authorizes the project, program or activity. Such approval may be made only after consultation with the Office of General Counsel for the purpose of establishing the manner in which conditions precedent to disbursement or covenants in project and other agreements will avoid an irreversible commitment of resources before environmental review is completed.

(8) *Monitoring.* To the extent feasible and relevant, projects and programs for which Environmental Impact Statements or Environmental Assessments have been prepared should be designed to include measurement of any changes in environmental quality, positive or negative, during their implementation. This will require recording of baseline data at the start. To the extent that available data permit, originating offices of A.I.D. will formulate systems in collaboration with recipient nations, to monitor such impacts during the life of A.I.D.'s involvement. Monitoring implementation of projects, programs and activities shall take into account environmental impacts to the same extent as other aspects of such projects, programs and activities. If during implementation of any project, program or activity, whether or not an Environmental Assessment or Environmental Impact Statement was originally required, it appears to the Mission Director, or officer responsible for the project, program or activity, that it is having or will have a significant effect on the environment that was not previously studied in an Environmental Assessment or Environmental Impact Statement, the procedures contained in this part shall be followed including, as appropriate, a Threshold Decision, Scoping and an Environmental Assessment or Environmental Impact Statement.

(9) *Revisions.* If, after a Threshold Decision is made resulting in a Negative Determination, a project is revised or new information becomes available which indicates that a proposed action might be "major" and its effects "significant", the Negative Determination will be reviewed and revised by the cognizant Bureau and an Environmental Assessment or Environmental Impact Statement will be prepared, if appropriate. Environmental Assessments and Environmental Impact Statements will be amended and processed appropriately if there are major changes in the project or program, or if significant new information becomes available which relates to the impact of the project, program or activity on the environment that was not considered at the time the Environmental Assessment or Environmental Impact Statement was approved. When on-going programs are revised to incorporate a change in scope or nature, a determination will be made as to whether such change may have an environmental impact not previously assessed. If so, the procedures outlined in this part will be followed.

(10) *Other Approval Documents.* These procedures refer to certain A.I.D. documents such as PIDs, PAIPs, PPs and PAADs as the A.I.D. internal instruments for approval of projects, programs or activities. From time to time, certain special procedures, such as those in § 216.4, may not require the use of the aforementioned documents. In these situations, these environmental procedures shall apply to those special approval procedures, unless otherwise exempt, at approval times and levels comparable to projects, programs and activities in which the aforementioned documents are used.

(b) *Pesticide Procedures*—(1) *Project Assistance.* Except as provided in § 216.3(b)(2), all proposed projects involving assistance for the procurement or use, or both, of pesticides shall be subject to the procedures prescribed in

§ 216.3(b)(1) (i) through (v) below. These procedures shall also apply, to the extent permitted by agreements entered into by A.I.D. before the effective date of these pesticide procedures, to such projects that have been authorized but for which pesticides have not been procured as of the effective date of these pesticide procedures.

(i) When a project includes assistance for procurement or use, or both, of pesticides registered for the same or similar uses by USEPA without restriction, the Initial Environmental Examination for the project shall include a separate section evaluating the economic, social and environmental risks and benefits of the planned pesticide use to determine whether the use may result in significant environmental impact. Factors to be considered in such an evaluation shall include, but not be limited to the following:

(a) The USEPA registration status of the requested pesticide;

(b) The basis for selection of the requested pesticide;

(c) The extent to which the proposed pesticide use is part of an integrated pest management program;

(d) The proposed method or methods of application, including availability of appropriate application and safety equipment;

(e) Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use and measures available to minimize such hazards;

(f) The effectiveness of the requested pesticide for the proposed use;

(g) Compatibility of the proposed pesticide with target and nontarget ecosystems;

(h) The conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils;

(i) The availability and effectiveness of other pesticides or nonchemical control methods;

(j) The requesting country's ability to regulate or control the distribution, storage, use and disposal of the requested pesticide;

(k) The provisions made for training of users and applicators; and

(l) The provisions made for monitoring the use and effectiveness of the pesticide.

In those cases where the evaluation of the proposed pesticide use in the Initial Environmental Examination indicates that the use will significantly effect the human environment, the Threshold Decision will include a recommendation for the preparation of an Environmental Assessment or Environmental Impact Statement, as appropriate. In the event a decision is made to approve the planned pesticide use, the Project Paper shall include to the extent practicable, provisions designed to mitigate potential adverse effects of the pesticide. When the pesticide evaluation section of the Initial Environmental Examination does not indicate a potentially unreasonable risk arising from the pesticide use, an Environmental Assessment or Environmental Impact Statement shall nevertheless be prepared if the environmental effects of the project otherwise require further assessment.

(ii) When a project includes assistance for the procurement or use, or both, of any pesticide registered for the same or similar uses in the United States but the proposed use is restricted by the USEPA on the basis of user hazard, the procedures set forth in § 216.3(b)(1)(i) above will be followed. In addition, the Initial Environmental Examination will include an evaluation of the user hazards associated with the proposed USEPA restricted uses to ensure that the implementation plan which is contained in the Project Paper incorporates provisions for making the recipient government aware of these risks and providing, if necessary, such technical assistance as may be required to mitigate these risks. If the proposed pesticide use is also restricted on a basis other than user hazard, the procedures in § 216.3(b)(1)(iii) shall be followed in lieu of the procedures in this section.

(iii) If the project includes assistance for the procurement or use, or both of:

(a) Any pesticide other than one registered for the same or similar uses by USEPA without restriction or for restricted use on the basis of user hazard; or

(b) Any pesticide for which a notice of rebuttable presumption against reregistration, notice of intent to cancel, or notice of intent to suspend has been issued by USEPA,

The Threshold Decision will provide for the preparation of an Environmental Assessment or Environmental Impact Statement, as appropriate (§ 216.6(a)). The EA or EIS shall include, but not be limited to, an analysis of the factors identified in § 216.3(b)(1)(i) above.

(iv) Notwithstanding the provisions of §§ 216.3(b)(1) (i) through (iii) above, if the project includes assistance for the procurement or use, or both, of a pesticide against which USEPA has initiated a regulatory action for cause, or for which it has issued a notice of rebuttable presumption against reregistration, the nature of the action or notice, including the relevant techni-

48

cal and scientific factors will be discussed with the requesting government and considered in the IEE and, if prepared, in the EA or EIS. If USEPA initiates any of the regulatory actions above against a pesticide subsequent to its evaluation in an IEE, EA or EIS, the nature of the action will be discussed with the recipient government and considered in an amended IEE or amended EA or EIS, as appropriate.

(v) If the project includes assistance for the procurement or use, or both of pesticides but the specific pesticides to be procured or used cannot be identified at the time the IEE is prepared, the procedures outlined in §§ 216.3(b)(i) through (iv) will be followed when the specific pesticides are identified and before procurement or use is authorized. Where identification of the pesticides to be procured or used does not occur until after Project Paper approval, neither the procurement nor the use of the pesticides shall be undertaken unless approved, in writing, by the Assistant Administrator (or in the case of projects authorized at the Mission level, the Mission Director) who approved the Project Paper.

(2) *Exceptions to Pesticide Procedures.* The procedures set forth in § 216.3(b)(1) above shall not apply to the following projects including assistance for the procurement or use, or both, of pesticides.

(i) Projects under emergency conditions.

Emergency conditions shall be deemed to exist when it is determined by the Administrator, A.I.D., in writing that:

(*a*) A pest outbreak has occurred or is imminent; and

(*b*) Significant health problems (either human or animal) or significant economic problems will occur without the prompt use of the proposed pesticide; and

(*c*) Insufficient time is available before the pesticide must be used to evaluate the proposed use in accordance with the provisions of this regulation.

(ii) Projects where A.I.D. is a minor donor, as defined in § 216.1(c)(12) above, to a multi-donor project.

(iii) Projects including assistance for procurement or use, or both, of pesticides for research or limited field evaluation purposes by or under the supervision of project personnel. In such instances, however, A.I.D. will ensure that the manufacturers of the pesticides provide toxicological and environmental data necessary to safeguard the health or research personnel and the quality of the local environment in which the pesticides will be used. Furthermore, treated crops will not be used for human or animal consumption unless appropriate tolerances have been established by EPA or recommended by FAO/WHO, and the rates and frequency of application, together with the prescribed preharvest intervals, do not result in residues exceeding such tolerances. This prohibition does not apply to the feeding of such crops to animals for research purposes.

(3) *Non-Project Assistance.* In a very few limited number of circumstances A.I.D. may provide non-project assistance for the procurement and use of pesticides. Assistance in such cases shall be provided if the A.I.D. Administrator determines in writing that (i) emergency conditions, as defined in § 216.3(b)(2)(i) above exists; or (ii) that compelling circumstances exist such that failure to provide the proposed assistance would seriously impede the attainment of U.S. foreign policy objectives or the objectives of the foreign assistance program. In the latter case, a decision to provide the assistance will be based to the maximum extent practicable, upon a consideration of the factors set forth in § 216.3(b)(1)(i) and, to the extent available, the history of efficacy and safety covering the past use of the pesticide the in recipient country.

**§ 216.4 Private applicants.**

Programs, projects or activities for which financing from A.I.D. is sought by private applicants, such as PVOs and educational and research institutions, are subject to these procedures. Except as provided in §§ 216.2 (b), (c) or (d), preliminary proposals for financing submitted by private applicants shall be accompanied by an initial Environmental Examination or adequate information to permit preparation of an Initial Environmental Examination. The Threshold Decision shall be made by the Mission Director for the country to which the proposal relates, if the preliminary proposal is submitted to the A.I.D. Mission, or shall be made by the officer in A.I.D. who approves the preliminary proposal. In either case, the concurrence of the Bureau Environmental Officer is required in the same manner as in § 216.3(a)(2), except for PVO projects approved in A.I.D. Missions with total life of project costs

less than $500,000. Thereafter, the same procedures set forth in § 216.3 including as appropriate scoping and Environmental Assessments or Environmental Impact Statements, shall be applicable to programs, projects or activities submitted by private applicants. The final proposal submitted for financing shall be treated, for purposes of these procedures, as a Project Paper. The Bureau Environmental Officer shall advise private applicants of studies or other information foreseeably required for action by A.I.D.

**§ 216.5 Endangered species.**

It is A.I.D. policy to conduct its assistance programs in a manner that is sensitive to the protection of endangered or threatened species and their critical habitats. The Initial Environmental Examination for each project, program or activity having an effect on the environment shall specifically determine whether the project, program or activity will have an effect on an endangered or threatened species, or critical habitat. If the proposed project, program or activity will have the effect of jeopardizing an endangered or threatened species or of adversely modifying its critical habitat, the Threshold Decision shall be a Positive Determination and an Environmental Assessment or Environmental Impact Statement completed as appropriate, which shall discuss alternatives or modifications to avoid or mitigate such impact on the species or its habitat.

**§ 216.6 Environmental assessments.**

(a) *General Purpose.* The purpose of the Environmental Assessment is to provide Agency and host country decision makers with a full discussion of significant environmental effects of a proposed action. It includes alternatives which would avoid or minimize adverse effects or enhance the quality of the environment so that the expected benefits of development objectives can be weighed against any adverse impacts upon the human environment or any irreversible or irretrievable commitment of resources.

(b) *Collaboration with Affected Nation on Preparation.* Collaboration in obtaining data, conducting analyses and considering alternatives will help build an awareness of development associated environmental problems in less developed countries as well as assist in building an indigenous institutional capability to deal nationally with such problems. Missions, Bureaus and Offices will collaborate with affected countries to the maximum extent possible, in the development of any Environmental Assessments and consideration of environmental consequences as set forth therein.

(c) *Content and Form.* The Environmental Assessment shall be based upon the scoping statement and shall address the following elements, as appropriate:

(1) *Summary.* The summary shall stress the major conclusions, areas of controversy, if any, and the issues to be resolved.

(2) *Purpose.* The Environmental Assessment shall briefly specify the underlying purpose and need to which the Agency is responding in proposing the alternatives including the proposed action.

(3) *Alternatives Including the Proposed Action.* This section should present the environmental impacts of the proposal and its alternatives in comparative form, thereby sharpening the issues and providing a clear basis for choice among options by the decision maker. This section should explore and evaluate reasonable alternatives and briefly discuss the reasons for eliminating those alternatives which were not included in the detailed study; devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits; include the alternative of no action; identify the Agency's preferred alternative or alternatives, if one or more exists; include appropriate mitigation measures not already included in the proposed action or alternatives.

(4) *Affected Environment.* The Environmental Assessment shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in the Environmental Assessment shall be commensurate with the significance of the impact with less important material

summarized, consolidated or simply referenced.

(5) *Environmental Consequences.* This section forms the analytic basis for the comparisons under paragraph (c)(3) of this section. It will include the environmental impacts of the alternatives including the proposed action; any adverse effects that cannot be avoided should the proposed action be implemented; the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity; and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented. It should not duplicate discussions in paragraph (c)(3) of this section. This section of the Environmental Assessment should include discussions of direct effects and their significance; indirect effects and their significance; possible conflicts between the proposed action and land use plans, policies and controls for the areas concerned; energy requirements and conservation potential of various alternatives and mitigation measures; natural or depletable resource requirements and conservation potential of various requirements and mitigation measures; urban quality; historic and cultural resources and the design of the built environment, including the reuse and conservation potential of various alternatives and mitigation measures; and means to mitigate adverse environmental impacts.

(6) *List of Preparers.* The Environmental Assessment shall list the names and qualifications (expertise, experience, professional discipline) of the persons primarily responsible for preparing the Environmental Assessment or significant background papers.

(7) *Appendix.* An Appendix may be prepared.

(d) *Program Assessment.* Program Assessments may be appropriate in order to assess the environmental effects of a number of individual actions and their cumulative environmental impact in a given country or geographic area, or the environmental impacts that are generic or common to a class of agency actions, or other activities which are not country-specific. In these cases, a single, programmatic assessment will be prepared in A.I.D./Washington and circulated to appropriate overseas Missions, host governments, and to interested parties within the United States. To the extent practicable, the form and content of the programmatic Environmental Assessment will be the same as for project Assessments. Subsequent Environmental Assessments on major individual actions will only be necessary where such follow-on or subsequent activities may have significant environmental impacts on specific countries where such impacts have not been adequately evaluated in the programmatic Environmental Assessment. Other programmatic evaluations of classes of actions may be conducted in an effort to establish additional categorical exclusions or design standards or criteria for such classes that will eliminate or minimize adverse effects of such actions, enhance the environmental effect of such action or reduce the amount of paperwork or time involved in these procedures. Programmatic evaluations conducted for the purpose of establishing additional categorical exclusions under § 216.2(c) or design considerations that will eliminate significant effects for classes of actions shall be made available for public comment before the categorical exclusions or design standards or criteria are adopted by A.I.D. Notice of the availability of such document shall be published in the Federal Register. Additional categorical exclusions shall be adopted by A.I.D. upon the approval of the Administrator, and design consideration in accordance with usual agency procedures.

(e) *Consultation and Review.* (1) When Environmental Assessments are prepared on activities carried out within or focused on specific developing countries, consultation will be held between A.I.D. staff and the host government both in the early stages of preparation and on the results and significance of the completed Assessment before the project is authorized.

(2) Missions will encourage the host government to make the Environmental Assessment available to the general public of the recipient country. If Environmental Assessments are prepared on activities which are not country-specific, the Assessment will be circulated by the Environmental Coordinator to A.I.D.'s Overseas Missions and interested governments for information, guidance and comment and will be made available in the U.S. to

interested parties.

(f) *Effect in Other Countries.* In a situation where an analysis indicates that potential effects may extend beyond the national boundaries of a recipient country and adjacent foreign nations may be affected, A.I.D. will urge the recipient country to consult with such countries in advance of project approval and to negotiate mutually acceptable accommodations.

(g) *Classified Material.* Environmental Assessments will not normally include classified or administratively controlled material. However, there may be situations where environmental aspects cannot be adequately discussed without the inclusion of such material. The handling and disclosure of classified or administratively controlled material shall be governed by 22 CFR Part 9. Those portions of an Environmental Assessment which are not classified or administratively controlled will be made available to persons outside the Agency as provided for in 22 CFR Part 212.

**§ 216.7 Environmental impact statements.**

(a) *Applicability.* An Environmental Impact Statement shall be prepared when agency actions significantly affect:

(1) The global environment or areas outside the jurisdiction of any nation (e.g., the oceans);

(2) The environment of the United States; or

(3) Other aspects of the environment at the discretion of the Administrator.

(b) *Effects on the United States: Content and Form.* An Environmental Impact Statement relating to paragraph (a)(2) of this section shall comply with the CEQ Regulations. With respect to effects on the United States, the terms environment and significant effect wherever used in these procedures have the same meaning as in the CEQ Regulations rather than as defined in § 216.1(c) (12) and (13) of these procedures.

(c) *Other Effects: Content and Form.* An Environmental Impact Statement relating to paragraphs (a)(1) and (a)(3) of this section will generally follow the CEQ Regulations, but will take into account the special considerations and concerns of A.I.D. Circulation of such Environmental Impact Statements in draft form will precede approval of a Project Paper or equivalent and comments from such circulation will be considered before final project authorization as outlined in § 216.3 of these procedures. The draft Environmental Impact Statement will also be circulated by the Missions to affected foreign governments for information and comment. Draft Environmental Impact Statements generally will be made available for comment to Federal agencies with jurisdiction by law or special expertise with respect to any environmental impact involved, and to public and private organizations and individuals for not less than forty-five (45) days. Notice of availability of the draft Environmental Impact Statements will be published in the Federal Register. Cognizant Bureaus and Offices will submit these drafts for circulation through the Environmental Coordinator who will have the responsibility for coordinating all such communications with persons outside A.I.D. Any comments received by the Environmental Coordinator will be forwarded to the originating Bureau or Office for consideration in final policy decisions and the preparation of a final Environmental Impact Statement. All such comments will be attached to the final Statement, and those relevant comments not adequately discussed in the draft Environmental Impact Statement will be appropriately dealt with in the final Environmental Impact Statement. Copies of the final Environmental Impact Statement, with comments attached, will be sent by the Environmental Coordinator to CEQ and to all other Federal, state, and local agencies and private organizations that made substantive comments on the draft, including affected foreign governments. Where emergency circumstances or considerations of foreign policy make it necessary to take an action without observing the provisions of § 1506.10 of the CEQ Regulations, or when there are overriding considerations of expense to the United States or foreign governments, the originating Office will advise the Environmental Coordinator who will consult with Department of State and CEQ concerning appropriate modification of review procedures.

**§ 216.8 Public hearings.**

(a) In most instances AID will be able to gain the benefit of public par-

ticipation in the impact statement process through circulation of draft statements and notice of public availability in CEQ publications. However, in some cases the Administrator may wish to hold public hearings on draft Environmental Impact Statements. In deciding whether or not a public hearing is appropriate, Bureaus in conjunction with the Environmental Coordinator should consider:

(1) The magnitude of the proposal in terms of economic costs, the geographic area involved, and the uniqueness or size of commitment of the resources involved;

(2) The degree of interest in the proposal as evidenced by requests from the public and from Federal, state and local authorities, and private organizations and individuals, that a hearing be held;

(3) The complexity of the issue and likelihood that information will be presented at the hearing which will be of assistance to the Agency; and

(4) The extent to which public involvement already has been achieved through other means, such as earlier public hearings, meetings with citizen representatives, and/or written comments on the proposed action.

