

WHITE PAPER:

# X-ray Inspection

## Do I need X-ray inspection, and how can I ensure I get the right machine?



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A variety of reasons lead companies that pack food to invest in X-ray inspection systems. Some see them as an essential tool for managing risk, others believe they will help improve quality, and yet others see them as a marketing tool for managing their own reputation.



### What can an X-ray inspection system do?

X-ray inspection picks up inconsistencies in materials. In a pack, or in a flow of product passing a given point, it can detect pieces of bone, stone and glass and of metals such as iron, steel, stainless steel and aluminium, as well as many plastics, such as Nylon, PVC and Teflon. The minimum size of particle that can be detected varies from one material to another, and also depends on the sensitivity of the system.

Foreign bodies are not the only inconsistencies an X-ray system can spot. Voids and broken or missing product pieces show up clearly, opening up whole areas of quality control. These inspection systems can be used to detect a full range of inconsistencies in products packed in cans or in metallized film.

X-ray inspection can also perform a number of other functions, from estimating piece weight to measuring the fat content of meat. While we will mention these in the context of price, this article mainly concerns inspection for foreign bodies and product imperfections.

### How it works

An X-ray beam is passed through the item to be inspected, and a photodiode array on the other side of the item picks up the radiation that gets through. The photodiodes give out a voltage or current signal depending on the level of X-ray that they detect, which is then converted into a greyscale image that can be easily saved.



If inclusions are present which are denser than the product, these will show up as darker patches, where less X-ray radiation was able to get through. Voids and fissures will show up as lighter, as more radiation is able to penetrate.

The system can be set to automatically reject items that have either type of defect.



### A tool for risk-management

Proper management of risk always involves assessment of what exactly could go wrong, the effects it might have and the likely consequences, including costs. Legislation often demands that a food business take reasonable steps to prevent such events. This naturally leads one to examine the possible prevention steps and to assess their cost.

### What can go wrong?

Foreign bodies in food products can lead to a variety of outcomes among consumers, ranging from mild disapproval and a slight loss of confidence in the product through painful incidents (such as broken teeth) to severe health hazards. Even minor incidents can lead to complaints, while private or criminal legal action often results from illness or death.

Action or complaint on the part of victims or their families may involve the retail outlet, the manufacturer and indeed any point in the supply chain, with damage to the reputations and brand names of all concerned. Actual financial damages can of course range into the millions.

Even if the contaminated item is spotted by the retailer before it can reach the consumer, suppliers can still suffer the cost of product sent back by the retailer, which may include hefty fines. In such cases, the supplier may lose its contract, or at least find that its reputation in the retailer's eyes is severely damaged.

### A means of improving quality

As mentioned previously, X-ray inspection can pick up imperfections unrelated to contamination.

These include:

- Voids or gas bubbles
- Undersize or missing pieces of product
- Underfilled compartments in ready meals
- Product with cracks or fissures
- Agglomerations (grains stuck together) in powdered products
- Metal ties or other securing devices missing or out of place.

The system can also estimate the weights of individual items in a pack, if these are sufficiently separated. This enables rejection of packs which have underweight pieces.

Many of these occurrences can be used to pick up problems from the manufacturing stage (for example, if a product is cracking, is this due to moisture loss prior to packing?) and to enable them to be corrected. All-in-all, the availability of X-ray inspection is revealing new quality parameters that can be checked, as well as making existing parameters easier to check at high speed. The result can only be that food quality will improve in a whole variety of ways. X-ray inspection will initially confer a competitive advantage on those who use it, but will ultimately raise standards and take competition to a higher level.



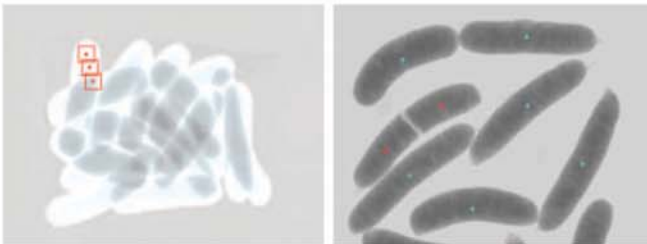
### The cost of not having X-ray inspection

Clearly legal action arising from dangerous contamination is the chief concern justifying expenditure on X-ray equipment.

Just as costly, however, can be a spurious claim, when a confused or dishonest consumer asserts, for example, that a tray of salad contained a dangerous foreign body, and offers the pack in evidence. Enterprise resource or other data systems linked to X-ray inspection and to labelling can

enable retrieval of the X-ray of that precise pack, establishing beyond doubt whether or not it contained any stone, glass or metal.

