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SAW SAFETY Risk in the Real World

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STATIONARY SAWING MACHINERY is a leading source of "contact with objects" injuries in the U.S. For the period 2009 to 2012, Bureau of Labor Statistics (BLS, 2009; 2010; 2011; 2012) data show that "metal, woodworking and special material machinery" was a leading source of contact incidents causing days away from work (DAFW) injuries. (Data were compiled from the BLS injuries and illnesses resource tables for each year using Table R27, detailed source by selected events or exposures.) Within this group, the "sawing machinery—stationary" subgroup had the highest DAFW injury total. Worker injuries using stationary saws can be quite serious, often involving amputations. A review of the NIOSH (2019) Work-Related Injury Statistics Query System website, based on the Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System review of emergency room visits, estimates 2016 stationary-saw-related emergency room visits as 9,500 ±2,900 with 7,000 ±2,400 related to contact with the finger. This same database estimates that table saws were indicated in 7,200 ±2,300 of these visits with 5,600 ±1,900 of those related to contact with the finger as a body part.

A review of saw-related claims data from 2001 to 2009 provided by Ohio Bureau of Workers' Compensation (OBWC) shows that machine-body contact and kickback (where the workpiece is thrown towards the operator) are the leading types of stationary saw-related injuries (Beery et al., 2014). Numerous regulations and consensus standard guidelines have been developed to prevent these injuries. However, in many situations, risk reduction measures such as blade guards or anti-kickback pawls are not utilized as prescribed by those standards. This study reviewed existing standards and regulations for stationary saws and examined the hazards of stationary saws through a task-based risk assessment. The study team also met with several employers in Ohio that use stationary saws in an effort to better understand real-world stationary saw use, including the use of existing risk-reduction measures, if any. While the field observation and subsequent follow-ups were done in Ohio,

other than industry mix, the authors believe it is likely representative of other work in the country.

Current Standards & Regulations for Saw Safety

Several industry consensus standards and OSHA regulations provide guidance for stationary saw safety as summarized in Table 1. Pertinent requirements and recommendations from these standards that apply to stationary saw operation include the installation and use of:

- transparent blade guards (prevents body/blade contact and allows user to see the cut; Figure 1),
- anti-kickback pawls (prevents kickback of the workpiece; Figure 2),
- riving knife (keeps the workpiece from closing, which could lead to kickback; Figure 2),
- rip fence (to align and control cuts and limit kickback; Figure 3),
- miter gauge (to align and control cuts and limit kickback),
- spreader (to keep the workpiece from closing, which could lead to kickback),
- recessed start switch (to minimize unintended actuation/start-up), and
- (red) emergency stop button.

These standards also require that belts, pulleys, gears, shafts or other moving parts be guarded if they present a likely risk of injury. For table saws, a blade guard, riving knife, anti-kickback pawls and rip fence are required. Not surprisingly, stationary saw manufacturers design and build saws to meet the safety requirements in the voluntary industry consensus and OSHA standards.

In addition to these design specifications, current industry consensus standards require that risk assessments be completed for machinery (ANSI B11.0 in the U.S., Machinery Directive 2006/42/EC in the EU). Although industry consensus standards specify risk reduction measures for particular hazards, no general risk assessment has been published for stationary saws. As a part of this study, a task-based risk assessment was conducted to better understand and evaluate the risks of injuries from stationary saws, and to make those findings available to the public.

Method

The team visited 15 sites throughout Ohio. To minimize disruption to normal operations at each site, visits were limited to about 2 hours. The team spent time at stationary saw stations observing standard workflow and procedures. Occasionally, as workflow allowed, team members held conversations with sawyers. The team performed visual checks to record the use of blade guards, anti-kickback devices, splitter devices (e.g., riving knife, spreader) and other safety measures as appropriate for the specific type of saw in use. The purpose of this study was not to render judgments on employers or sawyers, but to better understand the current state of stationary saw usage. Team members only visited workplaces with

permission of employers and cooperation with OBWC. Although feedback was provided to each participating facility, the purpose of the site visits was to conduct research, not to audit the sites. Table 2 (p. 26) summarizes the facilities visited and the saws used.

A risk assessment for a floor-mounted table saw was also conducted to identify all work tasks and the associated hazards presented during task execution. Risk assessment is a systematic procedure for identifying hazards, estimating the initial risk from these hazards, incorporating risk reduction measures, and evaluating residual risk to determine whether an acceptable level of risk has been achieved. The risk assessment was conducted using the tasked-based approach contained in ANSI B11.0–2015, which emphasizes understanding the work that must be done so that hazards can be identified, and risks most effectively reduced. As defined in ANSI B11.0, risk is the combination of the probability of occurrence of harm and the severity of that harm. The severity of harm and probability of the occurrence of harm for each hazard before and after risk reduction was assessed using the risk scoring system presented in Table 3 (p. 26).

Once the initial risks are evaluated, risk reduction occurs according to the hazard control hierarchy (Table 4, p. 27), which prioritizes preferred methods of risk reduction in the order of elimination (or substitution), guards, awareness devices, training and PPE.

Results

General Observations

Of the 75 saws observed within the 15 facilities, five machines had safety issues that required resolution. Among the issues were saw cuts being made on a SawStop saw (a saw with a safety control system that quickly stops blade rotation when the blade contacts flesh) without a blade guard (Figure 4a, p. 28); a table saw with no blade guard installed (Figure 4b; Note: End of blade guard stored below and lower right of saw); a table saw with blade guard installed, but no anti-kickback or splitter devices installed (Figure 4c); a table saw with no blade guard, no anti-kickback device and no splitter (Figure 4d; Note: Blade guard found stored on wall); and a broken table saw with a broken blade guard; guarding protects from contacting blade from the side, but not the front (Figure 4e; Note: Guards may have been modified by the operator to allow for better visibility).

