SEARCHING FOR METAL

By
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Poor metal detection of a log up front can mean disaster down the line.

Metal detection implementation demands attention to detail.

I have often been asked: "What makes one metal detector better than the next? Is metal detection a black art or science?" Black art it is not and to answer this question more completely requires a bit of scientific explanation as well as the dispelling of some common myths surrounding metal detection. This information will allow you to ask the kind of intelligent questions that need to be asked of any prospective supplier and will greatly assist you in purchasing the "right product" for your specific application.

Experience has shown me that most people think all metal detectors are the same, that their performance and capabilities are the same, and only the name changes. Nothing could be further from the truth.

Simply stated, there are two basic types or principles of metal detection. Although there are derivatives and variations of both systems, depending on the manufacturer, the theory is the same. The most common system or principle is called "Phase or Phase Shift." With this type of system there are three coils: One transmits and two receive. They are balanced to cancel each other out so that when metal enters the field, it causes the metal detector to trip. This type of system is very sensitive and has been proven to be the best for the forestry industry; however, because of the degree of sensitivity that can be attained, it takes very sophisticated system electronics.

The second type of system is called "Pulse or Pulse Eddy." Some manufacturers use a single coil that both transmits and receives. Some use a dual coil system, but the theory of operation is unchanged. The system sends out a signal or pulse which energizes any metal present and this in turn sends a signal to the electronics which in turn causes the metal detector to trip. This type of system is commonly used to search for large metal objects in highly conductive material such as black coal. These systems are far less sensitive than "Phase" and therefore should not be used for whole log metal detectors or waste wood systems with a burden depth exceeding 6 in.

This writer does not know of any "Pulse" system that is manufactured for whole logs. The balance of this article will only address the "Phase Shift" system and its performance.

ELECTRONICS

Without question the key to a metal detector's performance is the electronics. This is the heart and brain of the system. Any metal detector using analogue circuit boards or derivatives of analogue technology such as digital processors or converters are obsolete and cannot compare in performance to a microprocessor driven system. Ask yourself when was the last time you bought a television with tubes. If your computer, calculator, cell phone, motor vehicle or just about any other electronic device was equipped with analogue circuitry, consider the consequences. Electronic components such as capacitors, resistors, transistors, diodes, etc. all age and therein lies the fundamental problem. On an analogue

board as these components age, the system cannot process the information without error and there is no way to compensate for these anomalies thereby rendering the piece of equipment unreliable.

With a metal detector the results can manifest themselves into what is commonly known as *false or nuisance tripping* or they can and will ignore metal altogether. Anyone reading this article that has a metal detector with analogue circuitry has experienced this problem, the result of which has been phone calls to the manufacturer's tech support line, then mounting frustration, then acceptance. Next, you decrease the sensitivity, but this is self-defeating. You are now resolved to accept poor performance.

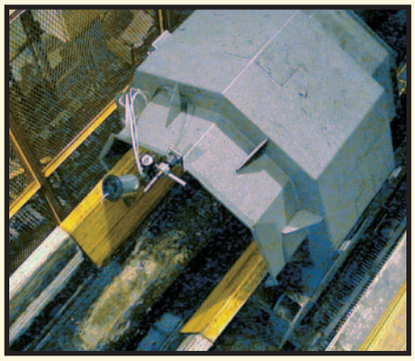
On the other hand, a microprocessor constantly goes through a self-checking or testing process and compensates for any anomalies that are found, enabling it to perform 100%, 24/7.

Other big benefits of a microprocessor controlled system are the ability to filter out transient influences such as two way radios, variable frequency drives and product effects such as moisture, minerals and salts as well as pitch pockets in certain species of wood. These also are major contributors to false and nuisance tripping. The ability to accurately dye mark the contaminated section of the material being scanned can also be accomplished with a microprocessor. Some microprocessor controlled systems can even provide an electronic signature of the exact location of metal contamination in the material being conveyed and in turn send this information to a PLC or process software. With a whole log system this electronic signature can be sent to the optimization or bucking software, enabling the system to make the decision as to how much of the log to cut out.

The rule of thumb then becomes: *Do not purchase a metal detector that has any type of analogue or digital electronics unless you are prepared to keep an inventory of spare circuit boards and change them out regularly, no matter how much smoke and mirrors the manufacturer tries to use to convince you otherwise*. When purchasing a microprocessor controlled metal detector, a single board system is best.