(b) If public hearings are held, draft Environmental Impact Statements to be discussed should be made available to the public at least fifteen (15) days prior to the time of the public hearings, and a notice will be placed in the FEDERAL REGISTER giving the subject, time and place of the proposed hearings.

**§ 216.9 Bilateral and multilateral studies and concise reviews of environmental issues.**

Notwithstanding anything to the contrary in these procedures, the Administrator may approve the use of either of the following documents as a substitute for an Environmental Assessment (but not a substitute for an Environmental Impact Statement) required under these procedures:

(a) Bilateral or multilateral environmental studies, relevant or related to the proposed action, prepared by the United States and one or more foreign countries or by an international body or organization in which the United States is a member or participant; or

(b) Concise reviews of the environmental issues involved including summary environmental analyses or other appropriate documents.

**§ 216.10 Records and reports.**

Each Agency Bureau will maintain a current list of activities for which Environmental Assessments and Environmental Impact Statements are being prepared and for which Negative Determinations and Declarations have been made. Copies of final Initial Environmental Examinations, scoping statements, Assessments and Impact Statements will be available to interested Federal agencies upon request. The cognizant Bureau will maintain a permanent file (which may be part of its normal project files) of Environmental Impact Statements, Environmental Assessments, final Initial Environmental Examinations, scoping statements, Determinations and Declarations which will be available to the public under the Freedom of Information Act. Interested persons can obtain information or status reports regarding Environmental Assessments and Environmental Impact Statements through the A.I.D. Environmental Coordinator.

[22 U.S.C. 2381; 42 U.S.C. 4332]

Dated October 9, 1980.

Joseph C. Wheeler,

*Acting Administrator.*

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# APPENDIX II

**Excerpts from:**

**ENVIRONMENTAL ASSESSMENT
VECTOR CONTROL AND WATER
AND SANITATION ACTIVITIES
OF THE
HEALTH SECTOR II PROJECT, HONDURAS**

**June 1988**

A) Table of Contents

B) Recommended Procedures for Environmental Consideration and Criteria Review

Managed by Medical Service Corporation International
under contract to the U.S. Agency for International Development

54

APPENDIX IIA

TABLE OF CONTENTS


| | | Page |
|---|---|---|
| SECTION 1 - | EXECUTIVE SUMMARY | 1 |
| SECTION 2 - | PURPOSE, SCOPING PROCESS, SCOPE OF WORK, PROJECT DESCRIPTION, NEED, AND THRESHOLD DECISION DETERMINATION | 5 |
| 2.1 | Purpose | 5 |
| 2.2 | Objectives | 5 |
| 2.3 | Scoping Process and Scope of Work | 5 |
| 2.4 | Project Description | 7 |
| 2.5 | Threshold Decision Determination and IEE Findings | 9 |
| 2.6 | Need for the EA | 9 |
| SECTION 3 - | ALTERNATIVES - INCLUDING THE PROPOSED ACTION (VECTOR CONTROL) | 11 |
| 3.1 | Proposed Action | 11 |
| 3.2 | Alternative: The Elimination of ONe or More of the Proposed Actions | 11 |
| 3.3 | Alternative: The Use of Alternative Insecticides | 12 |
| 3.4 | Alternative: The Elimination of Operational Control Approaches in Favor of a Response-only Approach | 13 |
| 3.5 | Proposed Action | 13 |
| 3.6 | Alternative Action: Exclude Physical Larval Control | 14 |
| 3.7 | Alternative Action: To Also Drain Larger Areas of Marshlands and Pristine Swamps | 14 |
| 3.8 | Programming Evaluation, Monitoring and Maintenance Activities Under the Proposed Action Physical Larval Control | 14 |
| SECTION 4 - | AFFECTED ENVIRONMENT (VECTOR CONTROL) | 17 |
| 4.0 | Affected Environment (Types of Aquatic Habitats Affected) -- Physical Larval Control | 17 |
| 4.1 | Proposed Action | 17 |
| 4.2 | Alternative: Eliminate Physical Larval Control | 18 |
| 4.3 | Alternative: Drain Larger Areas of Marshland and Pristine Swamps | 18 |
| SECTION 5 - | ENVIRONMENTAL CONSEQUENCES: ISSUES ANALYSIS AND MITIGATION MEASURES (VECTOR CONTROL) | 19 |
| 5.1 | The USEPA Registration Status of the Requested Pesticide | 19 |

TABLE OF CONTENTS (continued)


| | | Page |
|---|---|---|
| 5.2 | The Basis for Selection of the Requested Insecticide | 19 |
| 5.3 | The Extent to Which the Proposed Insecticide Use is Part of an Integrated Pest Management Program | 20 |
| 5.4 | The Proposed Method or Methods of Application Including Availability of Appropriate Application and Safety Equipment | 20 |
| 5.5 | Any Acute and Long-Term Toxicological Hazards Either Human or Environmental, Associated with the Proposed Use and Measures Available to Minimize Such Hazards | 21 |
| 5.6 | The Effectiveness of the Requested Insecticide for the Proposed Use | 21 |
| 5.7 | Compatibility of the Proposed Pesticide with Target and Non-Target Ecosystems | 22 |
| 5.8 | The Conditions Under Which the Insecticide is Used, Including Climate, Flora, Fauna, Geography, Hydrology and Soils | 22 |
| 5.9 | The Availability and Effectiveness of Other Insecticides or Non-Chemical Control Methods | 22 |
| 5.10 | The Requesting Country's Ability to Regulate or Control the Distribution, Storage, Use and Disposal of the Requested Pesticide | 22 |
| 5.11 | The Provisions Made for Training Users and Applicators | 23 |
| 5.12 | The Provisions Made for Monitoring the Use and Effectiveness of the Insecticide | 23 |
| 5.13 | Bacillus thuringiensis var. israelensis (B.t.i.) | 24 |
| 5.14 | The USEPA Registration Status of the Requested Pesticide | 24 |
| 5.15 | The Basis for Selection of the Requested Insecticide | 25 |
| 5.16 | The Extent to Which the Proposed Insecticide Use is Part of an Integrated Pest Management Program | 25 |
| 5.17 | The Proposed Methods or Methods of Application Including Availability of Appropriate Application and Safety Equipment | 25 |
| 5.18 | Any Acute and Long-term Toxicological Hazards Either Human or Environmental, Associated with the Proposed Use, and Measures Available to Minimize Such Hazards | 26 |
| 5.19 | The Effectiveness of the Requested Insecticide for the Proposed Use | 26 |
| 5.20 | Compatibility of the Proposed Pesticide with Target and Non-target Ecosystems | 26 |
| 5.21 | The Conditions Under Which the Insecticide is Used, Including Climate, Flora, Fauna, Geography, Hydrology and Soils | 26 |

TABLE OF CONTENTS (continued)


| | | Page |
|---|---|---|
| 5.22 | The Availability and Effectiveness of Other Insecticides or Non-Chemical Control Methods | 27 |
| 5.23 | The Requesting Country's Ability to Regulate or Control the Distribution, Storage, Use and Disposal of the Requested Pesticide | 27 |
| 5.24 | The Provisions Made for Training Users and Applicators | 28 |
| 5.25 | The Provisions Made for Monitoring the Use and Effectiveness of the Insecticide | 28 |
| 5.26 | Physical Larval Control | 28 |
| 5.27 | Endangered Species | 30 |
| 5.28 | Alternative: Do No Physical Larval Control | 31 |
| 5.29 | Alternative: Also Drain Larger Areas of Marshlands and Pristine Swamps | 31 |

APPENDIX IIB

# *RECOMMENDED PROCEDURES FOR ENVIRONMENTAL CONSIDERATION AND CRITERIA REVIEW OF VECTOR CONTROL ACTIVITIES UNDER HEALTH SECTOR II - HONDURAS

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* From "Environmental Assessment, Vector Biology and Rural Water and Sanitation Activities of the Health Sector II Project, Honduras, 1988 pp. 112-125

## ENVIRONMENTAL CONSIDERATIONS AND CRITERIA REVIEW

In addressing environmental considerations criteria review for integrated vector-borne disease control activities under Health Sector II, only five options are available: physical larval control, house spraying (fenitrothion); larviciding (*B.t.i.*); chemical prophylaxis and treatment, and no long-term action. Described below are generalized situations in Honduras with available options, followed by environmental considerations and criteria review processes for the various vector control approaches that might be taken, viz., pesticides (adulticides for residual wall spraying of dwellings and larvicides for treating anopheline habitats) and physical larval control through alteration of aquatic habitats.

Should modifications be necessary during the course of the Health Sector II Project, it is expected that the review mechanisms presented here can be adapted to either modified or expanded activities.

## Malaria Control Options

| Situation* | Options** |
|---|---|
| 1. Area has a low or negligible malaria incidence. Malaria incidence indicates need for vector control. Proceed to 2, below. | 4.5 |
| 2. -Urban area with known or suspected resistance to organophosphorus or carbamate compounds. | 4.1.3 |
| -Urban areas with known vector susceptibility. | 4.2.1.3 |
| -Rural areas with known or suspected resistance to OP or carbamate compounds. | 4.1.3 |
| -Rural areas with known vector susceptibility. | 4.2.1.3 |
| -Rural areas with scattered housing and well defined treatable impoundments (accessible with negligible environmental impact). | 4.2.1.3 |
| -Rural areas with scattered housing in inaccessible or environmental impact impoundments. | 4.2 |
| -Rural areas with concentrated housing and well defined and treatable impoundments (accessible and negligible environmental impact). | 4.2.1.3 |
| -Rural areas with concentrated housing and inaccessible or environmental impact impoundments. | 4.2.3 |

*Treatment Options:

1. Physical Larval Control
2. House spraying with fenitrothion
3. Larviciding with B.t.i.
4. Case detection and chemical prophylaxis and treatment.
5. No long-term action, but consider all options for dealing with epidemicity.

*See criteria review check list.
**Options are listed in descending order of consideration. Option 4 should be an adjunct to all vector control options.

60

## ENVIRONMENTAL CONSIDERATIONS AND CRITERIA REVIEW

### Insecticides

Should it become necessary under this project to procure or use pesticides not specifically approved in this EA, an amended EA must be prepared and approved by the LAC Chief Environmental Officer prior to their use.

The selection and use of pesticides by A.I.D. supported programs are covered in great detail under A.I.D. Regulation 22 CFR Part 216, Environmental Procedures. A model procedure for the future selection of pesticides to be used in the Honduras vector control program should be based on the subject document.

The following procedure is recommended:

1. Is the proposed product or its use exempt under Reg.22 CFR 216?

   (Note: Pesticides are generally not exempt; however, in some cases, e.g., controlled experimentation exclusively for the purpose of research and field evaluation which are carefully monitored might be (216.2(c)(iii) (2)(ii)). In all cases of exemption questions, approval should be received from the appropriate A.I.D. Environmental Officer(s). Exempt:

   Yes ____ No ____

   If the intended use of the pesticide is not clearly exempted under 22 CFR 216 and appropriately approved, the Pesticide Procedures of 22 CFR. 216.3(b)(1) should be carefully addressed. (Note: It is advisable to assume that the operational use of a pesticide is not exempt.) Subject to regs.:

   Yes ____ No ____

The factors that must be considered under 22 CFR 216.3(b)(i) are as follows:

- The USEPA registration status of the requested pesticide. ____
- The basis for selection of the requested pesticide. ____
- The extent to which the proposed pesticide use is part of an integrated pest management program. ____
- The proposed method or methods of application, including availability of appropriate application and safety equipment. ____

61

- Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use measures available to minimize such hazards.
- The effectiveness of the requested pesticide for the proposed use. _____
- Compatibility of the proposed pesticide with target and non-target ecosystems. _____
- The conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils. _____
- The availability and effectiveness of other pesticides or nonchem cal control methods. _____
- The requesting country's ability to regulate or control the distribution, storage, use and disposal of the requested pesticide in strict adherence to the label. _____
- The provisions made for training of users and applicators. _____
- The provisions made for monitoring the use and effectiveness of the pesticide. _____

2. Will the use of the pesticide impact on an endangered or threshold species? _____ _____

62

## Aquatic Habitats*

(See following page for Criteria Review Check List)

| | | Yes | No |
|---|---|---|---|
| 1. | Is the standing or slowly moving water problem man-made? | T | 2 |
| 2. | Is the standing or slowly moving water problem to be affected by a single project (e.g., a drainage system) less than 0.1* ha in surface area during the wettest season (June-August)? | T | 3 |
| 3. | Will the project affect only actively grazed pasture land? | T | 4 |
| 4. | Will the project affect an area of contiguous, possibly pristine wetland (as indicated by vegetation) exceeding 0.5* ha. during the wettest season (June-August)? | DNT1 | 5 |
| 5. | Does the affected project area contain American crocodiles (Crocodylus acutus) or banded tiger herons (Tigrisoma fasciatum)? | DNT2 | 6 |
| 6. | Does the affected area contain a total area of ungrazed, but not necessarily pristine wetlands exceeding 5.0* ha.? | 7 | MT |
| 7. | Has the effect or removing wetland area or downstream water quality been considered (wetlands can filter and purify runoff from surrounding watersheds) and deemed insignificant and has a search been conducted for resident animals and plants known to be endangered or threatened species with negative results? | 8 | DNT3 |
| 8. | Does the total area of all aquatic habitat being treated within the 3 km radius exceed 1%*(28ha.)? | DNT4 | MT |

T - Treat
MT - Minimal Treatment. Treat only what is absolutely necessary to treat for health reasons (e.g., do not drain an entire natural pond if only the edge needs to be treated).
DNT - Do Not Treat.
* - Values are estimated according to the professional opinion of CLM and may be modified in consultation with him.
1 - Risk to uncertain wetland value seems too great; 2 - Risk to known habitat value is too great; 3 - Risk to uncertain value is too great; 4 - Risk to uncertain value seems too great.

67

# CRITERIA REVIEW OF VECTOR CONTROL ACTIVITIES UNDER HEALTH SECTOR II

1. Project Area

1.1 Project Habitat Description
- Rain forests
- Riverine habitats
- Irrigation channels
- Estuaries
- Lakes and ponds
- Cultivated wetland (e.g., rice)
- Natural wetland
- Rivers and streams
- Coastal lowland
- Human settlements
- Grazed pastures
- Natural drainage channels
- Manmade drainage channels

1.2 Size of Project Area
- 0.1 - 0.5 ha.
- 0.5 - 2.0 ha
- 2.0 - 5.0 ha.
- 5.0 ha. or greater

1.3 Human population of Area
- Dense
- Moderate
- Sparse

1.4 Malaria incidence
- Low (API 0 - 2.0)
- Medium (API 2.0 - 9.0)
- High (API 10 or greater)

1.5 Project site distance to town or village
- Less than 1 km.
- 1 to 3 km.
- 3 to 5 km.
- 5 km. or more

1.6 Malaria transmission pattern
- Seasonal
- Permanent
- Endemic

64

1.7 Economic character of area
- Agricultural _____
- Industrial _____
- Geological _____
- Other _____

1.8 Vector susceptibility to insecticides
- Confirmed resistance _____
- Confirmed tolerance _____
- Susceptible _____

1.9 Agricultural insecticide pressure present
- None to negligible _____
- Low _____
- Medium _____
- High _____

1.10 Water-use Pattern
- Irrigation _____
- Used by animals _____
- Growing fish _____
- Bathing _____
- Washing clothes _____
- Human consumption _____
- Other _____

1.11 Disease control methodology prior to project
- Physical measures _____
- Chemical measures _____
- House spraying with residuals _____
- Drug treatment _____
- Other _____
- None _____

1.12 Land Ownership
- Private _____
- Public _____
- Other _____

2. Proposed Methodology for Larval Control

2.1 Physical Measures
- Shore line alteration _____
- Water course management _____
- Sloping of banks _____
- Removing vegetation _____
- Channeling _____
- Deepening _____
- Filling _____
- Draining _____

65

Sumping _____
Other _____

2.2 Chemical Measures
Use of *B.t.i.* _____
Other _____

2.3 Biological Measures
Use of larvivorous fish _____
Other _____

2.4 Project Design
Engineering input needed _____
Engineering input not needed _____

VECTOR BIOLOGY & CONTROL

**Vector Biology & Control Project**
1611 North Kent Street, Suite 503
Arlington, Virginia 22209
(703) 527-6500

Telex 248812 (MSCI UR)
Cable MSCI Washington, D.C.

# APPENDIX III

## Excerpts from:

## ENVIRONMENTAL ASSESSMENT OF THE PAKISTAN MALARIA CONTROL II PROJECT EXTENSION NO.: 391-0472

**August 1988**

A) Table of Contents

B) Insecticide Management, Transport, Storage and Disposal

**UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT**
**MISSION TO PAKISTAN**
**ISLAMABAD, PAKISTAN**

67

Managed by Medical Service Corporation International
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APPENDIX IIIA

TABLE OF CONTENTS


| | | Page |
|---|---|---|
| | ACKNOWLEDGEMENTS | i |
| | LIST OF ACRONYMS AND ABBREVIATIONS | ii |
| 1.0 | EXECUTIVE SUMMARY | i |
| 2.0 | APPLICABLE ENVIRONMENTAL PROCEDURES | 1 |
| | 2.1 A.I.D. Environmental Procedures | 3 |
| | 2.2 Government of Pakistan Pesticide Legislation | 3 |
| | 2.3 Previous Environmental Assessments and Need for Current Assessment | 3 |
| | 2.4 Conditions Precedent to Disbursement and Covenants | 4 |
| 3.0 | SCOPING PROCESS | 5 |
| | 3.1 Conduct of Environmental Assessment | 5 |
| 4.0 | ANALYSIS OF ALTERNATIVES TO THE PROPOSED PROJECT | 6 |
| | 4.1 No Action (Discontinue Existing Program) | 6 |
| | 4.2 Use of Alternative Insecticides and/or Environmental Management Malaria Control Methods | 6 |
| | 4.2.1 Description | 6 |
| | 4.2.2 Presumed Environmental Impacts | 7 |
| | 4.3 Malaria Control Through Chemotherapy Alone | 7 |
| | 4.4 Conclusion | 8 |
| 5.0 | PROJECT DESCRIPTION | |
| | 5.1 Background, Goal, Purpose and Outputs | 9 |
| | 5.1.1 Background | 9 |
| | 5.1.2 Impact of Agricultural and Engineering Activities on Incidence of Malaria | 10 |
| | 5.1.2.1 Pesticides | 10 |
| | 5.1.2.2 Dams | 11 |
| | 5.1.2.3 Irrigation | 11 |
| | 5.1.2.4 Farm Productivity | 11 |
| | 5.1.3 Project Goals, Purpose and Output | 12 |
| | 5.2 Other Donor Activities | 12 |
| | 5.2.1 World Health Organization | 13 |

