VI. WORK PRACTICES

Based on personal research, Wolfe [194] stated that over 97% of the pesticide to which the body is subjected during most exposure situations is deposited on the skin. Feldmann and Maibach [128] indicated that spraying or dusting with pesticides may result in the deposition on the exposed skin surface of an amount of pesticide 20-1,700 times greater than that which reaches the respiratory tract. Maibach, in the Report to the Federal Working Group on Pest Management, [195] stated that pesticide skin depositions of 718-1,755 mg/hr were observed during spraying operations. Studies by Maibach et al, [31] in which they applied malathion to various skin sites of human volunteers, indicated that dermal absorption ranged from 5.8% on the palm to 28.7% at the axilla. Because of this demonstrated deposition of pesticides on exposed skin surfaces and the experimentally reported dermal absorption of malathion, personal protective measures should be observed insofar as possible to limit malathion exposure.

For personal protection against pesticide exposure, Wolfe [194] recommended long-sleeved outer garments, such as coveralls, that can be washed daily, rather than rubberized or plastic waterproof clothing which may be too uncomfortable because of heat absorption and trapping of body heat. Wolfe [194] also recommended wide-brimmed waterproof hats, unlined waterproof boots or shoes, gauntlet gloves, goggles, and respirators for additional protection. When skin exposure does occur, the affected area should be washed promptly and medical surveillance instituted to determine whether overexposure has occurred. The rate of dermal absorption will vary with the composition of the formulation, but measurements of the degree of variation have not been found in the literature.

Malathion-contaminated equipment and surfaces should be decontaminated to minimize exposure. Although only qualitative results were given, treatment of malathion by alkali has been shown by Kennedy et al [196] to degrade malathion to an inorganic phosphate. The use of alkali decontaminants, however, could be damaging to wooden surfaces. El-Refai and El-Essawi [197] found that laundering in detergent removed up to 98% of the malathion contamination from cotton fabric.

Another important route of entry is through the respiratory tract. If exposure to airborne concentrations of malathion cannot be reduced either by engineering controls or by administrative measures to the level specified in Chapter I, Section 1(a), then respiratory protection as specified in Chapter I, Section 4(b) must be utilized.

The other potential route of exposure is oral. Hence, effort should be made to avoid contamination of foodstuffs and their containers, tobacco products, and other materials placed in or near the mouth. Handwashing before eating, as recommended by NIOSH, is a common practice in malathion industries. [131]

Wolfe et al [198] and Mail et al [199] discussed the health problems of discarded pesticide containers and stressed the necessity of decontaminating and destroying them. Mail et al [199] recommended that fiber drums used as pesticide containers be crushed, and metal containers washed and punctured prior to their disposal. Lime slurry may be a highly effective agent for both destroying and immobilizing malathion. Floor sweepings containing malathion should not be sent to a public sanitary landfill, but rather disposed of by trained plant personnel. Wolfe [194] recommended two thorough rinsings with water as a minimum decontamination procedure for 5-gallon metal drums after removal of their pesticide content. Both sets of recommendations by Mail et al [199] and by Wolfe [194] were based on studies of parathion decontamination. Containers may also be returned to the supplier or sold, burned, or buried 18 inches deep in isolated areas. However, when containers are sold, buyers must be informed of their previous use with pesticides, and decontamination must be accomplished by washing the outside with water and the inside with water and caustic soda (2 lb/55-gal drum). Glass containers should be broken, plastic containers punctured and mutilated, and metal containers punctured and crushed. [200]

The thermal decomposition of a commercial malathion formulation (5 lb/gal) was measured [196] to be from 95.3 to 96.7% at temperatures of 600-1,000 C. At 900 C, decomposition products of burning analytical grade malathion were determined [201] to be carbon monoxide, carbon dioxide, sulfur dioxide, hydrogen sulfide, oxygen, and four unidentified products. Stojanovic et al [202] also tentatively identified diethyl succinate, diethyl maleate, and diethyl fumarate as thermal decomposition products. Some of the undecomposed fraction of burning malathion will vaporize, and contaminated particles will become airborne. The National Agricultural Chemicals Association (NACA) [203] recommends that self-contained breathing apparatus, rubber gloves, hats, suits, and boots be worn by firefighters in the case of parathion fires, and that these be cleaned before being removed. Firefighters are advised [203] to shower thoroughly and change to clean clothing after the operations have ended. Workers should avoid being downwind of the fire, and only those workers essential to the firefighting operation should remain in the vicinity of the fire.

