DAIRY PRODUCTION: ELIMINATING FOREIGN BODY CONTAMINATION AND ENSURING BRAND INTEGRITY

Introduction

Contamination of product with foreign objects is a permanent threat to the dairy sector and its implications can be deeply unpleasant, not only for any consumers unfortunate enough to encounter the contaminated goods, but also for the manufacturers themselves.

Around the globe, food safety is enforced through a raft of regulation and legislation, with responsibility beginning in the field and ending long after the point of sale.

Contamination with foreign bodies (Fig.1) can occur at any of these points; it may come from processing machinery, factories, transportation, or via the addition of non-dairy ingredients. This means that in the dairy sector, legal and reputational risk extends to processors, manufacturers and retailers alike, and all have a vested interest in keeping dairy products contaminant-free.

For dairy producers that supply major retailers, the risk is particularly acute. This is because those retailers may impose substantial fines or other penalties upon suppliers when contamination with a foreign object occurs.

Retailers and food producers have brands to protect and that brand is a lucrative asset. So naturally, they seek to ensure the highest possible standards in the dairy products they provide, particularly if those go out under their own label.

The negative publicity via the press or the fast-moving social media landscape can often be nearly as costly to a brand in terms of damaged reputation and lost revenue as that of product recalls.

In practice, this means risk-sharing: retailers will often only contract with suppliers if those suppliers adhere to rigorous protocols intended to minimise the risk of contamination.

Historically the retailers “Codes of Practice” were very prescriptive in specifying how food producers have to achieve the desired foreign body detection in their plants.

However this is now starting to change with retailers increasingly indicating an acceptable quality level and leaving it to food producers to implement the required processes and equipment to meet these standards. This has placed a much greater responsibility on dairy producers to have the expertise required within their facility – or through their supply chain – to ensure suitable foreign body detection systems.

Fig.1: Typical foreign bodies which can be found in dairy products: metal, glass, rubber, stones and ceramic.

WHY DAIRY PRODUCTION PLANTS NEED AN IN-LINE **INSURANCE POLICY**

Since 1998 all food businesses have been legally bound to have a food safety management system based on the principles of the Hazard Analysis and Critical Control Point (HACCP) system.

This means dairy manufacturers are required to safeguard the quality of their final product by identifying potential hazards and minimising any associated risks, which would include preventing contaminants in products.

What are the options available to dairy producers for contaminant detection?

For dairy producers looking to detect foreign bodies in their products, there are a variety of options available, with two main technologies to consider.

- **Metal detection**, which has been used in food manufacture since the 1950s.
- **X-ray technology**, is a more recent innovation but now firmly established as an excellent way to enhance technical performance in preventing foreign body contamination.

Metal detection

Metal detecting machines (Fig.2) have been used in food manufacture for more than sixty years now and retain several of the advantages that made them so popular in the first place.

They are established, reliable, easy to maintain, require a low initial investment and are simple to install.

For those smaller independent businesses, metal detection offers an ideal method of quality control, which is why it's remained a popular option for many companies for a number of years.

As their name implies, however, metal detectors can only detect metal: if the dairy product is contaminated with stones, glass, plastics, rubber, or anything else that isn't metallic, the metal detector will let it through.

And even if the foreign body is metallic, the metal detector may still miss it, for example if the contaminating item is smaller than the sensitivity set for, or achievable by, the detector – which can be a particular issue for dairy products with high moisture and salt content.

Detectors may also have problems finding metals according to their ferrous or non-ferrous nature: it is easier for them to pick up a ferrous metal than a non-magnetic metal such as stainless steel.

So, while a detector may be able to find a ferrous metal particle of 1.5mm, a foreign body made of stainless steel may have to be 3mm or greater to be detected by the same machine.

Metal detectors may also have problems with items packaged in metallised packs, such as foil for yogurt pots or packages insulated with metallic materials which are commonly used to ensure the quality of the product throughout its shelf life.

