



Mekitec X-Ray Inspection – How to Get the Best Value from a Critical Control Point in Food Production

Mekitec Group
E-book

ABSTRACT

Food inspection industry has changed a lot during the last decade; in the past food producers often ended up choosing an affordable, yet limited metal detection method, and they were rarely able to invest in X-ray inspection as Critical Control Points (CCP) on individual primary packaging lines. Nowadays, thanks to a more accessible X-ray technology, both the consumers and the food producers can benefit from having this technology available for individual food production lines, creating the best value for all the stakeholders.

Today, production plants are more likely to either complement or completely replace the existing metal detectors on individual food production lines, thus taking quality control to a level beyond foreign object detection. There are multiple drivers for this change, e.g. food safety standards and trends that create expectations for improved inspections of packaged goods. Also, consumer awareness and the global reach of social media are raising food recall rates and increasing the interest in better detection accuracy and traceability.

The purpose of this e-book is to give a thorough understanding of the matter and provide information required for choosing a quality inspection solution with the best value for food producers today. The main goal of this book is to consider all the factors involved in a quality control implementation project, with a view to ensuring the highest return on investment.

CONTENTS

Abstract	2
Contents	3
1 Choosing a Food Safety System.....	4
1.1 Identify Your Needs	4
1.2 What Are the Costs.....	8
1.3 X-Ray Performance and Advantages	9
2 Implementing MEKI™ X-Ray System.....	11
2.1 What is the MEKI™ Concept.....	11
2.2 Performance	11
2.3 Lower Costs	13
2.4 Reliability.....	15
3 Conclusions.....	16

1. CHOOSING A FOOD SAFETY SYSTEM

Every food producer encounters the need to ensure and monitor food safety with inspections. This process begins with the comparison and validation of different inspection systems and vendors to find the best solution. Nowadays there are various inspection solutions available, from metal detection to vision technology, and this may seem a little overwhelming, especially if the food producer is not sure what they need and want from the inspection system and what these systems can achieve.

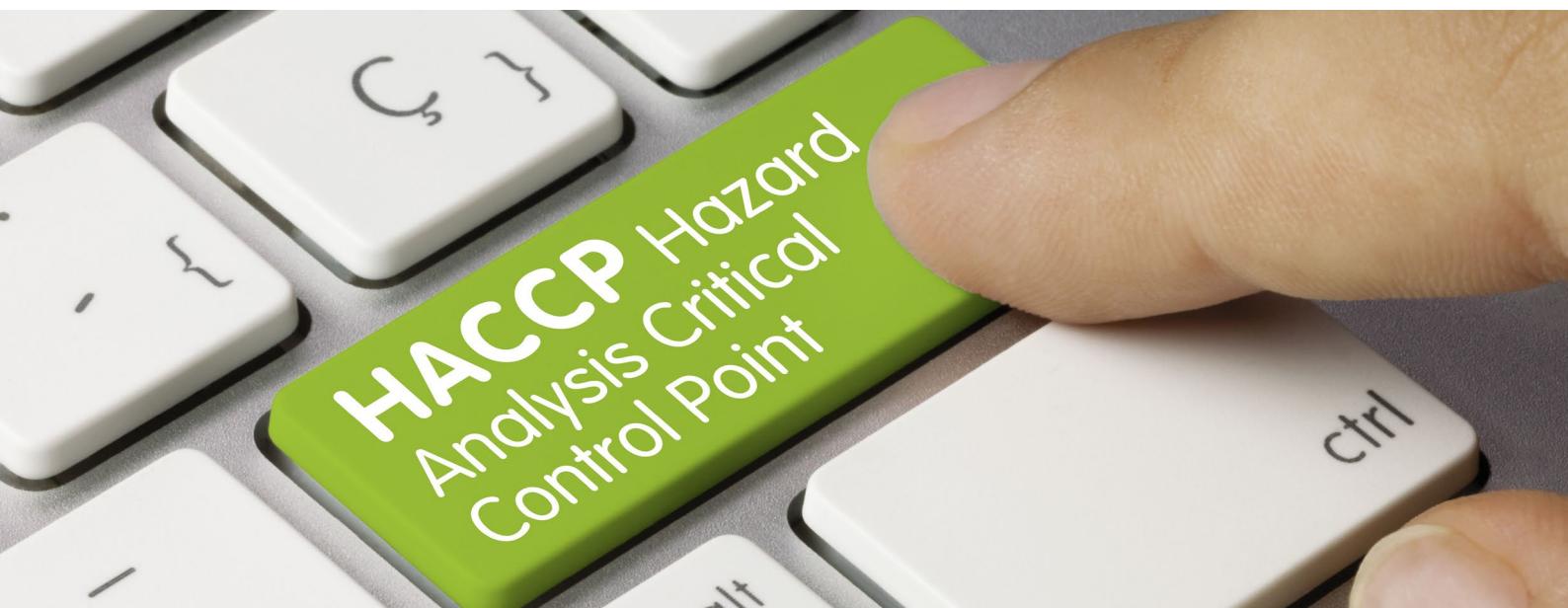
In this chapter, we break down the different factors that should be evaluated when planning the implementation of Critical Control Points.

