**SCOPE:** This procedure applies to employees who handle, prepare, or serve food.

**PURPOSE:** The purpose of this procedure is to ensure best practice of metal detector and that machine and process are operating within tolerance as described in the HACCP plan.

**RESPONSIBILITY:** It is the responsibility of the management to ensure that the following procedures are adhered to and understood by all relevant personnel and the personnel follow State or local health department requirements.
It is the responsibility of the General Manager to ensure the metal detector check is carried out and that there are trained staff available to carry out the check.

**BACKGROUND:**
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.
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**

Construction techniques ensure that independent mechanical movement of the search head's components, and the ingress of water and dirt, are prevented.

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 products pass - is lined with a non-metallic material (usually plastic), which provides a 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.

**The Signal Processor**

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 nonferrous 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.

**INSTRUCTIONS:**

1. Metal detection system needs to be sited in line with the main production flow, after or at the end of the finished packing point.
2. The system will be unaffected even if there is excessive water or steam at that point.
3. 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.
4. 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**

1. Products to be foil-packed should be passed through a conventional detector system BEFORE they're packed in the foil.
2. Where this is not possible, though, products packed in aluminium trays or wrapped in aluminium foil must go through a "ferrous-in-foil" detector. Alternatively, consideration must be taken of the additional using x-ray inspection at this point
3. For products wrapped in metallised film, "compensated" conventional detectors or free fall detectors should be used to detect both ferrous and non-ferrous metals.

**Sensitivity**

1. 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 metal detector.
2. If detection systems is moved within your premises, or new products are introduced, system must be re-evaluated - once again, in consultation with its manufacturer.
3. 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.
4. To maximise the sensitivity of detection system, the following sensitivities to be used. The potential instability, where the effects of product/environment could cause false rejects must be considered.

| 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.

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.
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

**Equipment Testing**

1. Metal detection testing procedure must be communicated to all relevant staff.
2. Testing should take place at the start of each shift, between each change of product, and in any case, at least hourly.
3. Intervals between tests need to be short enough that, if a fault is found, products potentially affected have not left premises and can be identified, recalled and retested.
4. When testing conventional metal detection systems, both ferrous and nonferrous test packs need to be used. 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 dispatch.
5. Fresh test packs need to be made up at a frequency that reflects the nature, durability and shelf life of the product concerned. "Stale" test packs will not reflect the same properties as the products which the metal detector is inspecting.
6. When testing finished packed products on a conveyor system, the test piece of metal to be placed, where possible, at the extreme end of the pack. If this is impractical - e.g. when testing individual small packs or sandwich wedges - the test piece of metal to be placed in the centre of the product.
7. Both ferrous and non-ferrous test packed individually to be passed 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, it must be observed that the test piece successfully enters the reject bin.
8. In the case of unwrapped products, every effort must be made to fit metal detection equipment to be used AFTER products are wrapped.
9. With freefall systems, ferrous and non-ferrous test pieces to be placed independently in the product flow, and appropriate rejection to be observed. This principle applies similarly to pipeline systems. However, where that is not practical within a pipeline system, the test piece to be inserted between the pipe and the search head, and then observe appropriate rejection.

**Dealing with Rejected Products**

1. 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.
2. Rejected packs must be investigated by a suitable, trained person, within one hour of rejection.
3. 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 the production line cannot be stopped, an off-line detector to be used with at least the same, if not higher sensitivity.
4. The rejected products must be passed through the detector positioned in the same way as they were when the originally went through the search head. Then the same products must be passed through the search head twice more, each time positioned in different ways.
5. If at any stage the products are rejected again, it's essential to find the contaminant and identify it.
6. The corrective action must be taken to ensure similar contamination does not recur.
7. 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.

**Maintaining Metal Detection Equipment**

1. As with any piece of vital precision machinery, high performance can only be assured if metal detector is regularly and properly maintained.
2. A planned programme of preventative maintenance must be established for systems to take place at regular intervals, in accordance with the manufacturer's recommendations.
3. Maintenance should be carried out by the equipment's manufacturers.
4. It can also be done by own engineers, provided that they have been trained by the manufacturers.
5. After any repairs, maintenance or adjustments, a full metal detector test is carried out before you use the system again.

**Training**

1. 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**

The relevant documentation and records must be kept and these to include:

1. 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

**MONITORING:**

1. A designated employee will inspect that each employee is following this SOP.

**CORRECTIVE ACTION:**

1. Any employee found not following the procedures in this SOP to be retrained.
2. Follow the corrective actions as per instructions above.

**DOCUMENTATION RETENTION:**

The records applied to this procedure are to be kept on file for a minimum of 3 years.

**AMENDMENT RECORD SHEET**

| **Amendment Record Sheet** | | | |
|---|---|---|---|
| **Issue No** | **Date** | **Revised Issue Details** | **Revised by** |
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