Product Inspection

How to Correctly Test
Your Industrial Metal Detector

Tips & Tricks Inside

METTLER TOLEDO

Validation and Verification
Understanding The Difference

Validation and verification are distinct processes. It is important to understand the purpose of each process to make sure that relevant tests are performed and documented correctly to comply with regulatory requirements; particularly where the equipment is designated as a Critical Control Point (CCP). Routine performance monitoring is a related process that is also essential for compliance purposes.

Validation Procedure

All metal detection equipment must be validated at the time of installation by the manufacturer or their representative. It should show, through the provision of objective evidences, that the requirements for the specific intended use or application have been met.

Validation aims to answer the question "will this piece of equipment meet the specified objectives?"

Product or Equipment Modifications

Re-validation may also be required if substantial modifications to the equipment, or the products being inspected (size, packaging material, etc), are made at any point after installation.

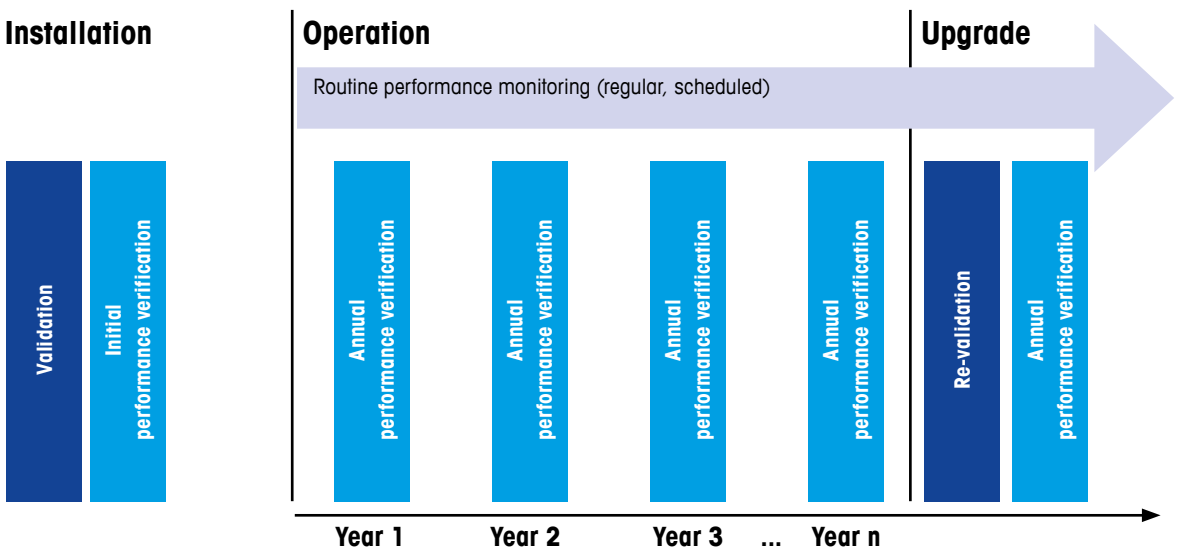
Verification Procedure

Any metal detection system should be periodically verified (typically at 6 to 12 month intervals) in order to demonstrate due diligence and that metal detection policies are being complied with. In addition, verification will ensure that:

- It continues to operate in accordance with the specified sensitivity standard
- It continues to reject contaminated product on detection of metal contaminants
- All additional warning/signalling devices are effective (e.g. alarm conditions, reject confirmation)
- Installed failsafe systems are functioning correctly
- All current safety standards are being complied with.

Verification uses standard, formal processes to answer the question "is the specified equipment under control and operating as expected?"

Validation, verification and routine performance monitoring points along the equipment lifecycle continuum



Routine Performance Monitoring

In ensuring that the metal detection system continues to detect and reject in accordance with the documented standard, the purpose of the test is to ensure that there has been no significant change in the detector's performance level since the last successful test. These changes could occur as a result of alterations to:

- Machine settings
- Product signal
- Metal detector's functionality

The selection of correct metal contaminant types for testing is important. This is because the significance of a change in machine settings, product signal or metal detection functionality can vary, depending upon the type of metal contamination.

