FOREIGN MATERIAL CONTROL:

FOREIGN MATERIAL Foreign material of any kind can potentially introduce a physical hazard in a food product. These range from natural sources such as rocks, wood, or product components such as shells or bones, to processing components such as metal shavings, equipment parts, or glass pieces from packaging materials. Other potential foreign materials can also be introduced to the finished product at many stages throughout the production of the good such as broken light bulbs, operator contamination, or pest contamination (Manitoba Agriculture 2010). All of these hazards must be evaluated and controlled for each product when producing food. Various governments as well as customers have varying limits on what is identified as hazardous when referring to physical contaminants. In the United States the Food and Drug Administration (FDA) has set the limit as anything between 7mm to 25mm in length is considered hazardous (FDA 2005). Objects less than 7mm must be evaluated to determine if a hazard is present. This is especially important if the product is intended for a more susceptible or at-risk group. Larger items are generally not considered to be hazardous as a consumer would identify the item before eating or placing themselves at risk (Olsen 1998).All of these items that present a potential risk must have control in place to ensure that the final product is safe. Ensuring a product is safe from physical hazardous is generally completed by multiple steps throughout the production process with added attention at Critical Control Points. Various programs such as pest control programs, good manufacturing programs, foreign material control, receiving and material control programs, and various other programs help lay the foundation for ensuring no physical contamination occurs (Schmidt and Rodrick 2003). Along the process flow depending on the nature of the product, basic technologies are implemented to remove physical contaminants. Often times these include screening or sifting of dried materials, filtering of liquid components, and washing or cleaning of solid materials. These methods are some of the most basic methods but are often very effective and cost efficient methods for controlling foreign materials. To add additional levels of foreign material control; magnets, metal detectors, X-Ray detectors, and new technologies are being implemented to identify and remove foreign materials from food products.

Process Controls During the production of food materials there are many potential steps or inherent methods that can be implemented to control foreign material. These will depend greatly on the product being produced but the wide range of process controls can be customized to effectively control some of the risks of most processes. Some processes can utilize a wash or spray step to remove foreign materials from certain produce, ingredients, or other products. This basic step can remove many items from the fields or extraneous material as products or ingredients enter a food process. These washes can also be useful in removing bacterial cells or other microbial concerns. This simple method can be effective in removing many quality and safety concerns but must be properly managed as these wash waters can quickly become contaminated and become a source of foodborne pathogens (Luo 2007).

Filtering and Screening As some products cannot support a wash step other physical separation methods such as screening or filtration can be used to remove the foreign material. These screens can separate solid foreign materials from liquid products or separate solid items based on size. Some systems require mechanical agitation or movement to allow for more effective product flow but the basic method is creating a physical barrier that removes as much foreign material as possible (Motarjemi and Lelieveld 2013) The designs of these systems must take known hazards into account as well as production speed to create the most effective parameters to reduce risk as well as allow effective operation. The advantage of these systems is the low costs and high effectiveness. Like the wash steps though, these separation methods must be adequately maintained and be part of effective food safety systems to ensure they do not become a source of contamination. These screens or filters will wear and break eventually and must be inspected and replaced before they become a source of

contamination and introduce metal themselves into the system (Motarjemi and Lelieveld 2013). These systems are effective in removing many hazards and foreign materials but can still fail, create contamination, and cannot stop downstream contamination. For these reasons additional steps may be needed for even further control of foreign materials.

Physical contaminants: in food processing and manufacturing plants can pose serious health hazards to consumers. Common physical contaminants include metal, stainless steel, glass, plastic, wood, stone, and natural fragments such as bone, seeds and pits. If accidentally ingested, these contaminants could cause dental damage, laceration of the mouth or throat, laceration or perforation of the intestine, and other serious injuries. Contaminated food products could cost millions in wasted product, recalls, lawsuits, and loss of sales due to damaged reputation. Fortunately, there are many cost-effective foreign material control solutions for food manufacturers to use for detecting and removing physical contaminants from food products. These approaches can include:

Magnets

Sieves and screens

Metal detectors

X-ray machines

Magnets

Industrial-strength magnets are one of the oldest and simplest methods for removing metal foreign material from food products. Magnets are particularly effective in facilities that have a high risk of ferrous and non-ferrous metal contaminants. Stainless steel is often non-magnetic, depending on the quality and type of material used to manufacture it, so magnets are not a good solution in facilities where stainless steel is a contamination risk.

Magnets will remove ferrous and nonferrous metals. They can also be used to protect processing equipment downstream of where the magnets are located. This is why they are often used in juice and beverage processing operations. The magnets will attract the piece of metal, preventing it from potentially damaging a filler and causing costly repairs and downtime. And magnets can enhance product quality. The advantage of magnets is that they will remove very, very small pieces of metal, such as rust particles, whereas metal detectors and X-ray machines have a finite detectability. Two kinds of magnets are used in food processing: ferrous magnets and rare-earth magnets. Rare-earth magnets are the stronger and more effective of the two types of magnets. They can remove fine metal dust and work-hardened or braided stainless steel.

There is also a range of formats that allows magnets to be used in different processing systems. These include grate, tube, plate, liquid line, pneumatic, chute, pipe and drum magnets. Each of these different magnets has different applications and different product uses. Processors who do dry blending often install grate magnets where bags are dumped to remove metals at the start of the process. Processors of dried fruit install plate magnets immediately before filling to remove metal dust, specifically rust.

Magnets must be inspected and tested on a regular schedule. If they are used as a Critical Control Point (CCP), they should also be validated. Most processors will mandate that in-line magnets be inspected and cleaned at least once a day. As part of this process, they often have the people performing these activities collect what is on the magnet and save it for future evaluation by the quality staff.

Magnets should also be tested on a regular schedule to ensure that they are performing properly. How often this is done depends upon individual companies. Equipment manufacturers recommend that this be done at least once a year, but companies should conduct a risk assessment to establish a schedule for their own operations. Pull testing repeatedly measures the holding strength in ounces of force or pounds at a predetermined distance from the surface or on the surface of the magnet itself. This may be done by the equipment manufacturer or in-house. It is not a hard test to learn how to do. Finally, magnets should be validated to ensure that they remove the metals being targeted. I have seen processors do this by passing product spiked with a known number of metal pieces. They would then look at the magnet to verify that the metal was on the magnet.

Another method of physical foreign material removal is the removal of ferrous metal through the use of various types of magnets. Magnets are the most basic level of metal removal used in the food industry. Often these are used to help protect machinery and help identify any downstream equipment failure (Stier 2017). These magnets vary in composition including; ceramic for general least expensive uses, Alnico magnets which are useful in high temperature processes that can exceed 400°F, and rare earth magnets which are the strongest and most effective but can vary effectiveness at extreme temperature (Wilks 2006). Magnets can remove ferrous materials and rare-earth magnets can also remove magnetic stainless metals as well as weakly magnetic materials. Magnets can also be used and safety control points downstream to remove metal prior to packaging. The advantage of using magnets as a metal removal option is that they can remove many particles, including metal dust and pieces too small for identification by other methods, with very little maintenance, cost, or product loss (Wilks 2006). One of the major disadvantages of magnets is that they can only remove magnetic materials. Other metals, such as aluminum, various stainless steels, and any other non-magnetic metal will not be removed from the product flow. To address these hazards additional control points must be used to ensure product safety (Wilks 2006).

Optical Sorters

Optical sorters and laser sorters are another process control that is commonly used to remove foreign materials or items that do not meet quality parameters from the product stream. These cameras or lasers can detect a multitude of surface level characteristics including color, shape, moisture, and even biological characteristics can be distinguished. Once these differences are identified an air jet or mechanical device can remove the nonconforming material from the surface flow (Motarjemi and Lelieveld 2013). Some studies have shown the ability to use these sorters as an effective measure for foreign material control as part of a HACCP program while also improving product quality through removal of discolored, damaged, and misshaped seeds. This can be even more advantageous for areas with limited resources where additional control measures would not be as affordable (Bayram and Oner 2006).

Sieves and Screens

Screens are flat panels made of wire mesh that filter foreign material from liquid products. Sieves are machines that shake dry ingredients, such as flour or spices, through one or more screens. Since screens and sieves don’t rely on magnetism, they can filter out any kind of contaminant, including metal, glass, wood, and others.

Metal Detectors

can be placed over conveyer belts, pipelines, and other areas where product is present. These devices generate an electromagnetic field, and whenever a metal object passes under it, the object disturbs the field and generates a signal. Metal detectors are highly effective at detecting both ferrous and non-ferrous metals but cannot detect all types and grades of stainless steel. Metal detectors can't detect glass, wood, plastic, or other non-metal contaminants.

Metal detectors are designed to detect all metal in food products above a certain size. The size of metal that is detectable depends upon the product and the package it is in. There are different types of metal detectors available to the food industry, including systems that pass the products through on a conveyor, in-line systems for liquids and vertical inspection systems. Metal detectors are almost always designed to reject product found to contain metal, although there are occasional units in which the product conveyor simply stops. Ideally, the best location for a metal detector is after packaging, which is why conveyor systems are so popular. If metal is detected, the package will be rejected. Of course, if the package itself contains metal (common with packages made from recycled materials), the processor might want to consider adding another metal detector to scan the packages themselves prior to adding the food product. This is, however, an expensive option.

Processors should work with the equipment manufacturer to establish minimum detection limits for the standards used with the unit. A processor might demand that their suppliers pass all products through a metal detector that can detect the following standards: 1.0 mm ferrous, 1.5 mm nonferrous and 2.0 mm stainless steel. If the processor is manufacturing hot dogs in a vacuum package, the customer demands can probably be met. However, if the goal is to pass 20-pound boxes of frozen entrees through the unit, that detection limit will probably be impossible. Processors should obtain a letter from their equipment manufacturer defining the minimum detection limits for the unit. Based on this letter, the processor should obtain the necessary standards from the equipment manufacturer, that is, a ferrous, nonferrous and stainless steel standard. For stainless steel standards, make sure that the type of stainless in the standard reflects the primary type of stainless in your plant and equipment. Processors must also decide, based on risk, how often they should test their metal detectors using these standards. At a minimum, each standard should be tested at the start and end of a product run with one test during the middle of the run. In reality, most operations will conduct these tests more frequently. Many operators write their procedures so that testing is at the minimum level noted above, but in actual operations will test every 1 to 2 hours. Why? Because no auditor will downgrade an operation for exceeding testing levels.

There is an ongoing debate as to how a company's metal detector should be incorporated into the organization's food quality and safety programs. Some companies have determined that metal detection should be a CCP in their Hazard Analysis and Critical Control Points (HACCP) plan, whereas others deem it part of quality management (prerequisite program). If the manufactured products are chopped or ground, and the company's Hazard Analysis determines that there is a significant potential for metal contamination, the company will probably adopt the former. However, if a processor is producing purées or juices, it might install an in-line metal detection unit not only to look for metal but also to protect equipment that is located downstream of the unit. Of course, there are processors that base this decision not on risk but on customer demands. If a processor's primary customer demands that metal detection be a CCP, they will usually comply.

