NORTH CAROLINA STATE UNIVERSITY/DEPARTMENT OF ENTOMOLOGY
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INFORMATION AND SUGGESTIONS FOR USE OF ULV GROUND EQUIPMENT FOR MOSQUITO AND BITING FLY CONTROL

Prepared by

J. C. Dukes, Research Associate in Entomology

R. C. Axtell, Professor of Entomology

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and
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PREFACE

Research at North Carolina State University has been conducted, and is continuing, on the methods of control of mosquitoes and biting flies. This research is supported by the N. C. Agricultural Experiment Station and the N. C. Sea Grant Program.*

As part of this research, we have used applications of ultra low volume (ULV) amounts of insecticide dispensed by truck-mounted equipment. The equipment used has been the LECO-ULV model HD machine.** Since several mosquito control operations have been purchasing this equipment, we are providing herein some suggestions and cautions on the use of this machine. These are findings from our research experience and should not be construed as an endorsement. Any suggestions from users would be appreciated. Although other machines are, or will be marketed, we lack experience with them. In any case, the principles contained herein would still apply.

Disclaimer Statement: Use of trade names in this publication does not imply endorsement of the products named or criticism of similar ones not mentioned.

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**Lowndes Manufacturing Co., Inc., Valdosta, Georgia.

ULTRA LOW VOLUME (ULV) INSECTICIDE APPLICATION

Introduction

The use of ultra low volume (ULV) insecticides applied by ground equipment is rapidly replacing the use of thermal aerosol generators for adult mosquito control. There are several important factors which are influencing this conversion to ULV equipment. Several researchers have reported that control of adult mosquitoes using ULV insecticides were better than or at least equal to that obtained with the conventional thermal fogs when applied at equal dosages. Thermal fogs use the insecticide diluted in fuel oil (to 3-5% insecticide in the final mixture) and applied at 30-40 gallons per hour. Non-thermal aerosol ULV equipment uses the concentrated insecticide undiluted and applied at a few ounces per minute (1.5-2 gallons per hour). Very careful operation of the ULV equipment is necessary and the spray droplets must be in the correct range of sizes. The ULV offers the distinct advantages of no use of fuel oil with the resulting cost savings and no introduction of the oil into the environment.

A second major consideration on equipment is that of hazard to automobile and pedestrian traffic caused by the dense fog from thermal aerosols. The use of ground ULV equipment virtually eliminates this hazard. The insecticides are discharged from the ULV nozzle in an ultra fine mist which has little or no effect on visibility behind the moving vehicle.

To those involved in mosquito control, the ease of operation and costs are major considerations. The ULV non-thermal aerosol generators are of such weight and construction that compact vehicles may be used.

This great reduction in weight and materials required from that of the larger and heavier thermal aerosol generator units provide superior accessibility in most areas. Greater accessibility also offers increased aerosol coverage. Eliminating the bulk and weight inherent in thermal aerosol generators by using more compact equipment also reduces the limitations on driver visibility and therefore increases the drivers safety.

The operating cost including machines, vehicles, and materials of the thermal aerosol has been compared to that of the ULV non-thermal aerosol used by the Chatham County Mosquito Control Commission, Chatham County, Georgia. The operating cost for thermal aerosols were 15.6 cents per acre. The ULV non-thermal aerosol cost 4.1 cents per acre to operate, thus realizing a 73.7 percent per acre savings. They also reported fewer repairs and fewer truck nights lost due to inoperative vehicles or machines.

Installation of a LECO ULV-HD

The ULV non-thermal aerosol generator should be permanently affixed to the bed of a truck following the instructions accompanying your machine (Fig. 1 & 2). The truck should have flashing caution lights and "slow vehicle" warning signs. The can-rack unit holding the insecticide should be placed in such a manner that heat from the engine exhaust and motor block does not continually increase your insecticide temperature during mosquito control operations.

Placement of the remote control panel (Fig. 3) in the cab of the truck is very important. The panel must be placed so that the driver of the vehicle can easily see the controls and be within easy reach in order that adjustments may be made while the operation is in progress.

After permanently mounting the remote control panel, the electrical connections, insecticide line, and air hoses should be connected. Caution should be used when connecting the hoses to prevent leakage. The connections should be properly threaded and tightened only hand tight. Do not use a wrench.

Operating Engine

Be sure that the engine block is filled with oil. Fill the gasoline tank. With the insecticide tank empty, you should then check the operations of the engine unit. The correct engine speed is 2500 RPM. Check to see that all lines are tight and that pressure is building within the tank. By adjusting the engine throttle, the pressure gauge on the instrument panel should read 4 to 4½ PSI.