Ultimately, when testing for contaminant types, the minimum requirements for such tests should be that they satisfy any external customer code, retailer code or company specific policy/test requirements.

Routine performance monitoring differs from the processes of validation and verification in that it is a series of performance verification checks completed at frequent, regular intervals.

Tips & Tricks

What To Expect During An Annual Performance Verification

The annual performance verification is far more in-depth than simply repeating the scheduled routine performance monitoring tests that are carried out by an individual site.

These verification checks must be in line with general HACCP-based requirements, fully documented and should include as a minimum, the following:

- Metal detector manufacturer's initial build parameters – not accessible to the user
- Electrical and mechanical installation checks
- System functionality checks including adherence to the specified critical limits
- Product-related information checks
- Failsafe functionality checks
- Customer's test piece verification checks
- Verification that line personnel are trained and knowledgeable in undertaking the Standard Operating Procedures (SOP) for monitoring CCPs by auditing a member of the production team (at random)
- A summary of the verification tests
- Commentary which gives an indication of the performance since the last test and any potential degradation in the previous year and the following year

Copies of training certificates/evidence of competency for all external personnel must be attached to all Performance Verification Certificates issued for each metal detector checked.

www.mt.com/pi-wp-vvm

Different Test Methods
For Different Metal Detectors

Metal detectors can be used at different CCPs including front-end, in-process and end-of-line. Different metal detection systems are available to inspect products in a wide variety of formats, including bulk, unpackaged or packaged products on a conveyor; unpackaged powders, granular or discrete products under gravity-fed conditions, or pumped liquids, pastes and slurries in a pipeline. This article highlights key test methodology for each application.

Testing Conveyors with Discrete Products or Packs

The test should be carried out so that, as a minimum, there is a test sample on the leading edge of one of the test packs, test sample in the middle of one of the test packs and a test sample on the trailing edge of another test pack (Figure 1).

Test packs should be passed down the production line through the metal detector one after another with the actual metal test piece passing through the geometric center of the metal detector's aperture as this is the least sensitive area of the metal detector.

(The above testing assumes that the system is as per the original validated system).

This test method will generally represent the worst-case scenario. It will verify whether the metal detection system can detect and reject contaminated product, regardless of:

- The position of the contaminant in the product
- The position of the contaminant as it passes through the metal detector aperture
- The system's ability to detect consecutive contaminants

If testing is carried out with three different contaminant material types:

- Sample 1 should be placed on the leading edge
- Sample 2 should be placed in the middle
- Sample 3 should be placed on the trailing edge

Precautions should be taken to ensure that any non-rejected test packs or test samples do not become lost in the product flow.

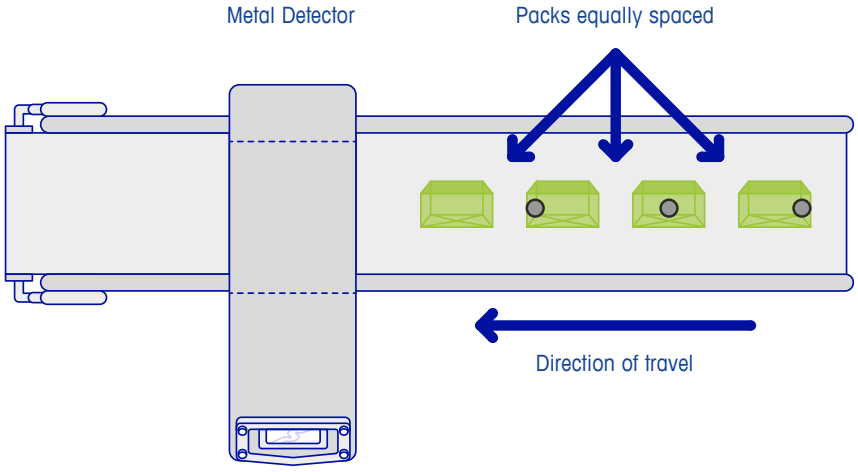


Figure 1: Test samples positioned on the leading edge, middle and trailing edge of test packs inserted into the product flow. Packs are spaced evenly on the line.

