Top 5 Considerations

When Upgrading From Metal Detection To X-Ray Inspection

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Surprise objects in food — and the disgust, anger, and fear they create — can evolve into viral news faster than you can say "**recall!**" If the foreign object happens to be broken glass, a hypodermic needle, bone, or stone, the item could have been caught during processing by an X-ray detection system.

The good news is food processors are increasingly upgrading from metal detection to X-ray systems to strengthen their foreign object detection programs. Metal detectors, historically the most common detection method, can only uncover metals. X-ray detection works by revealing differences in density. Therefore, X-rays can find a broad array of inorganic objects, including metal, quite effectively.

As the reliability, capability and affordability of X-ray systems have improved over time, food processors are finally able to benefit from X-ray's ability to detect a broader range of contaminants and analyze for other packaging anomalies. Not only can X-ray detect a greater variety of objects and metal, but X-ray systems offer additional quality control inspection options (e.g., counts, virtual weighing, fill levels) within one unit.

WHAT TO CONSIDER WHEN UPGRADING
Selecting the best detection system for your food processing operation requires evaluating a number of factors. The right solution depends on your needs, budget, and the fit within both your production line and compliance program. The five key areas to evaluate are as follows:

1. Targeted Foreign Objects
To select the best detection system for your needs, you must first identify the types of foreign objects with potential to be in your food products.

For **protein products**, bone detection is a big driver in making the switch to X-ray. Not only can X-ray detect calcified bone down to 1.5 to 2 millimeters, but it also can detect metal at two to three times smaller than metal detection, plus the additional dense, dangerous contaminants which have potential for consumer injury. Typical detection targets for protein products include:

- **calcified bone**, a byproduct of the slaughter process
- **hypodermic needles**, a result of broken injection equipment during veterinary procedures
- **injection needles**, a result of broken needles from marinating systems
- **buck shot or bird shot**, the outcome of accidental or intentional shooting

- **metal objects** (wire, shavings, screws, nuts, bolts, or other parts) originating from equipment, or from slaughter (knife pieces)
- **barbed wire** and other objects imbedded in beef tongue
- **stones or grains of sand** introduced from chicken gizzards during slaughter
- **PVC or TFE** from wire stripped during electrical maintenance

For **mechanically harvested products**, contamination can be introduced in the field at harvest time and during transport and storage. Typical detection targets include:
- **broken pieces of glass**, which can originate from multiple sources including bottles left in the field and picked up by harvesting machinery
- **stones**, a common contaminant in root vegetables, peas, beans, grains, sun dried tomatoes and products containing vegetables
- **metal objects** (wire, shavings, screws, nuts, bolts, or other parts) originating from equipment.

TARGET OBJECT	FOOD SOURCE			DETECTION METHOD	
	Protein	Harvest	Prepared	Metal	X-Ray
calcified bone	✓		✓		✓
glass	✓	✓	✓		✓
stone		✓	✓		✓
buck shot/bird shot	✓		✓	✓	✓
hypodermic needle	✓		✓		✓
metal object	✓	✓	✓	✓	✓
metal dust				✓	
PVC plastic					✓
teflon					✓
virtual weight	✓	✓	✓		✓
missing and/or damaged items	✓		✓		✓
cartilage, wood, hair, fingernails, rubber gloves, certain plastics, cardboard					

FOREIGN OBJECT DETECTION — Comparison of X-Ray vs Metal Detector

Prepared products, a combination of protein and harvested products, need to be targeted for both sets of foreign objects above.

While X-ray is especially strong for detecting dangerous hard objects like glass, hypodermic needles, calcified bone, stone, and metal fragments, it cannot detect organic materials or items with similar density to food products. X-ray systems cannot detect hair, fingernails, insects, rubber gloves, and cardboard — and neither can metal detectors.

See the table on the prior page for a comparison of capabilities of metal detection versus X-ray.

2. Cost-Benefit Analysis

Economy Versus Performance Technology

In considering the upgrade to X-ray, the initial price of the equipment is one of the cost considerations. Affordable economy X-ray options are competitively priced to metal detection equipment but offer additional benefits. Performance level X-ray models with higher resolution and detection accuracy are also available. The high-performance lines of X-ray equipment typically come with standard software features that can add additional quality inspections beyond contaminant detection and detect contaminants at a significantly more finite level.

FSMA: Food Safety Modernization Act

The recent implementation of FSMA requires processes to be proactive rather than reactive. FSMA requires food processors to identify and eliminate known potential risks. X-ray technology is being increasingly used as a preventive control to assure a better product is delivered safely to consumers and to meet FSMA requirements.

Risk Avoidance

Upgrading to X-ray is an investment in protecting your consumers, customers, and brand equity. What is the risk of not detecting the types of foreign objects present in your product? Is there risk of reputational harm? Is there risk of injury, compensation claim, or recall? Is there risk of losing an important customer?

Cost Elimination For Complaint Handling

Very often, improving your detection program reduces costs related to customer complaints or cost of replacing unsatisfactory product. How many complaints do you currently receive per month? What is the cost of consumer dissatisfaction in terms of handling the complaint, the potential for a lost consumer, and the negative social sharing or publicity?