Filling Insecticide Tank

Stop the engine and remove the insecticide tank (or you may have an arrangement to pump the insecticide into the tank on the truck). Be sure not to spill insecticide on the bed of the truck. When handling and pouring the insecticide be sure to wear protective clothing (Fig. 4).

Calibration of Flowmeter

Before the unit is operational, it must be calibrated to deliver the desired flowrate per minute. The dosage recommendations will usually be given in terms of rate of flow and vehicle speed. Due to the number of different insecticides and variations in atmospheric

temperature at the time of dispersal, no specific flowmeter setting can be given for a particular rate of flow. It must be understood that, even for the same rate of flow, each insecticide requires a different flowmeter setting due to its specific gravity and viscosity. It must also be understood that for any one insecticide, no specific flowmeter setting can be given for a particular rate of flow due to the change in viscosity caused by temperature changes. Therefore, it is necessary to calibrate your flowmeter for your particular insecticide at the temperature at which it will be dispersed.

During calibration, the ULV generator should be placed in an isolated area. The vehicle should be facing into the wind so that the spray is blown away from you and your equipment. Be sure it is not blowing towards people, houses, animals, etc. Start the generator engine and again check the pressure gauge for a reading from 4 to 4½ PSI. Open the flowmeter needle valve all the way by turning it in a counter-clockwise direction. Turn the fog switch to ON. Allow the insecticide to flow through the system until all air bubbles disappear and then adjust the needle valve for the proper flow.

The proper flow rate for malathion ULV can be determined by the temperature correction curve (Fig. 5 & 6) furnished by Lowndes Engineering Company with the LECO ULV generator. Read the temperature from the temperature gauge on the instrument panel. Find this temperature on the correction curve. Then move straight up the page to the intersection of the temperature line with that of the plotted curve for the proper delivery rate. From that point or intersection, move across the page to the flowmeter scale to obtain the correct flowmeter setting. Adjust the flowmeter so that the center of the floating ball

is opposite the proper rate of flow. Note that the flowmeter is labelled with numbers which lock the zeros so that 12 on the flowmeter equals 120 and so forth. The flowmeter setting should be changed for every two degrees change in temperature.

To calibrate the flowmeter for the proper delivery rate, disconnect the insecticide line from the fogging head. With your flowmeter set to deliver a certain volume (3 oz. per min.), catch the insecticide in a calibrated container for several minutes. Calculate the flow per minute. If the flow rate differs from that on the chart, minor adjustments may be made by increasing or decreasing the pressure by adjustment of the engine throttle. An increase in pressure will increase the flow rate. It is extremely important to remember that the pressure should always be greater than 3½ PSI but never exceed 6 PSI. When the correct delivery rate has been obtained, turn the fog switch to OFF and reconnect the insecticide line back to the fogging head.

In most instances, you will not be using the exact dosage rate plotted and will therefore have to make your own curve to fit your desired dosage rates. Refer to temperature correction curve No. 2 (Fig. 6) for malathion. If, for example, you needed a flow rate of 4 oz. per min., read across the bottom of the graph labelled "flow" to 4. Then go directly up the line to where each of the temperature lines intersect the line above 4 and record each. You should get a flowmeter setting of 163 millimeter for 65^{o}F, and 85 mm for 100^{o}F. After having found the flowmeter reading for each fixed temperature between 65^{o}-100^{o}F, you then plot each point on graph No. 1. You then should connect each point forming a gradual curve (not a straight line

between points). After the free-hand curve has been drawn in, you may then read the flowmeter setting for any temperature between 65^{o}-100^{o}F.

Temperature-Flow Chart

Using the temperature correction curve for the insecticide and rate of flow that you will be using, a flow chart (Fig. 7 & 8) should be made to include the proper flowmeter reading for each temperature reading between 60^{o} and 100^{o}F. This flow chart should be attached to the instrument panel and be used to correct for temperature changes during operation. Remember that for each 2 degrees change in temperature, the flowmeter setting should also be changed.

Droplet Size Determination

The effectiveness of adulticides in mosquito control work depends on four factors:

1. the susceptibility of the mosquito to the insecticide being dispersed,
2. the dosage rate per unit area,
3. the droplet size and number of droplets per unit area, and
4. the exposure time of the mosquito.

The dosage rate is determined by the vehicle speed, the swath width, and the rate of insecticide flow. Doubling your vehicle speed, other factors remaining constant, will decrease your dosage rate by one-half. The droplet size is determined by the flowrate, pressure, and the nozzle size.

