Pest M[illegible]
in Se[illegible]
Virginia [illegible] Program

Pest Management in Seafood Processing

By William H. Robinson

VPI-SG-81-12

Virginia Sea Grant Program
Extension Division
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

INTRODUCTION

Modern seafood processing establishments must comply with the high standards of sanitation and pest control expected by the public and strictly enforced by regulatory agencies. The consumer expects pure, wholesome seafood products that are prepared, processed, stored, and served in a sanitary and pest-free environment. Failure of seafood processing plants to meet proper sanitation and pest control standards and other food and health regulations may incur costly regulatory action, unwanted publicity, and loss of revenue.

Pests. Insect and rodent pests are serious threats to the sanitation and quality control standards necessary in seafood processing. Each establishment has its own particular quality control standards and the means to achieve them. The majority of seafood plant managers prefer to assign plant personnel to handle pest control responsibilities (in-house program). Others employ a professional pest control service (professional program) to handle these tasks. Regardless of whether plant personnel or professionals provide the pest control service, the most important considerations are (1) a pest control *program*, and (2) management *responsibility*.

Pest Control Program. To meet the changing standards of sanitation and quality required of seafood processing establishments, pest control operations must be carried out on a ***program basis.*** A program must be designed with the needs of management and the abilities of pest control in mind. It must be designed specifically for each establishment and must consider

- pests specific to the establishment,
- environmental and structural conditions,
- available chemicals,
- personnel, and
- current quality standards.

Whether in-house or professional services are used, the most cost efficient and effective pest control service will be a program that integrates sanitation, prevention, employee education, and chemical pesticides.

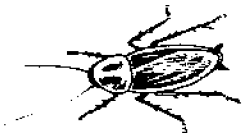
PESTS

MANAGEMENT and PEST CONTROL

PRINCIPLES OF PEST MANAGEMENT

Control of insect and rodent pests of food processing operations has depended almost entirely upon the use of chemical pesticides. Changes in Federal regulations, in material costs, in safety standards, and, in some cases, in the pest species or the behavior of existing pests, require reevaluation of the strategies and tactics of pest control. For example, several cockroach species are resistant to some of the standard insecticides used for years, and some cockroaches display avoidance to some of the new insecticide formulations.

Chemical Control. Controlling cockroaches and other pests with chemicals alone is becoming increasingly more difficult. Continued dependence on chemicals for control of pests will increase insecticide and rodenticide resistance in the pest population—and may result in an uncontrollable increase in the pest population. The traditional approach to pest control—chemical pesticides—must yield to a *pest management approach.*



ERADICATION vs MANAGEMENT

Management. The characteristics of a ***pest management program*** for seafood processing operations are as follows:

(1) The ***orientation*** is to the entire pest population, rather than to localized infestations. Individual pests or small numbers of pests in one area are interpreted as members of a larger group or population that may occupy an entire building.

(2) The **objective** is to manage the population, to lower the mean level of abundance of the pest rather than eliminate or eradicate it. This philosophy may be incompatible with the unrealistic concept of a pest-free environment. For some pests and in some situations, elimination may be possible, perhaps after the pest population is reduced through pest management practices, but it is more realistic to

think in terms of a continuous or on-going pest management program, designed to keep pest populations low, than to work toward pest elimination and program conclusion. It is virtually impossible to eliminate or eradicate most pests from an environment favorable for them.

(3) The ***method*** or combination of methods chosen is to give the maximum long-term reliability of protection, the minimum expenditure of effort and money.

(4) The ***significance*** is that alleviation of the problem is general and long-term rather than localized and temporary.

Pest management primarily involves dealing with pest populations interacting within the total environment. Pest management requires a holistic approach to controlling pest populations, integrating sanitation, prevention, exclusion, mechanical control, and chemical and non-chemical pesticides into a *program* with the goal of reducing (and possibly eliminating) a pest population.

PESTS ASSOCIATED WITH SEAFOOD PROCESSING PLANTS

A variety of pests are associated with seafood processing plants in the United States. The pests most likely to occur will depend on both the geographic location of the plant and the type of seafood being processed. These pests may be able to damage, destroy, or contaminate food. They must be controlled to protect the quality of the product. The presence or evidence of pests may result in the seizure of food products or other actions by federal or state agencies. The pests included for discussion here are birds, rodents, and insects.