Other nice features of microprocessor controlled systems include the ability to network multiple metal detectors to a common mill location using proprietary software. Even though most microprocessor controlled systems offer the ability to set up multiple levels of user security, the software allows you the ability to control/adjust all metal detectors from a maintenance or control room computer as well as the ability to lock out the key pad or controls at the metal detector itself. An added bonus for this type of system is the ability to have the supplier's service technician dial in to your system via modem to diagnose/trouble-shoot and reset on line—a definite plus if your mill is far removed from the supplier's location.

In researching information for this article I discovered and was quite shocked



to find that there is no UL (Underwriters Laboratories) or CSA (Canadian Standards Assn.) standard for metal detectors. No one at either agency could tell me why, but I did discover that the equivalent regulatory body in Europe, CE (European Union Directive), does have a standard of performance to which all manufacturers who wish to sell into Europe must comply. That standard is: "The metal detector must withstand a 2.0Kv line charge." Translated into layman's terms what this does is essentially eliminate 95% of false or nuisance tripping caused by such things as two way radios, variable frequency drives and mill noise in general, all of which can be basically classified as electromagnetic interference. This is a quantum leap forward and in your search for a metal detector find out if the manufacturer you are dealing with is CE compliant. This is one big bonus!

CHARACTERISTICS

Another important aspect to consider is the housing material of the metal detector. Why is this important? It is a primary segment of the design equation and has a direct correlation on shielding against the majority of outside influences that cause false or nuisance tripping. This is a critical factor when considering system performance. The best housing material is stainless steel and, as any electrician knows, stainless steel provides total shielding against electromagnetic interference. The next best shield is aluminum and following that, ferrous metal.

Some manufacturers use a fiberglass housing. It is cost effective to manufacture using this material, but it's incapable of shielding against these influences.

In conjunction with the type of housing material is the shape of the metal detector itself. In whole log applications the rule of thumb is: The greater the number of search faces, the better the sensitivity. This is especially important with a variable diet of log diameters. For whole log scanning, while square and rectangular apertures will work, hexagonal is better and octagonal is best. Should a company offer a round aperture system it would rank close in performance to an octagonal system; however, manufacturing a round aperture coil is expensive.

We are all familiar with the industry standard flat plate metal detector that sits beneath a vibrating or belt conveyor. However, as burden depths increase, it becomes ineffective. This style of metal detector must be positioned below a fiberglass section with a certain amount of clearance, and this clearance or distance between the sensing face of the metal detector and the material it is scanning equals sacrificed sensitivity.

The closer to the material you can place the sensing face of the metal detector the better it is. That is why some manufacturers now have a three-sided system cast integrally into a fiberglass section that is the same shape as the conveyor pan. These systems are as short as 20 in. and are becoming very popular especially with the ever increasing burden depths in conveyors. These systems create a *sensing grid* from all three sides, ensuring full coverage at burden depths beyond the capabilities of the flat plate style metal detector.

METAL FREE ZONE

The next thing to consider is the length of the Metal Free Zone (MFZ). The MFZ is fabricated from fiberglass or some other non conductive material and the metal detector is centered in or under this section depending on the detector configuration. The length of this section is based strictly on the laws of physics and until recently these laws could not be defeated.

For vibratory and belt conveyors the long standing required MFZ length was 60 in. and in some belt conveyor applications it grew to as much as 72 in. With the use of microprocessors and their superior filtering capabilities, some manufacturers have shrunk the MFZ to 48 in. (1219 mm) and in some cases to as little as 20 in. (508 mm) when the metal detector becomes an integral part of the

fiberglass section. The cast in place or integrally molded metal detector is a relative newcomer to the market and has been around for about five years. This technology would not be possible were it not for microprocessors.

These options present an unequaled opportunity for those users that do not have the unimpeded conveyor length available for a conventional MFZ but still require a metal detector to protect their downstream processing equipment.

The MFZ for whole log or tunnel/wrap around style metal detectors is far more complex an issue. Following the laws of physics, as the aperture size increases, the length of the MFZ also increases. Most manufacturers provide a formula to calculate the MFZ or as is most common provide a chart or technical specification sheet wherein the length of the MFZ is clearly stated. A good rule of thumb formula for calculating the approximate MFZ for square and rectangular aperture metal detectors is C+3A: Where C is the width of the detector housing and A is the aperture height.