TABLE OF CONTENTS (continued)


| | | Page |
|---|---|---|
| 5.2.2 | United National Children's Emergency Fund | 13 |
| 5.2.3 | Government of Japan | 13 |
| 5.2.4 | United Nations High Commission for Refugees | 13 |
| 5.3 | Affected Environment | |
| 5.3.1 | Land Utilization and Agricultural Resources | 13 |
| 5.3.2 | Forestry Resources | 14 |
| 5.3.3 | Parks and Protected Areas | 14 |
| 5.3.4 | Rare and Endangered Species | 14 |
| 5.3.5 | Human Population | 14 |
| 6.0 | PESTICIDE USE ASSESSMENT | 16 |
| 6.1 | U.S. EPA Registration Status of the Selected Insecticides | 16 |
| 6.1.1 | Malathion | 16 |
| 6.1.2 | Fenitrothion (Sumithion) | 16 |
| 6.2 | Basis for Selection of Insecticides | 17 |
| 6.3 | Integrated Pest Management and Malaria Control in Pakistan | 18 |
| 6.4 | Application Methods and Equipment | 19 |
| 6.5 | Acute and Long-term Environmental/Toxicological Hazards | 19 |
| 6.5.1 | Malathion | 19 |
| 6.5.2 | Fenitrothion | 20 |
| 6.6 | Efficacy of Selected Insecticides for Mosquito Control | 20 |
| 6.7 | Effect of Selected Insecticides on Non-target Organisms and Natural Environment | 23 |
| 6.8 | Conditions Under Which Insecticides Are to Be Used | 23 |
| 6.9 | Availability and Effectiveness of Other Insecticides and/or Nonchemical Control Measures | 24 |
| 6.10 | Ability of the Government of Pakistan to Regulate or Control the Distribution, Storage, Use and Disposal of Pesticides | 24 |
| 6.11 | Provision for Training Malaria Control Insecticide Users | 26 |
| 6.12 | Provision for Monitoring the USe and Efficacy of the Selected Insecticides | 26 |

TABLE OF CONTENTS (continued)


| | Page |
|---|---|
| 7.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION | 28 |
| 7.1 Unavoidable Adverse Environmental Impacts | 28 |
| 7.2 The Relationship Between Short-term Impacts and Long-term Productivity | 28 |
| 7.3 Irreversible or Irretrievable COmmitments of Resources | 28 |
| 8.0 ENVIRONMENTAL IMPACT MITIGATION PLAN | 30 |
| 8.1 Priorities | 30 |
| 8.2 Safety Protocols | 30 |
| 8.2.1 Protection | 30 |
| 8.2.1.1 Spray Uniforms | 30 |
| 8.2.1.2 Householders | 31 |
| 8.2.1.3 Overexposure | 32 |
| 8.2.1.3.1 Monitoring | 32 |
| 8.2.1.3.2 Treatment | 32 |
| 8.2.1.4 Transport, Storage, Disposal | 32 |
| 8.2.1.5 Safety Training | 33 |
| 8.2.1.6 Accident Contingency Consultant | 33 |
| 8.2.2 Research | 34 |
| 8.2.3 Monitoring Project Performance and Compliance | 34 |
| 8.2.4 Cooperative/Coordinated Planning | 35 |
| 9.0 LIST OF PREPARERS | 36 |
| 10.0 REFERENCES | 37 |
| TABLES | |
| 1 SUMMARY OF ENVIRONMENTAL FATE ATTRIBUTES OF MALATHION AND FENITROTHION | 21 |
| 2 SUMMARY OF TOXICOLOGICAL ATTRIBUTES OF MALATHION AND FENITROTHION | 22 |
| ANNEXES | |
| A - PERSONS CONTACTED | 38 |
| B - SCOPING STATEMENT | 42 |
| C - PESTICIDE LABEL - (MALATHION AND SUMITHION) | 46 |
| D - SLIDE POSITIVITY RATE AND ANNUAL PARASITE INCIDENCES (API) 1975-1986 | 49 |

TABLE OF CONTENTS (continued)


Page

ANNEXES

E - PROCUREMENT OF INSECTICIDES BY THE MALARIA ERADICATION/CONTROL PROGRAM - PAKISTAN (1961-1988) 50

F - USAID HOUSE SPRAYING OBSERVATION FORMS 51

G - ESTIMATED COSTS OF RECOMMENDATIONS 53

H - USAID MALARIA INFORMATION CARD 60

I - ENVIRONMENTAL CONSIDERATIONS AND CRITERIA REVIEW - INSECTICIDES 62

J - FIELD SURVEYS OF EXPOSURE TO PESTICIDES STANDARD PROTOCOL 64

FIGURES

1 SPRAY TEAM IN NORTHWEST FRONTIER PROVINCE WEARING UNIFORMS AND TURBANS PROVIDED BY DOMC 78

2 SPRAYMAN IN LOCALITY NEAR PESHAWAR SPRAYING WALLS OF A BEDROOM 79

3 MIXER PREPARING SUSPENSION OF MALATHION WDP TO FILL SPRAY TANKS OF SPRAYMAN 80

4 HOUSEHOLDERS' BELONGINGS AND FURNITURE REMOVED FROM HOUSE IN PREPARATION FOR SPRAYING 81

5 INSECTICIDE STORE-ROOM IN A VILLAGE OF THE PUNJAB PROVINCE 82

**APPENDIX IIIB**

## Pakistan Malaria Environmental Assessment Insecticide Management Transport, Storage, and Disposal

A.D. Long, Sc.D., P.E.

### Objective

Prior handling, transport, storage and disposal is a primary environmental concern. Potential environmental problems associated with malaria control programs will more likely occur from mismanagement and misuse of insecticides, than from environmental contamination following appropriate use in household residual spraying programs. The objective is therefore to training staff in appropriate use and provide adequate warehouse facilities. To use an old adage "An ounce of protection goes along way". Therefore the objective is to structure an evaluation program that identifies and corrects existing problems and anticipates potential problems and designs solutions prior to their occurring so as to minimize problems when they do occur.

### Background

Malaria control programs have been vertical public health programs primarily based on intra-domiciliary spraying. They have been staffed with committed and well trained and supervised staff and have been well funded. However, with the end of the focus on malaria eradication, support for malaria programs, both politically and economically, has decreased. Facilities have not been upgraded nor maintained, and training of new and existing staff have been reduced. However, at the same time insecticide use patterns and practices have changed with changes in insecticide from DDT o malathion to fenitrothion, etc. Recognizing this, the purpose of this proposal is to provide a methodology for improving facilities, staff training and awareness, and provide a self evaluation methodology so as to mitigate potential environmental problems that could arise from insecticide misuse and mismanagement.

### Methodology

The proposed self-evaluation methodology is based on the concept of inspection procedures, development of action plans, and designation of responsible parties to upgrade existing facilities and staff training. This methodology is based on experience gained in US hazardous waste programs and incorporates the concept of accident contingency planning and workers right-to-know laws.

Attached is the proposed inspection form. This draft form will be field-tested and revised during the Environmental Assessment. An implementation plan is proposed below under recommendations.

A detailed description of the form and its intended use follows:

| | |
|---|---|
| Location | Designate location of facility. The completed form should be posted at the facility so staff can see their responsibilities and should be reviewed during the next inspection. Note the paperwork stays at the facility, therefore this is not an attempt to create another paper trail for management, but rather a tool to be used by warehouse managers to improve their facilities. |
| Warehouse Manager | Indicate person responsible for facility under inspection. |
| Inspector | Indicate who the inspector is. the inspector should usually be the warehouse managers immediate supervisor, i.e. a district or regional supervisor; however, the supervisor of that person should also conduct spot checks and A.I.D.'s Environmental Officer should also conduct spot checks to ensure that the program is being successfully implemented. |
| Date | Self explanatory |
| Next Inspection Date | The purpose is to schedule the next inspection and provide a target for warehouse manager. |
| Action Required | Sets schedule for action by warehouse manager and inspector. |
| Next Inspection Date | The purpose is to schedule the next inspection and provide a target for warehouse manager. |

The remainder of the form is broken into the following columns: Inspection Item, Priority, Score, Action Person, Action. The inspection items are explained after the other column titles.

| | |
|---|---|
| Priority | This sets a priority for action. +++ items need immediate attention and should be doable with existing resources. ++ items are important but may need assistance above that the warehouse manager and inspector are capable of providing, such as training. + items are desirable should be handled within one year, but are not necessary. |

| | |
|---|---|
| Score | 0 or 1. The total score indicates the facility grade. The intention of the score and priority setting is not to move a facility from 10 to 25, for example, in one week (which is unrealistic) rather it is tended that through a series of inspections to show steady progress and thereby achieve the objectives to the program in a doable time period. |
| Action Person | Indicates who is responsible for implementing the proposed action. This could range from the warehouse janitor, to the warehouse manager, to the inspector, to the central office. |
| Action | Indicate an action that is doable by the action person. More than one pass may be required. For example, on general cleanliness, on the first pass the inspector may indicate that the janitor should sweep out and wash down the loading area. At a much later date the inspector might indicate that the warehouse manager should have the facility painted. |

## INSPECTION ITEMS

Inspection items are broken into the following sub-areas:

Transport/Receiving/Shipping
Warehousing
Disposal
Field Operations
Accident Contingency Planning

### Transport/Receiving/Shipping

| | |
|---|---|
| Transport Vehicle | Appropriate, maintained in good working order, properly, cleaned etc. Vehicle operations and maintenance program in place. If sea containers, are they returned properly cleaned? |
| Transportation Route | Known route, adequate roads, police informed, etc. |
| Driver Safety | Driver has excellent safe driving record |
| Vehicle Yard/Shop | Vehicle yard and shop in good order. Staff appropriately trained. What does shop do with waste oil, etc.? |



14

| | |
|---|---|
| Water/Wastewater | Adequate water supply. How is wastewater disposed of? |
| Inventory Complete | Inventory (in/out) up to date |
| Appropriate loading Area and Loading Equipment | Is loading area and equipment suitable for needs and volume/weight of materials being handled? |
| Protective Clothing | Personnel have and use appropriate protective clothing and masks |
| Cleanliness | overall cleanliness of the facility |
| Cholinesterase | Tests on transport and receiving/shipping staff complete |

<u>Warehousing</u>

| | |
|---|---|
| Security | Building properly secured. |
| First-in/First-out | First-in/first-out principals used in materials management. |
| Palleted/Shelved | All materials are properly stored to keep dry etc. Check to see if there are temperature requirements. |
| Ventilated | The building is properly ventilated so that gases/fumes do not build up. |
| No Spillage | |
| First Aid Kit | Appropriate first aid materials available. |
| Fire Extinguisher | Fire fighting equipment is readily available. |
| Water/Wastewater | Supply for washing - including showers for personnel at larger facilities - and for washdown of facilities. Wastewater disposed of in sewage system or soakaway. |
| Office Space | Located separately from warehouse space. |
| Cholinesterase | Tests on warehouse staff complete. |

## Disposal

| | |
|---|---|
| Return of large containers to vendors | Large containers should be returned to vendor or properly cleaned before being disposed of. |
| On/Off Site Burning | Appropriate location for burning and disposal of waste containers and fire fighting equipment. |
| Burial of Waste Material | Appropriate waste disposal site, clay lined, monitored etc. |
| Personnel Protection | Protective clothing, masks, hazards knowledge, etc. |
| Cholinesterase | Tests on staff complete |

## Field Operations

| | |
|---|---|
| Training | Training of field staff in proper/safe use on insecticides |
| Cholinesterase | Tests on staff complete |
| Equipment | Effective spray equipment operations and maintenance program |
| Storage | Spray equipment appropriately cleaned and stored between use |
| Personnel Protection | Protective clothing, masks, hazards knowledge, etc. |

## Accidental Contingency Planning

| | |
|---|---|
| Accident Contingency Plan | Plan in place and personnel familiar with its use etc. |
| Training | Personnel training plans developed and personnel scheduled for/completed required training |
| Personnel Hazards Knowledge | Workers right-to-know. This gets at how effective the training is |

| | |
|---|---|
| Safety Equipment | Personnel knowledgeable of location and use of safety equipment |
| First-Aid | Personnel knowledgeable of location and use of first aid equipment and emergency procedures. Who to call, when etc. |

Recommendation/Implementation Schedule

The following implementation schedule is proposed:

- o That the format be field tested during the EA
- o Following the EA, if the Mission and Malaria Program find this useful, that the invite S&T/H and VBC back to implement this self-evaluation program. Implementation would include:

  1. Finalizing forms and users manual
  2. Training of national staff in use of same
  3. Conducting all major facilities with national staff to initiate the system
  4. Developing the accident contingency plans

To implement this as recommended, some of the work could take place in Washington. However, 2 person team would be required in country for 3-4 weeks. One person would be responsible for running the training program and conducting the initial inspections, while the second person would be responsible for developing the plans in conjunction with national staff.

PAKISTAN MALARIA WAREHOUSE FACILITY INSPECTION REPORTS

ADL/TFS 7/28/88

LOCATION _____

WAREHOUSE MANAGER _____

INSPECTOR _____

DATE _____

SCORE

Unacceptable 0-5
Poor 6-15
Average 16-25
Good 26-30
Excellent 31-35

NEXT INSPECTION DATE _____

ACTION REQUIRED

0-5 = Immediate - Inspector should work with warehouse manager
< 16 = Reinspect weekly
> 16 = Reinspect monthly

| INSPECTION ITEMS | PRIORITY | SCORE | | ACTION PERSON | ACTION/COMMENT |
|---|---|---|---|---|---|
| | | 0 | 1 | | |
| **Transportation/Receiving/Shipping** | | | | | |
| Transport Vehicle | ++ | | | | |
| Transportation Route | + | | | | |
| Driver Safety | +++ | | | | |
| Vehicle Yard/Shop | +++ | | | | |
| Water/Wastewater | +++ | | | | |
| Inventory Complete | +++ | | | | |
| App. Loading Area/Equipment | + | | | | |
| Protective Clothing | +++ | | | | |
| Cleanliness | +++ | | | | |
| Cholinesterase | ++ | | | | |
| **Warehousing** | | | | | |
| Security | +++ | | | | |
| First-In/First-Out | +++ | | | | |
| Palleted/Shelved | ++ | | | | |
| Ventilated | ++ | | | | |
| No Spillage | +++ | | | | |
| First Aid Kit | +++ | | | | |
| Fire Extinguishers | ++ | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Water/Wastewater | ++ | | | | |
| Office Space | + | | | | |
| Cholinesterase | ++ | | | | |
| Disposal | | | | | |
| Return of Containers | ++ | | | | |
| On/Off Site Burning | +++ | | | | |
| Burial of Waste Material | +++ | | | | |
| Personnel Protection | +++ | | | | |
| Cholinesterase | ++ | | | | |
| Field Operations | | | | | |
| Training | ++ | | | | |
| Cholinesterase | ++ | | | | |
| Equipment | +++ | | | | |
| Storage | +++ | | | | |
| Personnel Protection | +++ | | | | |
| Accident Contingency Planning | | | | | |
| Accident Contingency Plan | ++ | | | | |
| Training | +++ | | | | |
| Personnel Hazards Knowledge | ++ | | | | |
| Safety Equipment | +++ | | | | |
| First Aid | +++ | | | | |
| TOTAL SCORE | | | | | |

| OVERALL COMMENTS |
|---|
| |
| |
| |
| |

PAKISTAN MALARIA WAREHOUSE FACILITY INSPECTION REPORTS ADL/TFS 7/28/88

LOCATION: INSPECTION

DATE

NEXT INSPECTION DATE

| INSPECTION ITEMS | PRIORITY | SCORE 0 | SCORE 1 | ACTION PERSON | ACTION/COMMENT |
|---|---|---|---|---|---|
| **Transportation/Receiving/Shipping** | | | | | |
| Transport Vehicle | ++ | | | | |
| Transportation Route | + | | | | |
| Driver Safety | +++ | | | | |
| Vehicle Yard/Shop | +++ | | | | |
| Water/Wastewater | +++ | | | | |
| Inventory Complete | +++ | | | | |
| App. Loading Area/Equipment | + | | | | |
| Protective Clothing | +++ | | | | |
| Cleanliness | +++ | | | | |
| Cholinesterase | ++ | | | | |
| **Warehousing** | | | | | |
| Security | +++ | | | | |
| First-In/First-Out | +++ | | | | |
| Palleted/Shelved | ++ | | | | |
| Ventilated | ++ | | | | |
| No Spillage | +++ | | | | |
| First Aid Kit | +++ | | | | |
| Fire Extinguishers | ++ | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Water/Wastewater | ++ | | | | |
| Office Space | + | | | | |
| Cholinesterase | ++ | | | | |
| Disposal | | | | | |
| Return of Containers | ++ | | | | |
| On/Off Site Burning | +++ | | | | |
| Burial of Waste Material | +++ | | | | |
| Personnel Protection | +++ | | | | |
| Cholinesterase | ++ | | | | |
| Field Operations | | | | | |
| Training | ++ | | | | |
| Cholinesterase | ++ | | | | |
| Equipment | +++ | | | | |
| Storage | +++ | | | | |
| Personnel Protection | +++ | | | | |
| Accident Contingency Planning | | | | | |
| Accident Contingency Plan | ++ | | | | |
| Training | +++ | | | | |
| Personnel Hazards Knowledge | ++ | | | | |
| Safety Equipment | +++ | | | | |
| First Aid | +++ | | | | |
| TOTAL SCORE | | | | | |

| OVERALL COMMENTS |
|---|
| |
| |
| |
| |

## ANNEX 1

## PESTICIDE LAW AND LABELING

### THE FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (FIFRA)

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as amended by Congress in 1972, placed the responsibility for pesticide registration and applicator certification upon the Environmental Protection AGency (EPA). Each State set up a lead agency for implementation of FIFRA under guidelines established by EPA. Since States have been required to develop their own parallel legislation, State and local laws may be more restrictive than the Federal law.

The parts of the law most relevant to practical control of vectors are as follows:

1. Pesticide uses must be classified by EPA as being either general or restricted. By law, pesticide uses that will damage the environment very little or not at all when carried out as the label directs are general uses. Uses that could cause damage even when carried out as directed on the label must be classified as restricted uses. In addition, some uses of pesticides are prohibited. Manufacturers must register every pesticide with EPA.

2. Persons applying restricted use pesticides must obtain the appropriate certification as to their competence in using them. A pesticide may not be used other than as the label or labeling directs, except when special regulations allow use at a lower rate than the label recommends. Also, disposal of any pesticide or its container must be as the label directs.

3. Penalties (fines and jail terms) are imposed on people who do not obey the law.

Any State may issue registrations for pesticides which are manufactured, sold, and used within that State and thus do not move in interstate commerce. States may also permit variances from federally registered labels within the State in order to accommodate special local or regional vector control needs.

---

NOTE: Verbatim from CDC 1981. Insecticides for the control of insects of public health importance, Atlanta, GA. pp. 7-10.

Many countries outside the Untied States have pesticide laws and regulations, and a number of developing countries are interested in establishing national pesticide registration and control systems.

Finally, there is a mechanism for obtaining experimental use permits through the lead agency within each State to conduct research into potential new uses of pesticides.

Other federal regulations applicable to vector control operations involve transport of pesticides across State lines, aerial application of pesticides, and worker safety. Interstate shipment of pesticides is regulated by the Federal Department of Transportation. Aerial application of pesticides is regulated by the Federal Aviation Administration. The Occupational Safety and Health Act of 1970 is administered by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. It requires anyone with 11 or more workers to keep records and make reports on pesticide usage by these workers.

**LABEL INTERPRETATION**

The major practical result of FIFRA is that the pesticide label <u>is</u> the law:

1. To manufacturers, the label is "license to sell."

2. To State or Federal Governments, the label is the means for controlling distribution, storage, sale, use and disposal of pesticide products.

3. To buyers or users, the label is the source of facts on using the product effectively, legally, and safely.

**PARTS OF THE LABEL**

Labels vary in complexity, but the items described below must be present on the label and must be completely understood for safe, legal use of the product.