The spacing between the packs should be the normal distance between products which travel down the line (Figure 1). The packs should be placed so as to break the photo-gate sensor beam (i.e. the pack sensor beam), if one is fitted.

For unpacked discrete product, the test sample should be placed into (or securely on top of) the product in the specified locations.

For smaller-length or triangular-shaped packs (e.g. sandwiches), the positioning of the test sample pieces at leading and trailing edges may not be practical. In these cases, the test pieces should be placed in the most convenient position that allows them to pass as close as possible through the center of the metal detector aperture.

Stop Alarm Systems

For a belt stop alarm system, each individual pack should be passed down the line. The test pack should be detected, and the conveyor should have stopped for the test to have been successful. It should only be possible to re-start the system using a key held by a nominated person.

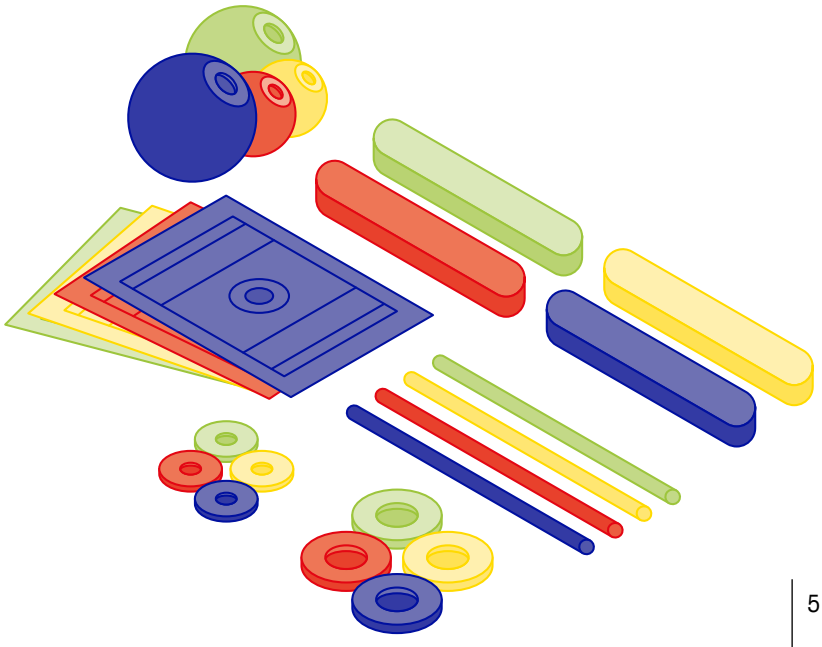
The test sequence should be repeated for the specified number of tests. As discussed previously, the types of contamination to be tested (and the number of tests to be performed) depend upon a variety of factors.

Ultimately, the types of contamination to be tested, and the number of tests to be performed, depend on the level of risk that the company is prepared to take.

Testing Conveyors with Bulk Product

Precautions should be taken to ensure that test samples will not be lost if they are not detected or rejected, especially if the product is being fed directly into another processing machine after the metal detection system.

The specified test samples should be evenly spaced, and placed into the product flow in the center of the belt. The test sequence should be repeated for the specified number of tests.



Testing of Free Fall (VFFS) Vertical Packaging Applications

Ideally, test samples should be placed independently in the product flow, somewhere above the metal detector and allowed to fall with the product as it enters the bagger. Providing the metal test samples are detected, the bagger should be observed to stop when the test sample is detected, and any associated alarms should be activated.