The droplet size is extremely important in ground adulticiding because heavier droplets tend to fall to the ground and droplets too small tend to drift up and away from the target mosquito. More than one-half of the total spray mass must consist of droplets in the 6 to 18 micron range. Four-fifths of the total spray mass must consist of droplets smaller than 24 microns. The mass median diameter of the droplets should not exceed 17 microns (that is, 50% of the spray volume is in larger than 17 micron droplets and 50% is in smaller than 17 micron droplets).

To obtain a perspective on the size of the droplets required, lets consider one gram of water. This one gram of water could be divided into:

30 rain drops measuring 4000 microns each,

30,000 spray droplets measuring 400 microns each,

30,000,000 aerosol droplets measuring 40 microns each,

30 billion medium aerosol droplets measuring 4 microns each.

The droplet size of your ULV non-thermal generator should be determined as frequently as necessary to insure proper droplet size. It must be determined before the machine is originally put into active use and following any mechanical changes or alterations. It should also be determined at regular intervals of approximately 50 operational hours. According to the literature and label on malathion from American Cyanamid Company, "malathion must not be used undiluted as a non-thermal aerosol applied ultra low volume by ground equipment for control of adult mosquitoes unless written authorization and specific instructions for this use are obtained from American Cyanamid Company." This authorization and instruction should be requested in writing.

Droplet sizes are determined by depositing a sample of the aerosol onto a silicone coated glass slide and measuring the droplets under a high-power microscope. The slides may be prepared using silicone (General Electric SC-87 Dri-Film) or purchased ready for use.

A sample of the malathion aerosol is deposited on a slide by placing the slide onto the end of a 3 ft. stake and waving the slide through the aerosol cloud at a distance of 25 ft. from the point of discharge. The slides are waved perpendicular through the aerosol cloud and stored in a tightly sealed box for transfer to a location for counting.

Making Treatments

Your control district or County should be logically divided into several control areas. Each area should then be mapped with detail to include all roads and alley ways. The driver should familiarize himself with each area and plan his route of travel before leaving the control headquarters. An alternate route or routes should also be planned to account for wind direction. Do not drive with the wind blowing the insecticide into the cab of the truck or down wind of areas immediately treated. You should never drive into unfamiliar driveways before checking for obstacles or hazards. You do not apply insecticides while going into a driveway, roadway, or in any other manner that will necessitate driving back through the insecticide.

Before leaving your mosquito control headquarters, you should make a routine check on the vehicle and safety equipment (see equipment check list). Never assume that everything is operational today just because it worked correctly the last time out. Record pertinent

information, such as treatment area, date, operator, flow rate, vehicle speed, fogging time, and volume of insecticide in your tanks before the operation begins.

Do not operate the flashing amber lights in route to your assigned control area. After arriving at your area, you should note and record the time, wind direction, and approximate wind speed. Start your aerosol generator and check out all systems (refer to Operation of LECO ULV Generator). Operate your flashing amber lights and your emergency flashers. Turn the fog switch to on and adjust the flowmeter reading (refer to Flowmeter Temperature Chart). It is imperative that you maintain your assigned vehicle speed in order to deliver the proper dosage rate. When possible, drive at right angles to the wind. Cover all adjacent roads before moving to other parts of your area. By doing so, you will obtain better aerosol coverage and deliver a more lethal blow to the mosquito population.

When you have completed your assigned area, you should flush the insecticide from the machine by cutting the insecticide flow off and the solvent flow on. Flush the system for approximately two minutes and then turn the fog switch to off. Turn your generator engine off. Use a calibrated dip stick to measure the amount of insecticide in the container, record and calculate the total amount of insecticide used. Record the time that spraying operation was completed.