1.1 IDENTIFY YOUR NEEDS

When starting their Critical Control Point (CCP) implementation project, food producers should have a Hazard Analysis and Critical Control

Points (HACCP) plan in place. Having the plan already prepared makes it easier to determine what the possible contamination risks are in the production environment. There should be a plan in place to avoid these contaminants and critical detection limits for the dangerous contaminants should be determined, because they are crucial for choosing the correct inspection solution for monitoring the critical limits.

Previously, the HACCP plans were mostly constructed around the detection of metallic contaminants but in many food industries the most common dangerous foreign object isn't necessarily metal. For example, in the snack industry, the risks may include stones from the field from where the raw material is harvested, and this must be taken into account in the HACCP plan.



Food producers may also have other inspection needs in addition to foreign object detection, such as detecting products or pieces of product missing from the package, in order to reduce the number of consumer complaints and to build a strong food brand.

At this stage, it is also crucial to evaluate the placement of the CCP. Food producers should consider the pros and cons of bulk/unpacked, primary or secondary packaging inspections to conclude which inspection method will bring the most value to their operations.

1.1.1 Foreign object detection

Foreign object detection is usually the first criterion when selecting any food inspection equipment. The inspection system should be able to detect and remove the dangerous physical contaminations identified in the HACCP plan without the risk of false rejection of conforming products or the failure to remove non-conforming ones from the production process.

Sometimes there can be an urgent need to upgrade the foreign object detection system because of an acute physical contamination that needs to be resolved quickly and which cannot be detected by the existing system, e.g. in the case of a metal detector and a non-metallic contaminant. Also, a new food safety standard that the food producer wants to adopt to boost exports or to win a new delivery contract can sway the decision toward upgrading the existing HACCP plans.

In both cases there should be an active HACCP plan in place. This plan helps food producers to determine the physical contamination risks in their production environment, along with helping to set the critical detection limits.

1.1.2 Total quality control

Even though foreign object detection is a crucial part of food quality control, the production methods, origin and over-all quality of products are now more important to consumers than ever before. They are more aware about food safety, but also expect food products to be of high-quality in terms of completeness, shape, integrity, and packaging. This drives food producers toward more comprehensive quality control systems, such as X-ray systems, which can guarantee the safety and quality of their products.



X-ray inspection also provides other valuable inspection features, e.g. the detection of a broken snack bar or missing filling inside a baked product. These features have been shown to bring additional benefits to food producers since they have reduced the number of complaints – while helping to build a stronger food brand.

When inspecting primary packaged products, the X-ray system also enables the producer to track products going through the system, trace possible contaminations and calculate pack rate and time stamp rejections.

In primary packaging lines, if a contamination is detected, the system will only reject a single package and not a whole carton, thus creating less waste and supporting more sustainable production. It also stores the X-ray image for true traceability that serves as proof for auditors and consumers alike.