Beware of the supplier that tells you "one size fits all" where one length of MFZ or fiberglass section will satisfy many different aperture sizes. This may be true if you do not plan to operate the metal detector at 100% sensitivity. However, any reputable manufacturer will always plan for the worst case scenario, which means operating the system at 100% sensitivity, and their charts and technical data sheets will reflect this. The last thing you want to be confronted with is being unable to run your metal detector at the required sensitivity setting because your MFZ is too short.

It is always a good idea to obtain a "performance guarantee" from your supplier and ensure that it has a clause stating that the length of the recommended MFZ will allow you to run the metal detector at 100% sensitivity. This avoids the "you never asked me, you never told me." scenario.

Available geography in a mill has often been a problem when retrofitting whole log systems, resulting in sacrificed sensitivity due to a shorter than required MFZ, the theory being that some protection is better than none. Some manufacturers have risen to this challenge and now provide a metal detector that at first appearance seems somewhat unorthodox by design. Upon closer examination what they have done is used a cleverly engineered set of external shields around the aperture to capture the electromagnetic field of the metal detector and contain it. This combined with microprocessor controlled electronics provides a compact package that will not only operate at 100% sensitivity, it will do so with unbelievable stability.

METAL DETECTION

As important to the length of the MFZ is the size of metal you want to find. With the flat plate or integrally molded style of metal detector, the closer the metal is to the sensing face the smaller the particulate size that will be detected. This of course is totally dependent on the sensitivity level you set your metal detector to. When first installed there is some trial and error testing to establish an acceptable standard. You want to find the 3 in. (75 mm) x 3 in. (75 mm) x 1/4 in. (6 mm) angle (iron) on the top of the burden that is heading to your chipper or hog, but will tolerate small metal particulate even though it causes wear. It is therefore a good idea to establish a mill standard and set your metal detector sensitivity accordingly.

Whole log or warp around/tunnel systems are once again far more complex. Square, hexagonal and octagonal aperture systems have equal sensing from all faces whereas a rectangular aperture system has a calculated correction factor formula. Once again you are faced with the laws of physics and to date these have not been defeated. Each manufacturer should have a chart or technical data sheet that will take you through the calculations or in some instances these calculations may have already been done for you. When analyzing sensitivity levels from various manufacturers, make sure they take into account the worst case scenario. The size of metal detected should be at the center of the aperture which is the farthest point from any sensing face.

A cautionary note: Some manufacturers have a sweet spot or dead zone in the middle of their aperture. Ask the obvious question and avoid this type of metal detector as you can be sure that if this fact is not openly disclosed in their literature (other than in the extra fine print), there are other things that may surprise you as well. Some manufacturers will also disclose in their fine print that they can not find metal such as nails in certain planar angles. Usually this is perpendicular to the sensing face, which is the normal position for a nail in a log! Be sure to ask the obvious question here as well so you are not disappointed. With a microprocessor controlled system, this is never an issue. It is only a problem with analogue type systems.

CHECKLIST

Now that you are armed with information, you can create a checklist of questions to ask your potential suppliers.

Do a calculation or measurement to see if you have enough room for a metal detector at the desired location. The obvious critical factor here is the MFZ. Thoroughly inspect the area where you want to install the metal detector to ensure there is no equipment in close proximity that could impede performance.

Write a system specification and be sure to decide what type (ferrous, aluminum, stainless steel) and size of metal you want to detect and the distance from the sensing face you want to detect it. This is especially important on single sensing face metal detectors such as flat plate of integrally cast systems. With whole log or wrap around/tunnel style systems you must decide the smallest piece of metal you want to find in the center of the aperture (worst case scenario).

Decide if you are willing to sacrifice performance. If not, then a microprocessor controlled system is a must. Is it Œ compliant?

In keeping with the performance theme decide the type of material you prefer for the housing. Remember, stainless steel is best.

Decide if there are any "nice to have features" you want and if you are willing to pay extra for these.

If you are considering used equipment, make sure you have it tested and certified by the manufacturer. If possible, obtain a limited warranty, even if you have to pay for it. Purchasing a used metal detector is worse than buying any used car.

You are now armed with enough knowledge and information so as to ask intelligent questions and carry on a discussion with the prospective manufacturer from which you are considering purchasing metal detection equipment. The goal of this article has been to educate and inform and, in doing so, hopefully dispel some of the common myths about metal detection.

There is no black art with metal detection, only pure science. TP

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