These limitations are significant in the dairy sector, where foreign objects often reach foodstuffs from factory processes, for example, bits of rubber seal falling from machines, or in products such as yoghurts with added fruit sections.

In addition, the use of protective and foil packaging is likely to increase as demand for long-shelf life products grow.

So it seems there are many good reasons to ponder the question — how does the dairy industry improve upon the quality control offered by traditional metal detection systems?

Fig.2: Metal detectors are widely used within the dairy industry.

X-ray technology

To reinforce brand integrity, it's possible for dairy producers to invest further in their quality assurance programmes, with advances in X-ray inspection offering a more robust approach.

X-ray systems (Fig.3) measure the density of a product as it crosses the inspection area, creating an image that is then analysed to identify anything that might be a foreign object.

Like metal detection, X-ray technology can be applied during production, to bulk flow materials prior to packaging, and to packaged retail goods before shipping.

While X-ray won't necessarily detect every possible contaminant, the technology does provide a much wider detection spectrum than metal detectors and will pick up contamination by foreign objects made of stone, glass, dense plastic/rubber and much else — including metal. In general X-ray technology has the ability to detect foreign body contaminants that have a density greater than water (1g/cm^3).

X-ray technology is versatile and it can be used on the production line not only for detecting foreign bodies but also for counting, weight estimation, detecting fill levels, identifying product flaws and ensuring the integrity of packaging.

Thus, while the capital investment cost of an X-ray machine will sometimes be greater than that required for a metal detector, the added capability can often offset that extra expense.

Is 0.6mm the magic number?

Where X-ray inspection really makes an impact, though, is in its greater scope for detecting foreign bodies. X-ray inspection can find not only a wider range of items than metal detectors, but also much smaller items. In fact, there are substantial differences between the ability of specific X-ray systems to detect very small items.

Depending on the generator and pixel array used in the X-ray, it can detect an object that is as small as 0.6mm. 0.6mm is often seen as the 'magic number' because particles of that size are typically the smallest detectable by consumers (and thus particles of 0.6mm and above are most likely to prompt complaints).

Fig.3: Ishida's range of X-ray systems.

FALSE **POSITIVES**

A further advantage of an X-ray system's ability to detect extremely small particles lies in tolerance levels both now and in the future.

For example, if a machine can detect items of 1.2mm and the purchasing retailer specifies detection of 1.5mm, then there is very little difference between the sizes and there will be a substantial number of 'false positive' detections.

As a result, perhaps one in 5,000 packs could be incorrectly rejected, which, over a production run or shift will add up to considerable cost.

However, if the producer uses a system that detects particle sizes as small as 0.6mm and the retailer still requests 1.5mm, then there's a much bigger difference and the producer could reduce that number to one in every 20,000.

The producer would still be very confident of hitting the retailer's targets but would significantly reduce the volume of waste and thus financial loss.

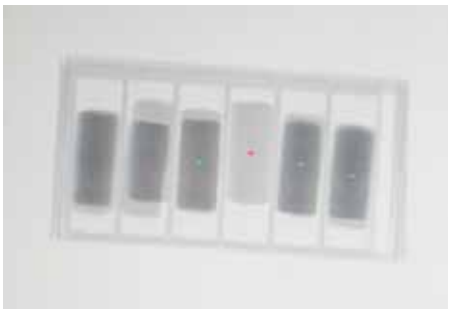
Furthermore, if the retailer decides to reduce the tolerance levels in the future or targets smaller particles, the dairy product producer with the better X-ray system will already have the correct technology in place.

At the moment, with the cost differential between metal detectors and X-ray systems having fallen, the move from one to the other – with the benefits gained – has become a far more viable proposition for food producers.

It all depends on the needs and priorities of the purchaser and the conditions imposed by the companies they serve.