To address nonmagnetic metal hazards, many facilities implement metal detectors for removal of hazardous non-magnetic and magnetic metal foreign materials as well as a final check of packaged product to verify product safety. Metal detection was first documented in the early 1800's to protect a Chinese emperor but may have been more similar to a strong magnetic doorway. Electronic metal detection was used to identify a bullet that was lodged in President Garfield in 1881. The technology advanced greatly following World War II due to the need to locate landmines that were left

undetonated. Advances to these machines have continued as the advancements in electronics, computers, and sensors have also advanced (Nelson 2004). Metal detectors have advanced greatly in their abilities to detect metal and to do so with high efficiency. The basic operation occurs by one of two methods; by a balanced coil system using electromagnetic induction or magnetic field systems. In basic balanced coil systems, there are three coils, one transmitting coil and two receiving coils. When an item is placed through the transmitting coil and contains metal, the metal will disrupt the magnetic field that is created by the transmitting coil. The detectors can identify changes in the amplitude and phase of the current caused by metal enters the detection field (Yamazaki 2002) This causes the metal detector to trip and remove the metal from the product flow .These systems can be limited in detection capabilities due to the material that is being tested and the type of metal that is targeted. Materials that have higher conductivity levels, usually due to salt or moisture, can be more difficult to identify metal using balanced coil systems. Magnetic field detectors have a strong magnetic field that can identify magnetic metal inside of aluminum cans and is used solely for identifying metal inside of already sealed cans (Graves and Batchelor 1998). These processes expand on the abilities of magnets to detect additional types of metal and the ability to test post canning. These basic detectors are common in the food industry and industrial versions continually advance to try and improve the level of detection (size of metal identified), accuracy (percentage of metal removed), and speed all while trying to do so in the most cost effective manner and reducing the amount of false trips and product loss (Choi 2014). Other aspects of metal detection improvements include; operation in various environmental conditions such as heat, vibration, and moisture and the reduction of cross signal effect from machinery or communication equipment (Ries 2017). One way that metal detection is being researched is to increase the number of transmitters and detectors within the unit. One method that is being researched is to use multiple transmittance frequencies with two perpendicular coil sets to increase the range of size detection with the additional frequencies while also improving the accuracy by expanding the detection angles with the extra set of coils. These methods were shown to be effective in some cases by cross signal noise and interference from the two coils which did cause some difficulties. (Choi 2014). Newer methods looked at increasing the number of frequencies without adding additional coils. This multiscan technology can run five frequencies simultaneously greatly increasing the level of detection, in some cases metal pieces as much as 70% smaller in size. The multiple frequencies help overcome the influence that the metals orientation and composition have on its detection. By reducing this influence the number of missed metal fragments could be greatly reduced (Ries 2017). If metal is the only hazard or quality concern present for a facility, these me may be effective in controlling a facilities risks. However, if a process has other inherent risks or a facility wishes to identify other nonmagnetic foreign materials, additional or alternative methods must be implemented to ensure product safety and quality.

X-Ray Machines

X-ray machines are particularly useful in facilities that have a high risk of multiple types of contamination. X-ray machines can detect most types of foreign materials, including metals, stainless steel, wood, glass, plastic, and natural contaminants. These machines are well-suited to check final packaged products because they can also detect if a package is not properly filled.

As noted earlier, there is a push within the industry to have their suppliers move from metal detectors to X-ray machines. X-ray technology has improved immeasurably in the last few years. Systems are faster, more versatile and can detect more than just metal. The same principles that were mentioned for metal detectors apply for X-ray systems. Work with the equipment manufacturer to determine optimum detectability and selection of standards; conduct tests to validate the system, especially if the X-ray system will be deemed a CCP; and examine what is rejected by the machine. And finally, work with the supplier to set up the machine for each product that will be run on the line.

X-ray machines can detect metal, glass, stones, calcified bone and some plastics. Depending upon the product and the material, they may be able to detect other materials. Note that one of the materials that X-ray machines can detect is calcified bone. Utilizing an X-ray system on chicken may not be as effective as one would think, because many birds are slaughtered before their bones have fully calcified.

X-Rays use shortwave lengths they can easily penetrate packaging materials and thus allow for the detection of foreign materials in packaged products. These detectors use high powered energy sources and various imaging systems to produce images of the material and identify foreign materials in packaged materials. In general a high-powered energy source passes the X-ray through the product. The photons are absorbed by various detectors, depending on the machine, resulting in an image of the foreign material. Some pass multiple wavelength or energy levels through multiple detectors to improve the resolution and identification of foreign material in various food medias (Haff and Toyofuku 2008). The ability of these X-ray devices to differentiate even small differences between food and foreign material has been shown detection of metal more effectively and detection of smaller metal pieces than metal detectors. Furthermore, X-rays can detect and identify bones, plastic, glass, and other foreign materials (Haff and Toyofuku 2008). One key aspect of these detectors is relatively efficient processing speed, which allows them to be effective in industrial settings. X-rays have been shown to detect insect infestation and presence in grain and various produce. At this time, this method has not been shown to be industrially feasible due to volume of product and testing times. The ability of X-ray to detect foreign materials is continually improving and allowing for more sensitive identification. Some developments, such as the use of dark field imaging, are being attempted to increase their ability to detect organic materials on a smaller scale. If these methods are shown to be effective the range of detection for X-rays could be greatly expanded (Nielsen et al. 2010). The cost of the Xray units and maintenance, processing speed, and the amount of radiation and safety aspects that are associated with it currently limits the use of X-ray detectors (Haff and Toyofuku 2008). These areas are being improved upon and as advancements are made and costs are reduced the use of X-ray detectors may expand into additional food sectors to improve physical contamination identification. This along with the advancement in algorithms and computer programing also are improving some quality aspects of products as well. This includes the identification of missing components, potential identification of damaged product, and some research believes the potential to identify spoiled product as well (Haff and Toyofuku 2008).

Visual Detection Methods:

The visual components of food products and foreign materials are also a field used to identify and remove physical hazards from food products. These methods include various wavelength or imaging sources to visibly identify contamination. One basic optical method using the visible light spectrum is reflectance measurements. Here a light source is used to create a reflectance off the surface of the product and differences between food and foreign material can be detected. This method has been shown to work in some produce production and helps remove sticks, stems, or rocks. Some limiting factors of this method are the heating caused by the illumination and that only surface materials can be detected. This makes testing some sensitive materials and thicker or bulk materials impractical. Other visual detection methods include testing with near-infrared wavelengths of light which uses the absorption ratios of molecular bonds to differentiate the different materials within a sample. Ultraviolet wavelengths can also be used by using radiation of the product and the signal that various materials will reradiate. These methods all vary with efficiency depending on the material being tested and the target foreign material (Graves and Batchelor 1998).

Hyperspectral Imaging:

Hyperspectral imaging is a method that combines spectroscopy as well as digital imaging computers. By allowing the use of multiple spectral wavelengths as well as the visible spectrums these methods can be customized to not only detect foreign bodies who do not share similar patterns but additional tests have shown the ability to also identify quality parameters such as the presence of insects, bruised produce, and ripeness detection (Liu et al. 2014). If these additional quality aspects can be combined with the ability to detect foreign materials it can add another level of effectiveness for those industries that find it suitable for their needs. Due to the speed and the many wavelengths that can be incorporated there are many potential avenues this method may be helpful in the future. Some of the disadvantages to this method are the large amount of data that can be collect and the additional research into computations and filters that will be needed in order to be applicable to industry use (Liu et al. 2014).

Thermal Imaging:

Thermal imaging can occur in one of two ways typically. If the material and foreign materials give off heat and a suitable range then infrared energy can be applied to the material and then this difference can be used to create a digital image and be used to remove foreign materials. The other method is to apply heat in a short burst then measure how far into the material the heat is able to penetrate. This creates the contrast that allows detectors to identify the foreign material (Ginesu et al. 2004). These methods may not be suitable for all food products but may be able to be adapted to processes where heating or heat treatment of products is already occurring. If these methods could be adapted then these may be a cost effective addition to the process to increase a facilities ability to identify foreign materials.

Additional Methods:

Other methods that do not rely on visual wavelengths but still used to detect foreign material usually use a way of excited or differentiating the materials and then using this and a detector to identify the foreign material. This includes the use of microwave ranges which uses moisture levels or microwave impedance to detect the differences between product and foreign material. The advantage to this method is that even small differences are differences between substances can be detected and very small particles can also be identified. Other advantages include the processing speed, wide product range, and wide range of identifiable foreign materials. Some of the disadvantages include adapting the technology to an applicable method that can fit with the current industrial processing environments. Further developments must be made before this is an applicable technology for industry (Edwards 2002).

NMR and MRI:

Nuclear magnetic resonance (NMR) and magnetic resonance imaging are two other areas of detection that show future potential for the food industry. These methods use strong magnetic energy fields applied to the food that is being tested. The magnetic field then excite the protons within the nuclei of the cells which then can be measure as they return to their natural state. In doing so this method gives the ability to identify many of the structures, components, and characteristics of the material (Graves and Batchelor 1998). These machines and analytical testing capabilities go much further than the ability to detect the presence of metal or other foreign materials. They can determine quality items ranging from fat and moisture content, concentration of hazardous elements, and identify internal browning within produce. As these units advance they can perform the functions of many other methods such as metal detection, Xray, and optical sorters while performing additional analytical testing as well. These units still need to advance in areas such as cost, sensitivity of foreign material detection, and testing

speed before being applicable to the industry or before replacing current more cost effective measures (Marcone et al. 2013).

Ultrasonic Imaging:

Ultrasonic imaging is another potential method for foreign material identification and uses the application of a 20 kHz or larger sound waves to a product and then detecting the resonating frequencies of materials (Graves and Batchelor 1998) or the measurement of sound impedance or time of sound transfer through the material to identify any hazards that are present (Cho and Irudayaraj 2003). These methods have the advantages of being nondestructive and do not negatively affect the tested product. They also have the advantage of being applicable to multiple products and to be cost effective (Cho and Irudayaraj 2003). Previous testing was shown to be more effective in areas when product is transported through water such as a produce facility where water flumes are employed (Graves et al. 1998) but recent studies have shown the ability to detect differences without contacting the material or the need for a conductive medium (Cho and Irudayaraj 2003). Other potential avenues for this method include detection of foreign materials in canned products. These have been able to identify foreign objects in cans as small as 1mm in length but can be negatively affected by container shape and irregularities (Meftah and Azimin 2012). Further development will need to be made if these units are to become used more commonly in the food industry. In process methods may be effective in identifying foreign material but as end of line critical control points they do not seem viable.

Continuous Wave Tetrahertz Imaging:

Continuous Wave Tetrahertz Imaging is a method that is being researched to detect foreign material in substances that include organic and low density items which have been difficult for current methods to identify. The goal was to identify less dense materials while still identifying hard materials. This would allow for identification of safety concerns as well as quality concerns such as insect, hairs, or other less dense foreign materials (Lee et al. 2012). Continuous Wave Tetrahertz Imaging is similar to X-ray technology in that it passes radiation energy waves through a product then by measuring the different levels of absorption and transmission a detector can differentiate between different items within a sample. The advantage to the tetrahertz waves is they are not as strong as X-rays and therefore do not pass through less dense materials so quickly. This allows for organic and less dense items to be seen by the detector and to be removed from the product flow. This method has the advantage of being able to detect both dense and less dense material but is not as sensitive at detecting some foreign materials then traditional methods. Another advantage to this method is that it can be applied to some food products that are too sensitive for the higher energies of X-ray detection. Some of the current draw backs to Continuous Wave Tetrahertz Imaging include the lack of current detectors and energy sources in the ranges needed for many food mediums. There is also interaction between these wavelengths and water so only dried products may feasible to test (Lee et al. 2012). If this method can be further developed it may help expand the range where dry products can ensure removal of both hard hazardous materials as well as those that effect quality and customer perception.