It is important to check that the specified test sample type is capable of being recovered if it is not detected, or if it is not successfully rejected. If this is the case, the specified test sample can be inserted into the product flow to verify the correct operation of the reject device, e.g.:

- Double pack made
- An audible and/or visual alarm activated
- Line stops

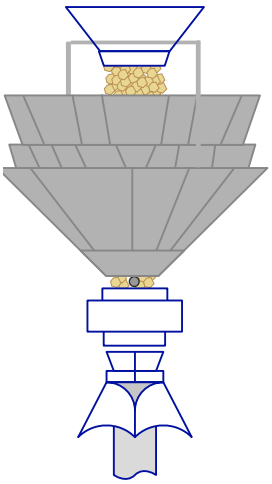


Figure 2: Test sample is inserted into the product flow above the metal detector in a VFFS application.

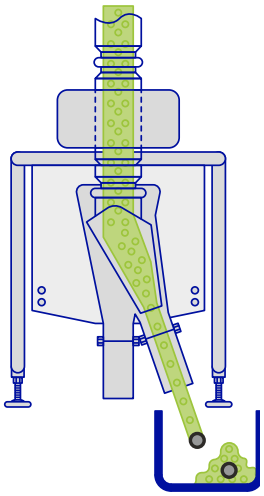


Figure 3: The reject device should be observed to successfully divert test pieces into the reject bin. It is best practice to include test piece catch grids on both the accept and reject outlets.

Testing of Gravity-Feed Inspection Systems

When inspecting bulk powders and granular products, test samples should ideally be placed independently in the product flow at the point above the metal detector where product begins to fall (not just above the metal detector itself). Providing the metal test samples are detected, the reject device should be observed to see if it successfully diverts the test sample to the reject position (Figure 3).

If the equipment has been supplied with a test kit, a test sample access port and safety catch grids will be located above the metal detector and beyond the reject device. The purpose of the sample access port and safety catch grids is to make it easy to introduce the test samples to the system and also to catch a test sample if the detector fails to detect/reject it.

If the above devices have been included, the specified test sample can be inserted into the product flow. Once the test sample has been inserted, its diversion to the reject location can be checked. The safety catch grids should be removed after testing so as not to restrict the flow of the product.

If there is no test port, an access point will need to be identified above the metal detector. This access point will be for the insertion of the test sample.

The location of the access point should be as close as possible to the location at which the product begins to fall. This will ensure that the speed of the test sample will be the same speed as that of the product. If the test sample is not rejected, a method of ensuring its recovery will also be required.

Tips & Tricks

It is highly unlikely that the above test procedures (or any other manual test procedure undertaken) will result in the test piece actually passing through the center of the metal detector's aperture. As such the test will not actually confirm worst case performance.

In such instances, a more controlled test should be done at agreed intervals where the test sample is guaranteed to pass through the center of the aperture i.e. worst case testing. To facilitate this, sophisticated automatic test systems are available to guarantee center-line performance. These can be used to supplement the manual test method described above or used periodically to confirm center line performance. Other benefits of using auto test devices are covered later in this document - turn to page 10 for further details.

Testing of Pipeline Applications (Liquids, Slurries and Pastes)

Ideally, test samples should be placed independently in the product flow upstream of the metal detector, and the reject device should then be observed to successfully divert the test sample to the reject position, and collected in the reject bin or collection vessel. It must be confirmed that the test sample has been caught in the reject bin.

If the equipment has been supplied with a test sample access port it should also include a means of catching the test sample if it is not rejected. This is normally done by incorporating a second failsafe valve in the product flow immediately after the primary reject valve. If this is the case, the specified test sample should be inserted into the product flow. It should also be confirmed that the test sample is diverted to the reject bin or collection vessel (Figure 4).

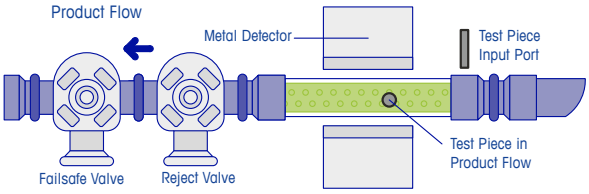


Figure 4: Test sample is inserted into the product flow of a pipeline metal detection system.