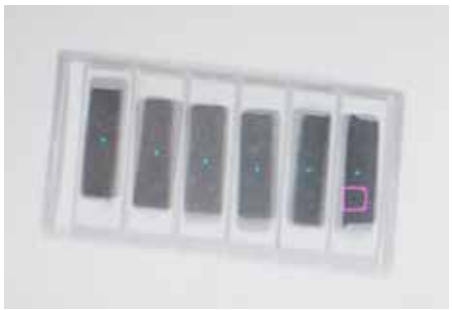
But clearly, investment in good X-ray technology and the right level of training can prepare a business for the future, and it may only take the avoidance of one product recall or reputation-scarring scandal for the machine to pay for itself.

Dairy products packaged in metalised film provide a challenge to metal detection inspection.



Missing item detected.

Damaged product detected.



Pieces of metal detected.

DAIRY FOCUS: **CHEESE**

Primary Processing

At a primary processing site cheese is produced and aged in large blocks, often in the region of 20kg each.

There are many processes that are required to produce cheese and each of these has the risk of adding foreign bodies - these can be from within the process and are often rubber sealing rings from mixing equipment or pipework or metal from poorly adjusted cutting or blending processes (Fig.4).

Additionally any process that has a high level of operator intervention also carries additional foreign body risks.

Whilst rubber may be present in the block at this point its detection is not possible due the relatively low density differential between the depth of the cheese block and the material requiring detection.

At the primary phase, before the cheese is cut for retail, 20kg blocks of cheese must be checked for any metal contamination to protect the integrity of the cutting blades.

If metal is not detected then damage to the blades in the cutting operation will occur and may in turn cause a wider contamination issue and potential recall.

There will of course also be losses in terms of machine downtime, lost production and maintenance costs.

Metal detectors are commonly used in this instance, however, because of the large block size a larger aperture metal detector is required which reduces potential sensitivity.

This coupled with the product effect caused by the salt and moisture levels in cheese means the detection limits are quite high and are typically around 5.0mm or greater for stainless steel.

Needless to say that even a piece of metal 3.0-4.0mm will do significant damage if contacted by the cutting blades when blocks of cheese are packed.

An X-ray system on the other hand is able to provide detection down to 1.5-2.0mm on the largest blocks and down to below 1.0mm in most cases providing a much higher level of protection.

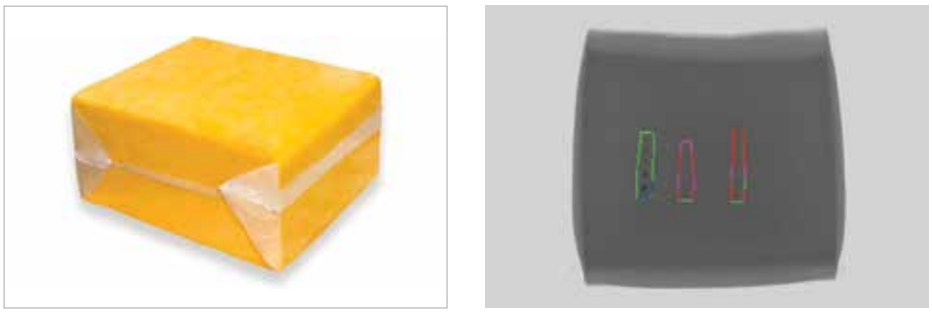


Fig.4: A block of cheese X-ray inspected for a variety of foreign bodies, such as metal, glass and ceramic.

Retail Packaging: cheese

Sliced cheese

Once the blocks have been aged they are then either moved to the retail cutting function within the site, or more often moved to a purpose built facility for cutting and packaging.

This may take the form of slicing for single serve portions, cutting into typical retail block sizes or grating.

For sliced operations, inspection of the final package can provide many benefits. From a foreign body perspective the sliced product gives a uniform density and the relatively thin nature of sliced cheese packaging means that a reasonable contrast between the product and potential contaminants is available.

Thus the rubber seals that may have been present from the primary operation can be detected as well as very small metals with stainless steel detection levels readily to 0.6mm - metal detection will be typically around 1.5mm (Fig.5).

Additional benefits that can also be employed at this stage include product in seal detection (Fig.6), should a small piece encroach upon the sealing area of the tray this can be easily detected to prevent possible product spoilage on the shelf.