On another level, poor quality, such as the voids and fissures mentioned above, can also damage brands by spoiling the consumer experience. But if they do not result in complaints, widespread low-level discontent may go unnoticed, with costly effects on product sales. X-rays provide a way of seeing the product inside its pack, as the consumer will see it.



### Marketing your reputation

Perhaps the most common reason for purchasing X-ray equipment is to demonstrate that one is practicing due diligence with respect to product safety. When metallized film or foil packaging are involved, having an X-ray system is nowadays reckoned to be best practice.

Even where a packing operation can get by without this technology, having it in place confers an advantage. Nobody is more conscious of their reputation than supermarkets and other large retailers. Many of these companies will either prefer suppliers who use X-ray over those who do not, or simply insist that all of their suppliers use it.

As always, there are companies who want to be more technologically advanced than their competitors even when there is no real pressure to do so. It is hard to condemn this attitude: while nobody should spend beyond their means, this 'advanced technology' positioning is a valid and recognized one, and may help in attaining financial success.

### What to spend

Inspection systems have become less expensive in recent years but still range in price from about \$45,000 to \$195,000, so it is important to be clear about your reasons for acquiring the technology. If it is purely a risk

management measure, you need to assess the likely contaminants, and form an opinion as to the range of costs that an incident might involve. If it is for quality control or reputation management, you have the more positive task of calculating what you might gain, for example by supplying chicken fillets which you can guarantee to be bone-free. Of course it may well be for all these reasons.

Having any kind of system, even the very cheapest, may enable you to claim that your products are X-ray inspected. However, retailers will want to be confident that your system is sufficiently sensitive and can be relied on. Some may even want to know which brand you have purchased, so it would be wise to select a manufacturer whose name has some recognition for quality and for food industry experience.

For risk management, sensitivity is the key issue. You should set levels (i.e. minimum particle sizes) for the contaminants you most need to guard against, and reject all systems that cannot detect these levels.



### Factors affecting price

It is important to have an inspection system adequate to the tasks in hand, but to avoid paying multiples of the basic price for 'bells and whistles' that add capability which you may never use.

Size is the first area to be concerned about. You should ensure that the system you purchase delivers an inspection beam that will accommodate the largest products you routinely produce on the line in question. Unless the need exists to future-proof the production line against larger packs, anything larger will escalate the price for no great return.

Dual sensor machines, which examine the transmitted X-rays at two different energy levels, can deliver greater sensitivity.

This technology can also be used to analyze fat levels in meat, but is expensive and is not always suitable for smaller products. Similarly twin beam models, which examine the product from two different angles, can increase detection power in certain types of products, but at considerable cost.

Extras which you may need can often be delivered by clever software, which means the cost over and above the most basic machines is not greatly increased. These include increased sensitivity, achieved by processing the image using special algorithms. Counting software allows you to keep track automatically of the number of pieces in each product, while weighing software estimates product or piece weight.

Even the most basic models often go beyond simple detection, and offer features such as masking (the ability to apply full sensitivity to areas under investigation while 'ignoring' items that form part of the packaging, such as clips and ties).

### Running costs

The most significant consumable in an X-ray detection system is the X-ray tube, responsible for generating the inspection beam. Modern tubes can last for years, depending on tube quality and the amount of use.

### Operator skill levels required

Since operator time is an important cost factor, you should check that the interface is easy to learn and use and that there are no lengthy set-up or calibration procedures.

Take particular care that any critical features of the inspection system you choose can be readily mastered and quickly adjusted by your operators. Some systems, for example, allow 'fine tuning' to make them more sensitive to specific, expected contaminants. You should not have to call in the supplier each time you want to vary such settings.

### Image storage and retrieval

If you wish to operate full traceability, you need to capture and store an X-ray image of every inspected pack. These images, with associated pack data, including time and date stamps, must be reliably retrievable on demand. Under these circumstances you need to be sure that the system you choose both has the right internal capabilities and can interface readily with your own data resource systems.

### How safe are X-ray systems?

As you might expect with a technique that is now so widespread, X-ray inspection has become a very safe part of the packing line. Radiation is contained in the inspection chamber and protected by the geometry of the machine itself and by special curtains, made from the material used to protect radiographers in hospitals. An operator should not be able to receive a significant radiation dose, even by deliberately inserting a hand into the chamber, as machines should be provided with full infeed and outfeed tunnel guard systems to stop this from happening. The radiation dose absorbed by inspected food is also insignificant.

Nevertheless, all due care should be exercised and any regulations on training or monitoring scrupulously observed. You should also ensure that you provide any monitoring of the equipment or its operators that local regulations demand.

### Choosing a supplier

As with any equipment purchase, the buyer is not just purchasing a piece of equipment but also entering into a long-term relationship that includes up-front application assistance, training, parts supply, and technical support. Choose a reliable supplier that you feel comfortable with and that offers ongoing assistance.



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