

A GUIDE TO METAL DETECTION IN THE FOOD MANUFACTURING INDUSTRY

HOW A METAL DETECTOR WORKS

The most widely-used type of metal detector in the food industry functions on the principle known as the "balanced coil" system. This was first registered as a patent in the 19th century, but the first industrial metal detector was not produced in the UK until 1948.

The progress of technology has taken metal detectors from valves to transistors, to integrated circuits and more recently, into microprocessors. Naturally this has increased their performance giving greater sensitivity, stability and flexibility, as well as widening the range of output signals and information they provide.

All the same, modern metal detectors are still unable to detect every particle of metal passing through them. The physical laws applied in the technology limit the absolute capability of the instrument. Consequently, as with any measuring instrument, metal detectors have restrictions on accuracy. These restrictions vary depending on the application, but the main criterion is the size of the detectable metal particle. Despite this, though, metal detectors perform a valuable and essential role in process quality control.

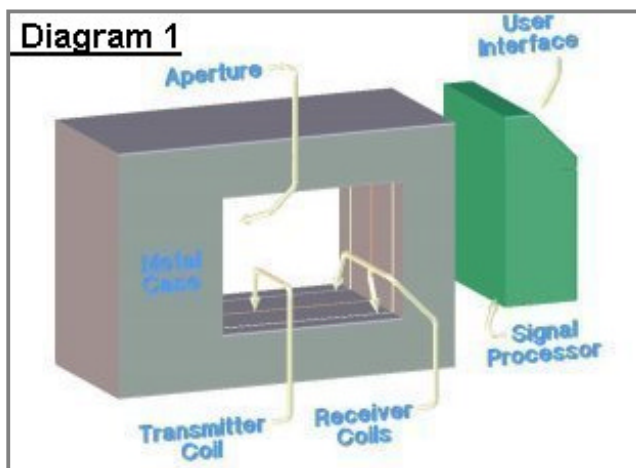


Two Main Categories for General and Foil-Wrapped Products

In the main, modern metal detectors fall into two main categories. The first consists of systems with a general purpose search head. These are capable of detecting ferrous and non-ferrous metals as well as stainless steels, in fresh and frozen products - either unwrapped or wrapped, even in metallised films. The other main category consists of systems which have a ferrous-in foil search head. These are capable of detecting ferrous metals only within fresh or frozen products which are packed in a foil wrapping.

The "Balanced Coil" System: How it Works

All general purpose metal detectors work essentially in the same way, although for optimum performance you should select a metal detector which has been designed specifically for your application. Construction techniques ensure that independent mechanical movement of the search head's components, and the ingress of water and dirt, are prevented.

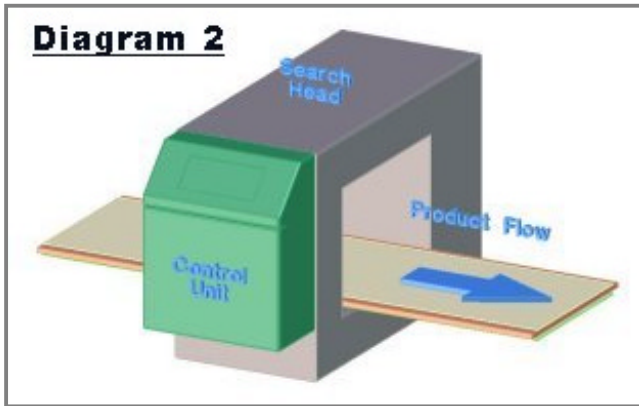


"For optimum performance you should select a metal detector which has been designed specifically for your application"

As you will see in diagram 1, the typical detector is encased in a metal box. This houses the coil components, and provides a shield to protect them. The aperture - the tunnel through which the

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products pass - is lined with a non-metallic material (usually plastic), which provides an hygienic environmental seal for the internal components.



The ratio of the aperture size to the size of the product is important, to achieve optimum performance. The sensitivity of the detector is measured at the geometric centre of the aperture, which is the least sensitive point. This is inversely proportional to the size of the aperture - in particular, to the smaller of the two sides.