Summary

Before selecting a **foreign material prevention method**, facilities should first determine which contaminants are most likely to occur. If a facility uses wooden pallets often, a metal detector may not be the best choice. If a facility is only concerned about ferrous and non-ferrous metal fragments, simple industrial strength magnets may be a good choice. In any case, testing procedures must be in place to ensure that all hazard controls are in proper working order and to ensure that all employees are trained on how to operate and maintain them.

The collection and production of food products leads to the possibility to contaminate food at many steps throughout the process. With the globalization of the food system this process continues to grow in size and in geographic distance. Foreign material can come from the fields, factories, producers, or during the transport or storage of products. Inadequate removal of foreign materials can lead to potential consumer safety concerns, quality concerns, or product recalls. All of which can be costly and detrimental to the image of a company. Therefore effective cost effective means are needed to remove these potential risks and reduce their potential to reach a consumer as much as possible. New requirements by legislative bodies as well as customer demands continue to increase the expectations for safe quality food that is free of foreign material contamination. To meet these demands risk-based food safety systems are being implemented to evaluate the risks as well as quality concerns for the industry. Once risks are determined and critical limits are set the overall level and food safety and quality should improve if these systems are followed. To meet these limits process controls can be implemented to help remove and reduce the potential risks of foreign materials. These controls along with effective maintenance and operation programs can allow for the production of products with minimal risk but the potential still exists for further contamination or foreign material getting past in place controls. In these events it is important for facilities to have additional means of identification and removal of foreign materials. Traditional methods such as optical sorters, metal detectors, and X-rays are still the common method throughout the food industry. As technologies improve, these units and their capabilities improve but there inherent nature still has multiple disadvantages or areas for potential improvement. To overcome these shortcomings multiple fields are being researched as to their ability to identify foreign materials as well as add other areas of quality parameter testing. As these methods improve and become more economically feasible, they may become prevalent in the food industry and continue to drive towards safer, higher quality food products.

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Managing and Controlling Foreign Materials

When developing a food safety program, food processors must assess potential biological, chemical (including radiological), and physical hazards (2). Among these, potential biological hazards are the most common and garner the most attention when developing a food safety program. Chemical hazards are rare, but very significant in the minds of consumers who have developed an unsubstantiated fear of food preservatives and other materials, which has led to the push for "clean labels." Physical hazards in foods are rare but can cause significant adverse health effects, including broken teeth, cut lips or gums, or a bone caught in the throat. Table I summarizes some of the common foreign materials found in foods and their sources.

The fact that foreign materials in a food product render that food adulterated and subject to recall by the company also is a significant issue. For example, in 2015 Kraft Foods announced a massive recall of their packaged macaroni and cheese product (4). "Due to the possibility that some boxes may contain small pieces of metal," 242,000 cases of product were recalled. The company received eight complaints, although there were no injuries. How did this happen? Obviously, the metal pieces were not detected during processing. It should be noted that metal detectors do not remove all metal from a product, only pieces down to a certain size. So, even if a product is deemed safe, it is still potentially adulterated.

The U.S. Food and Drug Administration (FDA) deems hard and sharp objects to be hazardous when they are between 7 and 25 mm in size (3). Most detection systems have the ability to remove objects that are even smaller, but processors need to focus on both safety and potential product adulteration.

A Systematic Approach to Foreign Material Control

Food processors need to adopt a systems approach to foreign material control. Relying on screens, filters, magnets, metal detectors, or X-ray machines to detect and remove contaminants can create problems because they do not remove all foreign materials and are limited by the size of the material. The following process elements should be included in foreign material control programs:

1) Understand what goes on at the farm
2) Identify potential issues with receiving, especially with bulk shipments
3) Adoption of Good Manufacturing Practices
4) Adoption of good production practices
5) Establishment of preventive maintenance programs
6) Adoption of cleaning procedures, including programs to verify efficacy
7) Employee sabotage
8) Utilization of various intervention technologies to detect and remove certain materials

Farming and Husbandry Operations

Food processors and ingredient manufacturers need to develop a comprehensive understanding of where their ingredients come from and how they are handled. This is even more important today considering the supplier verification element of the preventive controls regulation in the 2011 Food Safety Modernization Act (FSMA). For example, are the ingredients used harvested mechanically or by hand? If you have the chance to watch the receiving of raw agricultural produce at a canner or freezer, you'll notice that mechanical harvesters pick up a surprising variety of objects. Birds, mice, snakes, glass, and cans are only a few of the objects that may accompany an incoming load. Processors include unit operations to clean up the harvested product, but occasionally foreign materials slip past because these units are not 100% effective.

Meat and poultry also face potential foreign material issues, including bone and metal. Bone is a natural part of all animals, but it can cause problems. These problems are magnified if a processor labels a product as boneless.

Metal presents an interesting challenge for meat and poultry products. Ground or minced meats can contain metal fragments if processing equipment is not properly maintained or if a piece of metal is lodged in the product and ground up with the meat. Fortunately, this is something that can be anticipated. The potential presence of buckshot or birdshot in beef cattle poses another issue. Apparently, some people like to take random potshots at animals. The animal is wounded, and the wound heals over, but the shot remains embedded in the meat. Embedded needles present yet another issue. Cattle have a unique ability to twitch their muscles. Twitching while receiving a shot can cause the needle to break off below the hide. No effort is made to remove the needle because it is believed that it will hurt the animal more.

So, why dwell on this subject? Bakers, snack producers, and manufacturers of grain-based products use many different ingredients of both plant and animal origin in their products. Thus, they need to understand the potential risks up and down the supply chain.

Receiving

When materials are delivered to a food or ingredient processor, the receiving crew is responsible for ensuring that the items

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are safe and wholesome. Packaging must be intact, and delivery vehicles should be sealed. The biggest issue with receiving is encountered with bulk loads, both liquid and solid.

Processors receive dry materials such as grain, seed, flour, and sugar in bulk. These are transferred using pneumatic devices and conveyed into storage bins. Processors also receive sugar, vinegar, oil, milk, and other ingredients as bulk liquids. Processors receiving items in bulk loads should consider one or more intervention tools at receiving to help ensure that the products are clean. For example, delivery vehicles may contain foreign materials such as metals (rust). An in-line grate magnet or sieve can be installed between the bulk delivery vessel and storage bin to remove metal from dry goods. For bulk liquids, stainless-steel baskets, bag filters, or a combination of both can be placed between the delivery vessel and storage container to remove contaminants.

If these types of intervention tools are installed, the processor also should develop and implement a program to inspect the filters or magnets on a regular schedule. When foreign materials are discovered, the supplier should be notified concerning what was found and when. Photographs can be included so the supplier can better understand what was found and take steps to eliminate the problem.

Good Manufacturing Practices

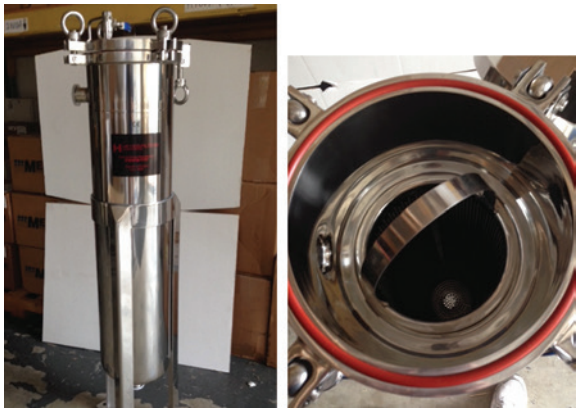
There are many programs that processors can develop, document, implement, and maintain that may reduce the risk of product contamination with foreign materials. These include, but are not limited to, pallet management programs, glass and brittle plastic programs, mandates for suppliers to adopt certain packaging requirements, elimination of wooden utensils, and personnel practices designed to ensure hygienic operations.

Pallet Management. It is surprising how few companies have implemented pallet management programs. A pallet management program should consist of the following elements: pallet specifications, pallet storage, pallet inspection, pallet use within and outside the plant, pallet maintenance, shipping requirements, and pallet cleaning. One of the reasons some food processors are switching to plastic pallets is that they can be washed. Many companies that have made the switch to plastic also have invested in pallet washers. These systems use hot water, spraying systems, and detergent to ensure that pallets are cleaned. Wood cannot be cleaned effectively using these types of systems. The exception is wooden pallets that are used for overseas shipping. Many countries require that pallets used to ship ingredients or products overseas be heat treated to ensure they are free of pests. Pest management is one reason a pallet management program is important. Insects, rodents, and birds have been known to gain access to food products on or in pallets. In the case of insects, borers can actually colonize the wood and enter the plant within the pallet. Heat treatment is important because it raises the temperature of the wood to levels sufficient to kill insects, larvae, and eggs.

Pallet inspection is essential to ensure that damaged pallets (e.g., splintered, loose nails, etc.) are not used in production. Plastic pallets must be inspected as well because they also break. This inspection program should extend to receiving. If a company will not use a damaged pallet in its own operations, why should it accept one from its suppliers? Damaged pallets must be kept out of the production environment to minimize the potential for product contamination with foreign materials.

Glass and Brittle Plastic. Processors also need to develop a glass and brittle plastic program as part of their Good Manufacturing Practices. These programs are now a standard element in most third-party audit schemes. First, processors need to establish a policy that no glass or ceramic items shall be carried into or used in the food processing area or warehouse at any time. Glass and ceramic items shall be confined to offices and break areas. Watches must be removed before entering the plant. Eye glass lenses must be manufactured from shatterproof materials. Windows in production or warehouse areas must be shatterproof or coated/covered with plastic to contain breakage.

The processor should inventory all glass and brittle plastic items in areas where foods and ingredients are stored or handled. This includes the warehouse, production, and packaging areas. When conducting the inventory, the location of a glass or plastic item, the type of glass or plastic (if possible), and whether it is shielded or strengthened in any way should be noted. This inventory must include the area or areas where glass or plastic is stored and be included in a master list or register. The master list for glass and brittle plastic serves as the basis for conducting a risk assessment to determine whether any of the instances of glass or brittle plastic within the plant pose a realistic threat of



Exterior (left) and interior (right) of a bag filter. (Published with permission from Hayes Filters, Torrance, CA)

Table I. Foreign material concerns and sources[a]

Material	Potential Injuries	Sources
Glass	Cuts, bleeding; May require surgery to find or remove	Bottles, jars, light fixtures, utensils, gauge covers
Wood	Cuts, infection	Fields, pallets, boxes, buildings
Stone	Choking, broken teeth; May require surgery to remove	Fields, buildings
Metal	Cuts, infection; May require surgery to remove	Wire, employees, machinery, fields
Insect	Illness, trauma, choking	Fields, plants, post-process entry
Insulation	Choking, long-term health effects if it contains asbestos	Building, packaging
Bone	Choking, trauma; May require surgery to remove	Fields, plants, improper processing

[a] Corlett and Stier (1).

contamination and potential injury. The potential risk (high, medium, low) should be noted in the master list, along with the date(s) of review. Situations that pose a realistic threat (high) must be addressed as soon as possible and corrective actions noted in the master list. Corrective actions may include, but need not be limited to, the use of shields or covers, replacement with stronger or shatterproof plastics, or removal of the potential hazard from the production or holding area.