Risk Assessment

The risk assessment identifies three users: operator (sawyer), maintenance technician (may also be the operator) and passerby (in this context, another worker or visitor; Table 5, p. 31). A total of 11 types of tasks and 44 hazards were identified in the risk assessment, some of which address potential subtasks (e.g., crosscuts and rip cuts are generalized into normal operation). For a specific operation, it is important to look at operations (direct or indirect) performed by others around the saw or machine. Table 4 includes only the 24 hazards that have serious severity and likely probability. The identified primary hazard of concern is the cutting hazard from the turning blade and the potential for a person to inadvertently contact it during a cut or other task. The initial risk (before risk reduction measures are taken) is high; that is, if a saw is used by a novice without the intended risk reduction measures in

place, it is likely that serious (or catastrophic if more than one finger is removed) harm can result.

To address this hazard, the primary risk reduction measures provided by saw manufacturers include:

- fixed guarding from the table base (which covers most of the blade)
- adjustable or moveable guards (covering the blade from above)
- warning labels
- instructions

While original equipment manufacturers (OEMs) are required to incorporate certain risk reduction measures into their designs, the employer must provide and the operator must use additional risk reduction measures such as:

- Stabilize the saw. Ensure that the saw is on a flat surface, leveled and secure. If on casters, the casters should be locked. In the case of bench saws and others attached to a board or bench, operators should consider the weight of the material and saw force as to the required stability.
- Provide proper shop floor layout and workflow (for ergonomics and material handling).
- Provide safety glasses and, in some cases, hearing protection.
- Train workers.
- Restrict users.
- Provide additional cutting tools or aides (push sticks/blocks to keep the operator’s hand at a safe distance).

Discussion

General

The results of the site inspections demonstrated that there were many saws, old and new, that had guards installed and were in very good condition. However, several saws were missing a blade guard, riving knife or anti-kickback device. In several situations, the saw blade guards were available (e.g., stored on the side of the machine or on a wall), but were not used. Users stated that they needed to see the saw blade in the cut line and did not feel this was possible with the blade guard in place. CPSC found that for injuries occurring where a blade guard has been removed, 75% were removed for “operational convenience” (Chowdhury & Paul, 2011).

Most saws ship from the saw supplier without a blade or blade guard installed to prevent damage to the guards and reduce shipping size. This requires the sawyer to install the guard, which does not always happen as evidenced by the site inspections. Some non-through cuts (in which the blade does not cut through the entire workpiece, such as dado and rabbet cuts) require removing the blade guard. To accommodate these cuts, the blade guards must be

removable, which prevents saw suppliers from permanently installing the guards. The risk assessment shows the cutting/severing hazard at item 1-1-1 (Table 5, p. 31). The initial risk (without any risk reduction measures) is high. With the risk reduction measures in place, including guarding, the residual risk level is low. Item 1-1-2 shows the same hazard, but without the guarding as a risk reduction measure. This correlates to a sawyer not using the guard. As shown, the residual risk in this configuration is medium because the probability of harm is unlikely rather than remote. In this instance, the sawyer is relying on the ability to use safe work procedures to avoid the turning blade. This risk may or may not be acceptable to an individual sawyer or the employer. Operator experience and execution become dominant factors in the overall level of risk when the task necessitates or a sawyer prefers guard removal.

Guard Visibility

An age-old trade-off exists between being able to see the cut clearly and having a guard in place to protect the operator. Nearly all guards provide some visibility, but all limit visibility to a certain extent. This is unavoidable with guards for traditional saws. The issue of guard visibility was raised in nearly every guarding-related discussion during the site visits. According to the saw operators the researchers spoke with, not only is it harder to make a precise cut with a dusty or opaque guard, but also the operator intuitively feels less comfortable and less in control when the user cannot see the cut being made. This reduced sense of control may lead the user to infer that an unguarded but clearly visible cut is actually the safer choice. Or to improve visibility, the worker may risk blade-body contact by manually raising the blade guard or positioning their eyes in line with the blade, increasing the risk of harm due to kickback.

There was no indication from the sawyers the research team met that there is a lack of awareness of the blade hazard or that guards are not provided or not available for use. This is not a “failure to warn” issue that can be addressed by adding a warning label. A cabinetry maker spoke with the team at one site, a professional who has worked more than 25 years in carpentry. He works with very good tools including a high-quality cabinet table saw. This operator stated that he never uses the blade guard because the “guards are more a hindrance than help,” and suggested that “anyone who uses a table saw will say the same.” He expresses great respect for the tool and fully understands the risks of working without the guard in place. But he also speaks to the problems of the blade guards: he cannot see sufficiently to make his precision cuts. Sawdust collects on plastic guards and metal guards obscure his view. He wants to see the cut and workpiece as it moves through the blade. In his view, the added safety of using a guard does not overcome its detriments.

Guard System Alignment & Adjustment

Many saws were observed with unadjusted or improperly maintained guards. Making any cut with a guard that is not properly aligned is challenging, and the likelihood of kickback on a misaligned guard is significantly higher. If a board gets hung up in a cut due to a guard, it can create a hazardous situation that would not exist if that guard was not in place. Some operators do not realize that the blade thickness and riving knife or splitter thickness must be compatible to properly guard against kickbacks and prevent jamming in the splitter.

This another situation in which the user may conclude that the saw is less safe with the blade guard installed. However, proper blade guard adjustment should allow cuts to be made effectively and efficiently.