In all, there are three coils in the system. The transmitter coil generates a field, rather like a radio transmitter. This process, designed to make a metal particle identifiable, is called "illuminating" the metal particle. The second and third coils are receivers, connected together to detect the presence of an "illuminated" metal particle. The response is related to the conductive and magnetic properties of the metal.

Control and the Signal Processor

Controls can be mounted on the search head itself, or remotely, depending on the design and the application of your system. Where the controls are mounted does not affect the performance of the system.

The signal processor is highly sophisticated. When a typical metal particle is "illuminated", the signal value at the receiver coils is one millionth of a volt. First this is amplified by a high-performance RF amplifier, then modulated down to low frequency. This provides amplitude and phase information. Finally the signals are digitised and digitally processed, to optimise the sensitivity.

Magnetic Field Systems for Foil-Packed Products

These systems operate on a totally different detection principle. They work by incorporating a tunnel or passage which is subjected to a strong magnetic field and, as a result, any magnetic material (such as a metal fragment with a ferrous content) is magnetised as it passes through. Incorporated in the tunnel are a series of coils. When the magnetised particle passes under them, a current is generated which is then amplified by the electronics of the detection system, and this is used to trigger the detection signal output.

Secondary effects, due to the movement of any conductive material in a magnetic field, will also generate signals for non-magnetic metals. However, these are small compared to the effect generated by materials with a magnetic content. Consequently, only the largest pieces of non-ferrous metals and stainless steel can be detected. So in the vast majority of applications, this technology is only applicable to the detection of ferrous metals.

The User Interface

The user interface provides the means of communication with the system, allowing you to set up and optimise it to operate with the application, environment and mechanical handling system. Microprocessors have enabled a wide range of communication links, statistical analysis and system information.

In the case of Loma Systems metal detectors, network modules (LomaEnet) can be fitted to each of up to 40 metal detectors eventually connecting all to a printer or PC, providing co-ordinated operational and management information within seconds.

The networking of information can also be linked with PVS Loma's Performance Validation Systems for metal detectors - developed in accordance with the strictest quality controls of

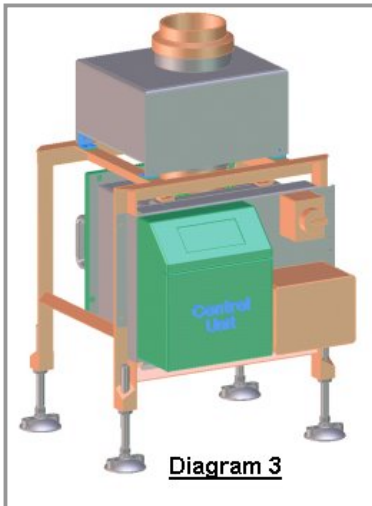
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Europe's leading retailers. The resulting combination of user information incorporates data not only on the detection of metal, but also on the quality of the detectors' performance.

Search Heads: Configuration

Search heads can be used in a variety of configurations. The most common, as shown in diagram 2, is mounted on a driven conveyor which has either a fixed or variable speed. When a contaminated product is detected, it is rejected automatically.

Search heads can also be configured in a slim-line case, and mounted on to the conveyor of a checkweigher. This creates a compact, space-saving "combination" system. Equally, a search head can be configured to operate in a freefall mode, where the product moves down through a gravity-based system, as shown in diagram 3.



Other search head configurations include those used in pipeline systems for pumped products, such as meat, and gravity-fed, small aperture systems for items like tablets.

HOW TO OPTIMISE THE PERFORMANCE OF YOUR METAL DETECTOR

Loma Systems: The Voice of Experience

Ever since Loma Systems was founded in 1969, the company has worked very closely with both food manufacturers and retailers. As a result, Loma has an unrivalled level of experience and expertise, in the practice of effective metal detection with food industry production lines.