<u>Brand Name</u>: Each company uses brand names for its products. It is the most identifiable name for a product since it is used in advertisements and shows plainly on the front panel of the label.

<u>Type of Formulation</u>: Different types of pesticide formulations (liquids, wettable powders) require different methods of handling. The label indicates which formulation the package contains. The same pesticide may be available in several formulations.



83

Common Name: Many pesticides have complex chemical names. Most compounds have been given another name or common name to make them easier to identify. For example, Carbaryl is the common name for 1-naphthyl methylcarbamate. A chemical made by more than one company be sold under several brand names but the same common name and chemical name will appear on all of them.

Ingredient Statement: Every pesticide label must list product contents so that active ingredients may be quickly identified. Active ingredient amounts are given as weight percentages or as pounds per gallon of concentrate. The active ingredients can be listed by either the chemical name or common name. Inert ingredients need not be named, but the label must show what percentage of the contents they constitute.

Net Contents: The net contents figure expresses of the manufacturer or distributor of a product must, by law, appear on the label.

Registration and Establishment Numbers: A registration number showing that a product has been registered with the Federal Government must appear on every pesticide label. The establishment number telling what factory made a chemical does not have to be on the label but will be somewhere on each container.

Signal Words and Symbols: One of the most important parts of the label is the signal word. It indicates the human toxicity of the material. These words are set by law and each manufacturer is required to use the correct one on every label:

DANGER - Highly toxic. A taste or teaspoonful will kill the average person.

WARNING - Moderately toxic. A teaspoonful to a tablespoonful will kill the average person.

CAUTION - Low toxicity or comparatively free from danger. A fatal does to the average person is at least an ounce to more than a pint.

The skull and crossbones symbol is used on all highly toxic materials along with the signal word "DANGER" and the word "POISON."

Hazards to Humans (and Domestic Animals): This section tells the ways in which the product is poisonous to man and animals, special steps or protective equipment for use, and for physicians, the proper treatment for poisoning.

Environmental Hazards: Environmental precautions to be read and followed must appear on the label. Examples are:



84

"This product is highly toxic to bees exposed to direct treatment."

"Do not contaminate water when cleaning equipment or disposing wastes."

Labels may contain broader warnings against harming birds, fish, and wildlife.

Physical and Chemical Hazards: Special fire, explosion, or chemical hazards posed by the product are enumerated.

Statement of Practical Treatment: If swallowing or inhaling the product or getting it in the eyes or on the skin would be harmful, the label must list emergency first aid measures, along with indication of what types of exposure require medical attention. The PESTICIDE LABEL IS THE MOST IMPORTANT INFORMATION TO BE TAKEN TO THE PHYSICAL IN SUSPECTED CASES OF POISONING.

Statement of Use Classification: Every pesticide label must show whether the contents are for general or restricted use. The restricted use statement must be at the top of the front panel of the label.

DIRECTIONS FOR USE: The use instructions indicate:

1. The pests the product is registered to control.

2. The location (for example, on marshlands or in containers) where the product can be used.

3. The form in which the product should be applied.

4. How much of the product to use.

5. When the product should be applied.

Misuse Statement: This is a remainder that using a product in a manner inconsistent with its labeling is a violation of Federal law. Do not use a product on a pest not listed on the label, and do not use a rate of application higher than recommended on the label.

Category of Applicator: If required for the product, this section will limit its use to certain categories of commercial applicators.

Storage and Disposal Directions: This section will specify how to store and dispose of the pesticide product and empty containers correctly.



85

**PRODUCT USE INFORMATION**

Product registrations and regulations are subject to change at any time by EPA, Congress, or local government. Occasionally, products come under the "rebuttal presumption" category set forth by EPA for products they wish to reassess in terms of risk versus benefit.

Registration of a product may be withdrawn if findings under rebuttable presumption proceedings are unfavorable to its continued use.

Also, from time to time, EPA puts out "pesticide enforcement policy statements" (PEPS) which are designed to clarify, extend, amend, or otherwise modify current regulations. Several of these "PEPS" have appeared thus far in the Federal Register.

Timely contact with the lead State agency for implementation of FIFRA or the local EPA regional office is advisable, to remain aware of current regulations and registrations and to have questions answered by those in authority.

SEPTEMBER 1987

# IMPORTANT

**BEFORE USING STOP! READ DIRECTIONS IN THIS LEAFLET!**

# CYTHION®

The Premium Grade Malathion

EPA Reg. No. 241-208-AA

# MALATHION ULV* CONCENTRATE

insecticide

EPA Reg. No. 241-110-AA

*Registered Trademark of American Cyanamid Company

*Trademark of American Cyanamid Company

Active Ingredient:

| | |
|---|---|
| Malathion** | 91.0% |
| Inert Ingredients | 9.0% |
| Total | 100.0% |

**O,O-dimethyl phosphorodithioate of diethyl mercaptosuccinate
(One gallon contains 9.33 pounds of malathion)

SPECIMEN

**KEEP OUT OF REACH OF CHILDREN**

## CAUTION

### STATEMENT OF PRACTICAL TREATMENT

**IF SWALLOWED:** Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not give anything by mouth to an unconscious person. Call a physician.

**IF ON SKIN:** Wash with plenty of soap and water. Call a physician.

**IF IN EYES:** Flush with plenty of water. Call a physician if irritation persists.

**NOTE TO PHYSICIAN:** This product may cause cholinesterase inhibition. Atropine is antidotal. 2-PAM may be effective as an adjunct to atropine.

**PRECAUCION**

**PRECAUCION AL USUARIO:** Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

Before using, read the directions contained in this leaflet for the proper methods and procedures which must be followed to achieve effective insect control and avoid permanent damage to automobile and other paint finishes.

## PRECAUTIONARY STATEMENTS
## HAZARDS TO HUMANS (AND DOMESTIC ANIMALS)

## CAUTION

HARMFUL BY SWALLOWING, INHALATION OR SKIN CONTACT

Avoid breathing spray mist • Avoid contact with skin • Wash thoroughly after handling • Change contaminated clothing • Do not contaminate food or feed products • Do not apply this product through any type of irrigation system

## ENVIRONMENTAL HAZARDS

This product is toxic to fish. Avoid direct applications to lakes, streams, ponds, tidal marshes and estuaries. Do not apply where runoff is likely to occur. Do not apply when weather conditions favor drift from areas treated. Do not contaminate water by cleaning of equipment or disposal of wastes. Shrimp and crab may be killed at application rates recommended on this label. Do not apply where these are important resources. This pesticide is highly toxic to bees exposed to direct treatment or to residues remaining on the treated area. Do not apply this product or allow drift when bees are actively visiting the treatment area. Applications should be timed to provide the maximum possible interval between treatment and the next period of bee activity. Further protective information may be obtained from your Cooperative Agricultural Extension Service. Apply this product only as specified on this label.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

**Pesticide Disposal:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

**Container Disposal:** Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

## DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

CYTHION insecticide or Malathion ULV Concentrate insecticide may only be used in accordance with the directions in this leaflet or approved supplementary labeling. Read all directions carefully before using.

Undiluted spray droplets of CYTHION® insecticide, The Premium Grade Malathion* or MALATHION ULV* Concentrate insecticide will permanently damage automobile paint. If accidental exposure does occur, the vehicle should be washed immediately.

**Note to Formulators:**
CYTHION or MALATHION ULV may be used for the preparation of malathion insecticides. Before using for this purpose, manufacturers should consult American Cyanamid Company for manufacturing and handling instructions. Each formulator is responsible for his formulated product(s).

## DISCLAIMER

The label instructions for the use of this product reflect the opinion of experts based on field use and tests. The directions are believed to be reliable and should be followed carefully. However, it is impossible to eliminate all risks inherently associated with use of this product. Crop injury, automobile paint damage, ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the use or application of the product contrary to label instructions, all of which are beyond the control of American Cyanamid Company. All such risks shall be assumed by the user.

American Cyanamid Company warrants only that the material contained herein conforms to the chemical description on the label and is reasonably fit for the use therein described when used in accordance with the directions for use, subject to the risks referred to above.

Any damages arising from a breach of this warranty shall be limited to direct damages and shall not include consequential commercial damages such as loss of profits or values or any other special or indirect damages.

American Cyanamid Company makes no other express or implied warranty, including any other express or implied warranty of FITNESS or of MERCHANTABILITY.

The sale of this product does not include a license under any patent owned by the American Cyanamid Company.

**ANNEX 2**

# Insecticides Labeled for the Control of Adult and Larval Mosquitoes by Ground and Aerial Application Methods

CARLISLE B. RATHBURN, JR., PH.D.

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The following tables contain a compilation of label recommendations of insecticides presently approved by the Environmental Protection Agency (EPA) for application by ground and aerial equipment for the control of adult and larval mosquitoes. They are presented as an aid to persons presently engaged in mosquito control. Also included are some general comments on the application of adulticides by ground equipment.

All formulations of an insecticide may not be included in the tables. Some formulations or applications registered for use only in a particular state, special use formulations and formulations containing a combination of toxicants are not included. Also not included are some insecticides used in the past but of limited use today which may still be labeled for mosquito control such as parathion, methyl parathion, lethane, dichlorvos, etc. Consult manuufacturer's or formulator's labels for use of these and other formulations. It should also be pointed out that not all insecticides or formulations registered by the EPA are recommended for use by all state or other agencies within whose jurisdiction the control operation is to be carried out. Because of the possible development of resistance and cross resistance to presently used adulticides; the organophosphates, chlorinated hydrocarbons and pyrethrin insecticides listed in Table 6 and Table 9 for the control of larval mosquitoes are not recommended by Entomology Services or the John A. Mulrennan, Sr. Research Laboratory of the Florida Department of Health and Rehabilitative Services.

Several factors should be considered in the selection of an insecticide for a particular use. First and foremost, is the effectiveness of an insecticide. All labeled insecticides have demonstrated effectiveness for a particular use; however, the efficacy of a particular insecticide may vary considerably between various habitats and with different meteorological conditions of wind, temperature, relative humidity, etc. Recommended dosage rates for many larvicides vary with the type of water to which it is applied, and label recommendations of many adulticides limit applications to times when wind velocities are less than a specified speed. The efficacy of adulticides and larvicides may also vary between mosquito species. For example, resmethrin and pyrethrins as adulticides are consider-

Rathburn, C.B. 1988. Insecticides labeled for the control of adult and larval mosquitoes by ground and aerial application methods. J. Florida Anti-Mosquito Assoc. 59(1): 27-36.

Table 1. Label Recommendations of Insecticides for Use as Ultra Low Volume and Low Volume Sprays in Ground Applications for the Control of Adult Mosquitoes.

| Insecticide[1] | Trade name[2] | Manufacturer or formulator | Concentrate | | Formulation | Application | |
|---|---|---|---|---|---|---|---|
| | | | lbs AI per gal | % AI | gals conc. per 100 gals | flow rate fl oz/min | speed mph |
| chlorpyrifos | Dursban MFC | Dow | 6.00 | 61.5 | — | 0.67–1.33[3] | 10 |
| | Dursban 1.5 ULV | Clarke | 1.50 | 19.4 | — | 2.7–5.3[3] | 10 |
| bendiocarb | Ficam ULV | Nor-Am | 1.67 | 18.87 | — | 1.7–7.5 | 10–15 |
| fenthion | Baytex LC[5] | Mobay | 9.67 | 93.0 | — | 0.5–2 | 5–20 |
| malathion | Cythion ULV | Cyanamid | 9.53 | 91.0 | — | 1–8.6 | 5–20 |
| | Malathion ULV | Prentiss | 9.79 | 95.0 | — | 1–4.3 | 5–10 |
| malathion + resmethrin | Mosquitocide 731 | Clarke | — | 63.97 +0.41 | — | 2.5–6 | 5–10 |
| naled | Dibrom 14 | Chevron | 14.00 | 85.0 | —[6] | 0.6–1.8 | 5–15 |
| | | | | | 10.0[8] | 3–18 | 5–15 |
| | | | | | 3.125[9] | 21.3 | 10 |
| | Naled | Amvac | 14.00 | 85.0 | —[6] | 0.6–1.8 | 5–15 |
| | | | | | 10.0[8] | 3–18 | 5–15 |
| | Dibrom LVC 10 | Stephenson | 1.40 | 15.0 | — | 3–18 | 5–15 |
| | Dibrom ULV | Sumit | — | 15.0 | — | 3–18 | 5–15 |
| | Dibrom ULV 15 | Vector | — | 15.0 | — | 3–18 | 5–15 |
| phenothrin | Multicide 2271 | MGK | — | 38.23 | — | 4.5–18 | 5–15 |
| propoxur | Baygon MOS | Mobay | 1.00 | 12.8 | — | 6–32[11] | 5–15 |
| pyrethrin/ pbo | Pyrocide 7067 | MGK | — | 5/25 | — | 2–2.25 | 5 |
| | Pyrocide 7088 | MGK | — | 12/60 | —[7] | 2–2.25 | 5 |
| | Pyronyl MA | Prentiss | — | 12/60 | —[7] | 2–2.25 | 5 |
| | Pyrethrum ULV | Summit | — | 5/25 | — | 2–4.50 | 5-10 |
| | ULD-BP-100 | Micro-Gen | — | 1/2 | — | 15 | 5 |
| | ULD-BP-300 | Micro-Gen | — | 3/6 | 33.3 | 15 | 5 |
| | Scythe | Vector | — | 1.5/3 | — | 10 | 5 |
| resmethrin | SBP-1382-40MF | Penick | 3.34 | 40.0 | 8.9[8] | 9.1 | 5 |
| | SBP-1382-4.22MF | Penick | 0.29 | 4.22 | — | 9.1–18.2 | 5–10 |
| resmethrin/ pbo | Scourge | Penick | 1.5/4.5 | 18/54 | —[7] | 1.5–18 | 5–10 |
| | Scourge[10] | Penick | 0.3/0.9 | 4/12 | —[7] | 1.5–18 | 5–10 |

TABLE 1 - FOOTNOTES

[1]LC = Liquid Concentrate. MA = Mosquito Adulticide. pbo = piperonyl butoxide. MFC = Mosquito fogging concentrate.

[2]Labeled for use only within Florida for control of *Culex nigripalpus* at 2.1 fl oz per min at 10 mph.

[3]Registered for use only Florida, Texas, Mississippi, Arkansas, Tennessee, Louisiana, Alabama and Georgia.

[4]Labeled for use in Florida at 20 fl oz in HAN, Chevron 400 or diesel oil to make 5 gals and applied at 10 gals per hour.

[5]Labeled states dilute 2 qts (64 fl oz) in 4 1/2 gals of HAN or soybean oil to make 5 gals of dilute solution.

[6]Labeled for use in Florida only.

[7]Consult label for various dilutions and application rates.

[8]Label states dilute 1 part of concentrate with 1.4 parts (wt) of oil to give a solution containing 5% pyrethrins plus 25% piperonyl butoxide. Consult label for oil specifications. Up to 8 fl oz per min may be used to control certain mosquito species.

[9]Label states mix 12.5 fl oz of concentrate with 1 gal of light mineral oil and apply at 3 fl oz of finished formulation per acre as a 300 ft swatch at a truck speed of 5 mph. Consult label for oil specifications. A formulation containing 4% SBP-1382 and 12% piperonyl butoxide is also registered for use only within South Carolina at 1.5 to 9.0 fl oz per min at 5 mph and 3.0 to 18.0 at 10 mph.

[10]Labeled for use in South Carolina only.

[11]Labeled for use in Florida only at 4-32 fl oz per min at 5-15 mph respectively.

89

Table 2. Label Recommendations of Insecticides for Use as Thermal Aerosols in Ground Applications for the Control of Adult Mosquitoes.

| Insecticide[1] | Trade name[1] | Manufacturer or formulator | Concentrate: lbs AI per gal | Concentrate: % AI | Formulation: gals conc. per 100 gals[2] | Application: flow rate gal/hr | Application: speed mph |
|---|---|---|---|---|---|---|---|
| allethrin/ pbo | Alleviate MFS | Fairfield | — | 0.625/2.0 | — | 28.1 | 5 |
| chlorpyrifos | Dursban MFC | Dow | 6.0 | 61.5 | 2.0 | 40 | 5 |
| | Dursban 1.5 ULV | Clarke | 1.5 | 19.4 | 6.0 | 52.5 | 5 |
| fenthion | Baytex LC | Mobay | 9.67 | 93.0 | 0.4– 0.8 | 40 | 5 |
| | Baytex 4[3] | Mobay | 4.00 | 45.0 | 1.0– 2.0 | 40 | 5 |
| | Fenthion 4E[3] | Prentiss | 4.00 | 45.0 | 1.0– 2.0 | 40 | 5 |
| | Prentox MFC | Prentiss | — | 10.0 | 4.5–10.0 | 40 | 5 |
| malathion | Cythion ULV | Cyanamid | 9.33 | 91.0 | 3.9– 5.2 | 40 | 5 |
| | Malathion ULV | Prentiss | 9.79 | 95.0 | 3.9– 5.2 | 40 | 5 |
| | 50 percent | SMCP | 4.33 | 50.0 | 4.0 | — | — |
| malathion/ lethane | Outdoor Fog | SMCP | — | 3.0/1.4 | — | (1 gpa) | — |
| | M/L Conc. | SMCP | — | 44.7/19.8 | 7.1 | — | — |
| methoxychlor | 25 percent | Prentiss | — | 25.4 | 3.5 | (5–7 gpa) | — |
| | 2 pound | Prentiss | 2.0 | 24.0 | 3.5 | (5–7 gpa) | — |
| naled | Dibrom 14 | Chevron | 14.0 | 85.0 | 0.775[4] | 40–120 | 5–15 |
| | Naled 85 | Amvac | 14.0 | 85.0 | 0.775[4] | 40 | 5 |
| pyrethrin/ pbo | Pyrenone MFS | Fairfield | — | 0.25/2.0 | — | 150 | 5 |
| pyrethrin/ pbo + malathion | Pyrenone + Malathion | Fairfield | — | 0.05/0.125 + 2.0 | — | 240–620 | 5 |
| resmethrin | Respond | Penick | 0.03 | 0.5 | — | (3.75 gpa) | 3 |

[1]E = Emulsifiable. LC = Liquid Concentrate. MFC = Mosquito Fogging Concentrate. MFS = Mosquito Fogging Spray. pbo = piperonyl butoxide.

[2]May be diluted in No. 2 diesel oil. No. 2 fuel oil or kerosene. Addition of additive may be required as a sludge inhibitor. Consult manufacturers recommendations for type and amount.

[3]Also labeled for use as a non-thermal aerosol at same formulation and flow rate.

[4]Label states dilute 3.1 quarts (100 fl oz) to 99 gals of No. 2 fuel oil or diesel oil.

ably more toxic to *Culex* species than *Aedes* species while malathion, chlorpyrifos and methoprene are more toxic to *Aedes* species than *Culex* species. Also to be considered is the effect of resistance of certain mosquito species to certain insecticides. In Florida, the primary resistance at the present time is the resistance of *Aedes taeniorhynchus* to malathion and, while important, this resistance is not universal throughout the State. Recently, *Culex quinquefasciatus* and *Cx. nigripalpus* have also shown some degree of resistance to malathion, fenthion and temephos in a few areas.