LIST OF FIGURES

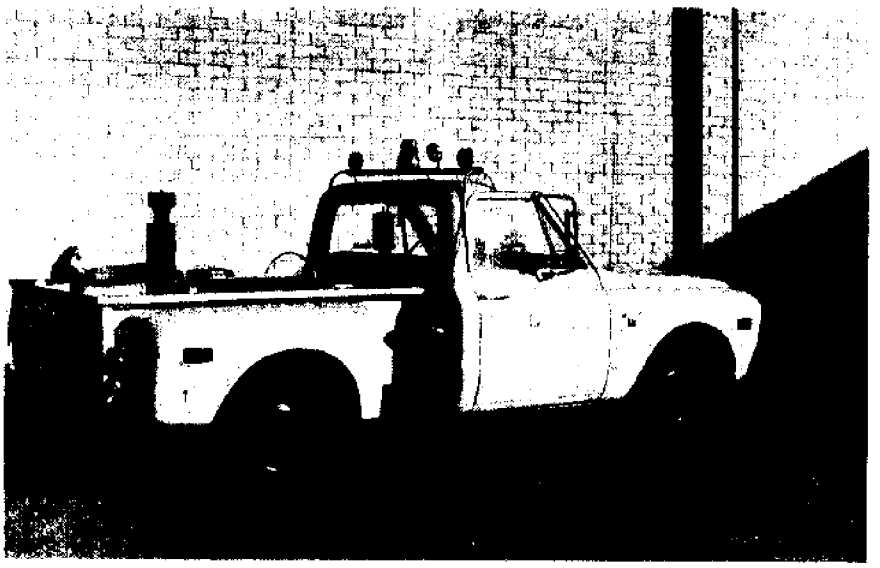


Figure 1

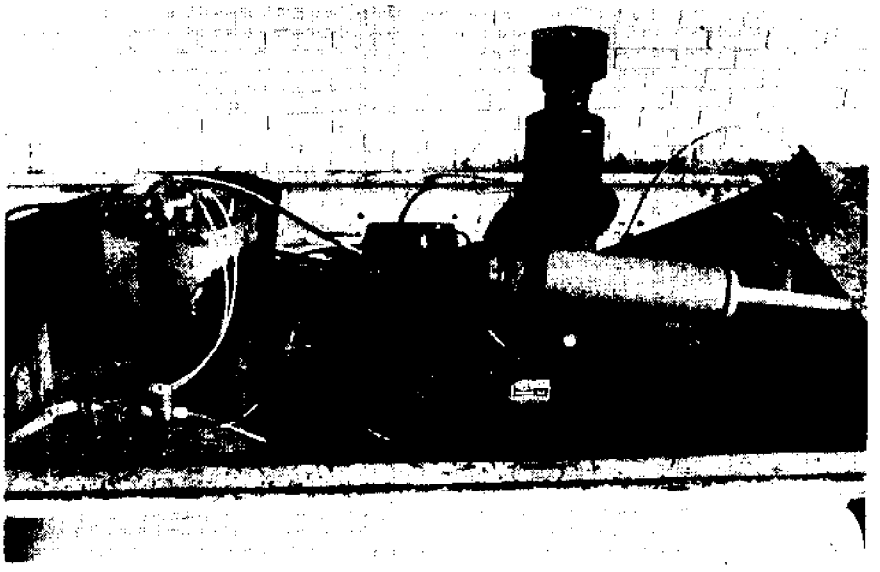