The company should establish a regular audit program to examine all glass and brittle plastic noted on the master list to determine their condition. If any breakage is noted, it must be noted on the master list and repairs made immediately. Employees must also be trained to report any broken glass or brittle plastic, such as cracked gauge covers or windows. Finally, whenever glass must be transported through the plant, it must be protected and contained in some way. For example, lights must be carried in their original box when being moved for replacement.

Packaging. Many ingredients are delivered bagged in boxes. Processors should work with suppliers to use brightly colored plastic bags for packaging because tears in colored plastic are easier to spot than if the plastic is white or clear. Use of colored plastic bags does not increase costs.

Utensils. All utensils should be manufactured from materials that will not shatter or splinter. Wooden utensils, especially wooden handles, must be eliminated from the process. Metals are the best materials for utensils. If a company uses plastic utensils, they must be inspected regularly and removed from service if they begin to chip or splinter. The FDA recall list includes a number for recalls for "small bits of plastic."

Personnel and Personal Hygiene. Processors should establish policies regarding clothing, hair restraints, and jewelry. Most companies provide employees with uniforms. Uniforms should be manufactured from breathable materials that will not shed and should have no pockets above the waist. Closures should be snaps, zippers, or hook and loop fasteners. Uniforms should not include buttons because they can pop off and fall into products.

To further minimize the potential for a contaminant making its way into a finished product, processors often provide their employees with metal detectable ear plugs. In addition, many processors mandate that any bandages worn by employees be brightly colored and metal detectable. Processors that use these procedures must also develop programs to verify that each lot of ear plugs and bandages is indeed detectable by their metal detectors.

Good Production Processes

In every production operation, there are small things that must be addressed to ensure the production of safe, wholesome, and unadulterated foods. These vary based on the specific operation, but there is always something that needs to be addressed. One of the more common issues that can cause problems involves opening bags containing ingredients. When opening bags, care should be taken to ensure that the cut is clean and that the bag and/or inner liner does not shred. Using good shears or scissors helps ensure a clean cut. One practice that should be discouraged is the use of razor knives. These often create a ragged cut when opening a bag, and of greater concern, the knife can snap or break. Companies that use number 10 cans for ingredients also can experience issues with metal shavings if can openers are not properly monitored and maintained. The option to purchase ingredients in pouches is a huge step forward when it comes to minimizing the potential for metal contamination. If you walk your own lines and look closely, I would wager that you will find one or two things that are accidents waiting to happen.

Another excellent tool for minimizing potential contamination with foreign materials is the use of start-up checklists. Create checklists that include step-by-step protocols for starting up lines and equipment. These should include not only turning things on in the proper sequence and recording settings that are necessary for proper operation, but also checking the condition of lines, belts, and other components. Is a belt frayed and in danger of shedding fibers? Is a gasket on a filler beginning to break, and could it end up in the product? Is a bolt loose, and could it come loose? There are many items that can easily be incorporated into these checklists. In addition, the checklists may be used for troubleshooting if problems arise.

Finally, processors should take a look at what is being done and play "devil's advocate." What can go wrong? If it does, how can the potential impact be minimized? For example, one processor of soy-based products switched from black to white gaskets believing that if a gasket failed it would be easier to find a white gasket than a black one in the end product. Guess what? They had a failure and easily found the white gasket material in the product.

Preventive Maintenance

A well-designed and managed preventive maintenance program offers another means of minimizing the potential for food product contamination with foreign materials. The type of program that is developed, documented, and implemented is, again, a function of the type of production operation involved. Every operation has different maintenance requirements, and there are always multiple schedules for each piece of equipment. There might be maintenance (lubrication or tightening bolts) that is done daily, as well as weekly, monthly, and quarterly maintenance checks. Processors need to look at their operations and determine what needs to be done when and how often. This is especially important when dealing with items that have a defined usage life, such as gaskets, fittings, and drive belts. The objective is to replace these before they fail, so preventive maintenance programs should be designed with these issues in mind.

It also is critical that the program be documented. Good maintenance records are an excellent tool for taking to management when it comes to requesting new equipment purchases.

Sanitation and Verification

One of the elements in the FSMA preventive controls regulation is preventive controls for sanitation. If a company is processing a product that could be compromised microbiologically by poor sanitation, a sanitation preventive control is required. Examples of food products that could be compromised by poor sanitation are ready-to-eat (RTE) meats, cheeses, seafood, and pasta, as well as many others. There are times when I wonder whether the focus on cleaning to a microbiological level has caused operators to forget other elements of their sanitation programs. Some operators who do not have metal detectors or other devices in their production processes rely on close inspections of their lines to verify cleaning. Because they do not have metal detectors, the postprocessing inspection is conducted to ensure that the line is not only clean, but that there is no evidence of damage or scoring, especially in unit operations in which there is a potential for metal to metal contact. This inti-

mate line inspection is done in lieu of use of metal detectors or X-ray machines.

Processors should consider expanding cleaning verification operations to encompass not only microbiological verification using ATP tests, swabs, or allergen tests, but to include a detailed line inspection, especially if there are places in the line where there is the potential for metal to metal contact.

Employee Sabotage

Employee sabotage is insidious and difficult to control. Disgruntled employees or those who believe intentionally adulterating a product is funny can seriously damage a company. Many years ago when I worked at the old National Food Processors Association, we saw many examples of employee sabotage: a mouse in a pickle jar and a condom in pet food are two examples. The FSMA preventive controls regulation requires companies to evaluate the potential for intentional adulteration, but this is challenging. Successfully anticipating employee sabotage and doing something proactively is similar to the odds of being struck by lightning—very remote.

The best thing a company can do to minimize the potential for employee sabotage is to make sure that its work force is properly trained. This training must be documented. One purpose of the training is to instill a sense of ownership in the work force. Training should emphasize that the workers are part of the company team and that they have an important role to play in ensuring product quality and safety. For example, if a worker sees something that is out of the ordinary, be it a pest, damage to equipment, a broken door, or a colleague doing something "funny," they need to report it. In addition, supervisors must oversee and work with their staff. They should praise people for a job well done and correct those who do things improperly and work to build a team in which everyone works and succeeds together.

Detection and Removal

As noted earlier, there is some concern in the industry that companies may rely too heavily on detecting and removing foreign materials rather than focusing on keeping them out. The main types of equipment used to detect and remove foreign materials have been alluded to already: metal detectors, magnets, X-ray machines, and electronic sorters.

Electronic Sorting. Electronic sorting systems are increasingly being accepted in the industry, due in large part to advances in sorting technology. Although these systems, whether they use lasers, vision systems, or other technologies, remove foreign materials, they are utilized primarily for quality control purposes. Sorting systems are programmed to look for specific defective characteristics in the product being processed and to remove items with these defects. There may be some loss of good product, but they are minimal. Laser sorting systems also can be used for cleaning up bulk shipments of grains, seeds, and nuts. This is especially important because bulk containers often are used to transport different products. I have seen a laser sorting system that has been set up to scan red lentils that has the sensitivity to find and remove grains of wheat, soy, and other items.

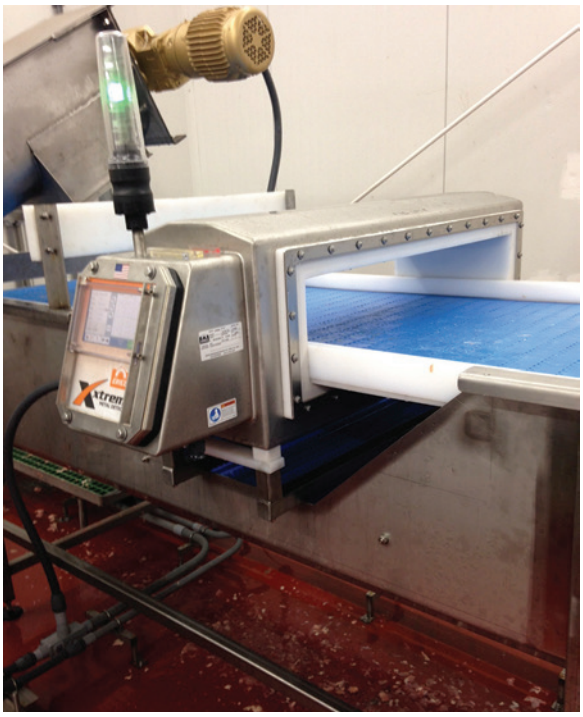
Magnets. Magnets are designed remove either ferrous or nonferrous metals. They serve two basic functions: enhancing product quality and safety and protecting equipment. Beverage producers frequently install magnets (or screens) just upstream of their fillers. The theory is that the magnets will attract metal that may damage the filler and shut down production. There are many different types of magnets that are designed to be used in different processing systems, including grate, tube, plate, liquid in-line systems, pneumatic, chute, pipe, and drum magnets. Processors who dry blend ingredients often install grate magnets through which bags are dumped to remove metals at the start of the process, whereas processors of dried fruits often install plate magnets immediately before filling to remove metal dust, specifically rust.

The advantage of magnets over metal detectors and X-ray machines is that they are capable of removing very small pieces of metal, such rust particles. Two different types of magnets are used in food processing: ferrous magnets and rare earth magnets. Rare earth magnets are the strongest and most effective magnets because they have the ability to remove fine metal dust and work-hardened or abraded stainless steel. Ferrous magnets only remove iron.

Magnets should be tested on a regular schedule using a pull test to ensure they are performing properly. How often they need to be tested depends on the risk assessment conducted by the company's HACCP or food safety team. Pull testing repeatedly measures magnet holding strength in ounces of force or pounds at a predetermined distance from the surface or on the surface of the magnet itself. This may done by the equipment manufacturer or in-house. Finally, magnets should be validated to ensure that they remove the metals being targeted. I have seen processors do this by passing product spiked with a known number of metal pieces over the magnet. They then look at the magnet to verify that all of the metal is on the magnet.

Metal Detectors. Metal detectors are designed to detect all metal objects larger than a certain size in food products. The size of the metal object that is detectable depends on the product and the product packaging. It is recommended that processors work with the equipment manufacturer to determine the optimal settings and metal detection limits for their products. Trying to be too fine (i.e., trying to set detection limits too low) will result in false positives and wasted time and effort evaluating rejected product. Processors should obtain a letter from their equipment manufacturer defining the minimum detection limits for the unit for each product they are passing through the metal detector. The processor should obtain the necessary standards from the equipment manufacturer (i.e., ferrous, nonferrous, and stainless-steel standards). If a customer demands a more stringent standard, the letter should be enough to convince them you are operating at the optimum detection limits.

