This article provides three main reasons metal detectors fail to detect metal fragments and explains what you can do to improve metal detection in your facility.

Companies have been integrating metal detection equipment into continuous processing lines for decades. Despite careful attention and sound manufacturing practices, metal fragments still find their way into consumer products. Why does this happen? What can be done differently? Before answering these questions, it’s important to understand the basics of how a metal detector operates.

**Metal detection basics**

The heart of a metal detector is the coil. As shown in the exploded view in Figure 1, the coil consists of a transmitter coil (shown in red) and two receiver coils (shown...
The plastic-to-plastic contact eventually leads to a static discharge. Understanding that tablet press and packaging rooms require strict environmental and process controls, several simple changes can help to minimize electrostatic buildup. While every strategy outlined may not be suitable for your application, consider these simple steps:

- **Increase the relative humidity**—Moisture deters static, so increasing the room’s relative humidity slightly will reduce static discharge.
- **Ground the detector**—Ensuring that a ground wire from the metal detector frame is attached to an earth ground will prevent electrostatic buildup.
- **Use a deionizing or static bar or anti-static blowers**—Today’s systems provide high performance with versatility and simple installation.
- **Use an alternative plastic such as Tivar for metal detector chutes and conveyor-system slider beds**—Tivar is a proprietary ultra-high-molecular-weight polyethylene that has antistatic properties and is suitable for direct product contact.

If you cannot implement these suggestions, some metal detectors, such as the Eriez Xtreme, have a special mode for high-static applications. This mode uses an algorithm that identifies the unipolar signal of static, ignores it, and drastically reduces its impact during operation. However, we strongly recommend first employing the static-dissipating strategies previously outlined where possible.

**Electrical interference.** Electrical interference (or noise) from surrounding equipment or the main electrical supply can also impact a metal detector’s signal, and at sufficient levels, such ambient noise will cause false trips. Accordingly, a metal detector’s power wiring should be run in a dedicated conduit. The best insurance against electrical noise and false trips is to run a separate circuit to the metal detector from the main power bus. This circuit should be free of all loads except the metal detector. If this is impractical, you can often obtain reliable operation...
by powering the metal detector from a “clean” lighting or instrument circuit. The circuit must be free of inductive loads such as motors, solenoids, and motor starters. If you must power the metal detector using a less-than-favorable source, you can use a constant-voltage transformer with harmonic neutralization to eliminate or reduce false tripping from line noise. This transformer should be mounted within 3 to 5 feet (1 to 1.5 meters) of the metal detector.

Further, the metal detector’s power source must contain a reliable ground connection. It must be connected to the metal detector’s protective earth terminal. The metal detector should be grounded at one point through the power supply ground wire. No other ground connections are permitted, including mounting hardware and conduit.

Inductive loads sharing the same power circuit usually create noise. While metal detectors are equipped with electronic filter circuits to reduce incoming electrical noise, there is a limit to what a detector can withstand without false tripping.

**Detector not working properly**

We have learned through the years that metal is often missed because the metal detector has been shut off, was improperly set up, or has a problem with its electronics. Use the following strategies to remedy these issues.

**Verification.** Verification is the process of proving that a metal detector meets its sensitivity requirements. This is accomplished by challenging the detector in a repeatable manner using a certified metal sphere at a predetermined time. Verification is most often executed daily.

A correct test protocol requires the certified sphere to be placed on the product. This is critical, as some products may impact the detectability of certain metals, especially stainless steel. This is often overlooked, and many operators simply place the metal test sphere in or through the detector’s aperture without the product. For most third-party audits, testing without product will result in noncompliance and could allow metal to pass undetected during production.

**Certified test pieces are readily available and should include a certification number that corresponds to a certificate of compliance. The certificate, which confirms the sphere size and metal composition, is essential to a sound metal detection program.**

**Validation.** Validation is the process of authenticating the metal detector to ensure that the equipment meets verification requirements. For instance, if your metal detector has been verified to detect a 2-millimeter stainless steel sphere, you should validate these results (typically on an annual basis) using a third party. Service companies that validate equipment should provide the user with a certification letter and a sticker to be placed conspicuously on the equipment.

Documentation is not limited to third-party validations. A sound program must also include recordkeeping. It is not enough to say that you are verifying your equipment; you must be able to prove it. This is much easier if your detection system features an event log for recordkeeping.