The following guidelines are drawn from Loma's extensive background of "best practice" and are designed to help you conform to the industry's most rigorous demands for quality control.

What the System Should Include

Your metal detection system needs to be sited in line with the main production flow, after or at the end of the finished packing point. The system will be unaffected even if there is excessive water or steam at that point.

Conveyor based detectors must include the following, for the most efficient performance:

- An efficient automatic rejection system
- A lockable box to receive the rejected product
- A full enclosure between the search head and the rejection bin
- A device to confirm that the contaminated products have been successfully rejected into the bin
- An automatic belt stop failsafe system, to activate if there is air pressure failure, a detector fault, failure of the reject system, or when the reject product collection bin is full.

Pipeline systems must include an audible and visual indication of rejection, and free fall systems require the facility to produce a double pack, if an automatic reject system is not possible.

Foil-Packed Products

Ideally, products to be foil-packed should be passed through a conventional detector system BEFORE they're packed in the foil. Where this is not possible, though, products packed in aluminium trays or wrapped in aluminium foil must go through a "ferrous-in-foil" detector - such as the Loma IQ2 ferrous-in-foil system. Alternatively, consider the additional benefits of using x-ray inspection at this point

For products wrapped in metallised film, "compensated" conventional detectors or free fall detectors should be used to detect both ferrous and non-ferrous metals.

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Sensitivity

For optimum sensitivity, the search head must be of the size appropriate for the specified food product. It's important that the best attainable sensitivities are established and set for each product, relating to product size, type and packaging. This process should only ever be carried out in consultation with the manufacturer of your metal detector.

If you move your detection systems within your premises, or if you introduce new products, your system must be re-evaluated - once again, in consultation with its manufacturer.

Many leading retailers will insist that their suppliers of private label goods agree any changes in metal detection sensitivity settings, with them, in writing. If your company is a private label manufacturer, Loma Systems strongly advise you to clarify the preferred policy with each of your retailer customers.

Sensitivity adjustment controls must not be accessible to untrained employees. Access should only be given to nominated, fully trained staff and for additional security, the controls should be password-protected or kept locked.

Obviously, you will want to maximise the sensitivity of your detection system. However, you need to guard against potential instability, where the effects of product/environment could cause false rejects. You may find the following sensitivities helpful as guidelines.

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Aperture Height	Dry Product	Wet Product	Wet Product
	Ferrous & Non-Ferrous	Ferrous	Non-Ferrous
Up to 50mm	1.0mm	1.5mm	2.0mm
Up to 125mm	1.5mm	2.0mm	2.5mm
Up to 200mm	2.0mm	2.5mm	3.0mm

Types of Contaminant

There are three main groups of metallic contaminant: -

- Ferrous
- Non-Ferrous
- Stainless steel Detection depends on the magnetic or conductive properties of the contaminant.
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Ferrous is both magnetic and conductive so easily detected

Non-Ferrous is non-magnetic but a good or excellent conductor so relatively easily detected.

Stainless steel is the most difficult contaminant to detect as it is usually non-magnetic and a poor conductor.

Stainless steel comes in various grades, some of which are magnetic varying to totally non magnetic. Their conductivity also varies but is generally low. Both of these factors contribute to poor detectability.

Processing plants in the food and pharmaceutical industries use the two most common grades, 304(L) and 316. The detectability of these grades are further hindered when the product is either wet, containing a high salt content or both, thus contributing to a high product signal.

As the properties of stainless can be modified by machining (increasing the magnetic effect) specific sensitivity figures are difficult to quote. In general it can be expressed as a ratio to ferrous, at best 1:1.5 rising to 1:2.5

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Further complications are the orientation of contaminants such as screen wires, and thin slivers (such as swarf) if the smallest dimension is smaller than the detectable sphere size.

Equipment Testing Procedures

Metal detection testing procedures must be clearly documented, and communicated to all relevant staff. Testing should take place at the start of each shift, between each change of product, and in any case, at least hourly.