Figure 2

Figure 3

Figure 4

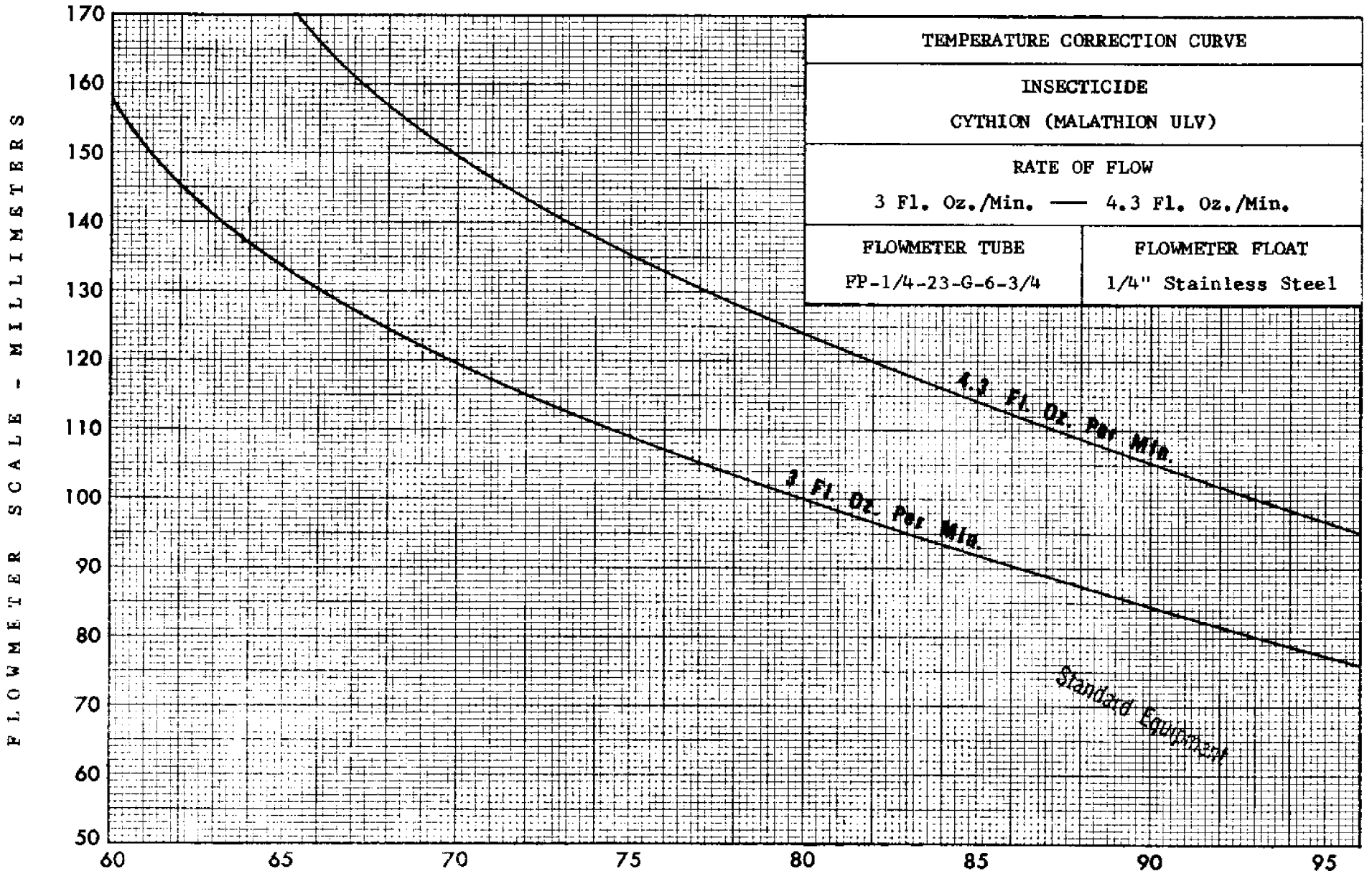
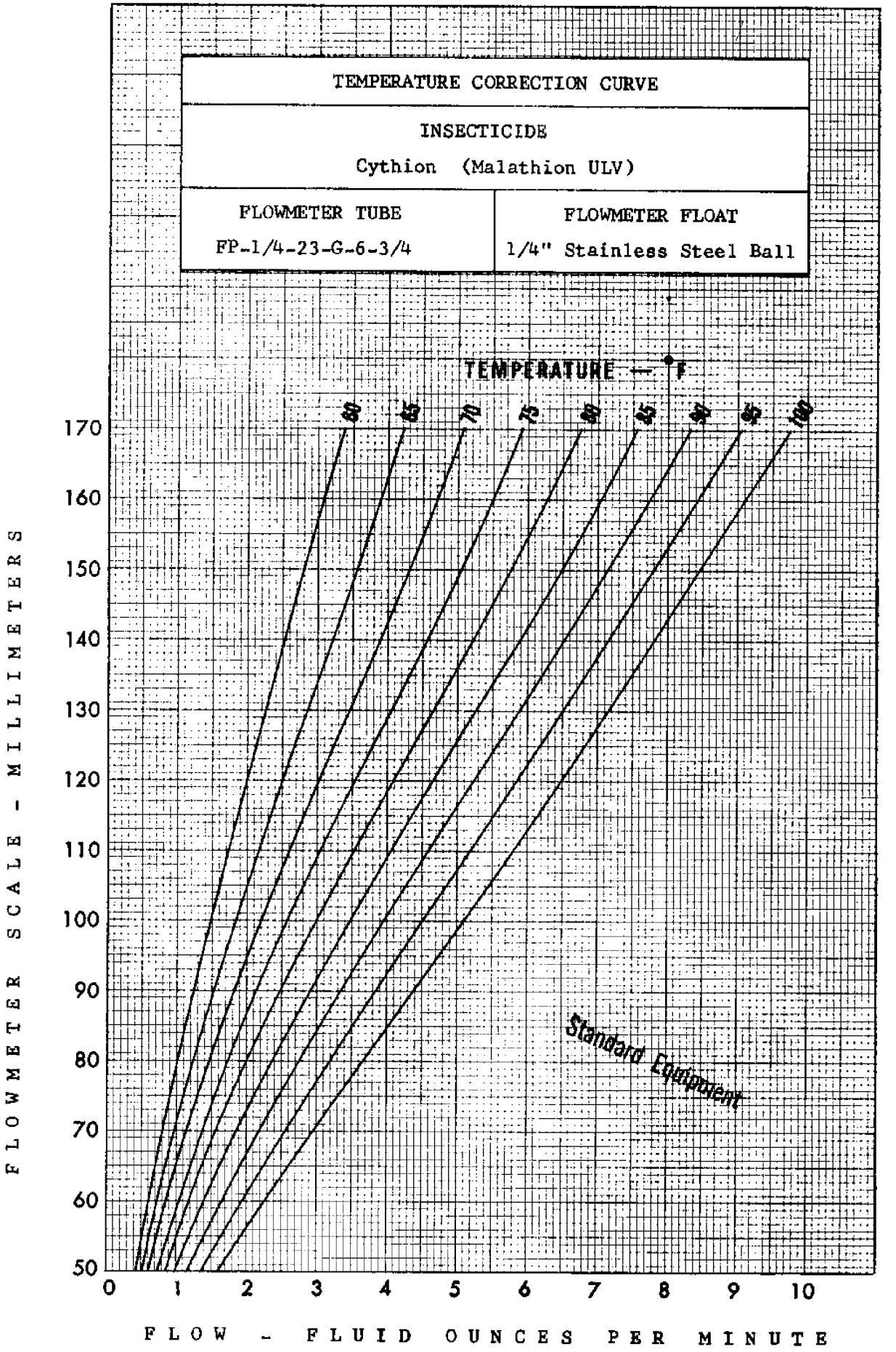