The impact of noise on a metal detector is illustrated by the real-time polar graph shown in Figure 3. Because electrical noise has a distinct irregular shape (the red squiggly line) the metal detector (Eriez Xtreme) can quickly identify the interference, drastically reducing troubleshooting and downtime.

**Vibration.** The impact of vibration on a metal detector is two-fold. First, at adequate levels, the vibration can trip the detector. Second, it can fatigue the solder joints on the detector’s circuit boards.

Like electrical noise, vibration has a distinct signature, as shown in red in Figure 4. Vibration presents itself at 0 degrees to the metal detector and is easily identified in the real-time polar graph. As the figure shows, the vibration signature penetrated the green boundary, causing a false trip. If vibration is present, consider dampening devices.

**Figure 3**

Real-time polar graph showing electrical noise

- Electrical noise
- Figure 3

**Figure 4**

Real-time polar graph showing vibration

- Vibration signature
- Figure 4

Certified test pieces are readily available and should include a certification number that corresponds to a certificate of compliance. The certificate, which confirms the sphere size and metal composition, is essential to a sound metal detection program.
Despite having policies in place, many companies don’t regularly verify or validate their metal detectors, sometimes with disastrous consequences. You can overcome this shortfall by using a smart detector with verification scheduling that prompts operators to test the detector at predetermined intervals. If testing does not occur, the detector can signal a warning alarm and, eventually, trigger a fault alarm.

To identify problems with a detector’s electronics, look for a detector with a continuous diagnostics feature that monitors the machine’s critical parameters and triggers an audible and visible alarm if a problem arises.

**Orientation effect**

If the equipment is operating at peak performance and has been verified but still allows metal to pass undetected, the reason could be a phenomenon called the orientation effect. The orientation effect relates to the alignment of metal as it passes the metal detector coils and is most common with wire or long, thin metal objects, such as broken tablet press dies.

As stated earlier, a metal detector has one transmitter coil and two receiver coils. Each of these can trigger a detection. In a typical coil architecture, the coils are wrapped completely around the aperture, as shown in Figure 5. The blue directional arrows depict how a product would pass through the detector’s horizontal aperture. (Note that, though we are limiting our discussion to horizontal-style metal detectors, the orientation effect applies to vertical systems as well.)

Consider a metal fragment from a broken tablet press die that is long and thin like a piece of wire. The fragment has two main dimensions, diameter and length. How such a fragment is oriented when passing over the metal detector’s coils has a profound impact on its detectability. When the fragment’s orientation is favorable, the detector can

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**Photo 1:** Static buildup often occurs when a detector is placed at a tablet press discharge outlet, which can lead to false trips and decrease the operator’s confidence in the detector.

**Photo 2:** Static buildup occurs on metal detector conveyor systems installed on packaging lines due to plastic-to-plastic contact between the belting and slider bed.

**Photo 3:** A metal detector’s aperture height and width determine the detectability of needle- or wire-shaped fragments.

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**Figure 5**

Typical metal detector coil architecture

Transmitter coil

Receiver coil 1 (+)

Receiver coil 2 (-)
easily detect the metal, when the fragment’s orientation is unfavorable, the metal is more likely to pass undetected.

Further, it is difficult to calculate the detectability of a wire-shaped object, which is why metal detector manufacturers use spherical test pieces with no orientation to measure metal detector sensitivity.

The orientation effect is an unavoidable limitation in today’s state-of-the-art metal detectors. However, a metal detector’s sensitivity is linear to its opening, so specifying the smallest aperture possible can help to reduce the orientation effect and provide better detection.

**Internet of things**

Finally, the internet of things (IoT)—the network of connected “smart” devices that communicate seamlessly over the internet—is transforming manufacturing facilities across the globe. For pharmaceutical processors, connected metal detectors can transmit useful information across multiple process lines and provide valuable data.

Today’s detectors can monitor activity and provide feedback about the equipment’s performance while also pushing data for electronic records. This information is vital for streamlining supplier audits and warning operations personnel of potential equipment failures to reduce downtime and properly schedule predictive maintenance. Accordingly, metal detectors are increasingly being connected to information systems in smart facilities. T&C

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