Repeated adjustments of guards and devices are problematic, especially with flimsy guards on some inexpensive retail saws. If guarding requires frequent adjustment or realignment, workpieces can be ruined, kickbacks are more likely and sawyers can become frustrated with the device, causing them to remove it. Reinstallation of the guard or device is not likely to occur in those circumstances. Larger and professional-grade saws tend to have better guarding with fewer alignment or adjustment issues, but these also have a higher cost. Guard design improvements that minimize or eliminate misalignment and maladjustment while improving visibility would offer significant value to both sawyers and OEMs in the form of safety (and likely increased sales).

Beginning in the early 2000s, manufacturers, through Power Tool Institute (PTI), worked collaboratively to improve guarding systems. Using operator surveys and testing of various guarding systems, PTI redesigned and patented a new modular guarding system. PTI allows free use of the patented design as part of its effort to improve operator safety. Modular guarding systems based on the PTI design began shipping with saws in 2008 and are now also provided by manufacturers from outside PTI. The typical system includes a riving knife, removable kickback pawls and a split guard (improving vision) that can be removed while leaving the riving knife in place.

Workspace Design & Layout

Workspace setup is a key factor in reducing risk to stationary saw operators. Several sites had saws in temporary, cramped or potentially unstable configurations that could be improved upon. Such configurations include:

- Saws in tight or limited locations where manipulating the saw or workpiece is difficult or can cause unexpected interference with other people or equipment, awkward work positions and saw movement.
- Provide support for workpieces with in and outfeed tables if necessary and lifting apparatus if needed during operations.
- Saws placed on uneven flooring or ground without being leveled.
- Unsecured saws near the edge of a workbench.

Maintaining a stable saw location and properly supporting and securing the workpiece is essential to avoiding harm from saw dislodgment or workpiece kickback. Many injuries have occurred when a saw or workpiece shifts due to an instability, causing the sawyer to reach to catch the saw or workpiece, resulting in contact with the turning blade. Permanent installations in workshops provide greater opportunity for improved saw setup and ultimately result in safer workspaces for sawyers and adjacent workers.

An interesting paradox often occurs in workshops regarding use of space. In nearly all shops visited, the primary goal is to complete the work and deliver the product as quickly and efficiently as possible within the confines of limited space, time and resources. This

often leads to workshop organization focused around doing the immediate task rather than a setup focused on long-term efficiency and safety. For many shops, a lack of sufficient working space exacerbates this issue. The paradox involves taking the time to arrange the workspace to do the work efficiently and safely, versus just making the cut. An organized and standardized workspace improves efficiency. If guards, tools, gauges and fasteners are in their place, little time need be spent looking for lost or misplaced items. In particular, guards that are removed but not placed in a specified location must be located before they can be reinstalled, often leading to them not being reinstalled.

Improved Guarding & Layout

In some locations, the saw users had improved the safeguarding provided by the saw OEM with innovative and effective designs. One user had installed interlocks on the saw covers of an older horizontal band saw. On a vertical band saw, a guarding solution was developed for the blade guide that improves on the OEM design and prevents inadvertent contact with the blade. At several sites, workpiece supports or tables had been added to saws to improve material handling capabilities. These supports and tables were a mix of aftermarket products and site-constructed solutions.

Dull Blades

A dull blade can cause problems with saws, including misalignment of the workpiece, kickbacks and the sawyer exerting additional force on the workpiece in the direction of the blade. This can lead to contact with the blade if a slip occurs, poor cuts and rework. Changing a saw blade is a time-consuming process; great temptation exists to make one more cut and leave changing the blade for another time or person. In some cases, the interruption to the work can be considerable if a new, sharp replacement blade is not immediately available. These and other reasons can lead to sawyers using saws with dull blades that can increase the risk of harm.

New Technology

New technologies exist that can minimize risk due to operator contact with the saw blade, and a few sites in this study had saws using this technology. SawStop table saws utilize a safety control system to detect increased electrical current (impedance) upon flesh contact with the table saw blade. When contact is detected, a fast-acting brake is deployed to stop blade rotation in less than 5 milliseconds and fold the blade under the table (SawStop, n.d.). Activation of the braking system will render the saw unusable until repaired. With this system in place, the typical injury is a small scratch. If conductive materials must be cut (e.g., metals, moist wood), the safety system and thus flesh detection must be deactivated using a key operated “bypass mode.” Drawbacks to the technology include cost, destruction of the blade upon braking and lack of availability for all sizes and types of saws. As noted, activation of the braking system ruins a blade and cartridge. However, the manufacturer reports blade replacement generally costs less than $100 and requires less than 2 minutes to complete.

One company in the study purchased saws with this technology and the company is not using blade guards on those saws. This decision runs counter to the OEM’s

recommendations. The company expressed the intent to replace other conventional table saws with more saws with this technology once they become available in the necessary sizes. Currently, their other conventional table saws are configured and used only for specialty cuts, while all general cuts are made on the saws with this technology, or on band or panel saws.

Note that new technology, such as the aforementioned saw, typically reduces the severity of blade contact injuries from catastrophic or severe to moderate or minimal when used properly. The manual key used to operate in the bypass mode gives the sawyer control to turn off flesh detection until motor restart. Effective administrative controls should be put in place to ensure minimal use of the bypass mode. Users should not be penalized for activation of the braking system and, thus, destruction of a blade, as it may inadvertently provide an incentive to defeat the system with the key.

Whirlwind Tool Co. (n.d.) has developed a different saw safety stop that electrically brakes the blade in one-eighth of a second after detecting flesh proximately to the saw blade. This system can be used repeatedly because the braking is nondestructive.