NIOSH recommends that the procedures advised by NACA [203] for parathion fires be followed for malathion fires as well. Attention should be given to the possibility of concomitant exposure to considerably more toxic organophosphates or to other pesticides and compounds which may also be burning in warehouse fires, and appropriate precautions should be observed.

The WHO Expert Committee on Insecticides, [41] in its 16th report, recommended that employees exposed to pesticides be properly informed of the associated hazards. Industrial experience indicates that written information on pesticides is sometimes not readily available at the worksite. [131] Recognizing the need for employees to have information on the materials with which they work, the WHO stressed the importance of employees being informed of the hazards of malathion. [41]

VII. RESEARCH NEEDS

Several aspects of the available information on malathion need extension, verification, or development. Information on the mutagenic and carcinogenic potentials of malathion is very scanty. Studies designed to detect the induction of these deleterious effects in at least two species over their entire lifetimes should be initiated as soon as possible.

The ingestion study of Moeller and Rider [21] needs confirmation. The results of 47 days of malathion administration indicated that the threshold of significant erythrocyte ChE inhibition was somewhat greater than 24 mg/day for 8 weeks.

The rate and mechanism of skin absorption of the various types of malathion formulations need to be determined. In particular, the enzymes or biochemicals which metabolize or activate the compound during dermal absorption need to be determined. This is the most likely area of exposure to malathion by way of liquid spills and splashes, atmospheric dust deposits, etc. It would be beneficial to better understand the degree of hazard posed via this route of exposure.

The physiologic significance of aliesterase inhibition should be examined further. The kinetics of inhibition and regeneration of aliesterase should be studied as functions of the dose and route of malathion administration.

An accurate field test for ChE activity should be developed. Current methods are unsuitable as they require special laboratory equipment or lengthy procedures, or are insufficiently quantitative.

The quantitative relationship between skin and respiratory exposure to malathion and the excretion of metabolites in the urine should be determined and correlated with the rate of AChE inhibition in vivo. Such knowledge would facilitate the development of a noninvasive technique for measuring malathion exposure.

Alternative methods, such as filters, for the collection of malathion dusts, vapor, and aerosols in the workplace should be further investigated. The efficacy of charcoal tubes in the collection of malathion vapor should be investigated.

The equilibrium constant for the reaction of malaoxon with purified AChE and the rate of aging of the dimethylphosphoryl AChE derivative should be measured. Such information is necessary to determine the rate of accumulation of dimethylphosphoryl AChE as a function of dose route and dose rate.

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IX. APPENDIX I

METHOD FOR SAMPLING MALATHION IN AIR

The sampling and analytical methods presented in Appendices I and II are taken from those described by Culver et al, [68] by Brody and Chaney, [139] and in the NIOSH Manual of Analytical Methods. [204]

Atmospheric Sampling

Breathing zone samples representative of the individual employee's exposure shall be collected. A description of sampling location and conditions, equipment used, time and rate of sampling, and any other pertinent information shall be recorded at the time of sample collection. Enough samples shall be collected to permit calculation of a TWA concentration for every operation or location in which there is exposure to malathion.

The midget impinger recommended in Chapter IV of this document must be operated in a uniform and consistent way if data obtained are to have meaning in the assessment of environmental conditions. The impinger should be made of glass in all portions that may contact the collection medium or the air stream before collection is effected. It should be emphasized that the ethylene glycol used as a collection medium must be free of contaminants that produce interfering peaks when extracted with hexane and analyzed by gas liquid chromatography (GLC). Consequently, only ethylene glycol that has been preextracted and found to be free of interfering substances by GLC utilizing a flame photometric detector can be used.

