How to Guide - Metal Detection Functionality

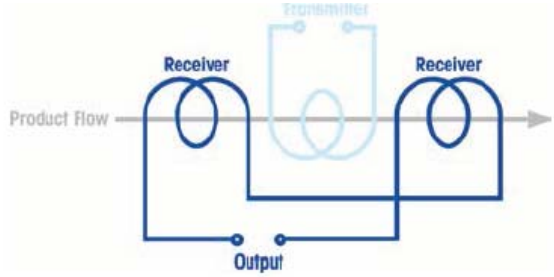
Basic principles of Metal Detection

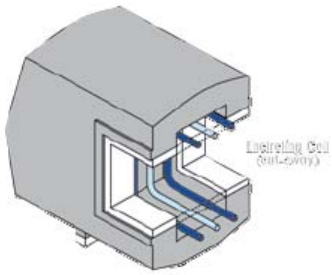
All general purpose metal detectors function in the same way and share many similar characteristics, though not all detectors are suitable for every application.

There are three types of metal detectors

- Conveyor Mounted Systems
- Vertical (Bag fill) Packaging systems
- Pipeline (In line) Systems

Most metal detectors in the food industry are based on a balanced coil system. A metal detector will usually contain 3 coils. The transmitter coil will generate a field that is designed to reveal metal particles in order to make them detectable. This process is called “illuminating” the metal particle. The remaining two coils are designed as receivers and are connected together to detect the presence of an “illuminated” metal particle. The detection is related to the conductive and magnetic properties of those metals. The ratio of the aperture to the size of the product is vitally important in ensuring optimal performance, due to the sensitivity being measured at the geometric centre of the aperture.





As much as we rely on metal detectors, as a means of quality control, they are still unable to detect every particle of metal passing through them. As with any measuring instrument, there are restrictions on accuracy and this varies depending on the application.

That’s when a different technology, known as “ferrous-in-foil” detection, comes into play. These detectors use strong, permanent magnets to create a constant magnetic field, which is disturbed by the introduction of magnetic metals. Although this equipment only detects magnetisable ferrous metals and magnetic stainless steels, it remains a cost-effective solution for some applications. Ferrous in Foil metal detectors should be used on foil packed, aluminium foil tray and like products, as these are capable of detecting ferrous metals only within fresh or frozen products which are packed in a foil wrapping.

Factors Affecting Metal Detection:

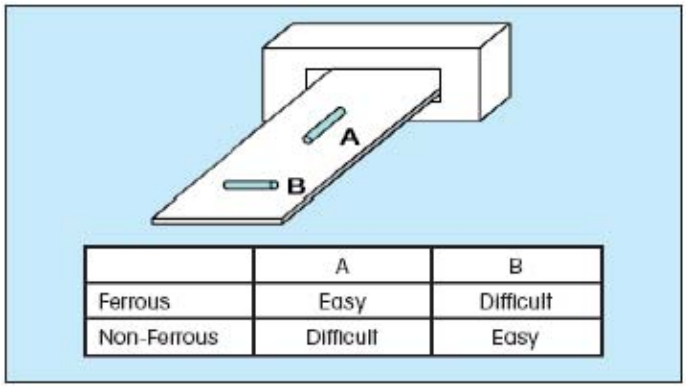
The factors affecting metal detection include:

- Metal Type
- Metal Shape & Orientation: *simply reporting that the detector located an object in one orientation doesn't preclude the possibility that it would be missed in another orientation.*
- Aperture Size / Position in the Aperture: *the maximum sensitivity occurs when the belt and food item is closest to the edge of the metal detector portal*.
- Detector Frequency
- Environmental Conditions: *not impacted by external electrical interference or by plant operating conditions – e.g. wet environments, areas of high vibration, extremes of temperature or harsh hygiene procedures. If the coil system is allowed to move or vibrate by just a few microns, the disturbance could be enough to cause rejection of a perfectly acceptable product.*
- Packaging Material: *Different packaging materials can effect sensitivities.*
    - *Paper, cardboard packaging, taking into account recycled content.*
    - *Glass (jars & bottles)*
    - *Moulded Plastics (jars & bottle, trays)*
    - *Poly Film*
    - *Metallised Poly Film*
    - *Aluminium Foil*
    - *Oxygen scavengers*
    - *Promotional material and inserts*
    - *Steel cans*
- Product Characteristics
    - *Dry Products - E.g. sugar, flour, snacks, confectionery, cereals etc:* ***High Sensitivity***
    - *Wet Products ('product effect' applications) E.g. ready meals, meat, fish, sauces, preserves, etc:* ***Reduced Sensitivity***
    - *Iron rich products* ***High Sensitivity***
    - *Products containing high levels of salt* ***Reduced Sensitivity***
    - *Irregular product shapes.* ***Reduced Sensitivity***

Table Metal Type

Metal Type	Ease of Detection	Electrical conductivity	Magnetic permeability
Ferrous	Easily detected	Good	Magnetic
Non Ferrous	Relatively easy to detect	Generally good or excellent	Non magnetic
Stainless Steel	Relatively difficult to detect	Usually poor	Usually non magnetic

Diagram Orientation Example



	A	B
Ferrous	Easy	Difficult
Non-Ferrous	Difficult	Easy

Source: www.mt.com

Sensitivity

The sensitivity of the equipment is essential in determining the type and size of pieces of metal detected. The equipment sensitivity is appropriate if all of the following parameters are met:

- The sensitivity can be maintained without periodic adjustment.
- The detector gives minimal false signals and does not reject good product.
- Detector does not go 'blind' after detecting a large metal piece.
- Detection in different orientations: *the resulting disturbance signal can be one to two orders of magnitude greater in one orientation than the other*. *Most test pieces use a spherical object, so the signal they give off is the same in any orientation; but when testing a returned foreign object, such as a needle or piece of wire, it needs to be tested in different orientation to ensure maximum effectiveness.*

Reject Mechanisms

There are a variety of reject devices available which may include:

- Carriage retracting band/ Sweep/diverter arm (product <5kg)
- Air blast (product <1kg). *These can be unreliable if you have a drop in air pressure. Ensure that the air pressure is sufficient to cope with any potential metal contaminants e.g. metal bolts.*
- Pusher (product <10kg)
- Stop on detect (product <60kg)

Detector fail safe systems where fitted, must be challenged at regular intervals (eg: start and end of shift/ day) to make sure they are effective.

Reject confirmation system: automatic belt stop fail safe system, to confirm metal contaminated products have successfully entered the reject bins.

As most metal detector conveyors are relatively short, with the reject system close to the conveyor out feed, it is not possible to ensure any contaminated product not rejected will be retained on the metal detector conveyor when it stops. It is therefore imperative to stop the following conveyor (or equipment) at the same time and additional outputs on the metal detection system should be available to facilitate this. After Reject Confirmation Alarm all product should be removed from the metal detector conveyor and following conveyor (or equipment) and rejected or re inspected.

Bin full system: an automatic belt stop fail safe system which activates should the reject product collection box become full.

Air pressure system: an automatic belt stop fail safe system to cover air pressure failures to the rejection mechanism. The access to adjusting the air pressure should be restricted.

Search head failure: an automatic belt stop fail safe system to confirm detection head fault.

Back up sensor: an automatic belt stop fail safe system, to activate should product back up under out the feed belt of the metal detector. Where appropriate a back up sensor should be installed to ensure product is prevented from backing up onto the metal detector conveyor.

Bin door unlocked alarm: an automatic belt stop fail safe system to activate should the reject bin door be left open/unlocked for longer than a preset time.

Product Testing – Test Packs

The test packs must be representative of the products going down the line e.g. shape and density. Actual product should be used as test packs. The packs used to make up test packs should be passed through the metal detector before they are used to ensure that they do not contain metal.