These new technologies are not without controversy, which has limited the introduction of the systems to the marketplace (Levin, 2013). Major issues limiting the adoption of new technologies include the initial purchase cost, practicality, functionality and liability for OEMs. It remains to be seen how consensus standards committees and regulatory agencies will consider these technologies in their requirements and recommendations. The existence of these new technologies, however, can increase liability for companies that choose not to use them because they clearly demonstrate that injury mitigation technology exists.

Cultural Aspects

Discussions with management at some sites highlighted certain cultural aspects that impact saw safety. One site manager noted the positive impact of a mature, experienced workforce. Mature workers tend to be more familiar with saw hazards and understand the expectations of working in an environment that uses saws. They also noted that mature workers are less likely to have high rates of absenteeism. Conversely, most new workers tend to be young and inexperienced, often unaccustomed to an industrial environment, and in most cases have little or no experience working with or around saws.

One site manager commented that with the economic down-turn, only one shift was retained at the facility and safety was a key factor in determining who remained. According to the manager, now the best, most mature employees work, and they work very well. There is significant experience and seniority in the workforce. According to the owner, as a result of these and other changes, injuries have dropped significantly. Some sites indicated that they experienced significant challenges identifying workers who could pass a drug test. Other sites indicated that absenteeism or failure to show up for work is such a serious problem that they pay a bonus to employees who work a full week. This lack of a consistent, stable and experienced workforce can increase the risk of injury to workers in this field.

The safety culture of a company also plays a significant role in worker safety. One facility experienced a culture change over the prior 7 years due to a senior management change. Previously, injuries were accepted and there were difficulties in the past with identifying and controlling employee drug use. At that time, inspections were completed by senior management only. Unfortunately, inspections were conducted infrequently as senior managers were assigned to inspect multiple locations in addition to their traditional managerial duties. This did not allow senior managers the time needed to complete regular, thorough inspections of each facility. As a part of the culture change, regular inspections are now completed by in-house supervisors. Hiring used to be a regular activity as employee turnover was high. Now employee retention has improved significantly. The facilities that commented positively on the quality of employees also seemed interested in providing safety items for employees. Machines were found to be well guarded and procedures were in place to protect employees. It is important for the employer to also provide a supportive culture for safety for the employee. Because the user or company is often responsible for guarding, employees need the support of time and money to purchase or create properly guarded cutting operations or by using extra fixtures or jigs as necessary. As has been frequently discussed, organizational culture impacts safety positively and negatively, a finding this study found to be true for companies using stationary saws.

Employer Liability

OSHA and insurance companies also have a voice in encouraging the use of stationary saw guards and devices. A saw with a guard missing will likely result in an OSHA citation. OSHA will likely not accept employers not using guards with saws, even with an experienced and skilled workforce. The expectation is that an employer will comply with OSHA standards and, therefore, the employer is subject to the penalties for noncompliance. Similarly, workers' compensation and liability insurance companies may place restrictions or increase premiums on a company that allows saws to be used without guards. In some states, a claim of wanton disregard for employee safety might be argued in an attempt to hold an employer liable under a products liability claim. Employers should recognize that a decision not to use OEM and industry standard recommended safety guards and devices can lead to increased risk of injury to employees, and increased liability for the employer. In Ohio, if a company adopts a policy that requires the use of guards, an OBWC consultant strongly encourages that a "documented, progressive disciplinary program be implemented." The consultant suggested it could be critical in helping to defend the employer against possible OSHA citations. Being able to show OSHA that work rules are documented and that the use of guards is enforced is an imperative aspect of demonstrating employee misconduct to OSHA in the event of a citation.

Risk Aspects

This study highlights a challenging situation in which the risk-based decisions of the individual worker may conflict with those of the employer or company. In this study, the experienced workers, who interacted with and used saws on a daily basis, appeared to understand the hazards and risks associated with their use. Unfortunately, many strongly believed that the risk of injury associated with using the OEM-supplied saw blade guards was higher than simply not using the supplied blade guard or devices. These individuals

had evaluated the risks and, in their judgment, had selected the lower risk option, which is consistent with the risk assessment approach. However, injury can occur in an instant, even to a skilled operator and the operator's assessment of risk, based on experience and intuition, is at odds with industry and government standards for saw usage.

It is common in machine safety risk assessment to caution evaluators of the possible under-evaluation of risk by experienced workers when a low occurrence event or infrequent task is coupled with an extremely high level of injury severity such as amputation or death. That caution seems applicable to the users who, while they may understand the inadequacies of the saw and guarding, may be underestimating their "acceptance of risk" and the potentially permanent consequences of a saw-related injury.

One element of the risk assessment involves trust; evaluators must recognize that sawyers may trust their ability to work safely with the saw without a guard or safety device installed. Sawyers may not trust the OEM guard or device to protect them when it is installed. In fact, many skilled carpenters adamantly believe a guard inhibits their ability to view a cut, and thereby creates a greater risk of harm than if the guard is removed. So, how does one go about telling a seasoned professional carpenter with a lifetime of experience working with saws that those methods are now unacceptable? A senior manager at one site says he finds that one-on-one safety discussions tend to be more effective than group safety meetings when trying to change safety-related actions, particularly if prior work practices are no longer considered acceptable.

One challenge of a safety policy requiring blade guard usage is that there are times when blade guard use may appear to be infeasible, such as a dado cut. In these instances, some may believe acceptable risk mitigation is achieved by relying on experienced sawyers to follow safe work practices. These approaches are lower on the hierarchy of controls (Table 4, p. 27). However, using such an approach to risk mitigation will likely have unwanted implications when trying to implement guard and safety device usage for all other cuts. For example, if sawyers can be trusted to work safely without the guard in certain conditions (dado cut), why can they not be relied upon to make other unguarded cuts safely, particularly when the experienced, expert sawyer believes the guard increases the risk of harm or greatly impedes work?