If this is not possible, the system must be tested by inserting a test sample rod/wand between the pipeline and the detector aperture. In this case it is not possible to test in the center of the metal detector – nor anywhere close – so the size of the metal in the test rod/wand should be smaller than the operating specification on the metal detector, as agreed with the equipment supplier. In this case when a detection event occurs the operation of the reject valve should be observed. A successful test is recorded when the test sample is detected and the reject valve undergoes a full rejection cycle i.e. opens and closes. Obviously, there will not be a test sample rejected into the reject bin/collection vessel. See figure 5 below.

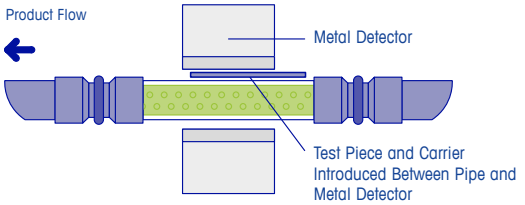


Figure 5: Test sample is inserted between the throughput pipe and the metal detector aperture.

Tips & Tricks

How To Choose The Right Certified Test Sample

Test samples should be certified and permanently marked with the ball size, material and batch-specific reference number. This information allows for traceability back to the original precision ball-bearing producer's manufacturing lot.

Test samples are available in a wide variety of formats to suit different applications:

Generic Carrier Type	Typical Application
Test Card	Conveyor lines with discrete packed products
Test Stick	Conveyor lines with discrete packaged or bulk products
Test Tablet	Pharmaceutical and nutraceutical applications; Freefall inspection in VFFS applications
Test Ball	Gravity-feed inspection of powders and granules; Freefall inspection in VFFS applications
Test Rod	Gravity-fed inspection of powders and granules and inspection of liquids, pastes and slurries (where test sample retrieval is not practical)

Expert Support
To Help You Meet Your Obligations

Regulations and food safety standards can be highly complex.

As global experts in product inspection equipment, METTLER TOLEDO can provide comprehensive and reliable support in **establishing correct test procedures** and **providing samples** to conduct the tests to support maximum operational compliance.

Download the FREE Testing Solutions catalogue
www.mt.com/test-pi

Retailer Requirements
Additional Test Routines

In addition to the basic 'continuous pack test' or 'single pack test,' some Retailer Codes of Practice require additional routine performance monitoring tests to be completed. The most common of these tests are explained below. Some metal detectors also provide built-in routines, offering step-by-step guidance to help operators conduct tests correctly.

Memory Test

The Memory Test comprises of 3 contaminated packs and 2 non-contaminated test packs as illustrated in Figure 6.

The theory is that the 3 contaminated packs are rejected and the 2 non-contaminated packs are accepted. However, in many cases due to line speed and the proximity of packs, the detector cannot distinguish between consecutive contaminated and non-contaminated packs.

In addition, if amplitude detection is being used, which is the norm for most metal detection systems in use today, the non-contaminated packs may well get rejected, which is perfectly normal and inherent to the way amplitude detection works.

In this case the code owner may require a written report from the equipment manufacturer that the equipment is working as intended.

Large Metal Test

The large metal test is used to confirm the photogating system is functioning correctly.

It is recommended that a large metal test piece (20mm ferrous) is introduced to the metal detection system once a day as a minimum. Ideally this test should be performed once a shift.

The test pack can be introduced amongst other packs or on its own. If introduced with other packs, multiple packs are likely to be rejected – this is normal.

- If the test is successful without causing the line to block or miss the pack with the large metal test sample in and the test pack is rejected no more testing is required.
- If the photogating sensor is switched off, missing or damaged the reject mechanism will operate early and automatically extend its reject time. For side-mounted reject types i.e. pushers, sweeps etc. this will result in a failed test and potential line blockage.