Other additional inspection such as weight by mass can also be used to ensure the correct number of slices are in each pack. Both these additional inspections can occur simultaneously with the foreign body inspection and rejects separated between quality defects and high risk contamination.

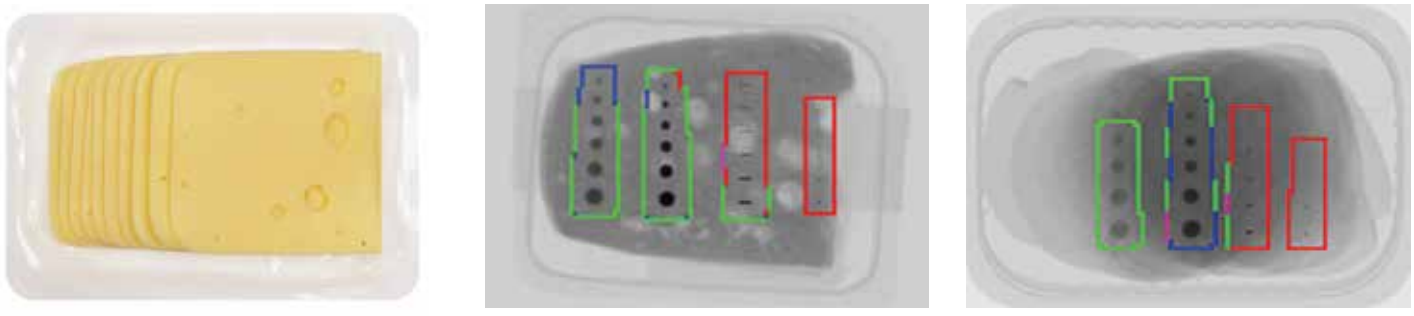


Fig.5: Sliced cheese X-rayed for a variety of foreign bodies, such as metal, glass, rubber, ceramic.

Fig.6: Trapped product detected in a seal of the tray with sliced feta cheese.

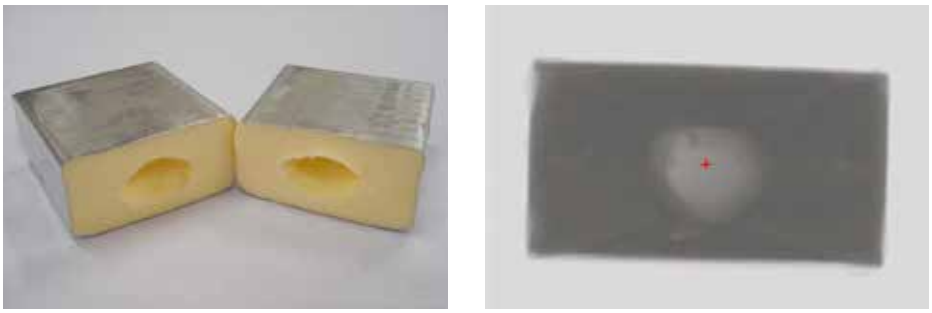


Fig.7: Incomplete product detected.

Block cheese

In the block cheese operation the inspection is often limited to foreign body control. However, X-ray inspection can also be utilised to confirm the block size and check that the block is whole and is not split or broken (Fig.7).

Similarly to the sliced example the consistent presentation and density lends itself to very successful foreign body detection with the rubber seals being detectable at this stage as well as achieving the same metal results as expected in the sliced products.

Grated cheese

For operations producing grated cheese the challenge is probably the greatest. In the case of grated cheese the final product gives a highly variable density as the strands overlap and combine with each other.

Here the differential with metals is still large and because of the lower height and overall density the metal, detection levels achievable with X-ray inspection are still impressive, being consistently below 1.0mm and still below the 0.6mm level in most cases (Fig.8).

However, the varying nature of the product means that the lower density contaminants are much more difficult to detect and thus the rubber seal parts, having been passed through the grating process, are unlikely to be detected.