Detectors must be checked using clearly identified test packs at the same temperature (and therefore maintained at same temperature) as standard product passing down the line and test pieces of a defined size.

The test pieces must be passed through the detector in the centre of the aperture with the test pack.

Consecutive leading and trailing checks must be completed in long packs to ensure the reject mechanism can successfully reject. The test must be representative of how products would normally travel through the detector during normal production.

The site should only use test pieces which are controlled and the size of the metal can be verified e.g. they are manufactured with a serial number or issued with a certificate. Test pieces are available in various sizes/shapes e.g. sticks or cards. The most appropriate type for the product should be chosen.

Test packs should be made up on an hourly basis with product from the line (same product). If it is not practical to do this and test packs are made up in advance, the test packs must be controlled and labelled with product, date, test piece size and type.

Product Testing - Location of Test Pieces & Consecutive Tests

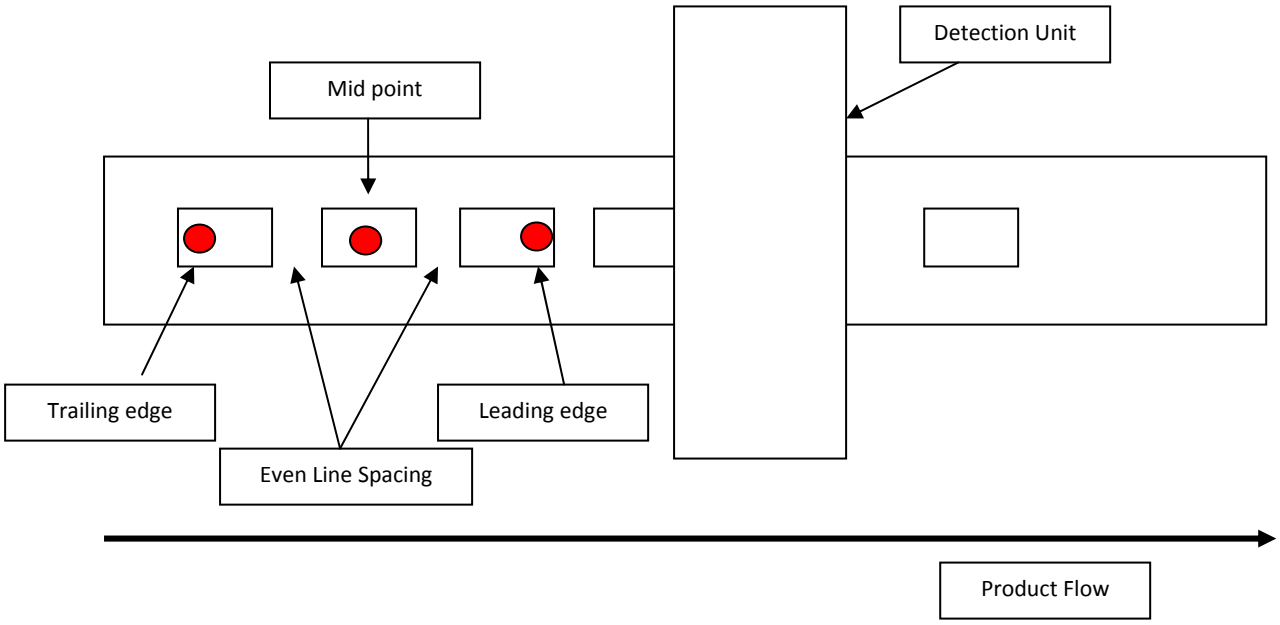
The test packs need to be made up to worst case scenario. The test pieces should be located in the leading, centre and trailing positions as per diagrams below for the 3 pack consecutive test, and the leading and trailing edge for the 2 pack Ferrous in foil. The leading and trailing positions would not be considered a requirement if the product is a small pack (i.e. less than 100mm).

The test packs should be marked with the location of the metal if it is not visible.