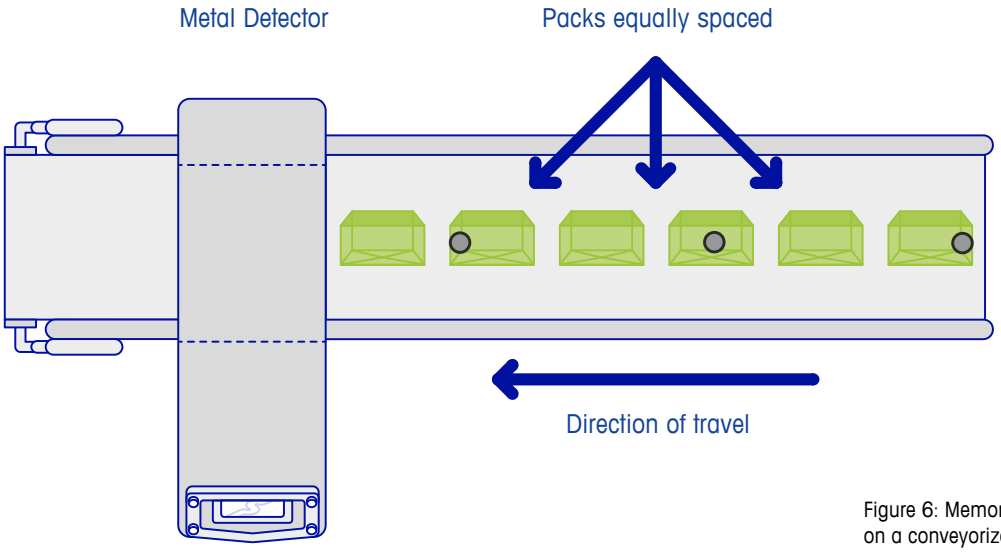


Figure 6: Memory test pack positions on a conveyorized production line.

Frequency of Testing

Procedures should clearly state when scheduled routine monitoring tests should be performed within the manufacturing cycle. Consideration should be given to implementing routine monitoring testing at the following stages:

- At the start and finish of daily production/shift
- At regular intervals during the production run (as necessary)
- At changes in production batches
- At changes in machine settings
- After downtime for repairs

Built-in Performance Routines

A metal detection system that has built-in performance verification and monitoring routines can aid the discipline and record-generation of testing procedures. Such routines can automatically request a test at an agreed pre-set time interval.

The approved test operative should enter a personal access number into the detector to allow the test to be completed with the correct test samples. Failure to test the equipment at the agreed time interval could cause a range of different outcomes.

Documenting Test Records

Different retailers may have different requirements for test records.

- In some cases, paper copies are sufficient. Hard-copy documentation (which proves that testing has been carried out) can be provided through a local printer.
- Alternatively, it can be downloaded to a USB stick or a central PC, using a detector with network connectivity capabilities.
- **Best practice** for documenting performance test data is to automatically record the results and store them electronically.

ProdX is a PC-based client server solution which monitors and manages data collected from METTLER TOLEDO product inspection devices. This software allows users to access records automatically on networked computers, making them easily accessible for audit purposes.

Tips & Tricks

How To Create And Correctly Use Test Packs

Test packs are commonly used on packed product inspection lines. The following requirements should be defined and contained within the test procedure:

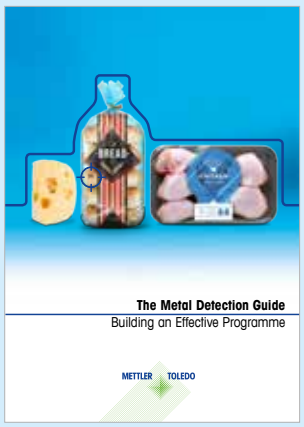
- The method of checking that the packs are free from contamination before inserting or attaching test samples
- The method of making up the test pack, including the position/location of the test sample within or on the test pack
- The frequency at which the test packs should be made up, so as to reflect the nature, durability and shelf-life of the product. Ideally, test packs should be freshly made up for each production batch, since the aging of the product may affect the sensitivity, and will not be representative of the actual product being manufactured.
- The method for labelling of the test packs (e.g. marking with colored tape), so that they are not accidentally put into the supply chain

Best practice dictates that test packs are not kept locally to the system i.e. in the reject bin – they should be kept away from the system, ideally off-line in a controlled area.