Fig.8: Grated cheese inspected for foreign bodes e.g. metal.

Pack of grated cheese enters X-ray inspection chamber.

The X-ray system inspects pack of grated cheese.

Foreign body has been detected.

Contaminated pack has been rejected.

DAIRY FOCUS: **YOGHURT**

Yoghurt production takes many forms, from single pot filling to large integrated machines filling and sealing many rows of pots at a time and automatically packing these in to the final case. Thus the inspection methods employed are equally varied.

Risks

- As with other processes there is a risk of foreign materials entering from within the process, be these metal parts, rubber seals or in some cases ceramics which comes from the processing machinery (Fig.9).
- Many products also include additions to the yoghurt itself or in the form of a separate side filling, these may include fruits or granola mixes but all pose an additional foreign body risk (Fig.10).
- Additionally many yoghurt products are foil sealed to ensure the integrity of the product is maintained throughout its shelf life and thus metal detection of the final sealed product is not always an option.

Benefits of X-ray inspection

- Reduced need for converging solutions, which maximises throughput and saves on important production line space.
- A fully automated line where pots are filled, sealed and packaged within the same machine uses X-ray systems not only detect foreign bodies but confirm the presence and fill level of the pots within the tray as a whole.
- Ideal for the popular two component pots - modern X-ray systems can independently confirm the correct quantity of the side filling (be it chocolate balls or fruit compote) and the correct yoghurt filling for each pot. In addition X-ray systems check the overall count in the tray and its core function of detecting any foreign bodies, all in a final tray, with multiple foil sealed products.

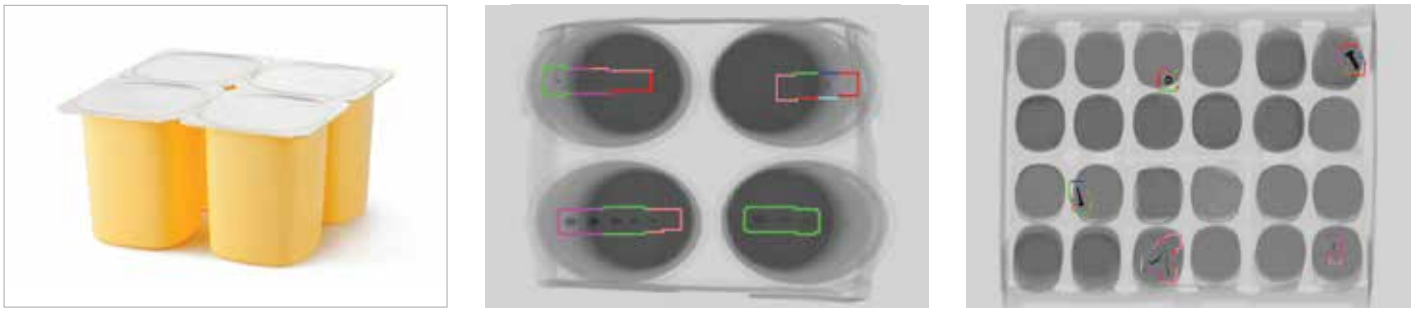


Fig.9: Yoghurt X-ray inspected for a variety of foreign bodies, such as metal, glass, rubber, ceramic.