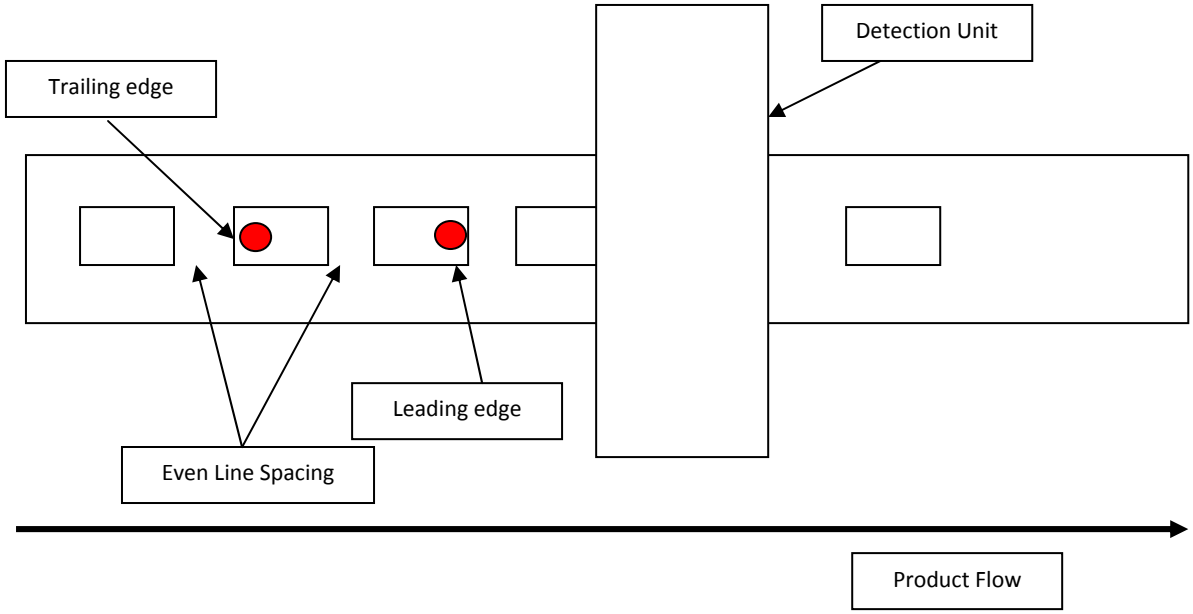
Where a pack contains products of different density, the location of the test pieces in the pack should be based on worst case scenario.

If the location of the test piece is not visible additional controls/checks need to be in place to ensure that the test pieces remain in the required locations if the packs are used for multiple locations e.g. after being rejected the test pieces may have moved.

All 3 test packs (Ferrous, Non Ferrous, Stainless Steel) should pass through the detector one after each other with normal spacing/line speed. The line should be running and the test packs introduced in the places of 3 un-inspected packs where possible.



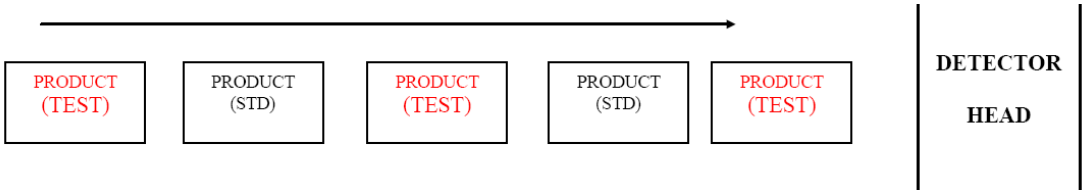
For Ferrous in Foil Detectors two test packs are required including two ferrous test pieces of the same size.



Product Testing - Memory Test

The objective of the test is to challenge the effectiveness of the reject system so that it does not blanket reject.