Non-food test packs can be used for testing metal detector failsafe systems. However, they should be representative of the size, shape and weight of the food products travelling down the line.

For more detailed guidance on test processes, download METTLER TOLEDO's Metal Detection Guide - 'Building an Effective Metal Detection Program.'

www.mt.com/mdguide



Process Innovations
Make Routine Testing Easier

Several recent developments make testing easier. The Automatic Test System (ATS) enables performance monitoring tests to be conducted regularly without interrupting production. Reduced Test Mode reduces the frequency of routine testing; Emulation makes the HMI more accessible for viewing test outcomes.

Automatic Test System

Automatic Test System (ATS) uses compressed air to transport test samples through the metal detector aperture, allowing operators to verify the metal detector is working correctly.

Advantages

- End-to-end test process is faster compared to manual testing (reduced from three to five minutes to less than 40 seconds)
- Test processes are more repeatable and the random nature of gravity-fed testing is eliminated
- Testing shortcuts are prevented
- ATS actually confirms center-line (worst case) sensitivity, unlike manual testing procedures
- Operators make fewer ladder climbs

How You Benefit

By using ATS, you can increase production capacity, improve operator efficiency and enhance process quality. As an added bonus, fewer ladder climbs lead to enhanced operator safety. ATS is the only practical way of actually confirming centerline (worst case) performance.

Note: ATS should not be used as a total replacement for manual testing. Whilst automatic testing systems may have the potential to detect any reduction in sensitivity of the metal detector, they cannot identify any problems with the reject mechanism or timing. Therefore, a manual routine performance monitoring test must still be conducted within the quarantine period.

HMI Emulation

Using a virtual network computing (VNC) client, Emulation enables users to extend and remotely control the interface of one or more Profile or Profile Advantage metal detectors from a variety of networked devices including other packaging line equipment.

Advantages

- Emulation makes it easier for quality personnel to view stored data and settings for audit compliance
- Simplifies operation of metal detectors installed in hard to reach locations - including operation of the ATS device

How You Benefit

Emulation delivers improved process efficiency and enhanced operator safety.

Reduced Test (RT) Mode

RT Mode involves intelligent software that continuously checks the performance of the metal detector to ensure it is always working to, or better than, the customer's specification.

Advantages

- Performance monitoring tests can be conducted less frequently (subject to quarantine periods)
- Minimizes the need to work at height to conduct routine testing

How You Benefit

Increase production capacity and improve operator efficiency, whilst ensuring process quality. As an added bonus, fewer ladder climbs lead to enhanced operator safety.

For more information, visit

www.mt.com/md-pve

Tips & Tricks

Eliminate Paper Test Records

To satisfy audit requirements, as a minimum, all test results must be documented, and paper records may be sufficient.

However, documenting and storing records electronically is considered best practice. It removes unwanted paper from the factory floor, makes the whole process faster, cheaper, and more robust, and makes it easier to meet compliance requirements.

ProdX is a PC-based client server solution which monitors and manages data collected from METTLER TOLEDO product inspection devices. It supports and maximizes rigorous quality control regimes, production optimization drives and simplifies production line operation.

Advantages:

- All compliance-relevant data can be collected and stored electronically
- Eliminates the potential for human error when recording test results
- Minimizes the risk of losing records compared to relying on paper copies
- Data can be viewed centrally for all connected equipment, for quick access to required records

How You Benefit

- **ProdX** significantly reduces the resource burden for food safety standard and retailer audit requirements.