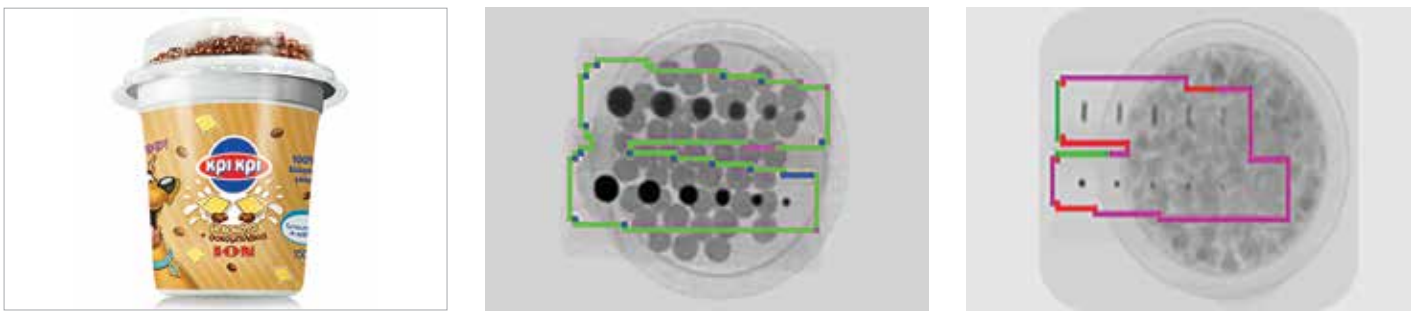


Fig.10: Foreign bodies detected in yoghurt toppings.

X-RAY INSPECTION **IN PRACTICE**

Fig.11: The Ishida X-ray inspection system ensures the high level of quality control for Greek company Kri Kri.

Case study - Kri Kri

In Greece, the reliability, accuracy and versatility of an Ishida IX-GA-65100 X-ray inspection system is helping one of the country's leading yoghurt producers to achieve very high levels of quality control and thrive in both national and international markets.

Kri Kri makes Greek yoghurt, a popular product for which there is large and growing demand. The firm manufactures a wide variety of yoghurt types, including yoghurts with fruit inclusions and a children's line, in sizes ranging from 150g to 500g.

The company currently processes 80-90 tonnes of yoghurt each day, with the Ishida X-ray system monitoring 12,000—14,000 cups.

The company chose the Ishida IX-GA-65100 because, being designed for larger items it allows the company to fill and pack the products before inspection and can be used to inspect complete cases (Fig.11).

Like all Ishida IX models, it includes Ishida's proprietary Genetic Algorithm (GA) technology to optimise detection for common foreign bodies and minimise false positives.

For Kri Kri this means that the machine can differentiate between fruit pieces in yoghurt and foreign bodies and is able to mask the small chocolate pieces used as a topping for children's yoghurts which are housed in a plastic dome above the main pot.

The ability to demonstrate extremely high levels of quality control has played a key role in Kri Kri's success, and in particular its expansion into foreign markets.

CONCLUSION

Producers of dairy products are at high risk of foreign body contamination and consequently at high risk of the potentially catastrophic results of contravening food standards stipulated by law and regulation.

The only viable defence against a breach of such regulation is proof by the manufacturer that they have taken all reasonable precautions against such an offence occurring, and this applies regardless of whether the breach was accidental or caused by deliberate sabotage.

This means that dairy producers simply must have in-line insurance against foreign body contamination, in the form of appropriate monitoring either using metal detection or X-ray technology.

Of these, X-ray has a wider spectrum of detection, a broader range of application and greater sensitivity.

Table 1. displays the benefits and limitations of the main technologies for foreign body detection.

Table 1. Benefits and limitations of metal detectors and X-ray technology

Metal Detector Technology	
Benefits	**Limitations**
Cost-effective solution to foreign body contamination	Can **only** detect **metal contaminants** in a food product
Simple technology which is easy to train operators on and monitor within (retail) code of practice guidelines	**Environmental factors**, from product moisture content to orientation of the metal contaminant, can have a large impact on detection capability
Typically can offer a relatively **compact** solution to foreign body detection in lines with limited space	Typically cannot detect contaminants within food products with **metallised foil** packaging
X-ray Technology	
Benefits	**Limitations**
Can detect a **wide range of foreign body** contaminants which have a density greater than water	**More expensive** solution which can be from three times more costly than metal detection
Can detect contaminants in a **wide range of packaging** materials including metal foil	Requires a **higher level of training** and expertise within the business to support
Can offer functionality **beyond foreign body detection** including product defect, missing item and weight estimation	Cannot detect **low density contaminants** including a lot of plastics that are used as food packaging

Should you invest in more sophisticated technology?