BIRDS

Only three of the many species of birds in the United States are normally considered pests around seafood processing plants: English sparrows, pigeons, and starlings. All three survive well in close association with man. They are objectionable primarily because their droppings can be a serious food contaminant and may spread diseases. Their droppings deface buildings and their nests plug gutters and cause roofs to leak. Their noise and odor are offensive to many people. Also, they sometimes carry mites which can bite man.

Control. Toxic baits, when eaten by pigeons, starlings, or sparrows, produce distress reactions in some birds. This frightens the rest of the flock away from the area.

Chemical baits are most effective when used against small flocks and when conditions can be carefully controlled.

Associated Problems. Dry, dusty droppings may contain fungus spores which can cause human diseases. Workers cleaning such areas, or involved in hand-capture of birds, should wear approved respirators.

RODENTS

Rodents constitute a major pest problem for the seafood industry. There are three domestic rodents in the United States: the house mouse; the Norway (brown or sewer) rat; and the roof (black or ship) rat. Rats eat almost everything man or animals use as food. They contaminate much more than they eat, with the result that contaminated food products must be destroyed, and damaged packages must be repaired or replaced. Before you can control rodents, it is important to identify the species and know its behavior patterns.

Senses, Agility, and Reactions. Rodents have a well-developed sense of touch in their highly sensitive whiskers and certain guard hairs. Rats and mice prefer to run along walls or between things where they can keep their whiskers in contact with side surfaces. Although their vision is well developed, rats and mice appear to be color blind, so that distinctive coloring does not reduce their acceptance of poison baits. Rodents apparently like the odors of most foods eaten by man. They are accustomed to the smell of man, so his odor on baits and traps does not repel them.

Roof rats and house mice are good climbers, and the Norway rat can climb quite well when necessary. Rats can jump nearly 2 feet vertically, 3 feet with a running start; they can jump 4 feet horizontally, and 8 feet from an elevation that is 15 feet above the finish point. Rats can reach upward about 18 inches. Rodents are good swimmers. They are able to swim up through floor drains and toilet-bowl traps.

The incisor teeth of rats grow 4 to 5 inches a year, so these rodents must do some gnawing each day in order to keep their teeth short enough to use. Rats also gnaw entrances to obtain food. Fresh gnawings in wood are light colored and show distinct teeth marks.

Dried rodent urine fluoresces bluish white to yellowish white. Commercial black lights are often used to detect the rodent urine. However, fluorescence caused by black light does not guarantee that the substance is rodent urine; numerous items will fluoresce when under a black light, including bleaches found in many detergents and lubricating oils.

Control. Control of rats and mice is essential to every food processing plant and storage facility and must be accomplished to satisfy legal requirements, prevent losses, and meet individual company operating standards. While the degree of emphasis on any single phase of rodent control varies with building structure, location, and species of rodent involved, *an effective control program must start by building rodents out.*

MICE and RATS

BAITS and TRAPS

BUILD RODENTS OUT!

Exclude rodents from plants and warehouses by having every possible opening in outer walls, at floor/wall junctions, and at all exterior doors tight enough to prevent entry, and by installing guards across runways to prevent entry at loading doors. No opening should be larger than ¼ inch.

Good housekeeping and proper storage practices discourage rodents by eliminating their food and harborage. It is important to maintain a clearance of 18 inches between pallets of merchandise and the wall. This clearance allows room behind the stock for proper cleaning and pest control. A stock rotation system, utilizing the first-in/first-out method, is a necessity in all sound warehousing programs.

After taking every practical measure to build rodents out, and to eliminate their food and harborages, you may use baiting and trapping to supplement preventive controls. In most cases, only those rodenticides falling within the anticoagulant group should be used in specific areas of food processing facilities. These are available in several forms, such as granular, cereal-based bait, paraffinized bait pellets, and bait blocks.

INSECTS

A variety of insect pests are associated with food materials and seafood processing operations. These include cockroaches, flies, and flour moths. Although there are no insect pests unique to particular food processing plants, some of the

common pests may be more numerous or more difficult to control in certain operations.