TEMPERATURE CORRECTION CURVE
INSECTICIDE
CYTHION (MALATHION ULV)
RATE OF FLOW
3 Fl. Oz./Min. —— 4.3 Fl. Oz./Min.
FLOWMETER TUBE
FP-1/4-23-G-6-3/4
FLOWMETER FLOAT
1/4" Stainless Steel
4.3 Fl. Oz. Per Min.
3 Fl. Oz. Per Min.
Standard Equipment
FLOWMETER SCALE - MILLIMETERS
170
160
150
140
130
120
110
100
90
80
70
60
50
60
65
70
75
80
85
90
95
TEMPERATURE - ° F

Figure 5

Figure 6


TEMPERATURE CORRECTION CURVE
INSECTICIDE
Cythion (Malathion ULV)
FLOWMETER TUBE
FP-1/4-23-G-6-3/4
FLOWMETER FLOAT
1/4" Stainless Steel Ball
TEMPERATURE — °F
60
65
70
75
80
85
90
95
100
Standard Equipment
FLOWMETER SCALE - MILLIMETERS
170
160
150
140
130
120
110
100
90
80
70
60
50
0
1
2
3
4
5
6
7
8
9
10
FLOW - FLUID OUNCES PER MINUTE

TEMPERATURE CORRECTION CHART

INSECTICIDE: Cythion (Malathion ULV)
RATE OF FLOW: 3 Fl. Oz./Min.
FLOWMETER TUBE: FP-1/4-23-G-6-3/4
FLOWMETER FLOAT: Stainless Steel

Temp. °F	Flowmeter scale	Temp. °F	Flowmeter scale
60	158	78	103½
61	150½	79	101½
62	145	80	100
63	141	81	98
64	137	82	96½
65	133½	83	95
66	130	84	93½
67	127	85	92
68	124½	86	90½
69	122	87	89
70	119½	88	87½
71	117	89	86
72	115	90	84½
73	113	91	83
74	111	92	81½
75	109	93	80
76	107	94	78½
77	105	95	77

Figure 7

TEMPERATURE CORRECTION CHART

INSECTICIDE: Cythion (Malathion ULV)
RATE OF FLOW: 4.3 Fl. Oz./Min.
FLOWMETER TUBE: FP-1/4-23-G-6-3/4
FLOWMETER FLOAT: Stainless Steel

Temp. °F	Flowmeter scale	Temp. °F	Flowmeter scale
60	*	78	128
61	*	79	126
62	*	80	124
63	*	81	122
64	*	82	120
65	*	83	118
66	166	84	116
67	161	85	114
68	157	86	112
69	153	87	110½
70	149½	88	108½
71	146½	89	107
72	143	90	105
73	140½	91	103½
74	138	92	102
75	135	93	100
76	133	94	98½
77	130½	95	97

*Off the flowmeter scale.