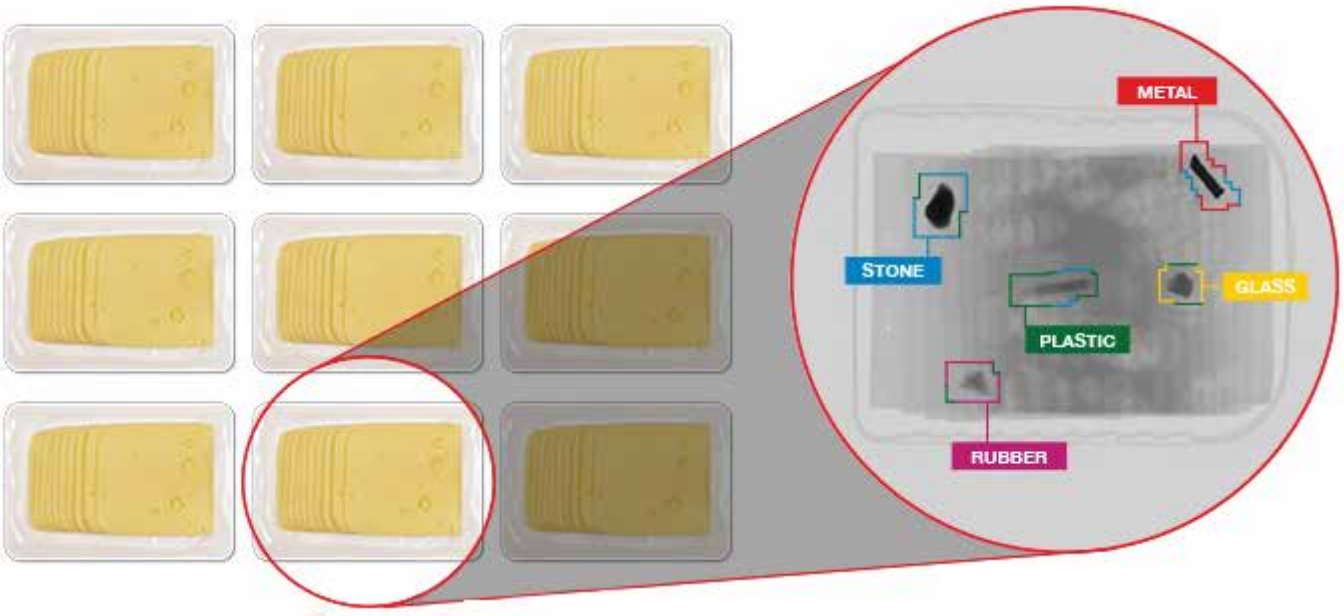
Ultimately, any supplier seeking to invest in quality control equipment of this type must assess their own situation — taking into account factors such as the nature and volume of their products, the nature of the foreign bodies likely to contaminate them, the demands of their customers and contractual obligations — and offset this against the perceived nature and impact of any contamination incident, the company's tolerance of risk and the required capital investment.

Using X-ray technology to detect foreign bodies in dairy products can not only assure the quality of the foods produced, acting as an insurance policy against prosecution and brand damage.

It can also give suppliers a real competitive edge: by using X-ray to exceed the standards demanded by their customers, companies can clearly demonstrate their commitment to quality while assuring potential clients that they can cope with demanding specifications both now and in the future.

Given the high risk inherent in dairy production, and the clear need to have insurance in place, suppliers must ask themselves difficult questions on behalf of their investors, their customers and their own reputation: should the production line use one type of Quality Control machinery or a combination?

Do the dairy items being produced require a more complex level of inspection?
And ultimately – do the risks in the dairy production process outweigh the necessary capital investment?



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▲ **Watch the VIDEO about Ishida Quality Control demonstration centres.**
https://www.youtube.com/watch?v=6TUcKbyloek

Ishida Quality Control demo room with X-ray, Checkweighing and AirScan systems.

Ishida Quality Control demonstration facilities in Birmingham.