COCKROACHES

COCKROACHES

Perhaps the most common and most important pests of seafood processing plants are the cockroaches. Most common because they occur around the world, in every plant, in every industry; most important because they can and do carry and spread numerous disease organisms. Cockroaches are known to carry four strains of poliomyelitis, more than 40 different pathogenic bacteria, and the eggs of several pathogenic worms. It has been estimated that a single cockroach can carry a total of 13,470 bacteria.

Female cockroaches produce small egg cases that contain from 16 to 40 eggs, and this egg case is deposited in a hiding place. Young cockroaches begin feeding soon after they hatch from the egg case. They feed on the same material as the adults, and look like adults except for the size and absence of wings. After shedding their skin several times to grow larger, they become winged adults. Adult cockroaches live from a few months to over a year, depending on the species. They mate several times and the females generally produce one egg case per month.

German Cockroach. In food processing plants, German cockroaches infest the main food preparation and storage areas, as well as offices, clothing lockers, and restrooms. They are not usually found in storage areas below ground level.

American Cockroach. American cockroaches usually inhabit basements, storage rooms, garbage areas, and sewers. These places are slightly cooler than the habitats of the German cockroach, and the cracks and crevices to hide in are larger.

In food processing plants, the American cockroach usually infests large storage areas (below ground level), loading docks, and basements.

Oriental Cockroach. The preferred habitat of the Oriental cockroach is similar to that of the American cockroach. They usually inhabit areas below ground level, such as basements, storage areas, sewers, etc. In food processing plants, they are common in below-ground storage areas.

Control. Cockroaches are a year-round pest in seafood processing plants. Therefore, control of these pests has to be a year-round project, and it has to be in the form of sanitation and the use of chemicals.

The first step and most important aspect of control is **sanitation.** Recognizing that cockroaches require food, water, and a hiding place, and moving against these areas with an on-going sanitation program, is the foundation of cockroach control. Chemical control has to follow sanitation; it cannot be used alone or in place of sanitation.

Most supervisors and managers in the food processing industry understand their role in controlling cockroaches through sanitation, and work hard in this regard.

FLIES

FLIES

The most common seasonal pest of food processing plants is flies. A variety of flies may be associated with these plants, but the most common are the house fly and the fruit fly.

House Fly. This insect is found all over the world. It is a pest to all segments of the community—from households to industry. Like cockroaches, house flies can and do spread pathogenic organisms to man and his food. It has been estimated that a single fly can carry 3,680,000 bacteria. The pathogenic organisms are collected on the feet and mouthparts when the fly visits garbage, and some of the organisms are taken into the gut. The organisms are deposited when the fly crawls on human food, or they are deposited in the fly excrement.

Control. Since house flies probably breed away from the plant site and fly to the site, there is little hope of controlling the size of the fly population outside the plant. Control must be aimed at (1) preventing entrance to the plant, and (2) reducing the number inside the plant.

Most food processing plants use wind screens and appropriate doors. These are excellent mechanical controls for flies, if they are strong enough. The stronger the better.

Control inside the plant can be achieved with electric fly traps. These work by

attracting the adult flies to a special blue light and killing them with an electrical grid. These traps should be run day and night, and the catch basin should be cleaned out every day.

Fruit Flies. These tiny flies are also seasonal pests, being most abundant in the late summer and fall. The adults are small, about 1/10" long, with light brown bodies and red eyes. The adults are attracted to fruit, especially rotting fruit, and to seafood processing operations and refuse piles.

The life cycle and feeding habits of fruit flies are similar to those of house flies. In the late summer the abundance of rotting plants and fruit allows the fruit fly population to increase rapidly. The adult flies live about a month.

Control. Complete control of these pests, like most insect pests, is nearly impossible. Wind screens and electric traps may be somewhat effective. Removal of all attractive material (rotting fruit, fermenting foods) will help.

FLOUR MOTHS

Flour moths are among the most common insect pests of grain products. They are called flour moths because they prefer products such as flour and meal. Flour moths can infest breading used with some seafoods.

Flour moths and other insect pests of grain products are present throughout the food manufacturing and distribution scheme—at the mill, in warehouses, in delivery trucks, and at their final destination. Therefore, these insects are likely to be a constant problem and will need constant attention.

Adult moths do not feed and return to the flour only to lay eggs. The infestation and damage to the flour is done by the caterpillar.