In this instance, the line between the employer risk-based decision and that of the individual blurs. An employer that supports a risk-based approach to safety decisions must rely on the input of the employees in making those decisions, as often no one understands the hazards of the job better than those experienced workers who perform it. Yet, the individuals' decisions may be at odds with regulatory and industry safety standards. This is not a unique circumstance; other safety devices have seen conflicting risk-based evaluations including fall protection harnesses, safety glasses and guards on other equipment that are hard to use, see through, remove or install.

In cases where the experienced sawyer suggests making a cut without a guard, it is the responsibility of the employer to proactively investigate alternate methods to complete the assigned job task safely. This investigative process should be completed collaboratively

with the experienced sawyer(s) until a workable, well-guarded solution has been created. The sawyer's views on the risks of using OEM saw guard must be heard and considered within the context of a company developing a workable policy on the use of stationary saw guards. Ultimately, the final "solution" may or may not include the use of the OEM supplied guarding system.

As a part of this process, the collaborative team should ask a few key questions as it approaches this type of problem. For example, has the employer provided the worker with the correct saw for the job task or cut to be completed? Do opportunities exist to revise the workflow to allow the unguarded task to be completed differently? Do opportunities exist to create or purchase supplementary tools, such as a sled and custom guard, to allow the existing saw to be used safely? Ultimately, this approach should build trust between employer and sawyer, improve worker safety and likely workflow, all while remaining in compliance with regulatory requirements and industry standards.

Finally, companies with novice sawyers or higher employee turnover should always require the use of guards on saws. Cuts that require the removal of the OEM guard should not be made by novice or less experienced sawyers. Employers must remember these inexperienced employees should be trained on basic saw usage. Employers should highlight the fact that not all saw guards are fixed. When an OEM saw guard is a movable or removable guard, the employer is trusting the novice operator to open and close the moveable guard on the workpiece as part of each cut. The employer must emphasize it is imperative that the operator close the guarding system prior to activating the saw. From a risk assessment perspective, the closing of the guard prior to a cut, the replacement of the guard after removal and supplemental guarding are all considered administrative controls and require trust that the operators will perform the tasks.

Summary & Implications

The results of this study suggest the following be considered by employers and employees when using saws:

1. Install and use workable guards. Workable guards provide protection but also allow the work to be performed safely and efficiently. A guard that is not workable will likely be removed or bypassed. Even new equipment may be lacking key risk reduction features because the operator did not install or has chosen to remove the device.
2. Maintain guards so that they function and adjust smoothly and do not bind. Guards that are not in adjustment will likely cause binding of the cut and can impact quality, safety (kick-back) and convenience. Guards in poor adjustment are highly likely to be removed.
3. Do not rush when making a cut.
4. Keep fingers and clothing away from rotating blades.
5. Do not reach into areas near rotating blades. Allow them to stop before reaching in.

6. Use the right tools for the job. Ensure that sawyers have the proper saw type and accessories for the cut to be performed to allow for proper guarding and safe use.
7. Use sharp blades and have replacement blades readily available. Select the appropriately sized riving knife or splitter for the saw blade in use.
8. Be certain that saws have the appropriate guards and warning labels as provided by the saw supplier. Contact the saw manufacturer for updated on-product warning labels and inquire about any updated guards that should be installed according to the OEM recommendations.
9. Develop a corporate/company policy related to the use of guards on saws.
10. The workforce must be considered. A company with novice employees or inexperienced sawyers should be diligent to ensure that guards are always installed and functioning.
11. A company with highly experienced and skilled employees should engage workers in a discussion regarding saw guarding if guards are found removed. Many skilled carpenters adamantly believe that guards inhibit their ability to view cuts and thereby create greater risk of harm than if the guards are removed. One-on-one training may be required for those who believe safe work practices alone will ensure their safety.
12. Saws must be stable during use. The saw should be level, rigid and, when possible, rigidly mounted and not be prone to movement with a given workpiece. Workpiece support will help to limit the risk of harm.
13. Provide sufficient saw work space layout. A workpiece that is not properly supported, clamped or secured may result in kickback or movement that can lead to an injury.
14. Work space layout should be appropriate for the application. Standardized operations based on saw type and commonly made cuts provide a better opportunity to implement the use of jigs, saw accessories and safe work practices. Utilizing such a process should reduce cut variability and quality errors while increasing worker safety.
15. New guard designs that minimize or eliminate misalignment and maladjustment may provide value to both sawyers and saw OEMs. Blade guards that are easily inserted into a slot or similar system that facilitates easy removal and reinstallation will be more likely to be installed. Guards that remain solidly aligned with the blade would represent improvements in safety through design.

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Biography

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KEY TAKEAWAYS

- Injuries related to the use of stationary saws constitute a significant portion of workplace injuries.
- This article reports the results of a field study on stationary saw use. It discusses current industry and OSHA safety standards for stationary saws; assessment of risks associated with the use of stationary saws at 15 sites; and lessons learned from the comparison of the theory and practice of using stationary saws.
- The results of the study show that many risk reduction measures are not used in practice, and that some operators believe that the risk of using a guard is higher than not using a guard. The article discusses the implications of these findings to operators and employers.