The second factor to be considered is the cost of the insecticide, not only the cost of the concentrate or formulation as purchased, but also the cost of the formulation dispensed to effect control, such as cost per acre, per mile or per hour. Insecticide formulations dispensed as ultra low volume (ULV) concentrate sprays are usually less expensive than thermal aerosols or mists due mainly to the cost of the necessary diluent used in thermal aerosol and mist applications. Also to be included in this comparison are the additional costs of application such as the large tanks needed to transport the large volumes of the more dilute formulations required by thermal aerosol and mist applications and the larger vehicles needed to transport this greater weight.

Probably the third most important factor is the ease in which the insecticide is handled and applied. Insecticides applied as concentrates do not require dilution and therefore result in lower costs. Also to be considered in the ease of use is the corrosiveness, volatility and/or mammalian toxicity (see Table 10) of the insecticide. These factors may increase costs due to the special handling procedures required. Some insecticides also have inherent formulation problems such as experienced with carbamates which are not soluble in

Table 3. Label Recommendations of Insecticides for Use as Mists in Ground Applications for the Control of Adult Mosquitoes.

| Insecticide[1] | Trade name[1] | Manufacturer or formulator | Concentrate: lbs AI per gal | Concentrate: % AI | Formulation: gals conc. per 100 gals[2] | Application: flow rate gal/hr | Application: speed mph |
|---|---|---|---|---|---|---|---|
| allethrin | Pyrellin SCS | Wright | — | 1.0 | 20.0 | 10.9 | — |
| allethrin/ pbo | Alleviate MFS | Fairfield | — | 0.625/2.0 | — | 28.1 | — |
| chlorpyrifos | Dursban M | Dow | 4.0 | 41.2 | (0.8–1.6 fl oz/a)[3] | — | — |
| | Dursban 2E | Dow | 2.0 | 22.4 | (1.6–3.2 fl oz/a)[3] | — | — |
| | Dursban 4E | Dow | 4.0 | 44.4 | (0.8–1.6 fl oz/a)[3] | — | — |
| | Dursban 4E | Prentiss | 4.0 | 44.8 | (0.8–1.6 fl oz/a)[3] | — | — |
| fenthion | Baytex LC | Mobay | 9.67 | 93.0 | 0.875–1.75[4] | 100 | 4 |
| | Baytex 4E | Mobay | 4.0 | 45.0 | 2.125–4.24 | 100 | 4 |
| | Fenthion 4E | Prentiss | 4.0 | 45.0 | 2.125–4.25 | 100 | 4 |
| | Prentox MFC | Prentiss | — | 10.0 | 9.07–19.02 | 100 | 4 |
| malathion | Cythion EL | Cynamid | 5.00 | 57.0 | 3.45[5] | 100 | — |
| | 50 percent | SCMP | 4.33 | 50.0 | 4.00[6] | — | — |
| methoxychlor | 25 percent | Prentiss | — | 25.4 | 4.00 | (5–7 gpa) | — |
| | 2 pound | Prentiss | 2.0 | 24.0 | 4.00 | (5–7 gpa) | — |
| naled | Dibrom 8 | Chevron | 8.0 | 58.0 | 0.75–1.25 | — | — |
| propoxur | Baygon WP | Mobay | — | 70.0 | (11.75–17.25 lbs) | 100 | 4 |
| | Baygon 1.5 | Mobay | 1.5 | 13.9 | 5.50–8.00 | 100 | 4 |
| | Carbamate EC | Prentiss | 1.5 | 14.6 | 5.50–8.00 | 100 | 4 |
| pyrethrin/ pbo | Pyrenone MFS | Fairfield | — | 0.25/2.0 | — | 150 | 5 |
| pyrethrin/ pbo + malathion | Pyrenone + Malathion | Fairfield | — | 0.05/0.125 +2.0 | — | 240–620 | 5 |

[1]E+ Emulsifiable. EC = Emulsifiable Concentrate. EL = Emulsifiable Liquid. LC = Liquid Concentrate. WP = Wettable Powder. MFS = Mosquito Fogging Spray. SCS = Space and Crop Spray.

[2]Water dilutions except where noted.

[3]Label states that formulation may be mixed with water or oil using sufficient spray volume to give uniform coverage of area treated.

[4]Requires addition of emulsifier and solvent when used in water solutions.

[5]Label states mix 1 part to 28 parts water, fuel oil or diesel oil.

[6]Label states mix 1 part to 24 parts water, fuel oil or diesel oil.

[7]Label states calibrate rate of travel and discharge to apply 0.1 lb AI per acre.

oils necessary for ULV and thermal aerosol applications.

The fourth factor to be considered is the availability of the insecticide. Insecticides which are readily available may save the user considerable time and expense. To change insecticides, because of the unavailability of the one currently used, requires the user to recalibrate their equipment for the new insecticide and change established operating and possible formulation procedures. Also, insecticides produced by manufacturers who have local sales or field repesentatives available to solve the many potential problems associated with the availability and use of their product is an important consideration and one that may also save the user considerable time and expense. There are many factors a potential user must consider; however, the four listed herein are probably the most important to consider in selecting an adulticide or larvicide for use in a mosquito control program.

91

Table 4. General Label Recommendations and Comments on the Ground Application of Insecticides for Adult Mosquito Control.

| | | |
|---|---|---|
| Speed | - | Most labels recommend a vehicle speed of 5-10 mph (8-10 kph) but some recommended speeds up to 20 mph (30 kph). An increase in speed must be accompanied by a proportional increase in discharge, but to avoid overdosing at higher vehicle speeds, the use of an automatic flow control devise is recommended. |
| Swath | - | Most labels recommend a swath of 300-500 ft. (90-107 m); the depth of an average city block. Apply perpendicular to wind direction and to one side of street only, since the wind direction controls the direction of drift of spray. |
| Wind | - | Most labels state to apply in winds of 5 mph (8 kph) or less, which is ideal. Good control with ULV sprays may be obtained in wind velocities up to 10-12 mph, but high winds reduce exposure time and mosquito activity. |
| Temperature | - | Apply at temperatures above 60-65°F (16-18°C) with good inversion conditions. Temperature inversion is when air at ground level is cooler than the air above it, which will keep the spray close to the ground. Mosquito activities is usually less at lower temperatures and therefore the degree of control obtained will be less. |
| Time-of-day | - | Apply from early morning to coincide with periods of greatest mosquito activity. This is also the period of optimum wind and inversion conditions. Most mosquito species are most active just before sunrise and/or just after sunset. |
| Formulation | - | Use only according to label recommendations. Consult manufacturer or label for information on dilutents and storage of formulated insecticides. |
| Discharge rate | - | For ULV machines using pressure to discharge the insecticide, changes in insecticide temperature usually require a change in flowmeter setting. Temperature is not a factor with thermal aerosol machines or ULV machines using constant volume insecticide pumps. |
| Calibration | - | Calibrate equipment prior to initial use and periodically thereafter. Check discharge setting before each use. |
| Droplet Size | - | For ULV machines, determine droplet size initially and periodically thereafter to see if it conforms to insecticide label criteria. Labels of most insecticides specify the droplet size to be used and some also describe the methods to be used to sample and measure the droplets. (see Table 5). |

Table 5. Label Requirements for Droplet Size of Ultra Low Volume (ULV) Non-Thermal Aerosols.

| | | Droplet size criteria | | |
|---|---|---|---|---|
| Insecticide | Trade name | VMD/MMD µm | size range µm | largest size µm |
| bendiocarb | Ficam ULV | 20 or <[1] | — | 30 |
| chlorpyrifos | Dursban MFC | 10–15 | 5–30 | — |
| fenthion | Baytex LC | 15 or < | 5–20 | 45 |
| malathion | Cythion | 17 or < | 6–32[2] | 48 |
| naled[3] | Dibrom | 15 of < | 11–20 | 50 |
| phenothrin | Multicide 2271 | — | 5–25 | — |
| propoxur | Baygon MOS | 15 or < | 5–20 | 45 |
| pyrethrins | Pyrocide 7088 | — | 5–50 | — |
| resmethrin[4] | Scourge | 8–20 | — | — |

[1]Label states LMD but this is equivalent to VMD or MMD when droplets are sampled by waving slide in aerosol cloud.

[2]Label states spray droplets should not exceed 32 microns in size. Three percent of the spray droplets can exceed 32 microns providing the MMD does not exceed 17 microns and no droplets exceed a maximum of 48 microns. More than 1/2 total spray mass must consist of droplets in the 6-18 µm range and a minimum of 2/3 preferably 4/5 of total spray mass must consist of droplets not exceeding 24 µm in range.

[3]Droplet size requirements are the same for other formuations of 85% and 15% naled.

[4]Labels of SBP-1382 40 MF oil base concentrate and SBP-1382 4.22 MF solvent dilutable concentrate state 12 µm MMD. Label for SBP-1382 40 MF Solvent Dilutable Concentrate states 8-20 µm MMD.

Table 6. Label Recommendations of Organophosphates, Chlorinated Hydrocarbons and Pyrethrins for Use in Ground Applications for Larval Mosquito Control.

| Insecticide[1] | Trade name[2] | Manufacturer or formulator | Concentrate lbs AI per gal | Concentrate % AI | Fl oz concentrate per acre | Gross amount per acre[4] |
|---|---|---|---|---|---|---|
| chlorpyrifos | Dursban M | Dow | 4.0 | 41.2 | 0.4–1.6 | —[3] |
| | Dursban 2E | Dow | 2.0 | 22.4 | 0.8–3.2 | —[3] |
| | Dursban 4E | Dow | 4.0 | 44.4 | 0.4–1.6 | —[3] |
| | Dursban 4E | Prentiss | 4.0 | 44.8 | 0.4–1.6 | —[3] |
| | Dursban 1G | Dow | — | 1.0 | — | 2.5–5 |
| fenthion | Baytex LC | Mobay | 9.67 | 93.0 | 0.67 | —[4] |
| | Baytex 4E | Mobay | 4.00 | 45.0 | 1.50 | —[3] |
| | Fenthion 4E | Prentiss | 4.00 | 45.0 | 1.50 | —[3] |
| | Baytex 1G | Mobay | — | 1.0 | — | 5–20 lbs |
| | Baytex 5G | Mobay | — | 5.0 | — | 4 lbs |
| malathion | Cythion ULV | Cyanamid | 9.33 | 91.0 | 6.9 | 1 gal[4] |
| | Cythion EL | Cyanamid | 5.00 | 57.0 | 13.0 | —[3] |
| | 50 percent | SCMP | 4.33 | 50.0 | 15.0 | —[3] |
| methoxychlor | 25 percent | Prentiss | — | 25.4 | 16.0 | 10 gals[5] |
| | 2 pound | Prentiss | 2.0 | 24.0 | 16.0 | 10 gals[5] |
| temephos | Abate 4–e | Cyanamid | 4.0 | 44.6 | 0.5–1.5 | —[3] |
| | Abate 4E | SMCP | 4.0 | 43.0 | 0.5–1.5 | —[3] |
| | Abate 1–SG | Cyanamid | — | 1.0 | — | 5–20 lbs |
| | Abate 1%SG | SMCP | — | 1.0 | — | 5–20 lbs |
| | Abate 1%CG | SMCP | — | 1.0 | — | 5–25 lbs |
| | Abate 2–CG | Cyanamid | — | 2.0 | — | 2.5–25 lbs |
| | Abate 5–CG | Cyanamid | — | 5.0 | — | 2–10 lbs |
| | Skeeter Abate | Clarke | — | 5.0 | — | 2–20 lbs |
| pyrethrins/ pbo | Tossits | Wyco | — | 1.0/10.0 | — | 1/100 ft² |
| | Pyrenone MC | Fairfield | — | 1.0/10.0 | — | 1/100 ft² |

[1]Abbreviations: E = Emulsifiable, EL = Emulsifiable Liquid, G = Granular, LC = Liquid Concentrate, pbo = piperonyl butoxide, SG = Sand Granular, CG = Celatom Granular.

[2]Rates recommended on label may vary with type of water or habitat. Consult label for specific amounts.

[3]Diluted in sufficient water or oil to give adequate coverage.

[4]Diluted in sufficient diesel or fuel oil to give adequate coverage. May require cosolvent.

[5]Diluted in sufficient water to give adequate coverage.

Table 7. Label Recommendations of Oils, Insect Growth Regulators and *Bacillus thuringiensis* var. *israelensis* for Use in Ground Applications for Larval Mosquito Control.

| Insecticide | Trade name[1] | Manufacturer or formulator | Concentrate percent AI | Amount of concentrate per acre | Gross amount per acre[2] |
|---|---|---|---|---|---|
| oils, etc. | GB–1111 | Witco | 98.7 | 3–5 gals | — |
| | GB–1356 | Witco | 98.2 | 3–5 gals | — |
| | Arosurf MSF | Sherex | 100.0 | 0.2–1 gals | — |
| | Fla. Larvicide | —[3] | 99.56 | 3–6 gals | — |
| methoprene | A.L.L. | Zoecon–PPM | 5.0 | 3–4 fl oz | —[5] |
| | Altosid SR–10 | Zoecon–PPM | 10.0 | 3–4 fl oz | —[5] |
| | Altosid G[4] | Zoecon–PPM | 0.2 | — | 8–10 lbs |
| | Altosid B | Zoecon–PPM | 7.9 | — | 1/100 ft² |
| Bti[6] | Bactimos WP[7] | Biochem | 50.0 | 2–12 wt oz | —[5] |
| | Bactimos FC | Biochem | 14.3 | 0.5–3 pts | —[5] |
| | Bactimos G | Biochem | 2.5 | — | 4–20 lbs |
| | Bactimos B | Biochem | 10.0 | — | 1–4/100 ft² |
| | Bactimos P | Biochem | 5.0 | — | 3–16 lbs |
| | Teknar HP–D | Zoecon–PPM | 1.6 | 0.25–1 pt | —[5] |
| | Teknar G | Zoecon–PPM | — | — | 3–6 lbs |
| | Vectobac 12AS | Abbott | 1.2 | 0.25–2 pts | 5–100 gals[8] |
| | Vectobac AS | Abbott | 0.6 | 0.50–2 pts | 5–100 gals[8] |
| | Vectobac G | Abbott | 0.2 | — | 2–20 lbs |
| | Skeetal FC | Nova | 15.0 | 0.5–2 pts | —[5] |
| | BMC WP | Reuter | 50.0 | 4 wt oz | 25 gals |
| Bti-methoprene | SAN 8091 | Zoecon-Sandoz | 1.50–0.2 | 0.2–1 pt | —[5] |

[1]Abbreviations: AC - Aqueous Concentrate, AS = Aqueous Suspension, B = Briquets, FC = Flowable Concentrate, G = Granular, WP = Wettable Powder, P = Pellets.

[2]Rates recommended on label may vary with type of water or habitat. Consult label for specific amounts.

[3]Florida Mosquito Larvicide is formulated by the user and consists of 0.375% Triton X-207 anmd 1.0% 30W motor oil by volume in No. 2 diesel oil.

[4]For formulation procedures of Altosid sand granular, consult Zoecon Corp. Tech. Bulletin.

[6]Bti-*Bacillus thuringiensis* var. *israelensis*. Toxic units are expressed either as AAITU or AAU per milligram and may vary between manufacturers of formulators. (one AAITU equals 2.5 AAU).

[8]Diluted in sufficient water for adequate coverage.

[7]May also be prepared as a sand granule on various carriers. Consult manufacturers for preparation instructions.

94

**Table 8. Label Recommendations of Insecticides for Use in Aerial Applications for Control of Adult Mosquitoes.**

| Insecticide[1] | Trade name[2] | Manufacturer or formulator | Concentrate: lbs AI per gal | Concentrate: % AI | Fl oz concentrate per acre | Gross amount per acre[4] |
|---|---|---|---|---|---|---|
| | | *Ultra Low Volume* | | | | |
| chlorpyrifos | Dursban 1.5 ULV | Clarke | 1.5 | 19.4 | 2.0 | — |
| fenthion | Baytex LC | Mobay | 9.67 | 93.3 | 0.66–1.3 | — |
| malathion | Cythion ULV | Cyanamid | 9.33 | 91.0 | 2.6–3.0 | — |
| | Prentox ULV | Prentiss | 9.79 | 95.0 | 2.6–3.0 | — |
| naled | Dibrom 14 | Chevron | 14.00 | 85.0 | 0.5–1.0 | — |
| | Naled 85[3] | Amvac | 14.00 | 85.0 | 0.5–1.0 | — |
| | Dibrom 14[3] | Chevron | 14.00 | 85.0 | 0.91 | —[7] |
| propoxur | Baygon MOS | Mobay | 1.00 | 12.8 | 6–16 | —[11] |
| pyrethrins | Pyrocide 7067[3] | MGK | — | 5/25 | —[10] | — |
| resmethrin/pbo | Scourge[4] | Penick | 1.4/4.5 | 18.54 | —[10] | —[10] |
| resmethrin | SBP–1382–40MF[5] | Penick | 3.13 | 40.0 | —[10] | —[10] |
| | SBP–1382–4.22MF[5] | Penick | 0.29 | 4.22 | —[10] | —[10] |
| | | *Low Volume* | | | | |
| chlorpyrifos | Dursban M | Dow | 4.00 | 41.2 | 0.8–1.6 | SFAC[3] |
| | Dursban 2E | Dow | 2.00 | 22.4 | 1.6–3.2 | SFAC[3] |
| | Dursban 4E | Dow | 4.00 | 44.4 | 0.8–1.6 | SFAC[3] |
| fenthion | Baytex LC | Mobay | 9.67 | 93.3 | 0.67–1.33 | 1–2 qts[6] |
| | Baytex 4E | Mobay | 4.00 | 45.0 | 1.6–3.2 | 4 qts[5] |
| | Baytex MFC | Prentiss | — | 10.0 | 7.2–14.4 | 4 qts[6] |
| | Fenthion 4E | Prentiss | — | 45.0 | 1.6–3.2 | 4 qts[5] |
| naled | Dibrom 14 | Chevron | 14.00 | 85.0 | 0.5–1.0 | 4 qts[6] |
| | Dibrom 8E | Chevron | 8.00 | 58.0 | 0.8–1.6 | 2–8 qts[6] |
| peopour | Baygon 1.5 | Mobay | 1.50 | 13.9 | 4.25–6.0 | 2–4 qts[6] |
| | Baygon WP | Mobay | — | 70.0 | (1–4 wt oz) | 2–4 qts[6] |
| | Carbamate 1.5 | Prentiss | 1.50 | 14.6 | 4.25–6.0 | 2–4 qts[6] |
| | | *Thermal Aerosol* | | | | |
| fenthion | Baytex LC[3] | Mobay | 9.67 | 93.0 | 0.4 | 0.2–0.8 qt[6] |
| malathion | Cythion ULV[3] | Cyanamid | 9.33 | 91.0 | 2.6 | 0.2–0.8 qt[6] |
| naled | Dibrom 14[3] | Chevron | 14.00 | 85.0 | 0.872 | 0.5 qt[6] |
| | naled 85[3] | Amvac | 14.00 | 85.0 | 0.872 | 0.5 qt[6] |
| resmethrin | SBP–1382–40MF | Penick | 3.13 | 40.0 | (0.007 lb AI) | 0.2–0.8 qt[6] |

[1]E = Emulsifiable. LC = Liquid Concentrate. WP = Wettable Powder. pbo = piperonyl butoxide.
[2]SFAC = Sufficient for Adequate Coverage. Ultra Low Volume applications used undiluted except as noted.
[3]Registered for use in Florida only.
[4]Diluted in diesel or fuel oil.
[5]Diluted in oil or water.
[6]Diluted in water.
[7]35% v/v in soybean oil at 2.6 fl oz/a.
[8]5% v/v in fuel or diesel oil.
[9]Labeled for use only in certain states. A 4%/12% formulation also available.
[10]Consult label for various dilutions and application rates.
[11]May be applied undiluted or diluted in kerosene or No. 2 fuel oil to obtain uniform coverage.