Grate (left), in-line (right, top), and variety (right, bottom) of magnets. (Published with permission from Eriez Manufacturing Co., Erie, PA)



Tunnel metal detector. (Published with permission from Eriez Manufacturing Co., Erie, PA)

There are different types of metal detectors available to the food industry. These include systems that pass products through the detector on a conveyor (gate systems), in-line systems for liquids, and vertical inspection systems. Metal detectors almost always are designed to reject product found to contain metal, although there are some units in which the conveyor simply stops when metal is detected. The best systems are those that include visual and audio alarms when they reject product. These alarms notify operators that there was a rejection and that they should look at the product in question. Ideally, the best location for a metal detector is after packaging, which is why gate systems are so popular. If metal is detected, the final package itself will be rejected. Of course, if the packaging contains metal, processors have to adopt another type of metal detection system or utilize X-ray detection.

Processors who utilize recycled fiber in their final packaging must be aware that recycled fiber occasionally contains metal that can be rejected by the metal detector. If this is the case, programs to evaluate the product and the packaging separately need to be implemented to ensure that the operator isn't chasing a problem with the product that does not exist.

Questions still remain as to how the FDA will look at metal detection in guidance documents developed to support enforcement of FSMA. The guidance for seafood indicates that metal detection be treated as a critical control point. It is very likely that metal detection will be deemed a process preventive control under the preventive controls regulation. If this is the case, it is imperative that companies validate their metal detection systems.

X-ray Machines. There is increased interest in the food industry, especially among major food and ingredient purchasers, to have suppliers move from using metal detectors to using X-ray machines. X-ray machines have the ability to detect metal, glass, stones, calcified bone, and some plastics. Depending on the product and material, they may be able to detect other materials as well. There are limitations, however. Manufacturers of products like breakfast bars indicate that X-ray technology is not as effective as they would like because the inclusions used in these types of bars (e.g., nuts, chocolate chips, etc.) are rejected as foreign materials by X-ray units.

X-ray technology has improved immeasurably in the last few years, and equipment has become a little less expensive as well. Although X-ray machines are still much more costly than magnets and metal detectors, the systems are faster, more versatile, and, as noted above, have the ability to detect more than just metal. The same principles that were mentioned for metal detectors apply to X-ray systems. Operators should work with the equipment manufacturer to determine optimum detection and selection of standards; conduct tests to validate the system, especially if the X-ray system will be deemed a critical control point; and examine what is rejected from the machine. Finally, processors should work with the supplier to set up the machine for each product that will be run on the line.

Summary

Foreign material control is an essential element of any processor's food quality and safety program. To be successful, processors should take a systematic approach to identifying potential foreign materials and ensuring that they do not end up in their food products. The tools that are used to detect and remove metals, glass, and other foreign objects (i.e., magnets, metal detectors, X-ray machines, and sorting system) must be augmented by in-house quality and safety programs, supplier verification, and proper training of workers. Detection tools must not be used as stand-alone devices to protect consumers and products. They should be used to verify that the production operations, food safety programs, and prerequisite programs are functioning properly.

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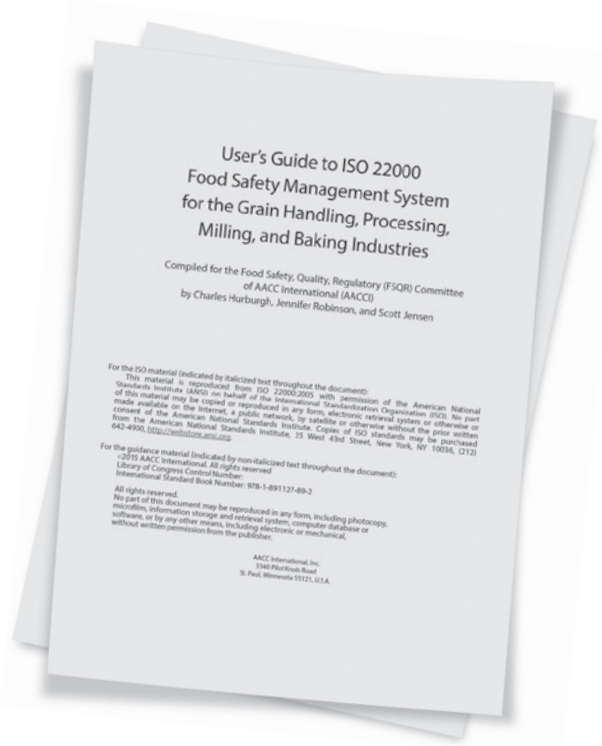

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GOOD MANUFACTURING PRACTICES (GMP)

Personnel A.

Disease Control A1. Any person who, By medical examination or supervisory observation, appears to have, an illness, open lesion, including boils, sores, infected wounds, or any other sort of microbial contamination by which possible food/packaging contact contamination, unless adequately covered, will be excluded from operations until condition is corrected. Personnel are expected to report such health conditions to their supervisors

B. Cleanliness B1. Wearing outer garments suitable to the operation to protect the food, foodcontact surfaces or food packaging materials

B2. Maintaining adequate personal cleanliness

B3. Washing hands thoroughly in adequate hand-washing facilities

B4. Removing all unsecure jewelry or cover by materials to ensure no contamination

B5. Maintaining gloves, if used for food handling

B6. Wearing, where appropriate, hair nets, headbands, caps, beard covers, or other hair restraints

B7. Storing clothing or other personal belongings in areas other than where food is exposed or where equipment or utensil are washed.

B8. Confine areas for eating food, chewing gum, drinking beverages or using tobacco

B9. Taking any other precautions to protect against contamination of food, foodcontact surfaces or food-packaging materials

C. Education and Training. Food handlers and supervisors should receive appropriate training on proper food handling and have a background of education or combination about clean and safe food production

D. Supervision. Should be someone responsible for all personnel and ensuring compliance

Plant and grounds A.

Grounds A1. Properly store equipment by removing waste and clearing weeds/grass within the vicinity.

A2. Maintain roads, parking lots etc. so that they do not constitute a source of contamination where food is exposed.

A3. Adequate drainage that could contribute to contamination by sewage, foodborne filth, breeding places for pests, etc.

A4. Proper areas for waste disposal so that they do not contribute as a source of contamination in areas where food is exposed.

A5. Care must be exercised if surrounding grounds are not under the operators control and not maintained in the manner like inspection and extermination of pests and filth that may be a source of contamination.

B. Plant Construction and Design

B1. Provide adequate space for equipment and storage of materials that are necessary for maintenance, sanitation, and production of safe food.

B2. Take precautions to reduce the potential of cross contamination of food with microorganisms, filth, chemicals, etc. The potential of cross contamination can be reduced by adequate food safety controls and operating practices or effective design.

B3. Permit the taking of adequate precautions to protect food in installed outdoor bulk vessels by any effective means, including: B3i. Using protective coverings. B3ii. Controlling areas over and around the vessels to eliminate harborages for pests. B3iii. Checking on a regular basis for pests and pest infestation. B3iv. Skimming fermentation vessels, as necessary.

B4. Be constructed in a manner that floors, walls, and ceilings may be cleaned and kept clean and kept in good repair; the drip or condensate of fixtures does not contaminate food/surfacing/packaging; and that aisles and workspaces are adequately designed to permit employees to perform their duties with our contaminating food/surfacing/packaging.

B5. Provide adequate lighting in hand-washing areas, dressing and locker rooms, and toilet rooms in areas where food is examined, manufactured, processed or packaged. Provide shatter resistant light bulbs/fixtures/skylights/glass suspended over exposed food.

B6. Provide adequate ventilation and operate fans to minimize dust, odors and vapors in areas where they can cause allergen cross contact or food contamination.

B7. Provide, where necessary, adequate screening or other protection against pests.

Sanitary operations A.

General Maintenance A1. Buildings, fixtures, and other physical facilities must be maintained in a clean and sanitary condition and repaired to prevent food from becoming adulterated. Cleaning of utensils and equipment must be constructed in a manner that protects against allergen cross contact and food contamination.

B. Substances used in Cleaning and Sanitizing; Storage of Toxic Materials

B1. Cleaning compounds and sanitizing agents used in cleaning and sanitizing procedures must be free from undesired microorganisms. Compliance with this requirement must be verified by any effective means. Only the following toxic materials may be used or stored in a plant where food is processed or exposed: *B1i*. Those required to maintain clean and sanitary conditions; *B1ii*. Those necessary for use in laboratory testing procedures; B1iii. Those necessary for plant and equipment maintenance and operation; and B1iv. Those necessary for use in the plant's operations

B2. Toxic cleaning compounds, sanitizing agents, and pesticide chemicals must be identified, held, and stored in a manner that protects against food contamination.

C. Pest Control C1. Pests must not be allowed in any area of a food plant. Guard dogs may be allowed in some areas of a plant if they are unlikely to result in food contamination. Effective measures must be taken to exclude pests from contaminating food handling/manufacturing/packaging areas. The use of pesticides is permitted under certain precautions and restrictions that will protect against food contamination.

D. Sanitation of Food-Contact Surfaces D1. All food surfaces, including utensils and equipment must be cleaned frequently to protect against allergen cross contact and food contamination. Surfaces must be clean and dry before use.

D2. In wet processing, all food surfaces must be cleaned and sanitized before use and after any interruption by which the food surfaces have been contaminated. Utensils and equipment surfaces should be cleaned as necessary

D3. Single-service articles (such as utensils intended for one time use) must be stored and handled in a way that protects against allergen cross contact and food contamination.

E. Sanitation of Non-Food-Contact Surfaces E1. Non-food-contact surfaces must be cleaned as frequently necessary to protect against allergen cross contact and food contamination.

F. Storage and Handling of Cleaning Portable Equipment and Utensils

F1. Cleaned and sanitized portable equipment in contact with food surfaces and utensils must be stored in a location and manner that protects against allergen cross contact and food contamination. Sanitary facilities and controls Each plant must be equipped with adequate sanitary facilities and accommodations including:

A. Water Supply The water supply must be adequate for the operation and be able supplied from an adequate source. Any water that contacts food/surfaces/packaging must be of safe quality. Running water at a certain temperature and pressure are required in certain working areas for food processing/cleaning.

B. Plumbing Plumbing must be of adequate size and design and adequately installed and maintained to:

B1. Carry adequate quantities of water to the required locations throughout the plant.

B2. Properly convey sewage and liquid disposable waste from the plant.

B3. Avoid constituting a source of contamination of food, water supplies, equipment, or utensils or creating an unsanitary condition.

B4. Provide adequate floor draining in all areas where floor cleaning or operations that release water or liquid waste onto the floor.

B5. Provide that there is no backflow or cross contamination from piping systems that carry waste water or water for food of food manufacturing purposes.

C. Sewage Disposal Sewage must be disposed of into adequate sewerage system or disposed of through other adequate means.

D. Toilet Facilities Each plant must provide employees with adequate and accessible facilities. They must be kept clean and not be a possible source of food contamination.

E. Hand-Washing Facilities Each plant must provide hand-washing facilities designed to ensure that employees are not a source of food contamination, by providing facilities with adequate, convenient, and furnished running water at a suitable temperature.

F. Rubbish and Offal Disposal Rubbish and any offal must be so conveyed, stored, and disposed to minimize development of odor and potential for the waste becoming an attractant for pests, and to protect against food contamination, water supplies, and ground surfaces.