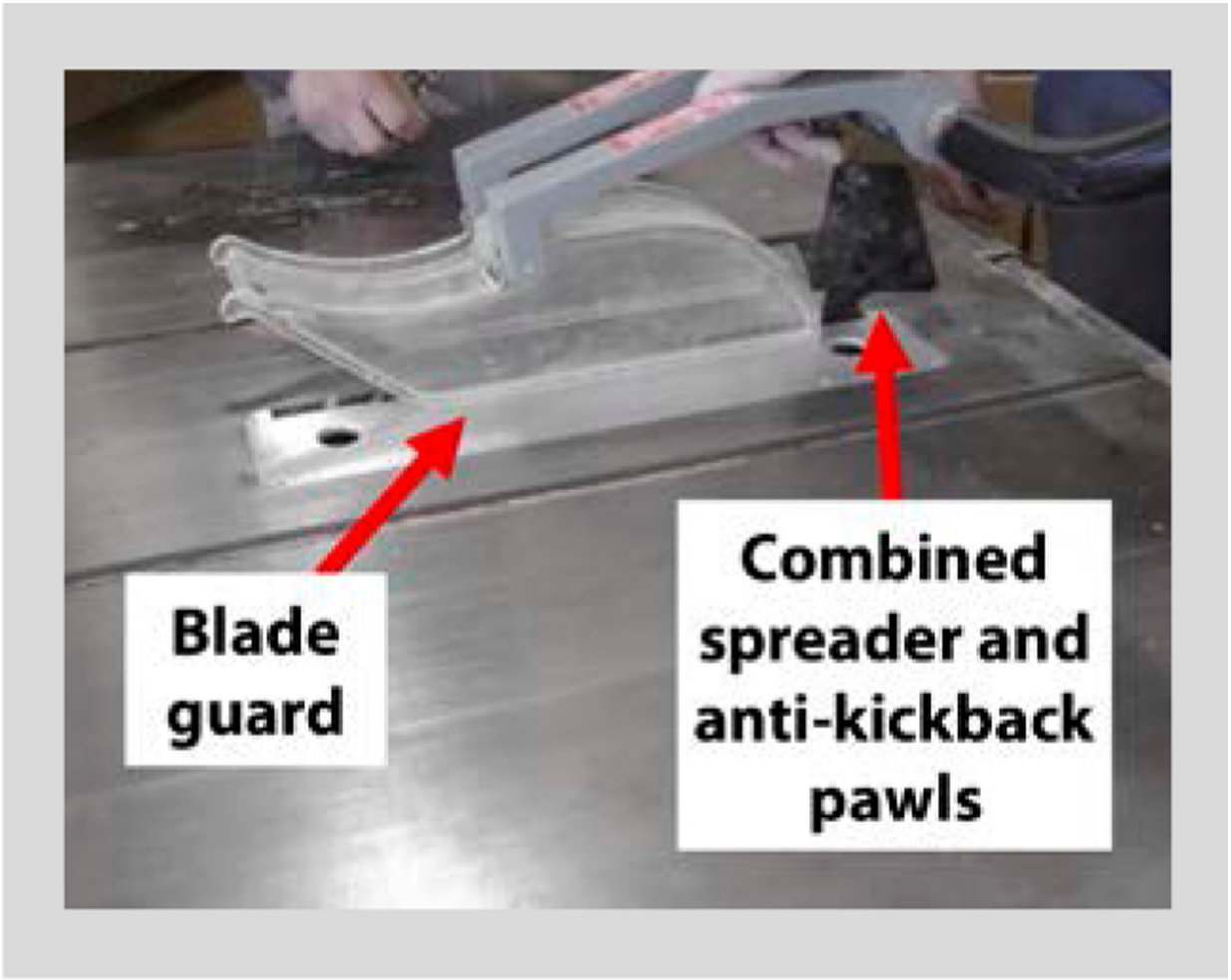

FIGURE 1.
PROPERLY GUARDED TABLE SAW

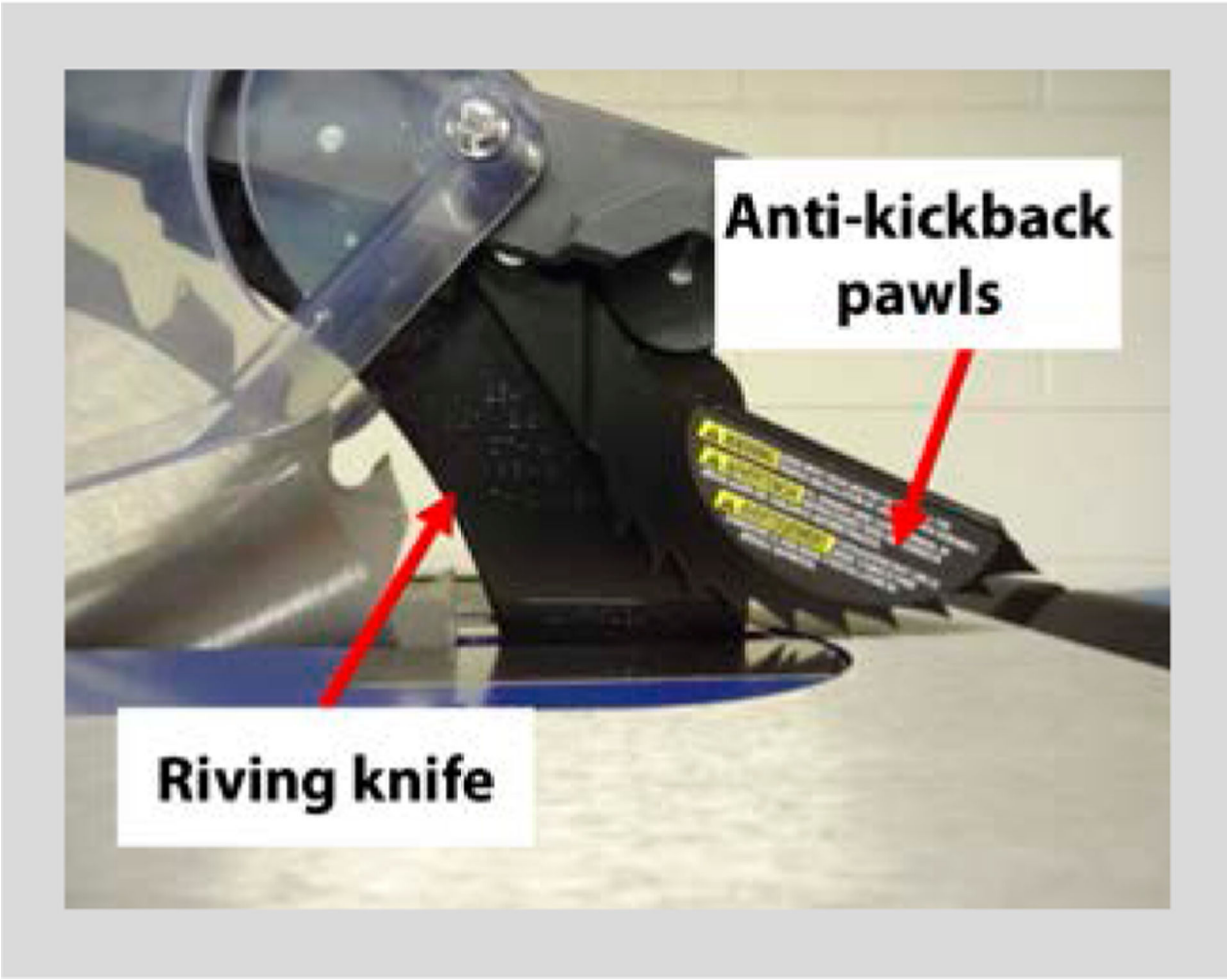

FIGURE 2.
RIVING KNIFE & ANTI-KICKBACK PAWLS

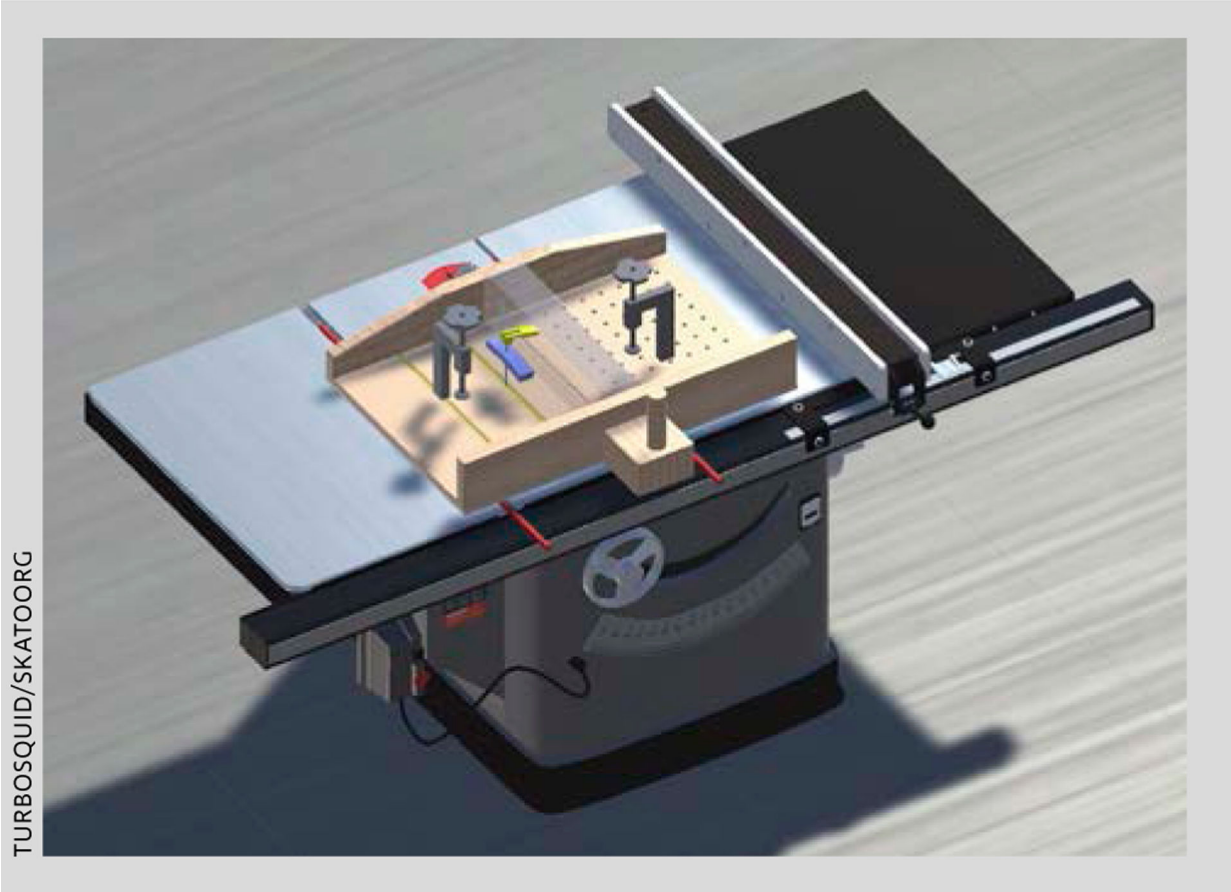

FIGURE 3.
TABLE SAW WITH RIP FENCE & CROSS-CUT SLED WITH CLAMPS

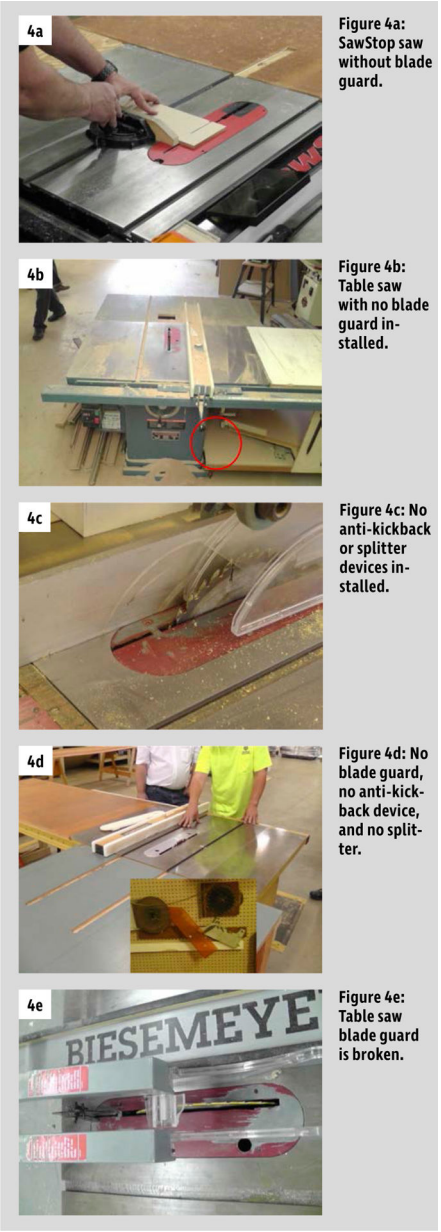

FIGURE 4.
SAFETY ISSUES THAT REQUIRED RESOLUTION

TABLE 1

APPLICABLE STANDARDS

Standard	Scope
ANSI 01.1-2013, Woodworking Machinery Safety Requirements	Covers woodworking machinery that is not handheld and has connected power greater than 5 hp (excluding sawmills)
ANSI B11.10–2003 (R2020), Safety Requirements for Metal Sawing Machines	Applies to metal stationary saws
ANSI B11.19–2010, Performance Requirements for Safeguarding	Contains specifications for different types of guards that can be used on saws
UL 987 (2011), Standard for Stationary and Fixed Electric Tools	Covers machinery less than 5 hp, machinery not covered by ANSI O1.1
ANSI B11.0–2015, Safety of Machinery	Applies to specialty saws and machinery not falling under the other standards
OSHA 29 CFR 1910.213, Woodworking Machinery Requirements	Woodworking machinery, largely based on earlier versions of ANSI O1.1, contains similar requirements

TABLE 2

FACILITIES VISITED

Facility type	Saws used