1.1.3 Placement of the Critical Control Point

While there are many opinions on the placement of the Critical Control Point, often the best setup is to use a combination that fulfills the HACCP plan needs.

Some may argue that an inspection system should be placed at an early stage of the production process in order to inspect e.g. bulk/unpacked product flow, thereby reducing the number of systems required. For example, in the meat industry, it can be beneficial to inspect the product before slicers.

However, these systems cannot fully guarantee the safety and quality of the final product, since there are multiple possibilities for the product to be contaminated before it is packaged and sealed.

Also, many large retail chains require that products are inspected after packaging to make sure there aren't any physical contaminations in the product prior to shipping out. Costs are also higher for systems for bulk/unpacked product inspections as they need to meet stricter requirements in terms of washing and environmental tolerance.

Often, there is an assumption that installing an X-ray system can be costly or complicated, and food producers might be tempted to install only a few systems close to the end of the packaging process to inspect the secondary packaging. However, there are multiple reasons why installing an X-ray system to do the primary packaging inspection is much more beneficial and efficient and offers the best value for the investment.

Primary packaging inspection has proven to be more a reliable and cost-effective strategy for food producers to guarantee product safety and quality:

- Maximizes product safety – When the product is packaged and sealed, there is no possibility for further contamination. Many retail chains and food safety standards expect producers to inspect the final, deliverable products before shipping them out.
- Improves detection accuracy – Inspecting primary packaged products results in the detection of smaller contaminants but also decreases the amount of possible false rejections caused by large density variations within the inspected product.
- Enables total quality control – X-ray inspection offers valuable quality inspection features for analyzing the content of packaged products for any quality defects,

Benefits of Primary Packaging Inspection:

Maximizes product safety – Packaged food product ensures that there is no possibility for further contamination after the Critical Control Point (CCP)

Improves detection accuracy – X-ray is able to detect more accurately (with less false rejects and find smaller contaminants) at primary packaging

Enables total quality control – Content inspection functions offer the best value at primary packaging

Increases traceability – When inspecting single packages, the X-ray system can track products going through the system, trace contaminations, calculate the pack rate and time stamp rejections

Reduces waste – If a contamination is detected, the system will only reject the single package and not the whole carton or box

Extends X-ray system's lifetime – The primary inspection systems are usually much smaller in size, require lower X-ray power and less cooling

Ensures production efficiency – Primary packaging inspection offers the lowest risk in case of any failure



such as misshaped, broken or missing parts of the products and removing them from the production. This has been proved to reduce consumer complaints and build stronger food brand.

- Increases traceability – With primary packaging inspection, food producers are able to track products going through the system, trace contaminations, calculate pack rate and time-stamp rejections.

- Reduces waste – In case of a detected contamination or quality defect, the system removes the non-conforming product from the production line. Primary packaging inspection results in less waste compared to secondary packaging or bulk inspection, where other conforming products are removed at the same time.
- Extends X-ray system's lifetime – Primary packaging inspection systems require less

X-ray power, which enables the systems to be less costly and smaller in size. Lower power consumption also helps to extend the lifetime of the X-ray generator and detector, which are the higher-cost components in the X-ray system.

- Ensures production efficiency – Having only one or a few X-ray systems for unpacked/secondary packaging increases the risk of having a lower production efficiency in case there are any failures with these systems. Primary packaging inspection offers the possibility to direct the production through multiple packaging lines and reduces the chances of losing the total production efficiency.

Placing an X-ray system in the secondary packaging area (i.e. inspecting entire cases or cartons) might initially seem attractive, but the reduced detection accuracy and the higher maintenance costs outweigh the other cost-related advantages. Also, food producers cannot benefit from additional quality inspection features, if the X-ray system is placed in the bulk production or secondary packaging area.

1.2 WHAT ARE THE COSTS

In the past, one of the main reasons for food producers to choose a metal detector over an X-ray system was cost-related. For many years, X-ray inspection systems required higher initial investments, took a lot of space from the production and were difficult to operate and more expensive to maintain.