Equipment and utensils A.

Equipment A1. All plant equipment and utensils used in manufacturing, processing, packaging, etc. must be designed in such a way that they can be adequately cleaned and maintained to protect against allergen cross-contact and contamination.

A2. Equipment and utensils must be designed and used appropriately to avoid the adulteration of food with lubricants, fuels, metal fragments and any other sort of contaminate.

A3. Equipment must be installed so as to facilitate the cleaning and maintenance of the equipment and of adjacent spaces.

A4. Food-contact surfaces must be corrosion-resistant when in contact with food.

A5. Food-contact surfaces must be made of nontoxic materials and designed to withstand the environment of their intended use, the action of food and cleaning compounds.

A6. Food-contact surfaces must be maintained to protect food from allergen cross-contact and from being contaminated by any source, like unlawful indirect food additives.

B. Food-contact surfaces Seams on food-contact surfaces must be maintained as to minimize accumulation of food particles, and organic matter and thus minimize the opportunity for growth of organisms and allergen cross-contact.

C. Equipment that is in areas where food is processed, manufactured, handled, etc. must be so constructed that it can be kept in a clean and sanitary condition.

D. Holding, conveying, manufacturing systems, and automated systems, must be of a design and construction that enables them to be maintained in an appropriate clean and sanitary condition.

E. Each freezer/cold storage compartment that is capable of supporting growth of microorganisms must be fitted with an indicating thermometer, temperature-measuring device/recording device so installed as to show the temperature accurately within the compartment.

F. Instruments and controls used for measuring, regulating, or recording temperatures, pH, water activity, or other conditions that control the growth of microorganisms in food must be accurate and precise and adequately maintained.

G. Compressed air or other gases mechanically introduced into food or used to clean food-contact surfaces or equipment must be treated in such a way that food is not contaminated with unlawful indirect food additives.

Processes and controls A.

General A1. All operations dealing with food must be conducted in accordance with adequate sanitation principles.

A2. Appropriate quality control operations must be employed to ensure that food is suitable for human consumption and that food-packing materials are safe and suitable.

A3. Overall sanitation of the plant must be under the supervision of one or more competent persons assigned responsibility for this function.

A4. Adequate precautions must be taken to ensure that production procedures do not contribute to allergen cross-contact and to contamination from any source.

A5. Chemical, microbial, or extraneous-material testing procedures must be used where necessary to identify sanitation failures or possible allergen-contact and food contamination.

A6. All food that has become contaminated to the extent that it is adulterated must be rejected, or if appropriate, treated or processed to eliminate the contamination.

B. Raw Materials and Other Ingredients

B1. Raw materials and other ingredients must be inspected or handled as necessary to ascertain that they are clean and suitable for further food processing and must be stored under conditions that will protect against microbial growth and allergen cross-contact. Raw materials must be washed to remove soil and/or other contaminations. Material used must be of safe sanitary quality. Water may be reused if it does not cause allergen cross-contact or increase the level of contamination of the food.

B2. Raw materials or other ingredients must either not contain levels of microorganisms that may render the food injurious to the health of humans, or they must be pasteurized or otherwise treated so they are no longer contain levels that would cause the product to be adulterated.

B3. Raw materials and other ingredients susceptible to contamination with aflatoxin or other natural toxins must comply with FDA regulations for poisonous substances before these materials are incorporated into finished food.

B4. Raw materials, other ingredients, and rework susceptible to contamination with pests, undesirable microorganisms, or extraneous materials must comply with FDA regulations for natural or unavoidable defects if a manufacturer wishes to use the materials in manufacturing food.

B5. Raw materials, etc. must be held in bulk, or in containers designed and constructed so as to protect against allergen cross-contact and against contamination. They must be held at such a temperature and relative humidity to prevent food from becoming adulterated. Material scheduled for rework must be identified as such.

B6. Frozen raw materials and other ingredients must be kept frozen. If thawing is required before use, it must be done in a manner that prevents the raw materials and other ingredients from becoming adulterated.

B7. Liquid or dry raw materials and other ingredients received and stored in bulk form must be held in a manner that protects against allergen cross-contact and against contamination.

B8. Raw materials, etc. that are food allergens, and rework that contains food allergens, must be identified and held in a manner that prevents allergen crosscontact.

C. Manufacturing Operations

C1. Equipment and utensils and food containers must be maintained in an adequate condition through appropriate cleaning and sanitizing. Insofar as necessary, equipment must be taken apart for thorough cleaning.

C2. All manufacturing, packing, etc. must be conducted under conditions as are necessary to minimize the potential for the growth of microorganisms, allergen cross-contact, contamination of food, etc.

C3. Food that can support the rapid growth of undesirable microorganisms must be held at temperatures that will prevent the food from becoming adulterated during manufacturing, packaging, etc.

C4. Measures such as sterilizing, irradiating, pasteurizing, cooking, etc. that are taken to destroy or prevent the growth of undesirable microorganisms must be adequate under the conditions of manufacture, handling, and distribution.

C5. Work-in-process and rework must be handled in a manner that protects against allergen cross-contact, contamination, and growth of undesirable microorganisms.

C6. Protective measures must be taken to protect finished food from allergen cross-contact and from contamination by raw foods, etc. When raw materials, other ingredients, etc. are unprotected, they must not be handled in a way to prevent allergen cross-contact or food contamination. Food transported by conveyor must be protected against allergen cross-contact and against contamination as necessary.

C7. Equipment, containers, and utensils used to convey, hold, or store raw materials and other materials that protects against allergen cross-contact and against contamination.

C8. Adequate measures must be taken to protect against the inclusion of metal or other extraneous materials in food.

C9. Food, raw materials, and other ingredients that are adulterated:

C9i. Must be disposed of in a manner that protects against the contamination of other food;

C9ii. If the adulterated food is capable of being reconditioned, it must be: A. Reconditioned (if appropriate) using a method that has been proven to be effective; or B. Reconditioned (if appropriate) and reexamined and subsequently found not to be adulterated within the meaning of the Federal, Food, Drug, and Cosmetic Act before being incorporated into other food.

C10. Steps such as washing, peeling, trimming, etc. must be performed so as to protect food against allergen cross-contact and against contamination. Food must be protected from contaminants that may drip, drain, or be drawn into the food.

C11. Heat blanching, when required, must be effected by heating the food to the required temperature, holding for a required time, then rapid cooling or passing the food to subsequent manufacturing without delay. Growth and contamination by thermophilic microorganisms in blanchers must be minimized by the use of adequate operating temperatures and by periodic cleaning and sanitizing.

C12. Batters, breading, sauces, gravies, dressings, dipping solutions, and other similar preparations that are held and used repeatedly over time must be treated in such a manner that they are protected against food contamination, and minimizing undesired microorganism growth.

C13. Filling, assembling, packaging, and other operations must be performed in such a way that the food is protected against allergen cross-contact, contamination and growth of undesired microorganisms.

C14. Food, such as dry mixes, nuts, etc. that relies principally on the control of aw for preventing undesirable microorganism growth must be processed to and maintained at a safe moisture level.

C15. Food, such as acid and acidified food, that relies principally on the control of pH for preventing growth of undesired microorganisms must be monitored and maintained at a pH of 4.6 or below.

C16. When ice comes in contact with food, it must be made from water that is safe and sanitary and must be used only if it has been manufactured in accordance with the current good manufacturing practice as outlined in this part.

Warehousing and distribution Storage and transportation of food must be under conditions that will protect against allergen cross-contact, food contamination, and food and container deterioration.

Holding and Distribution of Human Food By-Products for use as Animal Food

A. Human food by-products held for distribution as animal food without additional manufacturing by the human food processor, must be held under the conditions that will protect against contamination, including the following:

A1. Containers and equipment used for human food by-product for use as animal food before distribution must be designed, constructed of appropriate material, cleaned, and maintained to protect against contamination.

A2. Human food by-products for use as animal food held for distribution must be held in a way to protect against contamination from sources such as trash; and

A3. During holding, human food by-products for use as animal food must be accurately identified.

B. Labeling that identifies the by-product by the common or usual name must be affixed to or accompany human food by-products for use as animal food when distributed.

C. Shipping containers and bulk vehicles used for distribution must be examined prior to protect against contamination of the human by-products for use as animal food from the

container when the facility is responsible for transportation, or arranges for a third party to transport the human by-products for use an animal food.

STAFFING MANAGEMENT PLAN

Introduction

Regardless of what you do in an organization, a staff is required in order to execute work tasks and activities. If you are a project manager, you need to have an adequate staff for executing your project activities.

Just having the required number of staff members for your project will not help you to successfully execute the project activities. These staff members selected for your project should have necessary skills to execute the project responsibilities as well. In addition, they should have the necessary motivation and availability as well.

Therefore, staffing of your project should be done methodologically with a proper and accurate plan.

Understanding the Purpose

Before you start staffing your project, you need to understand the purpose of your project. First of all, you need to understand the business goals for the project and other related objectives. Without you being clear about the end results, you may not be able to staff the best resources for your project.

Spend some time brainstorming about your project purpose and then try to understand the related staffing requirements. Understand the different skills required for project execution, in order to understand what kind of staff you want.

Be Precise

Be precise when you prepare your staffing management plan. Make your staffing plan in black and white. Do not include things just to make the people happy. Always include the truth in your plan in a bold way. Whenever required, emphasize the roles and responsibilities of the staff and organizational policies as well.

The workforce should be disciplined in order to execute a project successfully. Therefore, you need to include discipline requirements to the staffing plan as well.

Use a Good Template

When it comes to articulating the plan, you need to use a good template for that. First of all, there are chances that you can find a suitable one from your organization itself. Talk to your peers and see whether there are templates that they have used in the past. In case if your organization has a knowledge management system, search for a template there.

Once you get a good template, articulate everything in simple language. The audience of the plan is the management and the staff. Therefore, articulation should be clear and simple.

Making the Connection

Connecting with your staff is the key. By properly connecting, you can measure them for their skills and attitude.

Interviewing the staff members is the best way to properly engaging with them. By doing this, you can measure their skills and you can see whether they are suitable for your project requirements. For interviews, you can come up with an interview schedule and a set of critical questions you may want to ask.

In case there are things you cannot uncover through interviews, ask assistance from HR.

Training

Before you start staffing for the project, you need to know what skills required for your project. This

way, you can measure the skills of your potential staff during the interviews. In most instances, you will not find all the staff members with desired skills.

In such cases, you will have to request for trainings from the training department. Get applicable staff members trained on required skills in advance to the project commencement.

