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STRUCTURAL INTEGRATED PEST MANAGEMENT: A SERVICE OF APPLIED FACILITIES ENGINEERING AND MANAGEMENT

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Abstract There has been a movement away from relying solely on pesticides to solve indoor pest problems in response to public concerns over pesticide use, pesticide resistance, and the possibility that pesticide applications may contaminate the environment. Pesticides regardless of rating as highly toxic or least toxic should not necessarily be the first choice for solving a pest problem. The new environmentally responsible approach to pest control with less reliance on pesticide use is known as integrated pest management (IPM), involves the safe prevention, reduction or elimination of unwanted organisms. It takes advantage of all pest management options such as biological, mechanical, cultural, or chemical. By combining multiple control measures versus relying on pesticide alone, IPM can reduce pesticide use and thus reduce the potential for harmful exposure to human health and the environment. Most pest control programs generally tend to be strongest in pest biology and pesticide technology. However, much of the specialized knowledge required for an effective IPM program can be more described as applied facilities engineering and management rather than applied biology.
Key Words Building design for pest management, pest management options

INTRODUCTION

Pest control operators and facilities managers or owners face tough challenges in solving pest problems around residential and commercial facilities that can create real or perceived risks. While facing with a challenge to provide a pest free environment, they also have to ensure a safety of human health and the environment. Traditionally, structural pest control consisted of the general application of one or more pesticides in indoor environments. However, there has been a movement away from relying solely on pesticides to solve pest problems in response to public concerns over pesticide use, pesticide resistance, and the possibility that pesticide applications may contaminate the environment. It is also important to recognize that pesticides regardless of rating as highly toxic or least toxic should not necessarily be the first choice for solving a pest problem.

The new environmentally responsible approach to urban pest control with less reliance on pesticide use is known as integrated pest management (IPM) in urban environment. Because of the complexities of the human and structural factors, pest management in urban environments requires a systems approach. It involves the safe prevention, reduction or elimination of unwanted organisms. It takes advantage of all pest management options such as biological, mechanical, cultural, or chemical. IPM can be viewed as a decision-making process in which observations (from inspection and monitoring) are used to make pest control decisions based on pre-determined management objectives. By combining multiple control measures versus relying on pesticide alone, IPM can reduce pesticide use and thus reduce the potential for harmful exposure to human health and the environment.

The pest management scientific community is catching up with producing information on various pest management options such as pest habitat manipulation, pest removal, use of low-impact pesticides, formulations and application methods (baiting, crack and crevice, spot treatment etc.). Even with this new approach, until now most of the pest control programs generally tend to be strongest in pest biology and pesticide technology. However, much of the specialized knowledge required for an effective IPM program

can be more accurately described as applied facilities engineering and management (pest exclusion) rather than applied biology.

Pests are dependent upon biotic factors to provide them nourishment and moisture and abiotic factors to provide them harborage and ingress into buildings. Pest habitat manipulation through sanitation, modified atmospheres and repellents, is critical component of urban IPM programs, But the question often asked is can habitat manipulation or management alone control pest? There is no one answer to this question. It can be the first approach in non-chemical pest management, providing total control of some pest situations. In other cases, it may not be the only answer, but it usually results in faster, more effective, and greater long term results, when complemented by building design that addresses all areas relative to pest management. Through steps taken proactively during building planning, design, construction, and commissioning, resources for pests can be minimized, making the building less susceptible to pest infestation during its functional life cycle. The shift is occurring in urban pest management away from the use of pesticide to solve pest problems. In part, this is why integrated pest management has caught the attention of general public. Many customers, government and private alike, have also started requesting the same from their service providers under the umbrella of Pest Control through principles of integrated pest management.