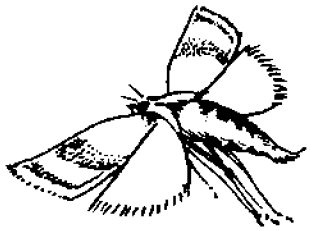
Indian Meal Moth. When full grown, the Indian meal moth caterpillar is about half an inch long and is grayish white, sometimes varying to greenish and pinkish colors. The caterpillar spins a web as it becomes fully grown and leaves a silken thread behind wherever it crawls. This webbing is often dense enough to be noticed when sacks of flour or meal have become heavily infested.

During warm weather, the Indian meal moth may pass through the egg, larval, and pupal stages in 6-8 weeks.

Mediterranean Flour Moth. The female moth lays small white eggs in accumulations of flour and meal. The caterpillars feed on flour and meal. The full-grown caterpillar spins a silken cocoon, in which it transforms into a reddish-brown pupa.

During warm weather, the Mediterranean flour moth requires 8-9 weeks to pass through the egg, larval, and pupal stages.

MOTHS



USE OF PESTICIDES IN SEAFOOD PROCESSING PLANTS

Supervisory personnel should have a basic knowledge of the federal regulations and pesticides used in controlling birds, insects, and rodents in seafood processing plants.

To understand the regulations involving the use of pesticides in food processing plants, we must begin by defining some terms.

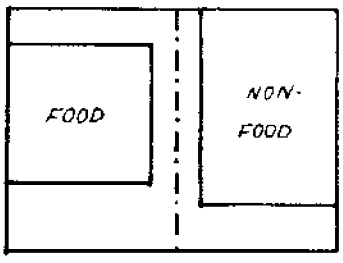
Food is defined by Section 201 (F) of the Federal Food, Drug, and Cosmetic Act to mean (1) articles used for food or drink for man and animals, (2) chewing gum, and (3) articles used for components of any such article.

A Food Handling Establishment is an area or place other than a private residence in which food is held, processed, prepared, and/or served.

Non-Food Areas of food handling establishments include garbage rooms, lavatories, floor drains (to sewers), entrances and vestibules, offices, locker rooms, machine rooms, boiler rooms, garages, mop closets, and storage areas (after packing, canning, or bottling).

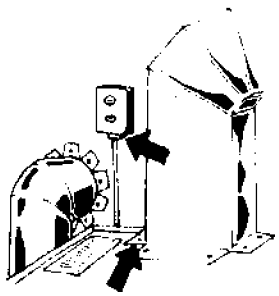
Food Areas of food handling establishments include areas for receiving, serving, storing (dry, cold, frozen, raw), packaging (canning, bottling, wrapping, boxing),

FOOD AREA



SPOT TREATMENT

CRACK and CREVICE



BAITS

preparing (cleaning, slicing, cooking, grinding), storing edible wastes, and closed processing systems (mills, dairies).

INSECTICIDES

Residual insecticides are those products applied to obtain insecticidal effects lasting several hours or longer and are applied as general, spot, or crack and crevice treatments. Since only certain residual insecticides may now be used in food areas, extreme care in application must be taken to avoid contamination of food, utensils, or the surfaces ordinarily contacted by the workers.

The types of residual insecticide applications include:

General treatment is application to broad expanses of surfaces such as walls, floors, and ceilings, or as an outside treatment.

Spot treatment is application to limited areas in which insects are likely to occur but which will not be in contact with food or utensils and will not ordinarily be contacted by workers. These areas may occur on floors, walls, and bases or undersides of equipment. For this purpose, a "spot" will not exceed two square feet.

Crack and crevice treatment is the application of small amounts of insecticides into cracks and crevices in which insects hide or through which they enter the building. It does not permit treatment of surfaces. Such openings commonly occur at expansion joints, between different elements of construction, and between equipment and floors. These openings may lead to voids such as hollow walls or equipment legs and bases. Applications to conduits, motor housings, and junction or switch boxes should be made using dusts to avoid possible shock hazard.

Non-residual insecticides are those products applied to obtain insecticidal effects only during the time of treatment and are applied either as space or contact treatments.

The types of non-residual insecticide applications include:

Space treatment is the dispersal of insecticides into the air by foggers, misters, aerosol devices, or vapor dispensers for control of flying insects and exposed crawling insects.