The approach involving comparisons of inspection solutions based on the initial investment cost and total cost of ownership is already outdated. Today, decisions are based on the total value of the investment; cost vs. benefits. Food producers all over the world are

seeking inspection solutions that provide the features and functions they need in order to operate most effectively in terms of foreign object detection and total quality control.

In this chapter, we will go through the initial investment and long-term operation costs associated with X-ray inspection systems.

1.2.1 Initial investment cost

The initial investment cost is usually the first thing food producers compare when evaluating different inspection solutions. This investment cost with X-ray often consists of the actual price of the equipment, possible add-ons (such as extra conveyors, rejection units and sensors), costs related to shipping and installing the system as well as training the operators. In some countries or states, there are also minor costs for the regulatory expenses such as the license cost.

Previously, food producers tended to choose metal detectors for their Critical Control Points because their availability was better, and the systems were more affordable than traditional X-ray inspection systems. However, modern technologies have enabled the development of compact and more affordable X-ray systems.

Companies operating in the food industry have noticed that X-ray inspection technology brings plenty of added value (traceability, performance, functions) and have started to implement more X-ray systems into production lines in all the different food applications. This is currently the fastest growing safety trend in the food industry.

1.2.2 Long-term operation costs

After the installation of an X-ray system, costs related to long-term operation are still incurred, like with any other production equipment.

These costs mainly consist of spare parts and preventive maintenance/servicing costs.

When selecting the right inspection solution, food producers should calculate the long-term operation costs and determine which equipment provides the best value.

With metal detectors, these costs are fairly low compared to traditional X-ray systems, where the high-cost parts are the X-ray generator and detector. Also, the consumable parts (e.g. conveyor belts and air filters) can cause costs to accumulate over time.

Contrary to an X-ray system, metal detector requires regular calibrations which increase the maintenance need and should be calculated as a part of long-term operation costs.

There are no major differences regarding energy consumption, and new X-ray systems are more compact, reducing the amount of power needed for the X-ray itself.

1.3 X-RAY PERFORMANCE AND ADVANTAGES

Up until a decade ago, production lines were mostly equipped with metal detectors as the Critical Control Points. X-ray inspection systems were considered expensive and complex to use. Hence, many food producers settled for metal detection, which was fairly inexpensive in terms of initial investment and long-term operation costs.

Technology and solutions have developed greatly since then. Inspection needs and requirements in the food industry have changed, becoming even more demanding. Food producers do not seek systems for foreign object detection only; they also want additional inspection functions that help them collect data, increase traceability and reduce customer complaints by removing non-conforming products from the production line, thus delivering only products of the highest quality to the customers and consumers.



Metal detection technology is based on reactions to the changes in a magnetic field caused by the conductive and magnetic properties of metal. Usually metal detector heads are very compact and can be placed even on top of a production line, but the magnetic field requires a metal-free zone around the detector. This takes up valuable space from the production line and the risk of disturbances caused by the environment cannot be totally eliminated.

On the other hand, X-ray technology is based on the inspection of X-ray intensity differentials, to which the density and physical attributes of the material affect. This enables the system to detect also other contaminants, in addition to metallic ones. Such contaminants can be glass, stones or high-density plastics. And since the detection is based on measurement of X-ray intensity, the X-ray inspection system is able to detect smaller contaminants than a metal detector.

For example, stainless steel (SUS316) has a density of 8.027 g/cm³ (i.e. about eight times the density of water), which makes it easy for the X-ray system to detect even small pieces of stainless, and the same applies for ferrous and non-ferrous steel. In many cases, the smallest contaminant that an X-ray is able to detect is less than 1mm in size, and it can achieve this in a real-life production environment.

Since X-ray inspection technology is based on measurement of X-ray intensity variations, rather than the magnetic properties of metal, product inspection with X-ray is easy and effective – irrespective of the packaging type. Also, with X-ray inspection, food producers are able to change the packaging type to e.g. metallized film later on without causing

disturbances in the inspection. This versatility is something that food producers should bear in mind when choosing a suitable inspection solution.