(a) Equipment

The sampling train consists of an all-glass midget impinger filled with 10 ml of ethylene glycol. The sampling pump is protected from splash-over or water condensation by an adsorption tube loosely packed with a plug of glass wool and inserted between the exit arm of the impinger and pump or, preferably, by a water trap inserted in the same location.

(b) Calibration

Since the accuracy of an analysis can be no greater than the accuracy of the air volume measurement, the accurate calibration of a sampling pump is essential to the correct interpretation of the volume indicated. The frequency of calibration is dependent on the use, care, and handling to which the pump is subjected. Pumps should also be recalibrated if they have been misused or if they have just been repaired or received from a manufacturer. If the pump receives hard usage, more frequent calibration may be necessary. Regardless of use, maintenance and calibration should be performed on a regular schedule and records of these kept.

Ordinarily, pumps should be calibrated in the laboratory. The accuracy of calibration is dependent on the type of instrument used as a reference. The choice of calibration instrument will depend largely upon where the calibration is to be performed. For laboratory testing, primary standards, such as a spirometer or a soapbubble meter, are recommended, although other standard calibration instruments, such as a wet-test meter or dry gas meter, can be used. The actual setups will be similar for all instruments.

Instructions for calibration with the soapbubble meter follow. If another calibration device is selected, equivalent procedures should be used. Since the flowrate given by a pump is dependent on the pressure drop of the sampling device, in this case an impinger, the pump must be calibrated while operating with a representative impinger in line. The calibration system should be assembled in series following this order: soapbubble meter, water manometer, midget impinger, and pump, as shown in Figure XV-2.

(1) The voltage of the pump battery is checked with a voltmeter to ensure adequate voltage for calibration. The battery is charged if necessary.

(2) The pump is turned on and the inside of the soapbubble meter is moistened by immersing the buret in the soap solution and drawing bubbles up the inside until they travel the entire buret length without bursting.

(3) The pump rotameter is adjusted to provide the desired flowrate.

(4) A soapbubble is started up the buret and the time required for it to move between calibration marks is measured with a stopwatch.

(5) The procedure in (4) above is repeated at least twice, the results averaged, and the flowrate calculated from the volume between the preselected marks divided by the time required for the soapbubble to traverse the distance.

(6) Data for the calibration include the volume measured, elapsed time, pressure drop, air temperature, atmospheric pressure, serial

number of the pump, date, and name of the person performing the calibration.

(c) Sampling Procedure

Any air mover capable of drawing the desired flowrates through the impingers may be used, so long as flowrates do not vary more than ± 5% during the sampling period. The sampling pump must be capable of operating at a pressure drop of 1 inch of mercury while providing the designated flow of 2.8 liters/minute.

An air sample is taken using a flowrate of 2.8 liters/minute. The flowrate of the pump must be calibrated and this calibration checked periodically to ensure that it has not changed.

When atmospheric samples are taken for determination of compliance with the recommended environmental limit, the impinger is placed within the breathing zone of the exposed employee to determine the employee's actual exposure to airborne malathion. This may be done by placing the midget impinger in a holster and fastening it to a lapel of a coat or collar of a shirt. The individual conducting the evaluation may also hold the impinger near the face of the employee during the sampling period.

The duration of sampling shall be such that the recommended analytical method may detect concentrations as low as 1/10 the recommended environmental limit, ie, 1.5 mg/cu m.

The contents of the impinger should be transferred to a sample bottle for shipping. The impinger and stem should be washed with 2-5 ml of ethylene glycol, the solution used for washing included in the sample bottle, and the exact amount of ethylene glycol used recorded. The bottle should be sealed tightly and placed upright in a carrying case. Every attempt should be made to prevent any loss due to spillage or evaporation.

The trapped malathion is extracted from the ethylene glycol with hexane and analyzed as described in Appendix II. Other collection methods shown to be equivalent may be used.