Rewards and Consequences

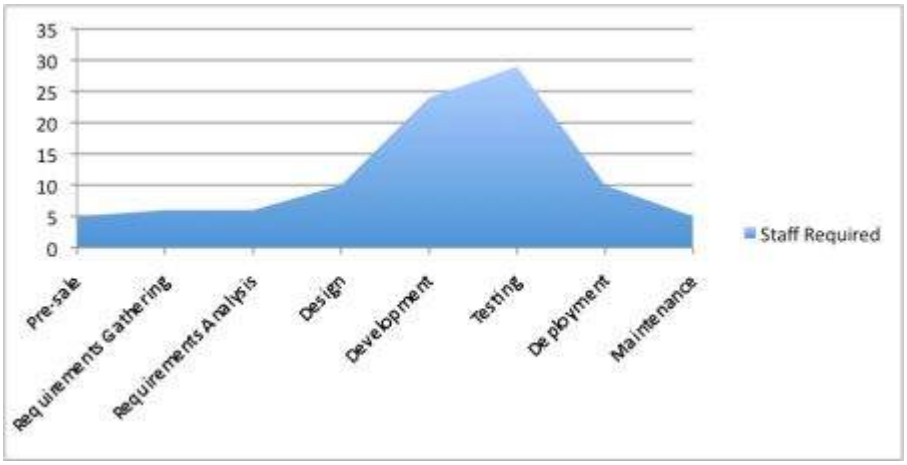
Staffing management plan should be crystal clear about the staff rewards as well as the consequences. The plan should illustrate the rewards in detail and how a staff member or the entire staff becomes eligible for rewards.

As an example, early delivery of projects is rewarded by paying a bonus to the staff members, who are involved in the project. This is one of the best ways to keep the staff motivation and focused on the project activities.

Considerations

In addition to the above areas, there can be additional considerations. One might be the duration of your staffing requirement. It's very rare that a project will require all the staff during the entire project life cycle.

Usually, the staffing requirement varies during different phases of the project. Refer to the following diagram in order to identify the staff variation.



Usually, during the initial phases of the project, the project requires only a limited number of staff members. When it comes to development or construction, it may need a lot. Again, when it reaches the end, it will require a less number of staff.

Conclusion

Staffing management plan for a project plays a critical role in project management. Since resources are the most critical factor for executing the project activities, you should be clear about your staffing requirements.

Once you know what you want, derive the plan to address the same.

Integrated Pest Management

Problems Caused By Pests

- Customer perception
- Damage to food, supplies, and facilities
- They can contaminate food and preparation surfaces
- They can spread diseases such as *Salmonella*

Pests create problems to us for many reasons:

A. Customers see a cockroach or hear about a "cockroach problem" may leave and never come back. Others may avoid your establishment.

B. Pest feeding and nesting activities can damage food, supplies and facilities.

C. Pest activity and their fecal droppings (and sometimes their urine) can contaminate food and food preparation surfaces and equipment.

D. They may spread disease organisms, such as *Salmonella*

A pest management program should:

- Rely less on pesticides
- Emphasize sanitation and exclusion of the pests
- Train employees
- Use a licensed pest control operator (PCO)

Pesticides are often temporary solutions to pest problems. IPM (Integrated Pest Management) uses both chemical and non-chemical methods to control your current pest problems and to prevent future problems. IPM emphasizes sanitation and exclusion ("pest proofing") first. Then, you should work with a trained pest management professional to determine your next best course of action. Whenever possible, start with the most effective non-toxic and least-toxic pest control methods.

Common Pest Problems

The most serious and consistent problems are usually caused by insects, such as cockroaches, flies, stored product pests, and ants, as well as by rodents (both mice and rats).

Cockroaches

Can be introduced into the establishment through boxes, bags, and workers' personal items.

Cockroaches are THE most common pests in food service facilities. They are active mostly at night. They prefer places that are: **Warm** (80^{o} F or higher) and **Moist** - 55% humidity or higher *(which is another reason to keep relative humidity at or below 50%).* Cockroaches like to hide in cracks and crevices and they frequently take advantage of "free rides" in delivery boxes, bags and personal items.

Cockroach Feces and Egg Cases

Noticeable oily odors

Egg cases and feces

Cockroaches leave coarse pepper-like fecal droppings (seen at right), as well as a fecal smears that dry on surfaces (left - arrows). Other signs of cockroach activity are the presence of egg cases (arrows at right) under and inside drawers, cabinets, equipment and other hiding areas.

NOTE: the manual mentions an "oily" smell. However, this smell is usually with very large cockroach populations which is a more common problem in residential settings than in most food service facilities.

Critical Areas for Cockroaches

Cockroaches are attracted to spilled food and water or beverages. Equipment, such as microwave ovens and electric grills need to be checked carefully. Inspect and clean all food preparation equipment and surfaces (such as the area above the refrigerator shown in the upper right picture). Remove food scraps from drains.

Use glue traps to monitor cockroach activity

Early detection of cockroaches is critical to successful IPM. Sticky traps similar to the ones shown here, can be placed in areas where you suspect or expect that there cockroach activity. This type of monitoring program will help you target your control efforts where they are most needed.

NOTE: in the trap at the lower right, you can see an adult female cockroach, plus her 'babies' that hatched from her egg case and became stuck in the glue.

Chemical Control of Cockroaches

- Target use of insecticides to reduce amount used
- Avoid contaminating food, prep surfaces and equipment
- Apply insecticides after business hours

Crack and crevice treatment and spot treatment

Liquid and dust forms of insecticides can be used when necessary, e.g., to reduce large cockroach populations quickly particularly in areas that are somewhat inaccessible. Residual insecticides (chemicals that remain effective on treated surfaces for weeks or months) should be limited to 'crack & crevice' or 'spot' (2 sq. ft. areas) applications. Whenever pesticides are used indoors, you must avoid contaminating food, food preparation surfaces and equipment. Only trained pest management professionals should apply pesticides in your facility and preferably only when the building is closed

Cockroach Baits

Baits are among the best choices as least hazardous insecticides for cockroach control. These products come in several forms (granular, dusts, gels and stations or trays, as shown on the right). Read the product labels carefully for the instructions on their proper use in food service facilities.

Here are examples of good placement of cockroach baits. Since roaches tend to congregate in dark corners, they are more likely to find baits such as this bait tray (upper left) on the bottom shelf of a storage cabinet. The gel type of baits (lower left) can be placed inside electrical boxes and other areas where cockroaches tend to hide.

Rodent Problems

- Rats and mice (usually mice are the more common problem)
- Damage/contaminate food and property
- Can spread diseases through their feces and urine or by contact with surfaces

Rodents are another big pest problem in food service areas. They can damage or contaminate food, supplies and property. They can spread diseases through their feces and urine.

Rodents nest outdoors in areas hidden by tall grass, landscaping, “clutter” or down in sewers.

Outdoors, rodents frequently nest or hide in areas that are hidden by tall grass and shrubs particularly along building foundations. Garbage and other improperly discarded “clutter” will attract rats and mice. Storm and sanitary sewers provide rodents (particularly rats) with water and a “highway” for moving undetected from one area to another.

Mouse Nesting Sites

Mice will often nest indoors (more often than rats will). Check boxes, furniture (such as filing cabinets and storage closets), and wall voids for signs of mouse activity.

Burrows and Runs

Look for holes in the ground that may lead to their burrows. The examples here are of a rat burrows behind a building (left picture). Rats may wear a trail through grassy areas (as shown at right) where they run constantly between their burrows and food sources.

Rodent Gnawing

A rat's teeth constantly grow, so it will gnaw on objects to keep its teeth filed down or to chew its way through boxes or even walls. Look for gnawing marks on wood or other objects.

Rub Marks and Droppings

Rats tend to run along walls (rather than out in open areas) and they will leave “rub” marks (left - arrows) on the surfaces along which they travel. Look for these rub marks along pipes and electrical conduits and at walls and cabinet bases.

Excluding Rodents

- Foam sealants alone will not stop rodents.
- Use metal hardware cloth to seal large openings.

Rats can fit through openings as small as a 25mm and mice can squeeze through 13mm gaps. Foam sealants for keeping out cold (or hot) air, but they will not stop a determined rodent that may be attracted for food odors from your facility. Place heavy metal screening cloth over vents or other openings to prevent rodents from getting indoors.

Rodent Traps

Mechanical traps are the best choice for indoor rodent control. Lethal traps include sticky traps (right) and regular snap traps (upper left). Mechanical rodent traps include “live traps” as shown here (lower left). Traps must be checked daily and rodents or their carcasses removed as soon as possible.

Rodent Baiting

Poison baits can be used outdoors and indoors. However, if baits are used indoors, rodents may die in a wall void, under appliances or in some other inaccessible place. Keep track of rodent feeding activity on these baits. Placement is critical. Rodents prefer to travel along walls, so place the stations where rodents are likely to find them (as shown in the two pictures above). One important point to remember: if you bait in public areas (i.e., accessible to people or animals), then you must place the baits in a secure bait station (i.e., the station cannot be picked, shaken and the bait dislodged). The station in the upper left corner is attached to the wall.

NOTE: Picture at bottom shows the use of block baits that are placed on metal rods within the trap so the baits cannot be removed by a rodent or dislodged if the station is shaken. This is the safer method to bait.

Proper Use Of Rodent Baits

If you bait indoors, NEVER use pellet baits (as shown on the left). Mice may carry the bait away and drop it somewhere else (“bait translocation”) where it could contaminate food or water. Always use the paraffin (“wax”) “bait blocks” as shown on the right. They The bait are more difficult for the mouse to remove from a bait station.

Common Fly Pests

- "Filth" flies -- house flies and blow flies

- Others -- fruit flies, drain flies, fungus gnats

Let's turn our attention to flies. "Filth flies" are the most common fly problems associated with food-handling facilities. They include house flies and the green, blue or coppery colored blow flies commonly seen around garbage cans. Fruit flies (lower left) are found near damaged or discarded fruits and vegetables. Drain flies (lower right) breed in floor/sink drain, as well as the driplines for air conditioners, freezers and ice-makers. Fungus gnats can also be found where indoor plants are overwatered

Fly Control

Sanitation is very important to fly control and prevention. Keep food prep areas clean and dry. Clean up spills around beverage dispensing stations. Routine drain cleaning prevents debris from building up and reduces the likelihood of problems with drain flies or fruit flies. Check your refrigeration and icemaker drip lines several times each year and clean them when necessary.

Exterior Trash Cans and Dumpsters

- Empty trash cans and dumpsters regularly.
- Keep areas around them clean.
- Keep dumpster lids and doors closed.

Trash receptacles particularly those located in customer areas and near doors (photo at right) need to be emptied regularly throughout the day so they do not attract flies to the building. Keep the areas around trash cans clean. Keep dumpsters and other garbage cans closed. Dumpsters should be emptied regularly (preferably twice weekly). Areas around dumpsters and trash compactors should be kept clean so that you attract fewer flies (and other pests).

NOTE: When dumpsters are cleaned, make sure they're returned with the drain plugs in place (lower left picture).

Keep Flies Out

Exclusion is an important component of a fly control program. Keep doors closed as much as possible. If doors must be open (e.g., during deliveries or to improve air circulation during hot weather), then use screen doors or air curtains ("fly fans"). Fly fans (right) are mounted above exterior doors (either inside or outside), such as those by loading docks, equipment cleaning areas or rear entrances to kitchens. When the door opens, a switch activates the fan that produces a "curtain of air" that keeps flies from entering. Make sure that your air curtain works properly, i.e., it turns on when the door opens and the louvers direct the air downward (not angled inward).

Light Traps

Lights traps are helpful indoors and outdoors to trap flies. They should be mounted preferably 4-6 feet off the ground, but out of the way of employee activities. Indoors, place these traps where they will *not* be visible from outside. Otherwise, they might attract flies to the building. Bulbs should be replaced yearly and the replacement date noted on the trap.