Table 9. Label Recommendations of Insecticides for Use in Aerial Applications for Control of Larval Mosquitoes.

| Insecticide[1] | Trade name[1] | Manufacturer or formulator | Concentrate: lbs AI per gal | Concentrate: % AI | Fl oz concentrate per acre | Gross amount per acre[2] |
|---|---|---|---|---|---|---|
| | | *Oils, Insect Growth Regulators, and Bti[2]* | | | | |
| oils, etc. | GB–1111 | Witco | 7.4 | 98.7 | (3–5 gals) | — |
| | GB–1356 | Witco | 7.4 | 98.2 | (3–5 gals) | — |
| | Fla. larvicide | —[3] | 7.4 | 99.56 | (3–6 gals) | — |
| | Arosurf MSF | Sherex | — | 100 | (0.2–1 gal) | — |
| methoprene | A.L.I. | Zoecon–PPM | 0.86 | 0.5 | 3–4 | 0.5–5[3] |
| | Altosid SR–10 | Zoecon–PPM | 0.86 | 10.5 | 3–4 | SFAC[3] |
| | Altosid G[3] | Zoecon–PPM | — | 0.2 | — | 10 lbs |
| Bti[1,6] | Vectobac 12 AS | Abbott | — | 1.2 | 4–32 | SFAC[3] |
| | Vectobac AS | Abbott | — | 0.6 | 8–32 | SFAC[3] |
| | Vectobac G | Abbott | — | 0.2 | — | 3–6 lbs |
| | Bactimos FC | Biochem | — | 14.3 | 8–48 | 10 gals |
| | Bactimos G[9] | Biochem | — | 2.5 | — | 4–20 lbs |
| | Bactimos P | Biochem | — | 5.0 | — | 3–16 lbs |
| | Teknar HPD | Zoecon–PPM | — | 1.6 | 4–16 | SFAC[3] |
| | Teknar G | Zoecon–PPM | — | — | — | 3–6 lbs |
| | BMC WP | Reuter | — | 50.0 | (8 wt oz) | 2–10 gals |
| | Skeeval FC | Novo | — | 15.0 | 16–32 | 2–4 gals[5] |
| Bti-methoprene | SAN 8091 | Zoecon–PPM | — | 1.5–0.2 | 3.2–16 | SFAC[3] |
| | | *Organophosphates* | | | | |
| chlorpyrifos | Dursban M | Dow | 4.0 | 41.2 | 0.4–1.5 | SFAC[8] |
| | Dursban 2E | Dow | 2.0 | 22.4 | 0.8–3.2 | SFAC[8] |
| | Dursban 4E | Dow | 4.0 | 44.4 | 0.4–1.6 | SFAC[8] |
| | Dursban 1G | Dow | — | 1.0 | — | 2.5–5 lbs |
| fenthion | Baytex LC | Mobay | 9.67 | 93.0 | 0.6–1.33 | 1–2 qts[7] |
| | Baytex 4E | Mobay | 4.00 | 45.0 | 1.6–3.2 | 1 gal[6] |
| | Baytex 1G | Mobay | — | 1.0 | — | 5–20 lbs |
| | Baytex 5G | Mobay | — | 5.0 | — | 4 lbs |
| | Prentox MFC | Prentiss | — | 10.0 | 7.2–14.4 | SFAC[7] |
| | Prentox 4E | Prentiss | — | 45.0 | 1.6–3.2 | SFAC[8] |
| malathion | Cynthion ULV | Cyanamid | 9.33 | 91.0 | 6.9 | 1 gal[7] |
| | Cythion EC | Cyanamid | 5.00 | 57.0 | 13.0 | SFAC[7] |
| temephos | Abate 4E | Cyanamid | 4.0 | 44.6 | 0.5–1.5 | SFAC[3] |
| | Abate 4E | SMCP | 4.0 | 43.0 | 0.5–1.5 | SFAC[3] |
| | Abate 1SG | Cyanamid | — | 1.0 | — | 5–20 lbs |
| | Abate 2CG | Cyanamid | — | 2.0 | — | 2.5–25 lbs[9] |
| | Abate 5CG | Cyanamid | — | 5.0 | — | 2–10 lbs[9] |
| | Abate 1% SG | SMCP | — | 1.0 | — | 5–10 lbs[9] |
| | Abate 1% CG | SMCP | — | 1.0 | — | 5–10 lbs[9] |

[1]E = Emulsifiable. G = Granular. AS = Aqueous Solution. FC = Flowable Concentrate. LC = Liquid Concentrate. WP = Wettable Powder. Bti = *Bacillus thuringiensis* var. *israelensis*. P = Pellets. SG = Sand Granule. CG = Celetom Granule.

[2]SFAC = Sufficient for Adequate Coverage.

[3]See Zoecon formulation procedures.

[4]Florida Mosquito Larvicide consists of 0.375% Triton X-207 and 1.0% 30W motor oil in No. 2 diesel oil.

[5]Diluted in water.

[6]Diluted in water or oil.

[7]Diluted in diesel or fuel oil with cosolvent.

[8]Rates vary with type of water and habitat. Consult label for specific recommendations.

[9]May also be prepared as a sand granule on various carriers. Consult manufacacurer for preparation instructions.

Table 10. Toxicity of Insecticides Used in Mosquito Control Compared to Some Other Common Insecticides and Chemicals.

| Common name | Trade name | Acute oral $LD_{50}$ in mg. Tech/kg. for rats by reference number | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| parathion | —[b] | 3 | 3–30 | — |
| bendiocarb | Ficam | 40 | 40–64 | 40–64 |
| dichlorvos | DDVP | 56 | 25–170 | |
| propoxur | Baygon | 90 | 83–104 | ♂95, ♀104 |
| DDT | —[b] | 113 | 87–500 | — |
| chlorpyrifos | Dursban | 135 | 82–245 | ♂163, ♀135 |
| fenthion | Baytex | 190 | 255–740 | ♂375, ♀290 |
| pyrethrin | —[b] | 200 | 200–2600 | 820–1870 |
| phenthoate | Cidial | 300 | 200–2000 | >2000 |
| allethrin | —[b] | 310 | 680–1000 | 920 |
| naled | Dibrom | 430 | 250–430 | 430 |
| fenitrothion | Sumithion | 490 | 250–740 | ♂300, ♀800 |
| malathion | Cythion | 1375 | 885–2800 | ♂1375, ♀1000 |
| aspirin | — | 1900[a] | — | — |
| temephos | Abate | 2030 | 1000–13,000 | ♂8600, ♀13,000 |
| resmethrin | SBP–1382 | 2500 | 1500 | 4240 |
| salt | — | 4500[a] | — | — |
| methoxychlor | —[b] | 6000 | 5000–7000 | >6000 |
| phenothrin | Sumithrin | 10,000 | >10,000 | >10,000 |
| piperonyl butoxide | — | — | 6150–7500 | 11,500 |
| monomolecular film | Arosurf | 20,000 | — | >20,000 |
| sugar | — | 27,000[a] | — | — |
| methoprene | Altosid | 34,600 | >34,600 | >34,600 |
| Bti | —[b] | non toxic | — | non toxic |

[1]Thompson. W. T. 1985. Agricultural chemicals. Book I Insecticides. 1985-86 Revision. Thompson Pub., Fresno. CA 255pp.

[2]Kenaga, E. E., and R. W. Morgan. 1978. Commercial and Experimental Organic Insecticides. 1978 Revision. Entomol. Soc. of Am. Pub. 78-1. 79pp.

[3]From manufacturers technical data.

[4]The Bottom Line. Dow Chemical Co., Midland. MI. January 1981. 7pp. (from: Hodge, H. C. and W. C. Downs. Toxicol. Appl. Pharmacol. 3:689–695. 1961)

[b]Manufactured under several trade names.

91

# ANNEX 3

## DISCUSSION TOPICS

3A Integrated Vector Control (IVC) and Integrated Pest Management (IPM)

3B Selection of Pesticides

3C Vector Resistance and Agriculture

3D Availability of Alternative Insecticides

ANNEX 3A

Integrated Vector Control (IVC) is the term often used in public health as the equivalent of Integrated Pest Management (IPM) in agriculture. Whenever possible Agency policy as stated for IPM should also be applied in vector control programs as an alternative to the total reliance on chemical insecticides to reduce vector populations and interrupt transmission of vector-borne diseases.

IVC is not a new concept in vector control. Prior to the development of the modern organic insecticides (OC, OP, etc.) in the 1940's, mosquito control was based on elimination of breeding sites (source reduction), larviciding near populated areas with oils or inorganic insecticides (e.g. Paris Green or copper arsenite), and personal protection (e.g. bed nets or exclusion). However, these measures were only applicable to certain populations at high risk in tropical areas or for more extensive use in temperate zones and higher socio-economic areas. The extension of vector control into highly endemic rural areas only became possible with the advent of house spraying with DDT. Other methods of control were essentially discarded during the period when malaria eradication was the objective.

Research on development of new methods of mosquito control, to be in integrated with intradomiciliary spraying, has not kept pace with the development of IPM techniques in agriculture. In part this is because most alternate measures against agricultural pests target larval stages, and their reduction bears a direct relation to potential or realized damage to the crop. On the other hand, most vectors transmit disease only in the adult stage. Larval reduction must be very extensive to significantly reduce adult populations and effective control of breeding sites over large areas is very difficult. This is one rationale for concentration on adulticiding, especially for malaria control.

The alternative measures of vector control most commonly suggested are:

- microbial insecticides (see Section 4.2 of the text)
- source reduction (elimination of vector breeding sites)
- impregnated bed netting (which serve as both personal protection and as a residual insecticide surface)
- insect growth regulators (IGR) or juvenile hormones-registered as insecticides
- methods of application that are inexpensive and long lasting - e.g. insecticide impregnated paints



99

- personal protection (e.g. bednets,use of repellents, housing improvements)

- zooprophylaxis - using domestic animals to divert largely zoophilic vectors from biting humans

It is apparent that a number of these methods employ insecticides (if in smaller quantities) and are subject to the same environmental considerations as house and space spraying.

Another important Agency policy is the use of community participation whenever possible. Some of the alternative methods (e.g. source reduction, personal protection, use of impregnated bed nets) are more suitable for community participation than routine spraying efforts and should be encouraged whenever possible.

Finally, in all attempts to control vector-borne diseases a broader effort must be made to determine whether suitable vaccines, chemoprophylaxis or chemotherapy are available at reasonable cost. An "integrated disease control" program based on these, in combination with vector control efforts, may provide more effective and least costly means of control.



100

Selection of Insecticides - If a project is planned for a three to five year period it is impossible to guarantee that any insecticide(s) initially proposed will remain effective for the life of the project. The possibility of the development of resistance to the insecticides used in a program, or in agricultural practices in the same area, has been known since 1947, when the salt-marsh mosquitoes Aedes sollicitans and Ae. taeniorphymchus began to show resistance to DDT in Florida (Brown, 1986). In some parts of the world, and in some species, this resistance developed slowly but in other areas it has occurred rapidly.

Genetically-based resistance has been well described in numerous works (Brown and Pal, 1971). Resistance has not only developed to specific insecticides, but the selective mechanisms of resistance have resulted in multiple and cross-resistance rendering whole classes of compounds ineffective.

The variety of resistance patterns shown by mosquitoes in Central America (Table 5) is illustrative, and linked to the extensive use of a broad range of insecticides to control cotton and other agricultural pests. Georghiou and Mellon (1986) have shown that in certain areas of Southern Mexico insecticides (of numerous classes-OC, OP, carbamates and phyrethroids) have been used at doses reaching a total of 30 liters of active ingredient/hectare (13 quarts [3.25 gallons] per acre). Such massive amounts are not required to pressure vector populations to develop resistance, however.

Although all well managed vector control programs are supposed to monitor target populations for the development of resistance this is often not the case. As a result large quantities of essentially worthless, but expensive, insecticides are employed and exert little if any control on the vector populations. As the cost of application is often equal to the cost of the insecticide employed there is additional waste of operational resources.

Monitoring for resistance should include all populations where insecticide spraying or larviciding is employed, and should be done at least twice a year to ascertain whether their $LC_{50}$ or $LD_{50}$ levels, as measures of susceptibility to the insecticide in use, are increasing over the original level. The preferred method of testing is the use of the WHO Insecticide Test Kits available from WHO/Geneva. Mosquitoes are exposed to either filter papers impregnated with precise concentrations of the insecticide being tested (adults), or liquid concentrations of the insecticide (larvae). Exposure is for one (1) hour (adults) or 24 hours (larvae) and mortality is observed directly (larvae) or after a resting period of 24 hours (adults). The dosage and observed mortality are entered on a graph (log-probity) and a regression



10

line is plotted. In simple field analysis, percent mortality is determined by the above procedures to indicate change in susceptibility over time.

It is also important to know the concurrent use of agricultural insecticides in areas where insecticides are used in vector control.

Vector Resistance and Agriculture. Agricultural use of insecticides can exert a selective pressure on vectors of the larval and adult stages, or both, thereby reducing or eliminating the effectiveness of similar insecticides as a means of disease control. This is especially true in areas where certain monocultural crops (e.g., cotton and rice) are intensely cultivated. Some vector breeding sites, e.g., rice fields, are treated for crop protection and the vector larvae in such situations are subjected to direct selection pressure.

Agricultural practices have been implicated in the development of vector resistance when:

- resistance appeared before the application of insecticides to control the particular vector;
- vector populations were suppressed by agricultural sprays, but were less affected by subsequent exposure;
- increases in resistance coincided with the use of agricultural insecticides; and
- the spectrum of cross-resistance was related to the compound(s) used.

Documented studies demonstrate that the application of agricultural pesticides has led to the development of resistance of a number of malaria vector species (anopheline mosquitoes) throughout the world: Anopheles gambiae and A. funestus in Africa; multi-resistance (to organochlorines, organophosphates and carbamates) of A. albimanus in Central America; and A. aconitus and A. culicifacies in parts of South-East Asia.

The mosquito vector (Culex tritaenioprhyncus) of Japanese encephalitis provides a good illustration of the impact of agriculture on vector resistance. Widespread use of insecticides to protect high-yielding varieties of rice in 1965 first led to concurrent control of these rice-field breeding mosquitoes. However by 1970, resistance had developed and population of this vector can no longer be controlled by agricultural pesticide application.

Although the concurrent use of agricultural pesticides has not always had a deleterious effect on efforts to control insect-borne diseases, there are sufficient examples to demonstrate that this is a common concurrence. Therefore, agricultural projects being developed in areas endemic for insect-borne diseases (which include most tropical developing countries) should be planned in a manner to minimize such an eventuality and done in coordination with public health authorities responsible for the control of vector-

borne diseases.

Vector-borne diseases and Agricultural Land Use

In addition to vector resistance to insecticides used in agriculture, the distribution and transmission patterns of many vector-borne diseases are influenced by other agricultural practices. Land-clearing and deforestation often extend the range of certain vectors and intensify the number of cases of such diseases among working populations. Road building and settlements in virgin lands serve as conduits for vector and disease expansion. Often such areas do not have adequate public health and disease control facilities. This may result in explosive malaria (e.g. in Brazil malaria increased from 60,000 cases in 1983 to over 500,000 in 1987, mostly in the Amazon region). Resettlement of previously unexposed populations from non-endemic to endemic zones may also result in outbreaks of vector-borne diseases.

In order to minimize such problems, agricultural development projects and regional resettlement projects should be planned in consultation with public health authorities knowledgeable about the endemic or potential vector-borne diseases of the affected areas.



104

ANNEX 3D

Availability of Alternative Insecticides: Very few insecticides are made exclusively for use in public health programs, and several that are only used in public health have been withdrawn by the producing companies for lack of profit on the investment. As a result, the pesticides available are those that have their primary market in agriculture. As these are frequently used in the same areas where they are also used in vector control programs the development of resistance in the vectors is not surprising.

The number of insecticides in use worldwide and approved by WHO for mosquito control is given in Table 2. This is a very small number compared to those used in agriculture. Furthermore, as resistance continues to develop, national control programs must rely on increasingly more expensive insecticides. An example of such increasing costs is shown in Table 3, where the cost of DDT (insecticide only, not of labor for application) is shown as an index of 1.0: malathion at 4.6; fenitrothion (Sumithion) at 7.3; propoxor at 21.0; and bendiocarb at 26.6. These figures will vary by place and time, but the general ratios will remain the same.

Therefore to conserve funds in financially limited national control programs and to delay the development of resistance it is advisable to use the most effective and least costly insecticides for as long as possible. When it is necessary to change, due to the development of resistance, selection of an alternative insecticide should be based on the tested resistance spectrum of the population to the candidate insecticide and the likelihood of development of resistance or cross-resistance. Consideration must also be given to the possible simultaneous use of new (or similar) compounds in agriculture in the same area. Cost must also be considered, as well as the safety of the compound to the populace, workers in the programs, and the general environment.



105

ANNEX 4

## Guidelines for the Selection and Use of Pesticides in Bank Financed Projects and their Procurement when Financed by the Bank

### Introduction

1. Pest control is widely recognized as an essential element in improving human welfare in all areas of the world. A wide range of insects, weeds, disease microorganisms, nematodes and rodents reduce food and fiber yields by attacking livestock, forests, crop plants and stored agricultural products in addition to directly damaging human health. Throughout the history of agriculture a variety of techniques have been used to combat this threat; control of pests has traditionally been accomplished through a combination of cultural practices, selection and breeding of resistant plant varieties, encouragement of natural enemies and the introduction of biological control agents, as well as the application of chemical control materials (including insecticides, acaricides, molluscicides, namaticides, fungicides, bactericides and herbicides as well as poison baits for rodent control). Properly used, chemical pesticides are essential elements in a pest management program. However, there is now great concern over the ever greater reliance on chemical pesticides throughout the world. The problem is particularly significant in the development world where exclusive reliance on chemical control is a common response to the increased levels of infestation by pests diseases and weeds which have accompanied recent increases in the intensity of crop and livestock production and human settlement. This approach is frequently taken without adequate safeguards for those who handle or may be exposed to the pesticides or for the environment, and with little regard to pest-induced crop losses or the cost-effectiveness of chemical control.

2. It is becoming increasingly evident that the unilateral chemical approach, in addition to posing potential threats to human health and to the environment, does not lead to sustainable and profitable agricultural production. The rapidly increasing cost of pesticides as well as the development of secondary pest species and the growing incidence of insecticide-resistance in pest population limit the effectiveness of chemical pest control. For this reason and in line with Bank policy to promote sound technologies which do not carry with them excessive environmental costs, it is important that use of pesticides in Bank projects should be consistent with sound pest management practices and accompanied by safeguards to protect the users, the general public and the environment. Sound pest management should aim to reduce dependence on chemical pesticides through the establishment of economic control thresholds and through the use, wherever possible,

of agronomic or related practices which reduce the severity of pest attack. The Integrated Pest Management (IPM) approach, which includes the prudent use of pesticides when damage reaches unacceptable levels, should be the objective of Bank strategy in agricultural development. In addition, it is important that appropriate attention be paid to technical suitability, safety and efficient procurement during the preparation, appraisal and supervision of all Bank projects which promote or increase the use of pesticides and particularly those which would finance the procurement of pesticides (either explicitly or through short term credit for production inputs).