Contact treatment is the application of a wet spray for immediate insecticidal effect. "Contact" means hitting the pest. If there is not the likelihood of actually striking the pest to be controlled, the spray should not be used.

To summarize the knowledge supervisory personnel should have regarding the use of insecticides in or around their plant:

- The insecticides used are either "residual" or "non-residual," but residuals are the most common (and the most regulated).
- Residual insecticides can be applied only as crack and crevice and/or spot treatments in food areas.
- Care should be taken to avoid spattering or "drift" of the insecticide out of the treatment area to adjacent surfaces or onto food.
- The supervisor should know the chemical and trade names of all insecticides used in the plant, when a different chemical is used, and when the application is made.

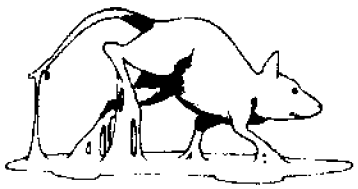
RODENTICIDES

Rodent baits shall not be placed in edible-product processing departments until operations have been ended for the day. Strict account must be kept of the location and number of baits set out. All uneaten baits must be gathered up and destroyed before operations are begun the next day. Baits shall not be placed in dry salt cellars. They may be placed in other departments containing enclosed meats, but care must be taken that they are so placed as to prevent contamination of the meat. All baits must be stored in a separate place designated by the inspector in charge at the plant.

Baits consisting of Warfarin, red squill, or ANTU (alphanaphthyl-thiourea) and inert ingredients may be left in rooms containing exposed meat provided that the

layout and conditions of the baiting are approved by the inspector in charge at the plant.

Baits consisting of 2-pivalyl-1, 3-indandione (Pival, Pivalyn); 2-isovaleryl-1, 2-indandione (PMP, Valone); chlorophacinone (Rozol); diphacinone (Diphacin); Prolin; DLP 787 (Vacor); Fumarin or Fumarol; or ZP (Zinc Phosphide) and inert ingredients may be used only under circumstances which absolutely assure no contact with food products.



Baits in which the inert ingredients consist mainly of cereal or other vegetable meals or flours must be colored blue or green. Where inert ingredients consist mainly of whole or cracked grain, or are presented as pellets, nuggets, or blocks, no addition of color is necessary.

Tracking powders consisting of the active ingredients listed in the paragraphs above and inert ingredients colored a definite blue or green may be used in departments having a dry cleanup, provided that there are no exposed food products present. Such powders shall not be used in a manner which will create a nuisance. Some may have to be placed in tamper-proof bait boxes.

Sticky boards may be used in departments having a wet or dry cleanup, provided that there are no exposed food products present and they are placed after the cleanup. Such boards should not be used in a manner which will create a nuisance.

PERSONNEL TRAINING, EQUIPMENT & STORAGE

Seafood processing plants that have an "in-house" pest control program must consider the aspects of personnel training, pesticide application equipment, and pesticide storage.

Personnel Training

The application of pesticides in and around food preparation, processing, and storage areas requires knowledge of and respect for the chemicals, the pests, and the regulations governing their use. The personnel responsible for pest control should be well trained in the proper use of pesticides, pest identification and biology, and safety. Pest control personnel should receive continued training to keep pace with changes in state and federal regulations, new pesticides, and application equipment.

Certified or licensed pesticide applicator. To apply some insecticides and most rodenticides, pest control personnel or their supervisor must be certified or licensed pesticide applicators in the state. To be certified or licensed, you must attend a training session (usually provided by the Cooperative Extension Service), earn a passing score on one or two written examinations, and demonstrate financial responsibility to the lead agency in the state (usually the Department of Agriculture). An initial and a yearly fee is usually required to maintain state certification. Most states require attendance at approved training sessions to maintain certification status.

Application Equipment

Effective pest control can only be accomplished with professional equipment. The most common piece of equipment is the compressed air sprayer. Only a few companies manufacture sprayers suitable for the long-term use and accuracy needed for industrial pest control. These sprayers usually have no-drip, variable nozzle openings, crack and crevice applicators, and other features.