X-ray inspection enables total quality control of food that goes beyond inspecting the products only for metallic foreign objects during production. This complete quality control encompasses detecting metallic and non-metallic contaminants, checking for missing products, fill levels, and the presence of components in the package, product counting and reporting etc.

As mentioned earlier, the placement of the inspection system plays an important role in the detection performance; when the inspection system is placed in the primary packaging area, food producers can benefit from all the valuable functions that X-ray inspection has to offer, such as content inspection (e.g. fill level monitoring, shape and integrity inspection) and a more accurate detection rate.

Additionally, X-ray systems collect more data and store images throughout production to ensure full traceability. Producers can easily determine the reason for any rejection from the X-ray image. These images and production line data are utilized in the development of production efficiency and food safety processes.

2. IMPLEMENTING MEKI™ X-RAY SYSTEM

Mekitec commits to deliver the best value for its customers by providing food X-ray inspection systems that are excellent in terms of performance, compact in size and easy to operate. We have developed our food X-ray inspection systems together with the food producers to make sure that they meet the actual needs.

The key components of our X-ray systems are developed in-house by our X-ray technology experts, and in close co-operation with our partners and suppliers. Our inspection software offers the best user experience to all of our customers. These factors create the accurate and easy-to-use X-ray inspection systems that Mekitec provides to its customers.



2.1 WHAT IS THE MEKI™ CONCEPT

The MEKI concept was created to change the way food quality control used to be carried out. The available inspection solutions were limited to affordable metal detectors able to detect only metallic contaminants, or expensive, complicated and space-consuming X-ray inspection systems that were difficult to implement and operate.

When the MEKI concept was introduced in 2011, Mekitec was the first X-ray provider able to offer significantly lower investment costs for their customers with a high value system. The initial idea behind the concept was to provide food producers a better inspection solution based on X-ray technology, but with investment levels closer to those for a metal detector. The systems are designed to replace or complement the existing metal detectors on individual primary packaging lines where the detection performance and quality inspection features create the most accurate results and best value for the user.

2.2 PERFORMANCE

When MEKI was released, it was the first truly compact X-ray inspection system, changing the food quality control market. Our most compact system model only requires around 1 meter (3.3 ft) of valuable production line space, which makes it easy to implement even for existing production lines that need comprehensive Critical Control Points.

As MEKI systems are equipped with very small (0.4 mm) pixel size detectors, they are able to detect contaminants much smaller than 1 mm. However, it is important to remember that



detection performance varies depending on the production environment/speeds, and the characteristics of the product being inspected. Mekitec always conducts thorough Application Tests with actual products to demonstrate the detection rate that MEKI system can offer to the customer.

On top of traditional foreign object detection, MEKI X-ray systems can simultaneously perform various quality checks for the food package. These checks are developed to analyze of the X-ray image, and they can detect defects such as misshaped, broken or too short products,

Benefits of MEKI X-ray Inspection System:

- Overall quality inspection through the detection of quality defects in the product without breaking the package. This covers the verification of e.g. filling, different parts, length, shape or correctness of the product.
- Detection of other, non-metallic, and even low-density contaminants, such as glass or stones.
- Low lifecycle costs/total cost of ownership (TCO) guaranteed by our service agreements and spare part kits.
- Fulfilment of the global food safety requirements, such as BRC Food Safety Standard and FSMA, and even exceeding them.
- Meeting consumer expectations regarding the quality of the food products.
- Providing true traceability for the food producer.

missing parts, and even verify the presence of filling inside individual confectionary candies.

These quality inspection features were developed together with food producers around the world to guarantee that their inspection needs are truly met.

Also, an important part of the MEKI experience is the user-interface. By emphasizing the user-friendly features, we make sure that the system is clear and easy to operate.

2.3 LOWER COSTS

One of the main goals with the MEKI concept was to offer X-ray systems at a reasonable investment cost, as well as competitive lifetime costs. We wanted to make it a true alternative that offers better inspection performance and is accessible for small and large food producers alike without them having to make compromises with the CCP placement in the production process.