(Whitmire-Microgen, St. Louis, MO)

Stored Product Pests

- Flour
- Baked items
- Spices
- Pastas
- Dried fruit
- Powdered milk
- Shelled nuts
- Bird seed
- Grass seed
- Rodent baits
- Cereals

Other important pests in food service are those that attack stored foods. The Indianmeal moth (a small moth with coppery-colored wings) is probably the most common stored products pest found in North Carolina. Flour and grain beetles are other important stored product pests. All of these insects attack a wide variety of foods.

Stored Product Pest Control

•Keep food storage, prep and serving areas clean and easy to inspect.

•Discard or return infested items.

•Store susceptible items in sealable, food-grade containers.

Pesticides are rarely needed to control stored product pests if you follow these suggestions:

•Keep your storage areas clean, particularly the floors under shelves or pallets.

Spilled food becomes a reservoir for these pests. Clean up spills quickly.

•Inspect your deliveries carefully. Discard (or return) infested or suspect items.

•Store susceptible items in sealable containers.

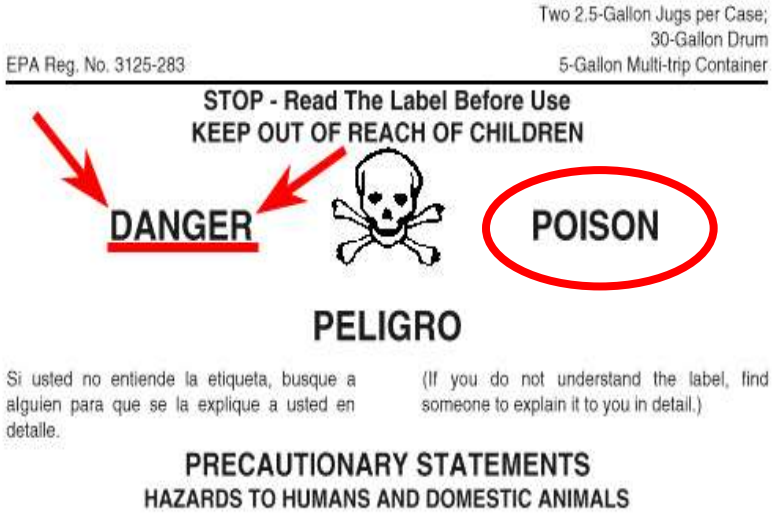
Use a Pest Logbook

A means of two way communication

Successful IPM programs use Pest Logbooks.

1. The log allows you and your employees to note pest sightings.
   This helps your PCO deal more effectively with specific pest problems.
2. The PCO can also record the locations of monitoring traps and bait stations.
3. The log also provides you with a record of recurring pest problems.
   In some cases, this information may allow you to trace certain pest problems back to other problems in the building or to deliveries from a particular supplier.
4. In turn, the PCO can use the log to point out improvements that YOU need to make in your facility sanitation and maintenance programs.

Pesticides Can Be Hazardous



- Liability issue
- Do not let untrained employees apply pesticides
- Preferably - use licensed pest management professionals
- Keep copies of the MSDS for all pesticides used in your facility

To summarize this topic, remember a few important points.

Pesticides can be very useful, but they can also be extremely hazardous if they're misapplied. In sensitive areas, such as a restaurant, or cafeterias in schools, hospitals and nursing homes, applying pesticides should be a job for trained professionals.

Demand a Pest Management Program

- Emphasize:
  - Good sanitation practices
  - Proper maintenance of the facilities
  - Inspection, monitoring, baiting and trapping for pests, such as cockroaches, rodents and ants
- Limit spraying to situations when necessary and *only* when facility is closed.

Most importantly: Pest Management starts with YOU. A well-maintained, well-organized facility is less like to have serious pest problems. The rest of your pest management program takes a cooperative effort between you and your pest management professional. Your pest control program should emphasize inspection and monitoring, not simply weekly or monthly sprays. Less toxic control measures such as baiting and trapping should be your first line of defense whenever possible. Limit the use of pesticide sprays to situations when they are absolutely necessary and only when customers and employees are not present.

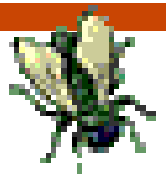
Pest Control

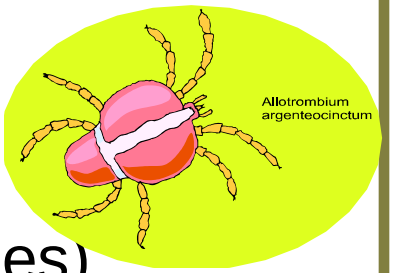
What do pests do?

Pests can:

- *Contaminate food (droppings → bacteria)**
- *Spoil food by eating part of it*
- *Carry disease*

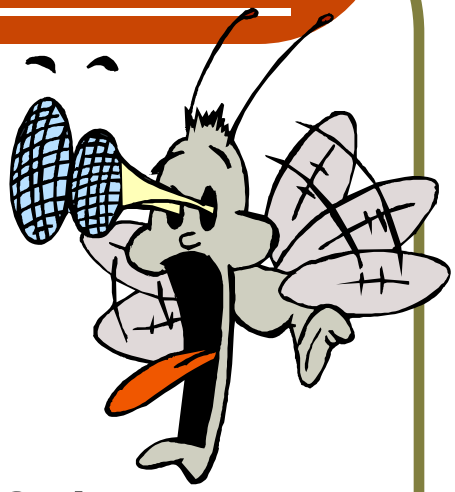
Main types of pests





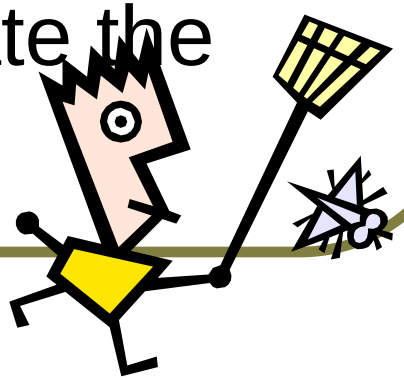
- Insects
  - Flying (adult moths / flies & larvae)
  - Crawling (beetles / weevils / cockroaches)
- Rodents
  - Mice (field / house)
  - Rats (roof / Norway)
- Birds
  - Pigeons / crows / starlings / gulls
- Other mammals
  - Skunks / raccoons / cats & dogs

Control methods



Need to determine:

- What mix of pests are present?
- What attracts the pest?
- What are the particular habits of the pest?
- What are the most effective control measures to control or eliminate the pest?



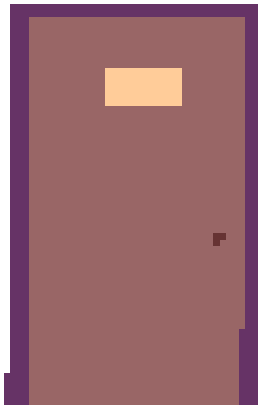
Effective pest control

An effective pest control program includes:

- Exclusion of pests
- Removing food sources by good practices
- Controlling pests with appropriate methods
- Specific procedures / records

Pest exclusion

- Keep doors closed / tight fitting
  - Minimize gaps
  - Use door seals / self closers
- Keep windows screened / closed
- Screen air inlets / exhaust openings
- Use air curtains / strip curtains
- Netting / eliminate perches (Branches) for birds
- Eliminate cracks / holes in walls
  - Small cracks harbor insects
  - New construction often creates spaces



Good Housekeeping

- Garbage & spoiled product: clean up
- Raw product: bring in “hitch-hikers”
- Garbage containers: clean and closed
- Building perimeter: remove vegetation / clean / slope away from building
- Process eqpt: clean daily after use / clean under / take apart / vacuum electrical

Pest infestation checks

- Watch for droppings / tracks
  - *Indicate type of pest present*
  - *May lead to entry points / nests*
- Watch for product or container damage
  - *Indicate type of pests present*
- Note presence of dead pests
  - *Baits are effective*

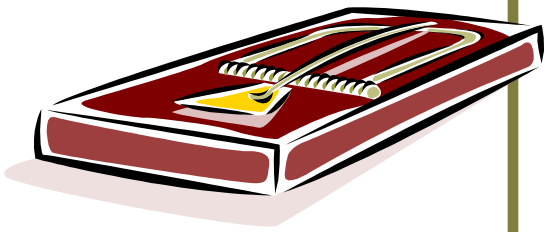
Capture or destruction

Traps work by:

- Attracting the pest
  - Attractants vary with pest (smell / curiousity)
- Confine the pest
  - Trip mechanisms / sticky pads
- Kill the pest
  - Baits (outside plant)
  - Mechanical levers / electric current

Rodent control

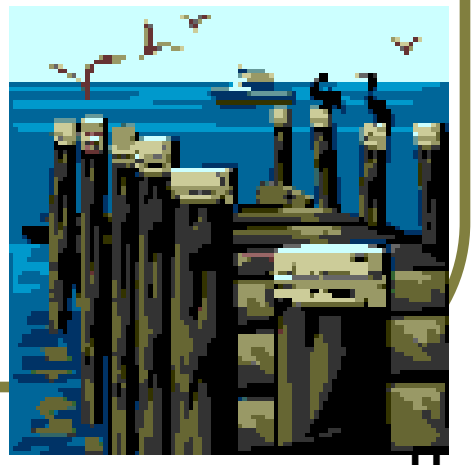
- Use of bait stations / traps most common
- Place traps inside production areas
  - Sticky pads for small rodents
  - Check & empty weekly (min.)



- Bait stations in non-food areas
  - Use approved baits only
  - Place in secured station (seal / lock / strap)

Bird control

- Eliminate roosts or nesting sites
- Minimize food sources outside of bldngs
  - Landscape plants can be attractive
  - Garbage
- Use netting or screens under eaves or structures open to outside

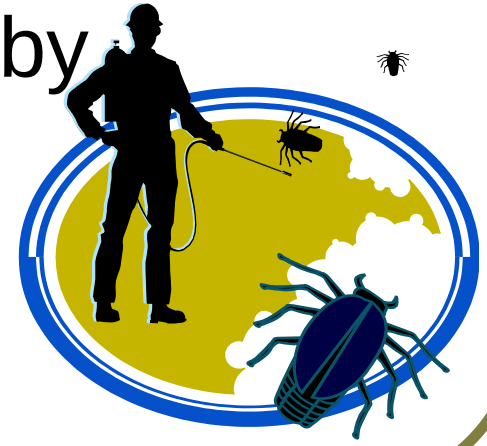


Insect control

- Physical
  - UV light attracts insects
  - Mount at right height / location
  - Charged electric grids kill insects
  - Sticky pads hold insects after impact
- Chemical
  - Handle pesticides with care
  - Use only approved chemicals
  - Don’t contaminate food
  - Use correct methods to target pests

Working with Contractors

- Pest control personnel must be knowledgeable / trained / licensed
- Draw up a plan for trap / bait placement
- Specify reporting to be done
- Hold contractor accountable by verification



Employees and Pest Control

- Don’t leave garbage lying around
- Replace traps that are out of place
- Place your lunches in designated areas only
- Let your supervisor know if you see evidence of pests