Intervals between tests need to be short enough that, if a fault is found, products potentially affected have not left your premises and can be identified, recalled and retested. Once again, if your company is a private label manufacturer, ensure that you agree any variation you make to the testing, in writing, with your retailer customers.

As mentioned above, to facilitate effective testing, all of Loma's IQ metal detectors have an integral PVS (Performance Validation System) feature. This automatically prompts the operator to carry out the required test at the pre-set interval.

Conducting Test Routines

When you test conventional metal detection systems, you need to use both ferrous and non-ferrous test packs. These should be made up from packs that are proven to be free from metal, and be clearly marked and labelled so they cannot be packed inadvertently for despatch.

You need to make up fresh test packs at a frequency that reflects the nature, durability and shelf-life of the product concerned. If you use "stale" test packs, they will not reflect the same properties as the products which the metal detector is inspecting.

In the case of Loma Systems metal detectors, your system comes with a ready supply of plastic "wands" which contain pieces of various metals in the specified test sizes. These are convenient and easy to place into your test packs, and also make the testing process even more efficient.

When you are testing finished packed products on a conveyor system, place the test piece of metal, where possible, at the extreme end of the pack. If this is impractical - e.g. when you are testing individual small packs or sandwich wedges - place the test piece of metal in the centre of the product.

Next, pass both ferrous and non-ferrous test packed individually through the search head twice - first with the metal test piece at the leading edge of the pack, and then with the test piece at the trailing edge. In each case, you must observe that the test piece successfully enters the reject bin.

In the case of unwrapped products, make every effort to fit metal detection equipment to be used AFTER products are wrapped. Where this is not possible, though, and you are manufacturing private label goods, it is advisable to agree the testing routine in writing with the retailer concerned.

With freefall systems, place ferrous and non-ferrous test pieces independently in the product flow, and observe appropriate rejection. This principle applies similarly to pipeline systems. However, where that is not practical within a pipeline system, insert the test piece between the pipe and the search head, and then observe appropriate rejection.

Should any part of your test fail, isolate all products produced since the last satisfactory test and re-screen them, using another detector functioning to the same standard as the original system on test.

Dealing with Rejected Products

Needless to say, no rejected product must ever be returned to the production line. However, this does not include products rejected during normal test procedures. If these are in a sound condition, you should replace them in the product flow for them to be re-detected.

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Rejected packs must be investigated by a suitable, trained person, within one hour of rejection. Frozen products must still be frozen, or refrozen. The investigation should be carried out using the metal detector system which initially rejected the products, but not while it is being used in production. If you can't stop the production line, use an off-line detector with at least the same, if not higher sensitivity.

Pass the rejected products through the detector positioned in the same way as they were when the originally went through the search head. Then pass the same products through the search head twice more, each time positioned in different ways.

If at any stage the products are rejected again, it's essential to find the contaminant and identify it. Then, take any necessary action to ensure similar contamination does not recur.

Having more than one metal-contaminated product rejected on a single production line within a shift, is a matter of great concern. Every effort must be made to ensure the identification and elimination of the cause. And if you are manufacturing private label goods, you should inform your retailer customers, in writing, about the incident.

Maintaining your Metal Detection Equipment

As with any piece of vital precision machinery, high performance can only be assured if your metal detector is regularly and properly maintained. So, it's worth instigating a planned programme of preventative maintenance for your systems to take place at regular intervals, in accordance with the manufacturer's recommendations.

Maintenance should be carried out by the equipment's manufacturers. It can also be done by your own engineers, provided that they have been trained by the manufacturers.

After any repairs, maintenance or adjustments, you need to ensure that a full metal detector test is carried out before you use the system again.

Training your Staff

For maximum efficiency and safety, all relevant staff should be properly trained in the principles and use of metal detection equipment and the use of testing routines.