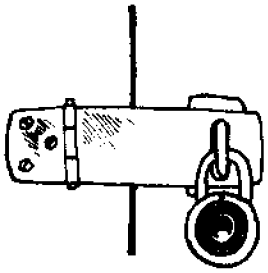
Pesticide Storage

STORAGE

All pesticides (insecticides, rodenticides, herbicides) cannot be stored under the same conditions. Each must be stored as specified on its label if it is to remain useful when removed from storage for use.

The shelf life of a pesticide is dependent on several factors:

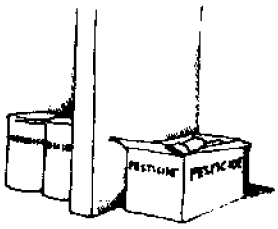
(1) storage conditions,
(2) the type of formulation,
(3) the kinds of inert ingredients present, and



(4) the nature and stability of the chemical itself.

Most pesticides can be stored for periods of 6 months to 1 year if the proper facilities are available. However, before storing any chemical, read the label. If you still have any questions, contact the manufacturer or supplier. Under normal conditions, the following rules apply for the storage of pesticides.

- **All Pesticides Should Be Kept in a Well Ventilated, Dry Place.** Also, keep chemicals in the dark, because some are decomposed by prolonged exposure to sunlight (especially when they are in glass containers).
- **Keep Different Chemicals Separated.** Herbicides, fertilizers, fungicides, and insecticides should, if possible, be stored in separate compartments with no air exchange between them.
- **Always Keep Chemicals in Their Original Containers** when possible. If the original container is damaged, use a substitute of similar composition and transfer the label to the new container. Glass, plastic, and paper are the best storage materials, because many pesticides will corrode metal. If a container is opened (especially a paper container), it should be closed tightly and then placed in a clear plastic bag for added protection and safety. Clear plastic bags allow for easy identification of the contents without opening the bag.



- The floors and exterior walls are usually the dampest places in a room. Therefore, keep powdered, granular, and dust formulations, and all chemicals in paper containers, away from such surfaces, where moisture may condense.
- Keep an up-to-date inventory of all pesticides and use the older materials first.
- When buying pesticides, try to limit amounts purchased to what will be used in 6 months to 1 year. Do not store (or use) pesticides longer than 2 years under any conditions. Most manufacturers will not warrant them if they are held longer.

PROFESSIONAL PEST CONTROL SERVICE

Professional pest control operators have the combination of skill, experience, training, proper chemicals and equipment, and insurance necessary to do an efficient job of controlling pests. However, most food operations do not utilize these professionals, or become dissatisfied with the service rendered and discontinue their contracts. Perhaps part of the problem has been the professional selected for the job, or the manner in which the manager worked with the pest control operator.

PEST CONTROL SERVICE

Selection of Pest Control Operator. The first step is knowing exactly what you want. *You* should specify the areas to be sprayed, when, how often, and (when possible) with what. You should deal from a position of knowledge of your operation and the pest problems you have. Do not simply throw open the doors of the plant and ask the professional service to "do whatever is necessary."

Consider *both* the large pest control company (state or national offices) and small local companies. Be sure that the company is a member of the National Pest Control Association.

Make it very clear that your quality control or sanitation manager will work very closely with the serviceman who treats the operation. Therefore, you should request that the same person do all the treating on a regular schedule.

Working with a Pest Control Operator. A professional pest control operator cannot solve your pest problems without your help! You will get the most out of the control program you are paying for if you'll work with the serviceman when he treats. Here are some suggestions.

1. Ask that the serviceman always check in with the manager before he begins treating. Someone in a leadership or management position should meet with the serviceman, and accompany him as he treats the plant. Ask what chemicals he will use. "Too much trouble"? "A waste of your time"? Consider this:
   - The application of pesticides in and around food preparation, processing, and storage areas requires knowledge and respect of the chemicals and the regulations governing their use.

- You should know exactly what is being done in your operation.
- By your demonstration that someone from management is interested in what is being done, the serviceman will be prepared to do a thorough job.
- You'll demonstrate to the employees that you are interested and that you participate in the pest control program of the plant. You'll set a good example.

2. Ask that employees report any and all pest problems. If cockroaches are sighted in a corner, in a room, in a locker, around a machine—these should be noted. Have this list ready when the serviceman arrives, and, as you walk through the plant, visit each of these locations and the person who reported the problem. In this way you'll be spraying where the pests are (if possible), or at least trying to figure out where they're coming from. You'll also be acknowledging the efforts of the employees who reported the problems.