Machine Reliability And Longevity

Similar to other types of complex equipment (e.g., automobiles and appliances), some detection equipment brands are more reliable and have better longevity than others. Reliability translates into more uptime and lower maintenance costs. Longevity factors into the lifetime cost. The company's installation base is an excellent example of design and reliability.

Parts Replacement Costs And Timeline

The longevity of expensive replacement parts, such as the X-ray tube, factors into the lifetime cost. The recent long life technology improvement for X-ray tubes (similar to the longer life offered by LED technology for the lighting industry), is transforming the lifetime cost calculations for brands of X-ray systems who apply this technology.

Protection Of Production Equipment

Can the detection equipment reduce damage to production equipment and downtime, and the associated costs? Using X-ray to inspect incoming blocks of meat for metal and large bone inclusions protects processing equipment and reduces the possibility of creating many smaller objects from that one large contaminant.

3. Operational Efficiency

Since foreign object detection takes place during a production process, the detection system needs to be reliable and accurate enough to not slow production time or cause downtime on production lines. Factors to consider for operational efficiency include:

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Accuracy — Detection equipment accuracy is important to maximize productivity. Equipment with high detection repeatability without false rejects optimizes production uptime and limits the cost of wasted product and packaging materials. The production team must trust the detection and rejection of the system for it to be an effective quality control tool.

Ease of Use — With new machinery on a production line, ease of use is a concern for operators, maintenance, and quality assurance employees. Fortunately, X-ray machines are often easier to use and understand than metal detectors. Other factors to consider are ease of assembly, repairs and preventative maintenance.

Versatility — If you need to run different products on the same production line, a limitation of metal detection equipment is its lack of flexibility. The aperture for metal detection equipment is fixed based on the size of a predetermined product. Whereas metal detection equipment cannot be maximized for different products, X-ray technology is more versatile. X-ray power can be adjusted to accommodate for changes in density and, therefore, detection can be maximized for running different products on the same line.

Stability — Another drawback to metal detectors is their sensitivity to environmental influences including product temperature, product orientation, vibration, and radio interference. All of these can interrupt the work of the detector. X-ray detectors are not impacted by environmental influences, nor are they sensitive to fresh or frozen states of the product like metal detectors are.

However, X-ray does require consistent density through the machine if set for that specific product. X-ray systems are set for either a specific product run or a random product run and can be adjusted for increases or decreases in density. If a significant density change happens during a dedicated production, which is typically a production issue that needs to be identified, additional suspect rejects will occur based on product presentation rather than an actual contaminant.

4. Production Line Integration
To meet your detection goals, consider the location of the equipment on the production line, the footprint size, and where it will fit. For example, maximizing stone detection may be best suited within a bulk flow format, but some installations are installed at the final package to assure no additional contaminant can enter. In general, X-ray systems

ADDED VALUE OF X-RAY SOFTWARE INSPECTION TOOLS FOR PREPARED FOODS

Additional inspection capabilities are standard on most high definition X-ray software systems. These inspections are performed simultaneously with the foreign object detection, without slowing production.

Detection Through Foil Packaging
X-ray systems are able to detect through aluminum and metallized packaging materials whereas metal detection cannot inspect most of these packages due to the interference of the metal package.

Virtual Check Weighing Or Weighing By Zone
During X-ray inspection, virtual weighing can be used to estimate product weight within 97 to 99% accuracy of the label weight to reject gross underfills. Bagged trail mix is a good example of a product that would benefit from this.

Another application is virtual weighing in locations where weighing is needed but the footprint does not allow for the size of a check weigher.

Virtual weighing can also be applied within zones of a multi-pack product. Weighing by zone can provide a higher level of accuracy than weighing a whole package of multiple products.

Missing Components
X-ray software can detect missing items in packages where multiple products have separate and predictable compartments. Examples of applications for this feature include a box of chocolates, a carton of eggs, a "TV dinner" tray, a case of yogurt cups, and even a display pack of gum.

Broken Components
X-ray software can detect a broken or missing piece of product. A broken cookie lying flat and within a specific zone is a good application for this capability.

Shape Detection
X-ray software can also detect a product with an abnormal shape. For example, if a cookie is supposed to be round, but ends up square, this can be detected.

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tend to be shorter in length than metal detection solutions and equipment size can vary by brand.

Lightweight products require special consideration for X-ray systems. Whereas a metal detector is basically a rectangular box with an unobstructed opening for the product to move through, X-ray systems require curtains for X-ray containment. With X-ray detection, lightweight products (for example, a small bag of popcorn) can be impeded by the safety curtains of the system. Lighter products require a unique solution, which can be accommodated, but may require additional space.

5. HACCP Integration
Finally, consider how the detection equipment will integrate with your HACCP (Hazard Analysis Critical Control Point) program. Some customers choose to maintain a metal detector on the line as the Critical Control Point, while adding an X-ray detector to strengthen their program. However, if you are replacing the metal detector with X-ray, consider the time required to rewrite the HACCP program.

CAN X-RAY DETECTION IMPROVE THE SAFETY OF YOUR FOOD PRODUCTS?
An effective foreign object detection program benefits the food processor, customers and consumers alike by providing safe food. When evaluating the decision to upgrade from metal detection to X-ray detection, the five considerations above will help you make the decision that works best for your products, budget, and operational needs. ●

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