Figure 8

CHECK LISTS

SAFETY

a. If necessary to handle insecticide containers, hoses, or fittings, use protective clothing and gloves which are kept in cab of vehicle at all times. Gloves and clothing should be washed with soap and water thoroughly upon returning to office.

b. If insecticide comes in contact with skin during handling, wash area immediately with soap and cold water.

c. Flashing amber lights are to be operated only when actual operations are being conducted or when vehicle is stopped for repair. DO NOT operate lights when going to or returning from assigned area.

d. DO NOT drive with the wind blowing the insecticide into the cab of the truck or down wind of areas immediately treated.

e. DO NOT apply insecticide while going into a driveway, roadway, or in any other manner that will necessitate driving back through the insecticide.

f. NEVER drive into unknown side roads, back yards, driveways, lanes, etc., unless first checked as SAFE.

g. DO NOT leave insecticide "ON" while vehicle is not moving (except during equipment check at office).

h. Drivers must take showers and change clothing upon completion of operation.

i. Failure to comply with safety regulations should be grounds for dismissal.

BEFORE STARTING OPERATION

a. Inspect tires for proper inflation.

b. Check oil level on dip stick.

c. Check water in radiator.

d. Check battery water level and electrical connections.

e. Check fan belt.

f. Confirm presence of jack, lug wrench, first aid kit, and fire extinguisher.

g. Adjust seat and rear view mirrors to desired position.

h. Check brake petal (height and resistance).

i. Check gas level in vehicle.

j. Check oil level in engine of spray equipment.

k. Check gas level of engine.

l. Check blower nozzle position.

m. Check insecticide and solvent containers.

n. Using dip stick, measure amount of insecticide in containers before start of operation and record.

o. Confirm presence of detailed maps of treatment areas.

p. Confirm presence of flow chart for your particular insecticide and your temperature range.

OPERATION OF VEHICLE

a. After engine has been started--check all gauges or warning lights.

b. Check brake lights, turn indicators, and head lights.

c. Fasten safety belts.

d. Observe all gauges at periodic intervals during operation.

e. If any vital or safety system does not function properly, do not drive, and report immediately to supervisor.

f. Observe all traffic rules.

g. Maintain vehicle at assigned speed at all times during actual operations.

h. Operate flashing amber lights at all times during actual operation.

OPERATION OF LECO ULV MACHINE

a. Attach flow rate chart for desired output to instrument panel.

b. Start Briggs and Stratton engine.

c. Check pressure gauge (not less than 4 psi, and not greater than 6 psi). Adjust accordingly using throttle of engine.

d. Begin operation by turning switch to "ON" position.

e. Check chart on instrument panel and make necessary adjustment to flowmeter to meet temperature changes.

f. Check insecticide temperature gauge at least once every 5 minutes and make adjustments and make adjustments for every 2 degrees of temperature change.

CONCLUDING OPERATIONS

a. Flush insecticide from machine by cutting insecticide flow off and solvent flow on; let run for a couple of minutes then turn switch off.

b. Shut Briggs and Stratton engine off.

c. Using dip stick, measure amount of insecticide in containers after completion of operation. Calculate total amount of output.

d. Record the time of the fogging timer and calculate the total time the aerosol generator was operational.

PARKING VEHICLE

a. Park vehicle in an assigned location.

b. Remove all unassigned equipment and waste from vehicle.

c. All switches should be in "OFF" position.

d. Close windows.

e. Report all needed vehicle maintenance or repairs to supervisor.

TRAFFIC

a. YIELD TO ALL TRAFFIC, vehicular or pedestrian, approaching from any direction.

b. Observe vehicles approaching from the rear. If their speed seems excessive, pull over to shoulder of the road.

c. If traffic build-ups occur, pull over on shoulder of road and stop.

d. Application should NOT be conducted on main traffic arteries, streets, or roads where high speeds are permitted.

e. Never conduct application ACROSS main traffic arteries.

f. Never drive against traffic.

g. Treat coming out of dead-end streets or drives--NOT going in.

MISCELLANEOUS

a. Riders other than mosquito control personnel are not allowed. NO EXCEPTIONS.

b. In case of an accident, notify the Police and your supervisor immediately.

c. Report all note-worthy problems or events to your supervisor following each assignment.

WIND

a. ULV application should be conducted at right angles to the wind, if at all possible.

b. Wind direction may change several times during the night. Therefore, the driver should constantly observe wind direction and adjust accordingly.

c. ULV application should NOT be conducted in winds in excess of 10 MILES PER HOUR.

TEMPERATURE AND RAIN

a. ULV work should not be conducted during daylight hours, except under special conditions.

b. Insecticide temperature should be checked frequently (at least every 5 minutes), and the flowmeter adjusted accordingly. Follow temperature flowrate chart attached to instrument panel.

c. ULV application should not be carried out in HEAVY rain. Light showers are permissible.

d. Engine should be covered during heavy rain to prevent drown-outs.