Now, let's see what you'll get for about an hour's worth of time every month.

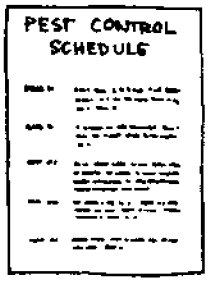
- You know what chemical was applied where in your operation.
- You demonstrate to your employees that their reports on pests are followed up, and that you are interested in pest control.
- The pest control serviceman knows that this is an "all business" stop, and he'll have to be on his toes.
- You get your money's worth of pest control services.

If there are any problems with the service or the serviceman, you should call the pest control company and report them. If the serviceman does a thorough, professional job, you should report that to his boss also.

IN-HOUSE PEST CONTROL PROGRAM

The application of pesticides in and around food processing operations requires a knowledge of and respect for the chemicals, the pests, and the regulations regarding their proper use and disposal. In addition, the person(s) assigned this responsibility should have basic and continuing training in the area of pest control. Guidelines for an in-house pest control program are presented below.

Leadership. The pest control program should be under the direction of the sanitation or quality control manager. All records regarding chemicals used, the time and location of their use, and the personnel involved should be maintained at this level of management. The sanitation and quality control manager should be fully aware of the in-house pest control program.



Personnel. In most food processing operations one or two employees can adequately handle the pest control program. Spreading the responsibility among several employees may lessen the importance and respect you have built into the job. Other suggestions include:

- Only the employees assigned to pest control should do the work--no substitutions.
- If two persons are assigned to pest control, they should work together, on the same schedule (e.g., not alternate areas or time between them).
- Employees should be selected on the basis of reliability, honesty, experience, and ability to work with others.

Program. The manager and the employees assigned to pest control should form a team and demonstrate teamwork. The team should establish a pest control program that includes chemicals, equipment, and a schedule of time and location of spraying. The spray schedule should be followed very closely, with any changes (regardless of how slight) reported and recorded.

The program should have input from other managers and employees throughout the operation. Everyone should understand that a successful pest control program involves *sanitation first*, and *chemical control second*. The pest control team should report sanitation problems to the quality control or sanitation manager. Employees should report pest problems to the pest control team.

Equipment and Chemicals. The pest control program designed can be only as good as the people and equipment used to carry it out. The pest control industry has developed some very specific and very effective spraying and fogging devices. Some of the materials basic to a pest control program include:

- one or two stainless steel spray cans equipped with multi-jet nozzles;
- one or two hand dusters;
- rubber gloves and apron;
- flashlights.

The pesticide chemicals available for use in food processing operations change from year to year. It is very important, though difficult, to be fully aware of the new materials and the changes in the labels of previously-approved materials. Some assurance that you are using the most effective material (and method) is to buy your equipment and chemicals from a supplier that works with the pest control industry in the area.

COMMONLY USED INSECTICIDES & RODENTICIDES

Insecticides. A variety of insecticides are registered for use in and around food processing operations. They differ in residual activity and in where they can be applied (crack and crevice, food storage, food preparation areas).

BAYGON (propoxur) - A carbamate insecticide; characterized by fast knockdown, long residual, and flushing effect. For use as a crack and crevice spray in food and non-food areas. Particularly effective against insects such as cockroaches and flies where rapid knockdown and residual properties are important.

BAYTEX (fenthion) - An organophosphate insecticide; characterized by long residual activity. For general use as a residual insecticide in crack and crevice application indoors and general treatment outdoors for a wide variety of pests.

BORIC ACID - A common household or medicine cabinet item that can be used as an insecticide, primarily for the control of cockroaches. Applied as a dry, light dust, boric acid has residual activity. It can be used as a crack and crevice treatment, but must be kept dry to be effective.

CYGON (dimethoate) - An organophosphate insecticide; used as a residual spray for controlling houseflies and other insects. For treating the outside of buildings.

DIAZINON (diazinon) - An organophosphate insecticide; used extensively in controlling a variety of insects, particularly cockroaches. Can be used as a crack and crevice spray in food and non-food areas. Characterized by a long residual effect and broad-spectrum control of insects indoors and outdoors. Available in dust, emulsifiable concentrate, and encapsulated formulations.

