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How to Assess and Design Guarding for Older Machines

It is essential to assess the machines usage, human interactions and changeover risks when trying to enhance guarding on older machines.

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Edward Bullard Sr. founded the Bullard Machine Tool Company in 1894. His son Edward Bullard Jr. continued the family business and brought the Turret principle to vertical boring mills, making it a Vertical Turret Lathe (VTL). These machines are still in operation in industries like aerospace, oil & gas, automotive and other machining services. VTLs are rigid high-speed machines that are built well enough to survive 100 years of production. They are also deadly machines that have documented fatalities. When VTLs were originally designed and manufactured, safety was not a consideration.

Following the OSHA hierarchy of controls, the ideal outcome would be to eliminate or replace the machine. Unfortunately, we have found, in some instances, older equipment can't be replaced. Sometimes the newer options don't have the efficiencies or quality of the older machines. Furthermore, cost for replacement is sometimes in the millions of dollars and the company cannot justify replacing them.

A lingering question is how to enhance the machine guarding and overall safety of old machines. The answer is custom guarding. Whether it's an internal initiative or you seek external support, here are some techniques to properly assess the equipment, and design a robust solution, for older equipment.

Assessment

When assessing the old machine guarding design criteria, there are several aspects to consider. First, you should look at the variations in usability. Is it a single feature machine or does this machine perform multiple tasks? You may have multiple models, and sometimes the machine model and types are completely different. Even though accounting or maintenance may consider them the same machine, each one should have their own individual assessment. Machines with the same model number or vintage have different features and may have been modified over the years. Variations in products that run over the machine can change the guarding design. Smaller or larger products cause different hazards thus, a different guard design is needed.

> *How much risk abatement one is striving for will dictate the level of design complexity.*

Next are the human interactions with the machine, which involve the operators and maintenance personnel. With the operator, it is best to observe the different aspects of the job. We like to call this process a Design Facilitation, as it mimics some Lean Manufacturing Kaizen principles. It is essential to observe normal production runs, setups and teardowns and the potential production stoppages. Those interactions could include tool changes or even machine issues that cause stoppages and operator interactions. Machine repairs or high-risk opportunities typical can be identified here. Verify the operator to machine interactions, especially for high-risk tasks that involve rotating hardware against a fixed object as those scenarios could lead to serious injury or death.

One of the more dangerous situations is often non-production related tasks, for example, when maintenance access is required. These situations typically involve more risk and danger, so it's important to capture these scenarios. These situations may cause additional safety features or interlocks that prevent or eliminate high risk exposure.

Another dangerous interaction is the machine loading for setup or production change over. This could involve an overhead crane, fork truck or be manually loaded. Regardless, it is important to witness and observe variations. Ultimately, we want the guard to protect them without impeding on any aspects of their job. Ideally, the design of the guard would address areas of concerns that make their job easier. Thus, the key outcome of the assessment process for guarding older machinery.

Design

Now that you have assessed the machine usage variations and human interactions, we want to move into the design characteristics. On older machines, we like to break them down into two buckets: mechanical guarding and electronic/electric interlocking.

The mechanical aspects of guarding can be summarized by restricting access over, under and through. The operator should not be able to reach through the guard. In expanded metal applications, understanding finger, hand and arm safety rated materials are critical in material selection. Metal guards are good for heat and harsh environments. But in some cases, there are risks of catastrophic failures where a tool or part could shatter. In those cases, we recommend polycarbonate/lexan guards.

One may notice that the guarding design eliminates the operator from reaching the machine. In most cases they do need access to the machine, but if regular access is required, you may need to design guard with vertical lifting or horizontal swing doors. Next, begin asking questions, such as does the guard need to have multiple sections or access points? Are there side access panels for setting up, tearing down or changing tools? In some cases, we have seen three to four access points on a single piece of machine guarding. The mechanical guard itself is a solution, but there is still risk, as the hazard is not entirely engineered out. Administrative control must be put in place, and overall safety is still determined by human factors. This may not be acceptable for you or your organization. Thus, we transition into electronic and electrical interlocking systems to mistake proof hazardous situations.

There are several interlock options to consider. First, older machines are typically wired for relay logic, which is standard relay, contactor and switch controls at 120Vac. Some just want to sustain that logic and use 120Vac rocker switches. Typically, they can be double switched and put in-line with the existing start/stop/e-stop circuitry. Although pricing is usually better, there are two concerns with the 120Vac Relay logic. First, the switches can easily be bypassed or tied off. Secondly, having a 120Vac switch on a movable guard, that is handle by the operator, increases risk of electric shock. Thus, we recommend using RFID 24Vdc interlocks.

Radio-frequency identification (RFID) switches are anti-tamper coded safety switches. RFID switches cannot be tied back or have a magnet or metal placed on them to bypass. They are uniquely coded so that the receiver is the only trigger for the switch. With RFIDs, there is no physical contact with the switch making them non-contact safety switches. Now that the switches are 24Vdc, an enclosure with a DC power supply and safety relays are required to convert to the machines 120Vac relay logic. Once DC power is introduced to the machine, this opens the door for electronic safety enhancements.

Regarding a recent VTL OSHA abatement, it was demanded that the guard remains in place and locked until the table comes to a complete stop. As a result, custom designed electronics were developed. The components included safety rated PLCs, lockable keyed solenoids for all moving guards and sensors for table Revolutions Per Minute detection. The custom code written to obtain a total safety electro-mechanical system can be challenging. It is imperative that the machine schematics are reviewed by a professional to make sure system enhancements are integrated correctly. In some cases, the schematics do not exist and should be reviewed by an electrical engineer and/or Certified Machinery Safety Expert.

Conclusion

It is essential to assess the machines usage, human interactions and changeover risks when trying to enhance guarding on older machines. How much risk abatement one is striving for will dictate the level of design complexity. It may be outside of the organizations technical capabilities if an advanced safety system is required. Thus, a proper make/buy decision may need to be completed upfront. There are many machine guarding experts that can properly guide one through this process thus reducing overall costs and time to compliance. Understanding this process will enhance one's abilities to properly guard older machines. OHS

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