Documents and Record Keeping

It's important that you keep all relevant documentation and records covering a number of areas. These include:

Commissioning and sensitivity tests and records for new equipment, and also those following the movement/relocation of equipment

- Results of routine tests showing time, result, sensitivity, product, and any action taken
- Number of rejected packs each shift
- Number and details of detected contaminants
- Action taken to trace source of contaminants
- Planned preventative maintenance programme and service work
- Personnel training

Preventing Metal Contamination by Maintenance and Cleaning Work

All your organisation's maintenance and cleaning staff should receive appropriate training on how important it is to prevent metal contamination.

The maintenance of your factory equipment should be planned, so that wear and tear can be remedied before defects occur. Try to ensure that any maintenance work or installation of new plant is done outside production hours. If that is not possible, then the area must be properly screened from adjacent raw material production or packing areas.

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Repairs on production lines should be carried out by staff using an enclosed box for their tools. It helps if they use a small vacuum brush and magnet for cleaning down afterwards, where this is appropriate.

Under no circumstances must welding, riveting, drilling or soldering be done on plant being used for production, or on any plant immediately adjacent to it.

Slicing or mincer blades, woven wire conveyors and sieves must be inspected every day for any signs of damage. This inspection needs to be clearly documented.

Maintenance and cleaning staff who dismantle equipment should carry a suitable, clearly marked container for the safe storage of nuts, bolts, washers, etc.

Staff must avoid using tape or wire to make temporary repairs to plant. Missing or loose screws and damaged fittings need to be replaced or repaired promptly and permanently and swarf, wire debris and any other potential contaminant disposed of safely and quickly. All welding should be continuous, and ground smooth.

It's important that all equipment repaired in workshops or in the factory is cleaned down and vacuumed (not blown with compressed air), before being returned to the production area. Workshop floors need to be swept and vacuumed at least once daily. Where workshops are within your factory building, a suitable trap should be fitted to the workshops exit, accompanied by a notice telling personnel to scrape their footwear before leaving.

Once repairs, maintenance activities and installations are completed, a member of the Quality Control or Hygiene team should inspect the plant and surrounding areas BEFORE production starts again.

LOMA SYSTEMS: QUALITY INSPECTION RESPECTED ACROSS THE WORLD

For over 30 years Loma has supplied the very best in metal detection, checkweighing and quality inspection. All Loma equipment is designed to operate in-line, ensuring that everything you produce is inspected to the same rigorous quality standards.

With over 35,000 installations in more than 60 countries, Loma are the exemplary partner for all your quality inspection needs.

Helping you to Achieve 100% Metal Detection

Whatever your product or process, there is a Loma IQ metal detector to suit your requirements. Whether your products are wrapped or unwrapped, on a conveyor or in a pipeline, the Loma IQ will detect any metal contaminated product and remove it.

If, on the other hand, your products are wrapped in foil, the Loma IQF will detect and reject any ferrous particle contaminated product and reject it with the same exacting precision.

An Automatic Choice for Checkweighing

The Loma range of checkweighers will accurately weigh products from only a few grammes up to 45kg. Running at speeds of up to 450ppm, with accuracy from just +/-0.2g the performance is outstanding.

A Perfect Combination

The AS Series Combo brings Loma's market leading metal detection and checkweighing technology together in a single compact space-saving unit.

Excellence with X-ray

To fully inspect products for metallic and non-metallic contaminants at high line rates, Loma's AXIS range of X-ray inspection equipment uses advanced image processing technology. Dynamic Analysis software automatically optimises sensitivity for each individual product

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simplifying product set-up and minimising changeover times. Models for package, bulk and pipeline applications ensure optimum designs to suite your process.

Complete Solution for your Quality Inspection

To give you even greater control over production, LomaEnet - Loma's management information system - collects key production line data from Loma metal detectors and checkweighers. LomaEnet then presents this information in an easy-to-view format on a central PC

A Dedicated Service Team Working for You - Worldwide

All Loma's products are supported by the most comprehensive service support available. So, whether you are commissioning new equipment, training new operators or just carrying out routine maintenance, the Loma customer service team is geared to provide everything you could possibly need, where and when you need it.