3. The following sections provide guidance on the use of pesticides and their selection and purchases. Section A outlines the present state of the art in Pest Management Practices within the context of which a pest control program should be assessed. Section B concerns handling, storage and application safety. Section C discusses particular considerations in the selection of pesticides for a particular situation. Section D treats pesticide procurement. These sections may from time to time require more detailed treatment than is appropriate in this OPN. In such cases Supplementary Technical Notes will be issued jointly by the Agriculture Department (AGR) and the Environment Unit (PPDES) and will have the authority of this OPN with which they should be filed.

4. During appraisal and supervision of Bank lending operations in which financing is being provided for pesticides, it is the responsibility of Bank missions to ascertain whether pest management is or will be appropriate and safe, and if necessary, to make appropriate recommendations to correct the situation.

## A. Pest and Pesticide Management Practices

5. Effective pest management involves maintaining quantity and quality of production or improving health by the least costly means and the maximization of net benefits should be the guiding principle of all pest management. While pesticides will continue to play an important part in pest management, an integrated approach combining the use of resistant varieties, biological control techniques and modified cultural practices where appropriate, together with judicious use of chemical pesticides, can offer better prospects for long term control and reduced environmental damage while increasing the margin between benefits and the costs of control measures.

6. The costs of pest control can be direct such as those for the purchase, distribution and application of pesticides and the increased costs of changing cropping practices, or indirect such as the harmful effects on human health and the environment which can arise from inappropriate and unsafe pesticide use. They can be short or long term, the latter including the cost of changing

chemical control materials to combat increased pest resistance. Some costs are straightforward while others are difficult to quantify. Use of pesticides as well as other control measures should always be the result of a considered evaluation that the benefits to be gained outweigh the direct and indirect costs in-so-far as these can be assessed.

7. Every effort should be made to promote the Integrated Pest Management concept within Bank agricultural projects by selecting pesticides and pesticide use patterns which are compatible with an IPM approach. Three major points should be considered:

a. pesticides should be viewed as a short-term response to the build-up of a particular pest species to threshold levels which have been found as a result of field trials and past experience to be economically damaging. The overall control of pest populations should be attempted by other methods such as the use of crop varieties which are resistant or tolerant to the past, biological control, and cultural practices including crop rotation, timing of planting to avoid the coincidence of particularly susceptible growth stages of the crop with peaks in pest populations or disease incidence, and timing of irrigation to discourage susceptibility of the plants to fungal infection.

b. wherever possible, narrow-spectrum pesticide materials should be selected which are effective against the pest species but cause minimum harm to other useful insects (especially the important predators and parasites of the pest species). This approach requires that one or more key target pest species and, if possible, their principal nature enemies first be properly identified.

c. application methods and timing also should be aimed at minimizing the risk of harming these natural enemies.

8. The build-up of pesticide resistance, particularly in insect populations, is a serious constraint on chemical pest control. Measures to reduce the rate of this build-up and thereby prolong the usefulness of effective materials include:

a. using a few chemical pesticide applications as possible and delaying application until pest populations reach present economic thresholds and susceptible life stages.

b. refraining from using agricultural pest control chemicals which are also in use in the same vicinity for human disease vector control.

c. using application methods which minimize the area of pesticide exposure.



108

It has also been suggested that using combinations of chemicals which differ in mode of action may prevent or delay the development of resistance to any one material. This may involve changing chemicals from one season to another or using mixtures of chemicals, each at a relatively low concentration. However, the effectiveness of this approach remains uncertain.

B. Handling, Storage and Application Safety

9. Correct and careful handling and application of chemical pesticides is essential for safe and effective pesticide use. To reduce the risk of accidents and damage to health or environment resulting from misuse of pesticides and to maximize the effectiveness of their application, it is essential that proper precautions be taken in the packaging, transport, storage and disposal of pesticides and surplus pesticide containers and that necessary equipment and proper training in application techniques be provided to the users.

10. Standards of packaging of pesticides should be specified in tenders and should be adequate to withstand the considerable abuse which can occur during transport and storage. Clear and durable labelling of all packages to depict the hazardous nature of the contents should always be required. The labels should be in an appropriate language and should be consistent with internationally accepted standards such as those specified in the FAO Guidelines on good Labelling Practices for Pesticides.[1] The distribution of pesticides in single dose packages or small containers should be encouraged to reduce the need for measuring our concentrates and alleviate some of the problems of on-farm storage of open pesticide containers. Repackaging should only be permitted in properly licensed and inspected facilities meeting acceptable safety standards and preferably under the control of the bulk supplier who should be fully responsible for the suitability of the new package including labelling and use instructions, the quality of the repackaged product and the safety of the repacking process.

11. While all empty containers should be destroyed, it would be unrealistic to expect adherence to this rule in countries where empty containers suitable for storing liquids are in short supply. To avoid this hazard, manufacturers should be encouraged to design containers which discourage such re-use and to adopt this type of container where a suitable design already exists. When such containers are available, the borrower should be required to specify them in tender documents. The Bank does not approve of re-use of pesticide containers and strongly recommends that all possible deterrent measures be taken but, in instances where the only available and suitable package offered by suppliers is a non-returnable drum and where destruction of all sound empty containers cannot be ensured, their thorough washing with an appropriate solvent and numerous water rinses should be required to minimize the risk in the event of re-use. Flammable containers should be incinerated in a site where fumes will not be carried onto occupied areas by prevailing winds.

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[1] See FAO Plant Protection Bulletin No. 2 1983 Vol. 13.

12. Stores should protect containers and their contents from the elements, be fenced to discourage unlawful entry, have a nearby water supply and be adequately ventilated. Containers should be stacked on a hard standing with a sill to contain spills and containers should not be stacked beyond the recommended stacking height. Drainage from the storage area should outfall into an evaporation pond to eliminate contamination of streams, canals or groundwater. Where substantial quantities of highly toxic pesticide materials are stored, their presence may require a Serious Hazard Assessment to be undertaken. This involves the consideration of the kinds of accidents which may occur, endangering the staff, people nearly and the surrounding environment. For such a situation the assessment would determine the adequacy of:

a. the warning systems installed which would alert staff and the public to an emergency

b. the established procedures to deal with such an emergency including evacuation of people if it should be necessary;

c. the availability and working order of emergency equipment; and

d. the training of staff and their regular practice of emergency drills.

Guidance on this should be sought from PPDES.

13. To prevent contamination in the process of pesticide distribution, food materials should never be transported simultaneously with pesticides. Vehicles used regularly to transport pesticides should be clearly marked and should not be used to transport food products. When other, general purpose vehicles are used to transport pesticides they should be thoroughly decontaminated by washing immediately afterwards. When offloading containers into store, a ramp should be provided in the absence of fork lift equipment to avoid rupture and damage to containers resulting from dropping to the ground. Any damaged containers should be set aside and the contents transferred to sound containers under supervision.

14. Persons handling concentrated materials should have protective face shields or goggles, gloves, aprons and footwear and should be adequately supervised. It is unrealistic to expect workers to wear more complete protection and respirators in hot conditions but selection of pesticides should take into account the minimal protection which handlers will practice. Materials which are likely to become widely distributed should be made available only in relatively low-toxicity formulations. Arrangements should be made for the washing and decontamination of clothing and particular care should be taken to avoid workers contaminating their home

environment. All spills should be promptly washed down.

15. Where pesticides are applied by contractors they should be required to take all necessary precautions to protect the public and the environment from damage due to spray drift or other accidental contamination. Licensing of operators on completion of an appropriate course of training is recommended when particularly hazardous materials are to be used. Operators and supervisory staff engaged in regular spraying operations should be trained in the specific first aid procedures for poisoning relating to the material being used. Medical services should be familiar with symptoms and treatment for such poisoning cases and specific antidotes should be readily available. With particularly toxic materials it may be expedient to require the supplier to supervise the correct handling and application of the materials in accordance with accepted safety standards.

16. Where pesticides are being supplied to farmers it is essential that materials are selected which can be applied safely and effectively without close supervision and that the extension services are adequately supported and trained in the use of the materials so that they may demonstrate the correct techniques and give appropriate advice, including advice for on-farm storage of concentrates and eventual disposal of surplus pesticides and empty containers and calling on specialists in past control when problem arise. Training should include the storage and handling of concentrates, dilution and mixing, application techniques and suitable application equipment, cleansing and maintaining spray equipment and precautions to avoid environmental damage through spray drift or leaching into streams or groundwater. Equipment and clothing needed for the safe and effective use of pesticides should be easily available and all reasonable measures should be taken to promote its proper use and maintenance. Farmers should be instructed on safety precautions, wearing a suitable protective clothing, the importance of decontamination and of avoiding introduction of pesticides into the household environment. They should also be able to recognize possible early symptoms of poisoning and be aware of the need to seek medical assistance quickly.

C. <u>Selection of pesticide materials and pesticide formulations</u>

17. The selection of chemical pesticides for use in agriculture should take account of the safety and effectiveness of alternatives under local climatic and environmental conditions, their compatibility with Integrated Pest Management, the existence of national or international regulations or recommendations regarding use of particular materials for particular crops and the reliability of potential suppliers to deliver products of a high quality, appropriately packages and backed by well qualified technical advice and support. In addition the indigenous capability for handling toxic materials and regulating their



112

distribution should be taken into account.

18. The World Health Organization periodically revises and reissues its Classification of Pesticides by Hazard. This lists technical products by their generic names, tabulating them in categories ranging from Extremely Hazardous to unlikely to present acute hazard in normal use. Guidance is given on use of the tables to assess the hazard of particular formulations. Materials listed in Categories 1a Extremely Hazardous or 1S Highly Hazardous are unsuitable for use by small farmers and should only be considered for use in large scale operations if all necessary training, protection and supervision can be assured. [1]

19. Certain products, notably many of the chlorinated hydrocarbon insecticides have characteristics of excessive persistence in he environment, bioaccumulation in tissues, biomagnification in food chains and in some cases carcinogenicity or cause genetic abnormalities. They should not be used for agricultural purposes but some which have environmental hazards but low health risk may be considered for other purposes such as disease vector control where the risks are minimized and satisfactory alternatives do not exist. Compounds containing Mercury, Thallium, Lead, Cadmium or Selenium are all unsuitable for agricultural use. Fumigant products having high vapor pressures and relatively high toxicities are too hazardous for use by small farmers who do not have sealed storage compartments for grain. [2]

20. Not only active ingredients but contaminants in the formulation may also be harmful. Suppliers should be required, in appropriate instances, to provide analyses by an independent and reputable laboratory showing the formulation to be free of such a contaminant or that the content of such a contaminant meets internationally accepted limits for use of the formulation for specific purposes under close supervision.

21. Preference should be given to products which are registered int he country of proposed use, if such regulatory authority exists, or which are already registered for an identical use in a country where capability exists to evaluate their efficiency, toxicity and long term effects. Products which do not meet this requirement should be considered only if their use for the same

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1 A current copy of the Classification is available for reference in the Sector Library.

2 AGR and PPDES intend issuing and periodically updating a Supplementary Technical Note listing specific materials and formulations, the use of which should be avoided or strictly limited.



13

purpose has been reviewed by the FAO/WHO Joint Meeting on Pesticides Residues 1 and acceptable daily intake and maximum residue levels subsequently recommended to the Codex Committee on Pesticide Residues 2 or if the material has been registered or reviewed for a similar rather than identical application. In both these latter cases special provisions must be made to monitor crop residue levels and the manufacturer may be required to submit information regarding residue decline rates and tolerances and an analytical method suitable for monitoring residues of the pesticide and significant metabolites and degradation products.

22. When pesticides are to be used on food crops it should be ensured as far as possible that FAO/WHO maximum residue limit recommendations will not be exceeded. In the case of crops which make a significant contribution to the diet, maximum residue levels must be viewed in the light of the need to ensure that acceptable daily intake levels are not exceeded. Where such materials are to be used on food crops for export, compliance with such accepted residue limits or tolerances established by the importing country must be assured. If a pesticide is being considered for which registration in developed countries precludes its use for treating forages and crop residues subsequently to be fed to animals, provision should be made to prevent such feeding of treated materials to animals.

23. If a proposed pesticide is not registered in the country of proposed use but a pesticide regulation authority exists, the necessary steps to assure registration should be taken before it is introduced into the country. Such registration should establish labelling requirements for the product and require the provision by the manufacturer of particular information on the material's toxicity and persistence and the movement of the material and possibly harmful breakdown products in the environment if it is not readily available in published literature.

24. Selection of pesticides should be based on a careful evaluation of possible hazard to the environment and to important natural resources. For example, materials having acute toxicity to fish or aquatic invertebrates should not be used where there are aquatic resources which could be adversely affected by runoff, drift or soil erosion and those highly toxic to honeybees should not be used when they will present a threat to important pollinators. Information on toxicity to non-target organisms should be available from the manufacturer if it is not in the

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1 FAO publishes periodically reports and supplements recommending maximum residue limits in food and livestock feeds.

2 The Committee is responsible for development of international limits for residues in food within the Codex Alimentarius Commission which is a joint FAO/WHO food standards program.

published literature. Any use of pesticides should be designated to minimize the area of exposure, but when materials known to present a significant environmental risk are used an environmental monitoring program should also be implemented.

D. Procurement of Pesticides

25. Wherever possible competitive tenders should be sought for the supply of pesticides. In order to evaluate tenders from different sources offering different materials in field tests is necessary to evaluate their relative efficiencies. Where adequate information is available, efficiency weightings may be given to different materials and used in the evaluation of bids but to do so, the weights must be made public in the documents supplied to potential bidders so that in making offers they are aware of the conditions under which their product will be evaluated. Such weights may be used to reflect the advantage a particular material might offer by controlling other pests besides the one for which the spray is intended, by being less harmful to predators, or by being less dangerous to handle and apply. Where data is insufficient to apply such efficiency factors, materials are compared on the basis of their cost per unit area when applied, in accordance with the local recommended practices in the country and taking account of the manufacturers recommendations, at the rate and frequency to control the pest concerned. Where one material has been shown in trials and in practice to offer a longer period of control than another so requiring fewer applications, the saving in application costs needs to be taken into account in evaluating bids.

26. To enable different suppliers, each formulating a particular active ingredient under one or more different trade names to compete, the invitation to bid and tender documents should use the accepted generic name or names of the material or materials which would be considered. The specification should define all the critical characteristics in the formulation covering such aspects as solvents, emulsifiers, and surfactants in the case of emulsifiable concentrates, or particle size in the case of dusts or suspensions, which may affect the performance of the pesticide. The manufacturer should certify that the product is exactly the same (in terms of physical and chemical properties, formulating ingredients and manufacturing process) as that marketed and registered in the country of origin, or be willing to state any deviations and provide an acceptable rationale for them. Materials to be used for seed treatments should be formulated with warning colorants or dyes which will persist under anticipated storage and handling conditions.

27. The specification should indicate any special features of packaging and labelling which are necessary for product protection during handling and storage and to ensure effective use. It should require packaging and labelling to be consistent with accepted



115

standards. Reference may be made to internationally accepted packaging and labelling standards such as those described in BAO Plant Protection Bulletin No. 2 1983 Vol. 13. In the case of products which are not water soluble, the manufacturer should be required to recommend and provide a suitable solvent for washing application equipment and containers. Where available, containers which discourage re-use for storing liquids should be specified.

28. Where only a single product from a single manufacturer is effective in controlling a particular pest or where a single product has such outstanding advantages over other products on the market that it would not be technically justified to use anything else, direct purchase may be resorted to following negotiations with the supplier. In such cases prudent enquiries should be made to determine the prices paid by other recent purchasers of the product in order to ascertain whether the price being quoted is a fair one, taking account of the quantity being ordered and delivery requirements.

29. Where quantities being purchased are small so that competitive bidding would not be an efficient means of procurement local shopping may be resorted to, obtaining quotations from at least three different suppliers.

ANNEX 5

# Hazards Involved in the Use of Pesticides; Storage of Pesticides and Disposal of Pesticide Containers and of Surplus Pesticides*

## HAZARDS INVOLVED IN THE USE OF PESTICIDES

### Acute Toxicity of Pesticides

Pesticides may be poisonous if swallowed, inhaled, or absorbed through the skin. They may cause irritation or inflammation of the skin, eyes, or respiratory tract (dermatitis, conjunctivitis, laryngitis, pneumonitis). Some pesticides may cause allergic responses in some or all persons coming in contact with them. In the case of pesticides in the "highly toxic" category, doses as low as a few drops, ingested by mouth or absorbed through the skin, could be fatal to an adult human. Even smaller quantities may be fatal to children.

Pesticide products vary widely in their toxicity to humans, depending on the toxicity of the active ingredient, its concentration in the formulation, other ingredients in the formulation, and other factors. Some products are highly toxic by mouth, but less toxic by skin contact.

Table 1 summarizes the criteria which determine the classification of the toxicity of a pesticide. "LD-50" in the median lethal dose, that is the milligrams of toxicant per kilogram of body weight lethal to 50% of the test animals. "LC-50" is the median lethal concentration, that is the concentration of toxicant in milligrams (µg) per liter of air which kills 50% of the test animals following a given exposure time. For each category, the quantity probably lethal to an adult man is given. "Signal words required on label" are those required by the U.S. Federal pesticide laws and regulations (see the section entitled PARTS OF THE LABEL).

It is the responsibility of the manufacturer of each pesticide product to determine its toxicity, and to give label directions on safe product use and what to do in case of accidental poisoning. The necessity for persons planning to use pesticides to be thoroughly familiar with their toxicity and all safety precautions set forth on the label cannot be met, or if the necessary protective clothing equipment as specified on the label are not available, or if their use is not practical or feasible, the product should <u>not</u> be used. A less toxic product of another pest control strategy should be substituted.

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* Verbatim from CDC. 1981. Insecticides for the control of insects public health importance. Atlanta, GA pp. 19-26

The toxic actions of the various classes of pesticides to humans are summarized below:

Organophosphate pesticides

The phosphate ester group of pesticides includes some of the most toxic pesticides as parathion. On the other hand, other organophosphates, including those most often used in public health, are only moderately toxic and some, notably malathion, when formulated and used correctly are among the safest insecticides. Parathion has been implicated in more pesticides poisonings than any other pesticide.

Symptoms of organophosphate poisonings include headache, nausea, sweating, blurred vision, chest tightness, abdominal pains, vomiting, and diarrhea. Onset of symptoms is rapid after heavy exposure. With some organophosphates, especially if the exposure has not been massive, onset of symptoms may be delayed for several hours, but rarely longer than 12 hours. In more advanced poisoning, difficulty in breathing, tremors, convulsions, collapse, coma, pulmonary edema, and respiratory failure may follow.

Fortunately, highly specific antidotes are available for the treatment of organophosphates poisoning. Timely administration of atropine sulfate, alone or in conjunction with pralidoxime chloride (2-PAM) can save victims who have absorbed several times a fatal dose.

An important precaution prior to the use of organophosphates, therefore, is to ask the physician who would be called in emergencies to obtain the necessary literature and antidotal drugs. The physician should also be given of copies of the labeling of the product(s) to be used which will contain additional important specific information.