IPM AND APPLIED FACILITIES ENGINEERING AND MANAGEMENT

A successful IPM program requires a good working knowledge on importance of good facility design (building type, space type, design discipline, design objective, product and systems), construction (project planning, management and delivery) and facility operations and maintenance (sanitation, housekeeping and structural & equipment maintenance). The following elements offer specific design suggestions that can greatly contribute to a successful IPM program. The facility architects and engineers should incorporate these into the design as applicable: 1) Overall facility design and construction, including the materials and construction detailing and the equipment and construction processes used to build the facility: Facility components and layout should minimize points of pest ingress and harborage and optimize accessibility for cleaning, sanitation, and pest inspection. 2) Architectural Designs: Exterior architectural features, including the development of the facade and roofing design, must be evaluated with respect to their potential for the occurrence of pests. For example: recessed windows, ledges, flat roofs, roof edges, columns, and so on can provide roosting spots for birds; overhangs or sunshades can be nesting sites for wasps or birds; runoff from the roof can attract and support pests around the building exterior; entranceway overhangs can provide nesting sites for birds and stinging insects; uses of hollow metal construction materials, particularly in windows, are potential nesting sites for stinging insects; roof gardens or eating areas will attract pests; roof vents and air intakes can be points of ingress for birds and insects; facades that are recessed and wall-mounted lighting provide nesting sites for birds and stinging insects; elevated planters can become harborage for rodents and accumulate debris and food trash.

These issues can create problems that will have an impact on the use of the building and ongoing maintenance and will be expensive to correct once the building is completed.

Building integrity. Closing cracks, crevices, and voids; penetrations through floors, walls, and ceilings; surface protection; and treatment and finishes affect pest activity. Closing holes, gaps, and voids is important to long-term prevention of pests. The closing of wall, floor, and ceiling penetrations, with the appropriate sealant, must be designed into all projects and performed during construction. Wall-mounted equipment and fixtures must be sealed when installed. The intent of this sealing is twofold. First, to deny pests, particularly insects, points of ingress and harborage sites in the building; Rodents can be prevented from entering a building by performing thorough sealing of the building envelope. Mice can move through a hole 6 mm or larger, and rats can get through a space 12 mm or larger. Second, to help promote sanitation and housekeeping by making areas easier to routinely clean and minimize the extent that spills may soil or contaminate an area. Caulking and sealing must be applied to all components of a facility, including but not limited to the following elements: building envelope, plumbing, and electrical and the installation of equipment, furnishings, and amenities in the fitting out of the building. Caulking and sealing are not replacements for good design and construction. It is more desirable not to design and construct gaps, voids, and recesses than it is to seal them after construction. Extensive sealing will add to the long-term operation

and maintenance cost of a facility since sealants often must be removed and reapplied numerous times to maintain integrity over time.

Landscape design and management. The key to creating a sustainable landscape understands that the design process should be considered first. Plant selection, implementation, and maintenance build on the design process, each having sustainability as a major consideration. Costly and undesirable maintenance practices including pest control and the need for site modifications can be minimized or avoided by including maintenance considerations and the use of IPM throughout the planning and design phase of a landscape development project for a facility. Landscape planting, for both aesthetic and functional needs, can impact the number and types of pests found around the exterior of the building as well as within the building envelope. For example, dense ground covers such as ivy provide cover and harborage for rodent pests. Ornamental plants such as *Spirea* are attractive to certain beetle species that can become a pest indoors. Mulch can provide food for termites, and dense foundation plantings can reduce air circulation around buildings, harbor pests such as wasps, and obstruct pest management survey and control activities. Raised planters or garden beds can be nesting sites for rodents. An open perimeter boundary around the entire facility is recommended. This barrier should be wide enough to facilitate inspections around the building and should be constructed from materials that are durable, do not obstruct grass-cutting or maintenance activities, and prevent encroachment of grasses or weeds around the exterior of the building. Properly maintained and healthy landscape will tolerate the presence of low levels of pest populations without suffering permanent damage. Healthy landscape usually recovers more quickly from insect and disease infestations. Lighting on the site and building exterior: Lights are attractive to insects and to some vertebrates. The type and placement of lights around and in a facility can impact the occurrences of pests and nuisance incidental invaders indoors. Wherever possible, light fixtures should be designed away from the building, thereby attracting pests away from the building. Lights should not be placed directly over loading dock doors or personnel doors. Lights that are less attractive to insects, such as sodium vapor types, are recommended. The design of the light fixture and the installation of the fixture can provide pest harborage outside a building. Outdoor lights should be shielded so they cannot be seen by insects from above, and they should be directed toward the area they are to illuminate. Many high-flying insects are attracted to lights they see below. Overhead lights with a flat upper surface can provide a nesting or roosting site for birds. The power conduit for the lights must be designed so that it does not provide roosting or nesting sites for nuisance birds.