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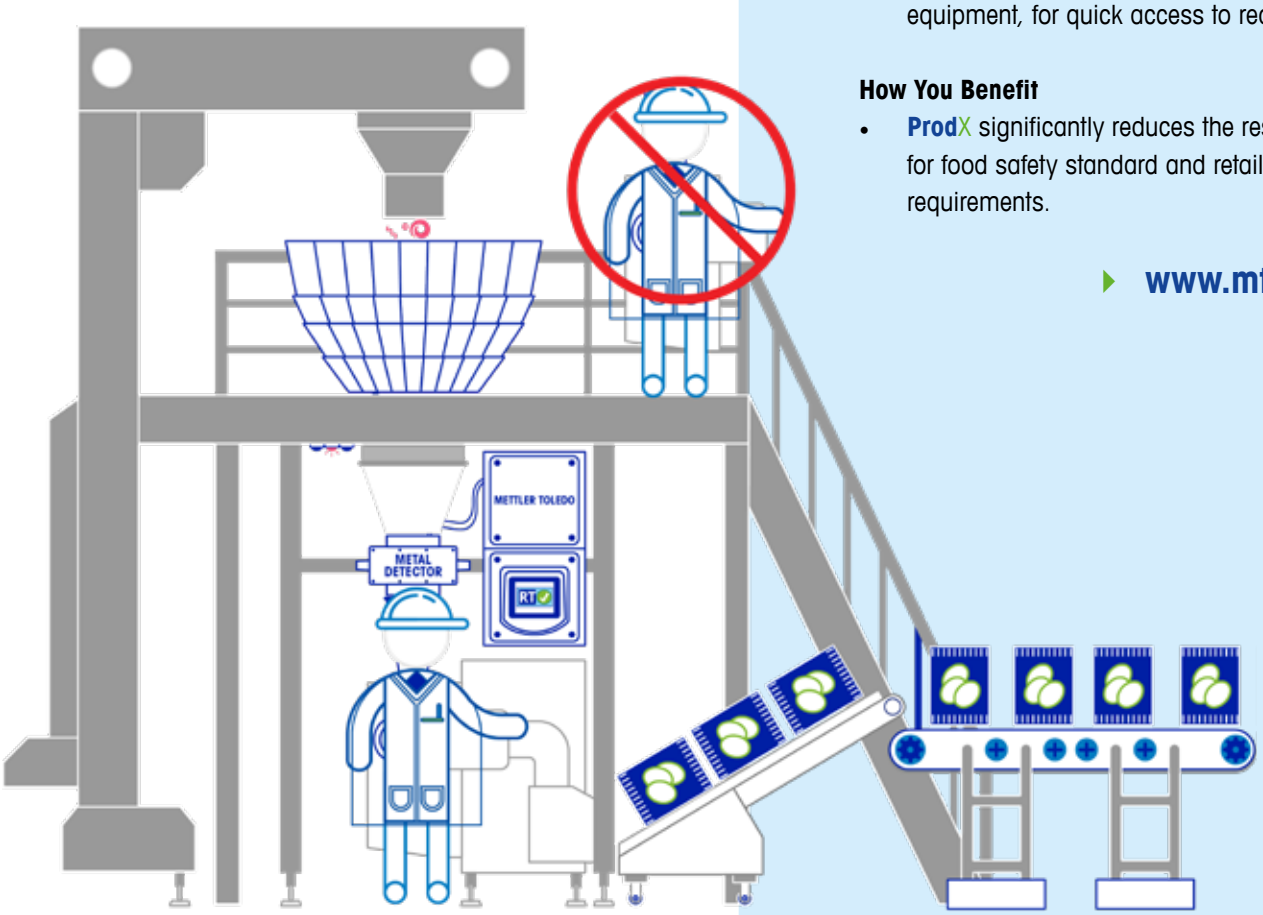

Testing innovations reduce or remove the need to wok at height to conduct routine performance monitoring tests.

Further Reading

Increase your Understanding
Of Metal Detector Sensitivity

Are you interested in understanding more about how your metal detector works? Would you like to understand why sensitivity is so important in helping you to reduce the risk of product recalls and to prevent choking hazards due to undetected metal?

METTLER TOLEDO's free guide "**Understanding Sensitivity in Metal Detection**" offers comprehensive guidance for food manufacturers and processors on a range of sensitivity-related metal detection topics. Download it today:

www.mt.com/md-guide-sensitivity

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