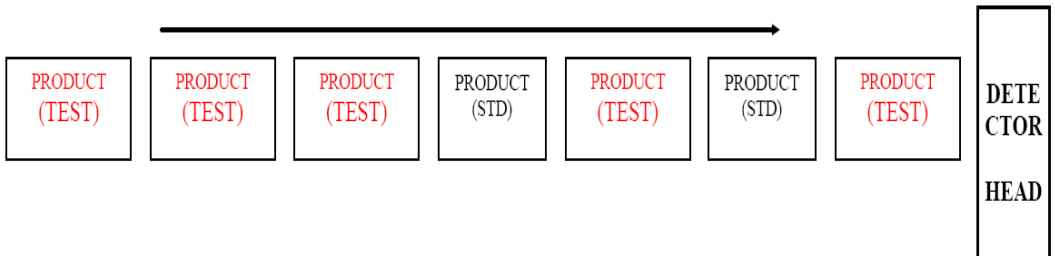
The test packs should be sent through the metal detector with a standard pack in between (which has already successfully passed through the metal detector).



It is a failed test if any of the test packs are not rejected. If a standard pack is rejected the line must be stopped and the issue investigated e.g. timing of reject mechanism.

If a machine struggles to not reject good packs, advice should be sought from the equipment manufacturer. The capability of the machine may be dependent on the line speed.

If a site wishes to combine the consecutive and memory test into one test, the procedure below is recommended:



Vertical Packaging systems

Vertical packaging systems consist of a throat metal detector and a bag former beneath. They can be used for certain product types e.g. snacks and confectionery.

Example

Reject Mechanism

On detection of metal the detector should send a signal to the bag-maker to produce a double bag or stop. The system should also be fitted with an audible and/or visible alarm to indicate that the system is stopped due to a metal contamination incident.

Testing

When testing vertical packaging lines, ferrous, non-ferrous and stainless steel test pieces should be independently placed in the product flow and successful rejections observed (i.e. double pack made and audible and/or visual alarm activated and line stops).

Confirmation must be sought that the test piece has been captured in the double pack produced.

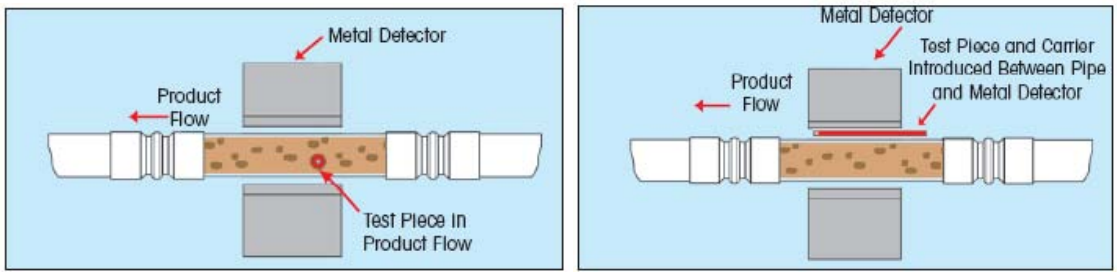
In Line Detection Systems

Liquid, paste and slurry type products can be inspected as they are pumped through a pipeline prior to being dispensed into the final pack. This form of inspection is recommended in applications where the product is packed in metal containers (e.g. tin cans).

Systems of this type should incorporate an automated reject valve system immediately after the metal detection head with an audible and visual indicator to signal when contamination is found. Contaminated product should be rejected into a suitable secure container.

Testing

With pipeline systems, test pieces should ideally be placed in the product flow and successful rejection observed. In instances where placing a test piece in the product flow is not practical, the system may be tested by inserting test pieces between the pipeline and the detection head (in the direction of product flow) and observing the operation of the reject system.



Source: www.mt.com

Sensitivity standards set in these instances should reflect that the test piece is not passing through the centre of the aperture (sensitivity is therefore higher). In these instances, the size of the test piece used should be adjusted to compensate (e.g. smaller test piece size) consult equipment manufacturer for advice.