Our systems are designed to deliver exactly what the customers need, without the need to pay any extra for features that are designed for a different industry or application. In this chapter, we investigate further what the initial investment cost of the MEKI system consists of and what the long-term operation costs are.

2.3.1 Initial investment cost

Mekitec was the first food X-ray system manufacturer able to significantly lower the initial investment costs compared to other traditional, similar tunnel-sized food X-ray inspection systems.

The founders of Mekitec have a background in X-ray detector development and this in-house expertise made it possible to develop our own X-ray detector, which is one of the high-cost components in an X-ray system. By developing the detector in-house, we were able to ensure that it suits our MEKI concept of providing the best value. The small and compact system size made it possible to have the detector inside the conveyor and closer to the generator, reducing the need for power and creating a better image.

Thanks to the detector development, MEKI systems can use a low-power X-ray generator that reduces costs in X-ray shielding (i.e. less material needed) and of the generator itself. Low-power generators have a longer lifecycle

compared to higher-cost X-ray generators with higher power requirements, which plays an important role in the long-term operation costs.

Combined, these factors provided unique benefits and made it possible to offer food producers across the world more cost-efficient X-ray technology designed to be implemented where X-ray detection works best: at primary packaging lines.

2.3.2 Long-term operation costs

While X-ray systems work continuously to guarantee food safety, there are operational costs involved, and like with every system on the food production line, eventually they need some service and new parts.

It's important to proactively plan for annual preventive maintenance visits as well as for the necessary spare parts and training. Our local and global service networks enable us to offer the lowest long-term operation costs and fast response times. By maintaining Mekitec systems according to the recommendations, you can be sure to achieve the best value, safety and performance throughout the system's lifetime. Training of operators and maintenance team guarantees that everyone is familiar with the X-ray system and technology.

Long-term costs can be calculated from:

- Spare parts and system warranty
- Maintenance costs and service contracts

To support the MEKI concept, we have created transparent spare part kits making it easy for the food producers to calculate their long-term operation costs for parts:

- Consumables kit
- First response kit
- X-ray generator and camera kit

Spare part kits give our customers more flexibility by having only the necessary parts in stock with a predictable and low investment. We recommend having a consumables kit in stock at all times to ensure that the system is always in top condition. Depending on the number of Mekitec systems installed at one location, the first response kit minimizes downtime should any problem occur.

Mekitec focuses only on X-ray quality control systems and this makes it possible for us to optimize our costs of generators and detectors. Therefore, we can keep costs at a considerably lower level compared to the standard pricing on the market, while providing excellent performance in terms of detection accuracy and the total cost of ownership.

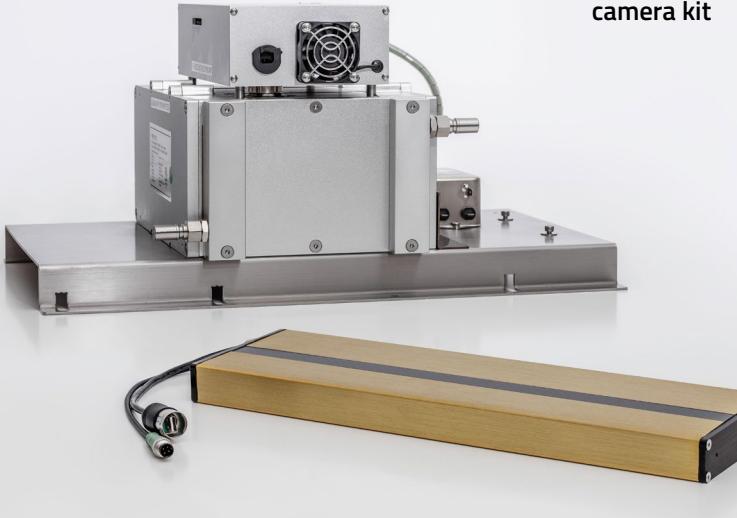
In addition to spare parts, we're committed to offering the market's leading warranty terms in order to ensure that our customers get the best value when they purchase MEKI X-ray systems. Unlike with other systems on the market, we offer a full 2-years warranty for the complete

X-ray system, excluding the consumables. We also complement this by offering a low-cost extended warranty for the X-ray generator, adding up to a total of 4 years of warranty for this main component.