DAILY MAINTENANCE

a. After each usage the entire system must be flushed out. Flushing can be done simply by removing the manifold cap from the insecticide can and inserting the drop tube into a container of solvent. Start the fogger and let it run for several minutes to be sure that all the insecticide is flushed out. Iso-propyl alcohol or naptha should be used as a flushing agent.

   An alternate to this system is to install a three-way valve into the insecticide line. One tube runs to a permanently mounted solvent container and the other to the insecticide. The third line goes to the flowmeter. Flushing can then be accomplished simply by turning the three-way valve so that the solvent runs through the system instead of the insecticide.

b. Refill the insecticide container.

c. Refill the solvent container.

d. Refill the gasoline tank to the generator engine.

e. Check all hoses and lines for leakage or wear.

WEEKLY MAINTENANCE

a. Check the belts and adjust if necessary. The proper adjustment is 3/4 inch deflection midway between the pulleys.

b. Check the engine speed and reset if necessary to obtain proper pressure in the system.

c. Check all bolts and fasteners and tighten if necessary.

d. Remove and clean the screen on the air intake silencer. Before replacing the screen, start the engine and while holding the throttle at idling speed, pour 1/8 pint of lubricating oil in the air intake. This will prevent a coat of rust from forming inside the blower.

e. Check the oil in the engine and change at given intervals. The oil drain plug on the LECO engine creates a problem when draining the oil. A large plastic bag makes an excellent catch container for the oil.

f. Check the points and plugs for proper setting and corrosion. Replace if necessary.

REGISTRATIONS FOR INSECTICIDES FOR ULTRA LOW VOLUME NON-THERMAL GROUND APPLICATION FOR ADULT MOSQUITO CONTROL

NOTE: Label registrations change and the latest information should be obtained. Always READ THE LABEL and follow the INSTRUCTIONS AND RESTRICTIONS. This list was prepared 1 April 1974 (R. C. Axtell). The rates given below are for a 300 ft. swath width which can be used to calculate amounts per acre.

1. Malathion: American Cyanamid Co.

   Trade names: CYTHION, MALATHION ULV CONCENTRATE

   Formulation: 95% actual malathion; 1 gallon contains 9 7 lbs. malathion

   Rates: 1.0 to 2.1 fld. oz./minute at 5 mph, 2-6 psi.

   2.0 to 4.3 fld. oz./minute at 10 mph, 2-6 psi.

   See label for droplet size requirements.

   USDA Reg. No. 241-208, 241-110

2. Pyrethrin: MGK Corp.

   Trade names: PYROCIDE CONCENTRATE, PYROCIDE FOGGING FORMULA 7067

   Formulation: Concentrate contrates 12% pyrethrin and 60% piperonyl butoxide (synergist). Formula 7067 contains 5% pyrethrins and 15% piperonyl butoxide.

   Rates: Concentrate is to be diluted 1 to 1.4 (by weight) to make a 5% pyrethrin material. Formula 7067 is used without dilution. Rates for 5% pyrethrin plus synergist are:

   2 to 2.25 fld. oz./minute at 5 mph, 3 psi.

   4 to 4.5 fld. oz./minute at 10 mph, 3 psi.

   EPA Reg. No. 1021-1185

3. Naled: Chevron Chemical Co.

Trade name: DIBROM 14 Concentrate

Formulation: 85% actual naled; 1 gallon contains 14 lbs naled

Rates: Concentrate is to be diluted 2 qts. in soybean oil or HAN to make 5 gallons of dilute solution. Apply dilute material at following rates:

3 to 6 fld. oz./minute at 5 mph, 1.5 psi.

6 to 12 fld. oz./minute at 10 mph, 1.5 psi.

See label for droplet size requirements. Mix immediately before use, do not store diluted.

EPA Reg. No. 239-1721-AA

Trade name: DIBROM ULV Insecticide (Summit Chemical Co.)

Formulation: A prepared dilution of naled containing 15% actual naled by weight. Ready to use.

Rates: 6 fld. oz./minute at 5 mph, 1.5 psi.

12 fld. oz./minute at 10 mph, 1.5 psi.

EPA Reg. No. 6218-40

4. Chlorpyrifos: Dow Chemical Co.

Trade names: DURSBAN, Dow Mosquito Fogging Concentrate

Formulations: 61.5% actual chlorpyrifos; 1 gallon contains 6 lbs. chlorpyrifos

Rates: 2/3 to 1 1/3 fld. oz./minute at 10 mph, psi not specified

See label for droplet size requirements.

EPA Reg. No. 464-428