Carbamate pesticides

The carbamates act almost like organophosphates. They produce the signs and symptoms of poisoning; however, the injury they cause can be treated more easily by a physician. For this reason, most carbamates are safer than organophosphates.

Chlorinated hydrocarbons

Chlorinated hydrocarbon insecticides have probably been used in larger quantities than any other group of synthetic pesticides. Their mode of action is unknown, even though much research work has been done in efforts to uncover it. Like the organophosphates, the chlorinated hydrocarbon insecticides also vary widely in their acute toxicity. Aldrin, dieldrin, and endrin are highly toxic products, whereas DDT, BHC, chlordane, and other are less toxic.



118

The most frequent source of acute poisoning from organochlorine pesticides has been dermal exposure to massive doses of concentrated liquid formulations from spilling material on the skin or on nonprotective clothing. Symptoms of acute poisoning indicate stimulation signs and symptoms of poisoning include headache, nausea, vomiting, general discomfort and dizziness. The person also may be unusually excited and/or irritable. With more severe poisoning convulsions follow; they may even appear without the warning symptoms. Coma may follow the convulsions.

Chemical analysis of blood samples may assist in the positive diagnosis of chlorinated hydrocarbon poisoning. In fatal cases, postmortem findings are nonspecific. There are no specific antidotes available for poisoning by these compounds, the physician is usually limited to symptomatic treatment of poisoning victims. Fortunately, only relatively few cases of acute pesticide poisoning have resulted from the use of chlorinated hydrocarbon pesticides.

Fumigants and solvents

Too much exposure to these compounds may make a person seem intoxicated. The signs and symptoms are poor coordination, slurring speech, confusion, and drowsiness. Repeated signs or exposure to the fumigant methyl bromide has caused permanent internal injury without early signs or symptoms of poisoning. A fatal dose of methyl bromide may be absorbed before symptoms appear.

Plant-derived pesticides

Some plant-derived pesticides, such as nicotine, are very toxic, but most are not. Technical pyrethrum may cause allergic reactions. Some rotenone dusts irritate the respiratory tract.

CHRONIC AND SUBACUTE PESTICIDE POISONING

Repeated exposure to subacute levels of pesticides may have cumulative toxic effects and result in gradual onset of poisoning symptoms. Workers handling pesticides over prolonged periods of time are exposed to this risk, as well as persons working in pesticide-treated areas.

The potential effects of repeated exposure to pesticides upon humans are difficult to predict from animal experiments; therefore, much of the knowledge about these effects develops slowly from human experience. Organophosphate and carbamate insecticides inhibit a vital body enzyme, cholinesterase, and this inhibition can be detected by appropriate tests of small blood samples before more severe poisoning symptoms occur. This offers an opportunity for early detection of low-level exposure of workers to organophosphates. Workers may be removed from further contact with the pesticide until their cholinesterase level has returned to

normal, and the source of exposure, usually unsafe working conditions or practices, can be eliminated.

Table 1. Toxicity and precaution categories of pesticides

## FIRST AID PROCEDURES

Read the directions in the "Statement of Practical Treatment" on each label. The label is the most important information that can be given to the physician in the case of suspected pesticide poisoning. Pesticide on the skin should be removed as quickly as possible. Remove all contaminated clothing. Prompt washing may prevent sickness even when a person has been exposed to a large amount of a pesticide by spilling the compound. Do not forget hair and fingernails. Eyes may be rinsed with water or saline solution. Water-wettable powders or suspensions are easy to remove with plain water, as are most emulsifiable concentrates and emulsions. Solutions of pesticides in petroleum oil or other solvents are harder to remove without soap or a detergent. Detergents work better; washrooms and emergency field washing facilities should have detergents rather than soap. In cases of pesticide inhalation, get the victim to fresh air immediately. When pesticide has been splashed into mouth or swallowed, rinse the mouth with plenty of water and go or be taken to a physician immediately. It is sometimes dangerous to induce vomiting, especially in the case of volatile organic solvents. FOLLOW LABEL DIRECTIONS.

## REPORTING AND CLEANUP OF PESTICIDE SPILLS

### Minor spills

Keep people away from spilled chemical. If the pesticide was spilled on anyone, give the appropriate first aid and decontaminate them immediately. The area should be roped off and flagged and someone should be present to warn of danger. Confine the spill; if it starts to spread, dike it up with sand or soil. Use an absorbent material, such as sawdust, soil, or any special product made for this purpose. Shovel all contaminated material into a leakproof container for disposal. Dispose of it as excess pesticides (See Chapter 7). Do not hose down the area -- this spreads the chemical. Put something on the spill to stop the chemical action. Common household bleach or a solution of lye or ammonia can be used. Call the chemical manufacturer if in doubt about what to use. To avoid hazards of contaminating workers cleaning up the spill, always work carefully and do not hurry. Restrict entry to the area until the spill is cleaned up.



122

Major spills

For spills too large for the personnel on hand to deal with or in cases of doubt about proper action, call the manufacturer for help. In either case, keep people away, give first-aid as necessary, and confine the spill. If a major pesticide spill occurs on a State highway, county road or city street, have someone call the highway patrol, sheriff of city police for help. (Carry these telephone numbers with you.) Do not leave the site of the pesticide spill until responsible help arrives. Report all major spills by telephone to your State pesticide regulatory agency. If water is contaminated, notify State health officials, regional, State, or Federal water quality or water pollution authorities, and the State fish and game agency.

## STORAGE OF PESTICIDES

All pesticides regardless of quantity should always be stored in the original labeled container with the label plainly visible. Pesticides must never be stored in any other container, especially not in old bottles or other container where they could be mistaken for food, beverage, or drugs for humans or animals. Pesticides must not be stored near food or other items which may become contaminated by spilled material, volatile pesticides, odors, etc.

Larger quantities of pesticides should be stored in warehouses or warehouse areas specifically designed for this purpose. Ideally, pesticide storage areas should have concrete floors with drainage to a sump or other holding area where contaminated water can be decontaminated before release. Earthen or wooden floors are difficult to decontaminate. The storage area should be dry and well ventilated. Some pesticides must not be stored at temperatures below freezing, while other cannot be stored at high temperatures. Specific storage requirements of each pesticide product should be ascertained from the label and complied with.

Pesticide storage areas should be locked and secured against theft and the entrance of unauthorized persons, especially children. These areas should be identified with prominent, water-proof signs over each entrance.

A complete inventory of all pesticides in the storage area is essential. The age of pesticides in inventory should be monitored to prevent them from becoming unusable due to deterioration. In case of emergencies, a list of products stored and their locations should be given to safety and fire department personnel.

All pesticide stocks must be examined periodically for leaks or any signs of deterioration in containers and for spills. Any spilled material or broken containers should be completely removed and the area decontaminated and cleaned promptly.

Steps should be taken to make certain that run-off water from cleaning in pesticide storage areas will not contaminate residential areas or bodies of water. The storage areas should be diked or otherwise arranged in such a way that all run-off water can be trapped in a suitable pool or sump for proper decontamination and disposal.

Since pesticide fires present grave dangers, fire prevention and protection measures in pesticide storage and warehousing areas are particularly important. These should include effective fire detection systems and use of spark-proof electrical wiring in equipment such as safety lamps, motors, switched, outlets, etc. Pesticides should be kept away from steam lines, heating units, exposed windows, and other heat sources.

Local police, fire department, public health and other concerned agencies should be familiarized with the pesticide storage area and the operating procedures of the facilities. All workers and supervisory personnel storage area involved in the handling, Transportation, and storage of pesticides should have ready access to qualified medical aid and to information on the chemical, physical and toxicologic properties of the pesticides, including detailed information on how to deal with spills.

Many pesticides, no matter how well manufactured, formulated, and packaged, deteriorate upon storage, especially under conditions of high temperature and high humidity. Such deterioration may include loss of active ingredient due to chemical decomposition, loss of emulsifiability in the case of emulsifiable concentrates, compaction and caking in the case of dry formulations, and corrosion or deterioration of containers and labeling. Some pesticides convert into more toxic (to mammals) substances upon aging.

In general, formulations containing low concentrations of active ingredient tend to lose active ingredient more rapidly than more concentrated pesticide forms. Some liquid pesticide products tend to develop gas upon deterioration which may make container very hazardous to open and lead to eventual explosive rupture of containers.

Stocks of pesticide products which have deteriorated in one or more of these ways may cause very serious problems. It is difficult to handle and transport them without breakage and spills, which present serious human and/or environmental safety hazards. If such products deteriorate to the point where they become unsuitable for their intended pest control use, their safe disposal may present an even bigger problem.

It is very important for persons involved in the purchasing of pesticides for use in other countries and in making arrangements for their transportation and delivery to be aware of these



124

problems. Acquisition of pesticides for use in tropical countries should be scheduled and implemented so as to minimize storage time and remove the pesticide from the original supplier to its ultimate user as expeditiously as possible. Sometimes, pesticides will have to be held over from one season to the next. Such storage should be held to a minimum, and under no circumstances should the time between manufacture and use exceed 24 months.

## DISPOSAL OF PESTICIDE CONTAINERS AND SURPLUS PESTICIDES

The proper handling and disposal of emptied pesticide containers and leftover or unwanted pesticide products, concentrated of diluted, is basically the responsibility of the person, company, or other organization who received and emptied the full container. Improperly handled or stored "empty" pesticide containers or surplus pesticides may present or become a serious safety hazard to people, especially children and unsuspecting persons, and to livestock, pets, wildlife, fish and many other forms of life. They may cause contamination of water, soil, or air, and have many other adverse effects. Safe disposal of emptied pesticide containers and surplus pesticides is therefore a very essential, although sometimes neglected, step in the proper handling of pesticides.

The problem of how to dispose of used pesticide containers, especially large, heavy steel drums, has received a great deal of attention in recent years, but no truly satisfactory or universally applicable solution has been found to date. This is not surprising in light of the fact that pesticide containers, as pointed out previously, have to be very durable to afford adequate protection of the pesticide product during transportation, often over great distances, involving different modes of transportation and rigorous handling during transfer from one vehicle to another, and storage under conditions of high moisture and humidity. On the other hand, it would be very desirable for pesticide containers to be easily disposable after they have been emptied at their final destination. No technology has bee developed to date which would satisfactorily fulfill these seemingly incompatible requirements. Technical pesticides to be formulated or formulated pesticides for repackaging are usually shipped in bulk or in larger containers, rarely in containers smaller than 30-or-55-gallon drums. If neither re-use nor return to the supplier are feasible, large metal drums may be sold to a cooperage firm equipped to handle drums contaminated with toxic materials. If this is not possible, ways must be found for the safe destruction and disposal of such drums.

Applicable laws and regulations vary greatly between countries and from State to State and are subject to change as new and better methods for dealing with this problem are developed. Therefore, it is not possible to supply generally applicable instructions at this time. Persons, companies, or agencies can jointly develop suitable procedures. No fast, easy and safe methods for handling

this problem have been perfected to date.

Pesticides are expensive and for economic as well as for safety reasons, pesticide containers should be emptied carefully and completely. Emptied pesticide containers are never completely "empty" and, therefore, are a serious hazard to people or the environment if not properly handled. The same is true of leftover or unwanted pesticide products or dilute tank mixes of pesticides.

The following procedures are commended to eliminate or minimize the hazards involved in disposal of pesticide containers or surplus pesticides:

For containers of liquid pesticides -- After "normal" emptying, drain the container into the spray tank in a vertical position for 30 seconds. Then rinse three times and drain into the spray tank in a vertical position for 30 seconds after each rinse. Use one quart for each rinse for a 1-gallon can, 1 gallon for each rinse for a 5-gallon can, and 5 gallons for each rinse for 30- or 50- gallon drums. This "rinse and drain procedure" has been found to be a simple, quick and economical method for significantly reducing the potential hazard of used pesticide cans and drums. This procedure will render the container ready for proper disposal but NOT for reuse for other purposes. No amount of cleaning or decontamination at the user level, including rinses with detergents, caustic soda or other purposes. In particular such containers must NOT be used for storage or transportation of food, water, or other items for consumption by humans or animals. Finally, rinse water should be disposed of in such a way as to avoid environmental contamination.

The EPA divides types of pesticide container into three groups based on suggested means of disposal:

Group I containers: These are containers which will burn and previously held organic or organometallic pesticides, but not organic mercury, lead, cadmium, or arsenic compounds. They may be disposed of by burning them in a special pesticide incinerator, burying them in a specially designed landfill, burying them singly at least 18 inches below the surface in open fields, or burning small numbers of them as directed by State and local regulations. In burning pesticide bags, boxes, fiberboard drums, etc., care must be taken not to expose people or animals to the smoke or fumes from the fire.

Group II containers: These are containers which will not burn and held organic or organometallic pesticides, but not organic mercury, lead, cadmium, or arsenic compounds. Before disposal rinse the containers three times. Many large containers in good shape can be reused by the supplier. Return these to the pesticide manufacturer or formulator, or

drum reconditioner. The containers may be sent or taken to a place that will recycle them as scrap metal. All rinsed containers may be crushed and buried in a sanitary landfill. Follow State and local standards.

Group III containers: These include any containers which held organic mercury, lead, cadmium, arsenic, or inorganic pesticides. Rinse them three times and bury them in a sanitary landfill.

Pesticide containers which are under pressure must not be punctured. Small, hand-size pesticide aerosols or pressurized sprays should be sprayed out completely, then buried as described above without puncturing or crushing. Heavier pressurized pesticide containers such as fumigant containers should be emptied completely, then returned to the supplier.

In burning pesticide bags, boxes, fiberboard, drums, etc., care must be taken not to expose people or animals to the smoke or fumes from the fire.

Pesticides should not be purchased or stocked by the user in larger quantities than needed for one season. If however, it becomes necessary to carry pesticide stocks over to the next season, they must be stored in the original, labeled container, with the label plainly visible (See CHAPTER 6 -- STORAGE OF PESTICIDES). Partially filled containers should be tightly reclosed and a notation made on the container label or tag attached to the container indicating the approximate quantity of pesticide remaining. Pesticide storage areas should be kept locked in order to prevent access by unauthorized persons (particularly children), theft, etc.

In determining pesticide requirements for the next season, leftover stocks should be taken into consideration and should be used up first at the beginning of the next season.

The safest and most effective way to dispose of small quantities of unwanted or leftover pesticides is to use them up in accordance with the directions and safety precautions on the label. Surplus tank mixes of pesticides can best disposed of in the same manner. All safety precautions and limitations on the label must be carefully observed.

# ANNEX 6

## FIELD METHODS FOR MEASURING BLOOD CHOLINESTERASE ACTIVITY

Organophosphorus insecticides are cholinesterase (ChE) inhibitors and the determination of blood cholinesterase activity is a good indicator of operators' exposure to this group of insecticides, i.e. his adherence to recommended precautionary measures. Because operators may have to be withdrawn from exposure if cholinesterase decreases significantly from a well-established pre-exposure value, their blood cholinesterase activity should be determined regularly whenever exposure to organophosphorus compounds of moderate or higher toxicity is prolonged over several weeks.

In a case of accidental exposure to an organophosphorus insecticide (accidental ingestion or massive skin contamination) a rapid fall in cholinesterase activity takes place. As a rule the fall in activity corresponds with the severity of symptoms of poisoning. The cholinesterase determination in such cases enables the physician to confirm the diagnosis of poisoning, and later to follow the (biochemical) recovery of the patient.

During a day-to-day occupational exposure to organophosphorus insecticides, the blood cholinesterase activity may become reduced slowly. In such a case it is possible to observe a reduction of activity in the complete absence of symptoms, and blood cholinesterase determination serves as an index of absorption of the insecticides. In these circumstances it is unusual for symptoms of intoxication to occur until the reduction of cholinesterase activity is profound (more than 50%). Thus cholinesterase determination is being used widely as a valuable tool in the surveillance of workers exposed to this type of insecticide.

Many methods are available for determing blood cholinesterase activity but only a few are considered feasible for field use. Most methods are based on the measurement of the product of the reaction between the substrate (e.g. acetylcholine or acetylthiocholine) and cholinesterase. Some methods measure the amount of acetic acid liberated by a known amount of blood in a given time interval and others measure the amount of choline liberated. For accurate measurement of either of the two hydrolytic products, very complex equipment is required. However, in several methods designed for field use a simplification of the procedure was made. The two methods that seem to be suitable for field or simple laboratory conditions are refered to in this Annex.

### 1 Tintometric method

This method was developed and described by Edson and subsequently improved. The necessary equipment is available commercially in the form of a field kit[1]. Besides the kit good quality glass-distilled and freshly boiled water is needed, as well as appropriate devices for blood sampling (sterile lancets, cotton wool, ethanol).

### 1.1 Principle of the method

The principle of the method is the measurement of the change of pH in a reaction mixture. The blood cholinesterase hydrolyzes acetylcholine, liberating acetic acid. The rate of this reaction (and thus the enzyme activity of the known amount of blood) is measured by the range of colour change of an indicator (bromothymol blue) present in the solution. A mixture of blood, indicator and acetylcholine perchlorate is prepared and allowed to stand for a fixed time depending on the temperature. The change in colour produced by change in pH is matched against the colours on a comparator disc.

As blood cholinesterase activity varies from person to person, the determination of a re-exposure value is an important prerequisite to assess later the degree of cholinesterase nhibition for a given operator. It is the proportionate reduction of activity from the ormal (proportionate inhibition) for the individual that is important rather than the umerical value for the test.

.3. Advantages and disadvantages of the method

The method is simple and requires little skill, although inaccurate pipetting may ntroduce considerable errors. The equipment is inexpensive and the method requires only a mall amount of blood. It is suitable for measuring activity in a large number of samples. he greatest disadvantage is difficulty in preparing good $CO_2$-free reagents, and a elatively low accuracy.

1.4. Interpretation of results (with particular reference to residual indoor application of insecticides in public health programmes)

Every reduction of activity in the region of 25% or more should be confirmed by repeating the determination.

The following are the guidelines on how to make use of the results in the weekly surveillance of operators:

Slight (about 12.5%) inhibition: (a) If observed in individual workers this may reflect normal fluctuation in activity or inherent variations of the method. (b) If observed in one or several squads, field supervisors should be advised to enforce better adherence to precautionary measures.

Slight-moderate (about 25%) inhibition: (a) If observed in an individual worker he should be warned about the precautionary measures to be observed; the proper way of application and handling the concentrate (e.g. filling the tank) should be again demonstrated to him in the field. (b) If observed in one or several squads, in addition to the above, supervisors should ensure that personal hygiene measures including washing facilities in the field and after work showers are adequately used.

Moderate-pronounced (about 37.5%) inhibition: Each case should be investigated individually in order to find out the most likely reason leading to over-exposure. The operator's technique should be closely watched in the field for this purpose and all errors rectified. At the same time he should be given a lighter application schedule for the following week.

Pronounced (about 50%) inhibition: This should occur only exceptionally, indicating usually either a serious error in technique or nonadherence to instructions, or continuous carelessness of a lesser degree over several weeks. The worker should be withdrawn from application (and any other exposure to insecticide) until cholinesterase activity returns to normal. This may sometimes take more than two weeks.

If the same operator shows pronounced (50%) depression on a second occasion, this may indicate an inability to follow instructions and he may therefore be an unsuitable person to continue to have contact with insecticide in this type of work.

The guidelines set out above have to be interpreted after taking into account the circumstances of application, the frequency of exposure, and any complaints of ill health by the man. In the latter case, the man should always be referred to the medical officer associated with the project for an opinion on his future work schedule.