With our service package agreement, you can ensure that any additional maintenance work, annual service checks, upgrades, trainings or spare parts are available based on your specific needs. Also, a Key Customer Portal access is available for customers who wish to be able to view the systems they have installed, and prioritized support tickets related to them.

Long-term operational costs should also be taken into consideration if the conditions or products on the food production line change. Mekitec X-ray systems and options are designed to work as versatile platforms that allow some changes without the need for unnecessary investing in a new system. This further increases the service life of our systems on the food production lines.

X-ray generator and camera kit



Consumables kit





There are several factors that affect the reliability of an inspection system:

- Operational reliability, meaning that the system and its add-ons perform well and there is no need for unexpected replacement of the critical parts (e.g. X-ray generator or detector).
- Detection reliability, meaning that the system detects the controlled foreign objects within the critical limits set in the HACCP plan without any problems.
- Rejection reliability, meaning that any products with some detected contaminants are effectively and automatically removed from the production flow without affecting production efficiency or generating false rejections.

2.4 RELIABILITY

Reliability is at the heart of decision-making when a product safety and quality inspection system is being selected. Food producers need to be able to rely on the equipment to work as intended without unnecessary interruptions to their production operations.

It is important to consider implementing additional add-ons to improve the reliability of the inspection system and to extend the system lifecycle, e.g. air conditioning for hot environments or higher IP class in environments that require full washdown, when installing a quality control system to a food production line. Also, annual servicing and preventive maintenance ensure that the systems perform

at the expected level at all times, minimizing the risk of production line down-time. By checking the system and its critical parts, i.e. X-ray generator, detector, radiation shielding and other main components, we make sure that the system's detection rate and lifecycle are optimal, allowing inspection to continue without unnecessary interruptions to production.

To further increase the reliability of the critical control point and quality control functions, food producers can choose to implement an automated rejection unit and reject confirmations. These features add reliability as the X-ray will then self-monitor all rejections to make sure that they are correct and alert the operators if there are any problems.

3 CONCLUSIONS

It is clear that a well-thought-out Hazard Analysis and Critical Control Points (HACCP) plan works as a good basis for starting a project to implement a food inspection system. When deciding on the right solution, food producers have multiple different inspection technologies to choose from, each with their different advantages and purposes.

As established in this e-book, X-ray technology provides great additional value in comparison with any other inspection method, like metal detection, and the best results and value are achieved when X-ray inspection takes place at primary packaging stage of the food production line.

In the past, implementing X-ray inspection in individual primary packaging lines was not feasible for all food producers due to high initial investment costs and long-term operation costs. It was more common to implement either metal detectors for inspecting the primary or secondary packaging or only a few X-ray

systems to inspect unpacked/bulk food or the secondary packaging line.

To change this, Mekitec developed the MEKI inspection system family making X-ray technology available for small and large food producers alike. Feedback from different food industries was collected to ensure that MEKI X-ray is a truly attractive option and will change the way food quality control is performed.

Mekitec provides food manufacturers with compact, easy-to-use X-ray inspection systems that provide excellent performance and the best value in the industry. And what's more, the systems offer low initial investment and long-term operation costs, excellent foreign object detection and total quality control performance, unparalleled traceability tools and reliability. In other words, all the factors that ensure the highest return on investment and guarantee safe food.

NOTES



Mekitec Group

Mekitec is a global manufacturer of innovative quality control systems based on X-ray technology for the food industry. We are committed to ensure safe food by providing inspection systems with the best value in the industry.

Our MEKI™ X-ray systems are a part of the food production line guaranteeing the quality by detecting and removing food products that contain unwanted foreign objects or other defects by using the latest X-ray imaging and processing technology, resulting in 100% food quality control.

For more information, visit our website at

www.mekitec.com