Air-intake and positive air pressure. It is important to consider air movement within the building. One method to consider is building double door entryways and adding positive air flow to further discourage insects from entering the building. Shipping and receiving areas, including the loading dock and storage facilities: The loading dock is the central point of activity in a building. Most goods and supplies enter or leave through this area. Solid waste is often containerized at the loading dock. According to the amount and duration of activity, the loading can be a point of pest ingress. Outside air can be pulled into negative buildings along with pests. The loading dock should be designed in a way to provide a buffer between the exterior and the interior of the building. Air screens, specialty doors, plastic strip doors, and electric insect light traps should be used to create a positive barrier to pests. The loading dock should be considered an extension of the building interior. The materials used to construct the dock should provide durability, ease of cleaning, pest exclusion, and accessibility for pest management services. In addition, the loading dock should have adequate space and lighting for proper marshalling, inspection, and cleaning of materials received and shipped from the building. The design component for loading docks should also consider keeping solid waste containers away from front of overhead doors and also segregating it from clean deliveries.

Personnel entry points. Building doors should be fitted with sweeps and seals that effectively exclude insect and rodent pests. Brush-type sweeps, along with bristle material that covers the entire perimeter of the door, are preferred. Doors must be durable and cleanable.

Solid waste management and removal. Management of solid waste and recyclables impacts building design and construction in three ways: 1) temporary storage of materials inside the building; 2) marshalling and disposing of waste materials through the building; 3) containment and removal of waste from outside the building. Any area designated to hold waste material must be durable, cleanable, and constructed to minimize gaps and voids since they obstruct cleaning efforts and can become a reservoir for spills, debris,

and pests. Solid waste containment equipment must be sited to minimize attraction of pests into the facility and to maximize cleaning and sanitation.

Housekeeping and sanitation. Proper sanitation is critical to effective pest management in all buildings. All buildings must be equipped with appropriately sized housekeeping closets located throughout the facility to adequately serve its needs. Appropriate construction materials help to promote cleaning and sanitation. Improper installation during the fitting-out phase of the building will create long-term obstacles to good sanitation and potentially foster rodent and insect infestation problems.

During construction. New structures or renovations are sometimes completed with rodents built into them because rodent control and sanitation were inadequate during construction. The goal should be to resolve sanitation and rodent problems on and around the work site prior, during and until completion of construction/demolition. The distance that the program should stretch must be tailored to the type of construction environment and the likelihood for rodent movement to and from the work site.

Staff support areas. Personnel/staff support areas, such as break rooms, kitchenettes, locker rooms, showers, conference facilities, cafeterias, and vending facilities, must all be designed and constructed to meet the rigorous use to which they will be subjected. Recommendations include: Use commercial-grade cabinetry in all break rooms and kitchenettes; Install lockers on legs. Do not install lockers on a void base, and if possible, do not recess lockers inside walls. Use open-wire lockers wherever feasible; Size kitchens properly for expected use. Use commercial-grade, National Sanitation Foundation-approved kitchen equipment, installed to maximize cleaning, and provide adequate ventilation; Do not recess trash or recycling containers inside cabinets or walls; Specify durable, highly cleanable finishes that can be sanitized with strong detergents and cleaning products in all vending areas; Lockers and locker rooms must be thoroughly caulked and sealed; Pay attention to the placement and design of outside eating areas for building occupants to minimize attraction of pests into the facility and facilitate waste removal. Sanitation and housekeeping are the primary issues in all personnel support areas. These areas receive extensive use, often 7 days per week. Areas not adequately designed can become cluttered and dirty, be a source of pests and odors, and present health and housekeeping problems. The use of proper materials can provide additional safeguards against pest problems.

Facility durability and sustainability. Over the life cycle of a facility, changes in the envelope, interior layout and equipment, and facility use and program changes have a direct influence on pest activity in and around a facility.

EXAMPLES OF APPLIED STRUCTURAL ENGINEERING AND MANAGEMENT

Effective utilization of IPM design, site modification and management practices reduces the need for pest control treatments, helping minimize pesticide use requirements and making resources available for other maintenance priorities. In turn, these benefits promote environmental quality and facilitate improvements in the aesthetic quality of the resource system. It also reduces the life-cycle maintenance costs of facility. The following case studies are examples of successful application of applied structural engineering and management in an urban environment.