DURSBAN (chloropyrifos) - An organophosphate insecticide; effective in controlling a variety of insects. Particularly effective against insects such as cockroaches where residual activity is necessary. Can be used in crack and crevice treatment of food areas and general treatment outdoors.

DDVP (dichlorvos) - An organophosphate insecticide. A contact and stomach poison, it acts also as a fumigant. Can be applied as a crack and crevice and general spray to both food and non-food areas. Effective against a wide range of insects. Available formulations include: emulsifiable concentrations, wettable powder, oil-base concentrates, aerosols, resin strips, and baits.

FICAM (bendiocarb) - A carbamate insecticide. A contact and stomach insecticide, it has no fumigant action at normal working temperatures and is characterized as a non-repellent/non-flushing, odorless, and non-staining insecticide. Effective against a wide range of insects, it can be applied as a crack and crevice and general spray to both food and non-food areas. Available formulations include a wettable powder and a dust.

KNOX OUT (diazinon) - An organophosphate insecticide in which diazinon is enclosed in tiny capsules (or beads) of thin plastic material to control release of the chemical and extend the residual life. Can be used in non-food areas. Effective against a wide range of insects.

KILLMASTER (chlorpyrifos) - An organophosphate insecticide in which chlorpyrifos is held in an organic solvent or binder and released a little at a time at the top surface of the coating. Applications can be made as a paint-on treatment (spot) and/or crack and crevice treatment.

MALATHION (malathion) - An organophosphate insecticide, characterized by its broad spectrum control and its low toxicity to mammals. Can be applied as a crack and crevice and general spray to food areas and non-food areas. Cythion, one brand name for malathion, is a low-odor product manufactured by a patented process, and is recommended for indoor use.

PYRETHRINS - A botanical insecticide; the flowers of a chrysanthemum plant are the source of the active principles of this insecticide. Characterized by a flushing action and rapid knockdown of a wide range of insects. However, there is little residual activity. Pyrethrins have a low order of toxicity to mammals, and can be applied as a spray to both food areas and non-food areas.

PYRETHROIDS - Synthetic pyrethrin-like compounds produced to duplicate the activity of natural pyrethrins.

RESMETHRIN - A synthetic pyrethroid insecticide; characterized by flushing activity and a moderate residual life. Can be used as a spot spray in food and non-food areas. Can be applied to non-food areas and outside areas.

SEVIN (carbaryl) - A carbamate insecticide, characterized by short residual activity. Can be used as a spray in non-food areas. Can be applied only to non-food areas inside, and to outside areas.

Rodenticides. Rodenticides differ widely in their chemical nature, and in the hazard they present under practical conditions.

WARFARIN - An anticoagulent, effective in controlling rats and mice. Odorless and tasteless, effective in very low dosages. Action is not rapid: usually about a week is required before a reduction in the rodent population is effected. Warfarin has found ready acceptance since rodents do not tend to become bait shy after tasting the material. They continue to consume it until its anti-clotting properties have produced death through internal bleeding.

FUMARIN - An anticoagulant, effective in controlling rats and mice. Recommended as a multiple-dose rat poison. Three to five consecutive feedings, daily or not over two days apart, cause death by internal bleeding.

RED SQUILL - A rodenticide made from plant material. Specific for rats and non-toxic to other warm-blooded animals when used in recommended dosages. The specific toxicity to rats is due to their inability to vomit; the product induces vomiting in other animals. Red Squill is mixed in baits.

DIPHACIN, PIVAL - Anticoagulants that have the same anticoagulant properties as Warfarin, and have replaced Warfarin where rodent avoidance behavior (bait shyness) has made it ineffective. Sold as baits; must be ingested for several consecutive days before they become effective.

TALON - An anticoagulant, effective against a variety of pest rodents. Effective against rodents which are resistant to conventional anticoagulants. Only a single feeding is necessary for rodent death to occur.

This work was sponsored by the Office of Sea Grant, NOAA, U. S. Department of Commerce, under Grant #NA81AA-D-00025 and the Virginia Sea Grant Program through Project #A/AS-2. The U. S. Government is authorized to produce and distribute reprints for governmental purposes, notwithstanding any copyright that may appear hereon.