Case Study 1

An office building had Chironomid midges (Diptera: Chironomidae) breeding in the flood channel running parallel to the back of the facility. These soft body insects were attracted to the building due to warmth around the security lights mounted on the exterior walls and also sucked in the HVAC system through the gaps between the air intake duct/vent filters. Midges have not been implicated in the transmission of disease; however, due to their large numbers, they become nuisance. However, the presence of their dead bodies (insect particles) in the air conditioning ducts or over drop ceilings in office environments as noted in this case was cause of concern, since Chironomids contains potent inhalant (human respiratory) allergens. Recommendations regarding altering exterior lighting system design, creating positive air flow and sealing the gaps between the air filters helped to resolve the problem.

Case Study 2
A newly constructed and occupied office building experienced sporadic mice activity throughout the facility. It was noted that during construction while installing electrical fixtures, construction crew failed to seal conduit openings leading to each computer terminal. This provided a runway for the rodents (mice) that spread very quickly throughout the facility. Recommendation with regard to sealing the conduit holes (exclusion) and intensive trapping helped to resolve the problem.

Case Study 3
A correctional facility experienced ongoing issue with birds (pigeons). Initially trapping and removal was used as primary method of control, however, population stress from the surrounding areas continued to re infest year after year. Recommendations with regard to the bird proofing the structure and relocating solid waste management away from the building helped to overcome this challenge.

Case Study 4
Three polyethylene film manufacturer one in Ontario, Canada, New York, USA and New Jersey, USA, had Chironmid midges (Diptera: Chironomidae) breeding in nearby water creek and swamps. These soft body insects were attracted to the building due to warmth around security lights mounted on the exterior walls and negative air pressure within the building, thus contaminating polyethylene film produced to wrap food and pharmaceuticals. Significant amount of shipments were rejected by the customers due to midges in the film. The pest control program as the time of discovery was using frequent ULV applications of pyrethrins to kill the adult midges as the water body could not be treated to control midges. Recommendations regarding facility engineering modifications — relocating all building exterior lights at least 100 feet away from the building, replacing fluorescent lights with low pressure sodium vapor lights, creating positive air flow within the building, and sealing all crack and crevices around exterior doors, windows and roof flashings, helped to resolve the problem.

Case Study 5
A bakery manufacturing plant in Montreal, Canada (part of a large North American Baking Company) built a new facility based on the engineering for food safety and sanitation recommendations as described by Timholte (1999), considering potential pests that could be an issue, namely rodents, cockroaches, and various stored product insect pests. This preventive design development had remarkable positive impact on pest management in this facility.

Case Study 6
A pet food retailer with 800 plus outlets in USA and Canada, successfully addressed pest management issues (rodent) through exclusion, spent approximately $300,000 to modify the store design to deny entry to pests.

Case Study 7
An upscale restaurant chain with 1000 plus locations in USA and Canada, successfully addressed flies (housefly, drain fly, fruit fly), roaches and rodents issues by creating a pest free task force team consisting of representatives from their pest control providers and others in building design and construction. The charter of this task force was to guide the restaurant management to take proactive approach in either remodeling older units or when constructing new units to ensure that the buildings are designed with specific design elements as discussed above.

CONCLUSION

Several of the precepts of IPM work in concert with facility sustainability. Designing a facility for long-term use aids in pest management since durability and stability of the facility infrastructure and systems make it less susceptible to pest ingress and infestation. Pest management and the pest management program function as part of the facility, providing specialized services designed for each area of application. Architects,

engineers, and project managers can improve the performance and quality of their buildings by following the guidance and recommendations provided by the pest control professionals. They should involve pest control professionals at early stages of planning facility design, renovation and maintenance.

In the commercial structural pest management arena it's rare to non-existing that pest management considerations are discussed at the design phase of the facility structure. Most of the time, a pest management service delivery company is challenged to design an effective pest management program under the existing building conditions. Often these buildings were originally constructed without any pest prevention designs considerations. Marriott (1999), Imholte (1999) and others have documented and discussed various designs for buildings that will prevent pest ingress.

The debate on use of low-impact or reduced risk pesticides replacing yesterday's conventional one will continue. Greener chemical choices of today will be questionable tomorrow. Besides emphasis on pest biology and pesticide technology, the focus of future urban pest management research requires a paradigm shift, developing convincing risk-benefit models — assigning a realistic value to the commodity or to the economic consequences of infestation and promoting structural pest management through facilities engineering and management.

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