Industrial	Vertical and horizontal band saws, large metal cutting machines, radial arm saw, panel saw
Industrial	Advanced saw configurations, guarding, jigs and clamping
High school shop	Table, radial arm, miter, chop, other
Vocational school	Many types, used to cut wood, plastics and metals
Fabrication shop for acrylic fixtures	Table saws, SawStop, panel saw, vertical band saw
Medical products manufacturer	Tube cutting saws
Vehicular engine manufacturer	Metal band saws
Park service facility	Metal and woodcutting saws
Park service facility	Metal and woodcutting saws
Park service facility	Many, primarily woodcutting
Highway maintenance facilities	Metal and woodcutting
Lumber mill (three locations)	Head saw, resaw, edger saw
Workshop for vocational training of developmentally disabled adults	Table saw, other vintage and modern equipment

TABLE 3

EXAMPLE RISK SCORING SYSTEM

PROBABILITY OF OCCURRENCE OF HARM	SEVERITY OF HARM			
	Catastrophic	Serious	Moderate	Minor
Very likely	High	High	High	Medium
Likely	High	High	Medium	Low
Unlikely	Medium	Medium	Low	Negligible
Remote	Low	Low	Negligible	Negligible

Note. Adapted from “Safety of Machinery (ANSI B11.0–2015),” by B11 Standards Inc., 2015.

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TABLE 4

Prof Saf. Author manuscript; available in PMC 2022 September 01.

HAZARD CONTROL HIERARCHY

	Risk reduction measures	Examples	Influence on risk factors	Classification
	Elimination or substitution	• Eliminate pinch points (increase clearance) • Intrinsically safe (energy containment) • Automated material handling (e.g., robots, conveyors) • Redesign the process to eliminate or reduce human interaction • Reduced energy • Substitute less hazardous chemicals	• Impact on overall risk (elimination) by affecting severity and probability of harm • May affect severity of harm, frequency of exposure to the hazard under consideration, and the possibility of avoiding or limiting harm depending on which method of substitution is applied	Design out
	Guards, safeguarding devices and complementary measures	• Barriers • Interlocks • Presence sensing devices (e.g., light curtains, safety mats, area scanners) • Two-hand control and two-hand trip devices	• Greatest impact on the probability of harm (occurrence of hazardous events under certain circumstances) • Minimal, if any, impact on severity of harm	Engineering controls
	Awareness devices	• Lights, beacons and strobes • Computer warnings • Signs and labels • Beepers, horns and sirens	• Potential impact on the probability of harm (avoidance) • No impact on severity of harm	Administrative controls
	Training and procedures	• Safe work procedures • Safety equipment inspections • Training • Lockout/tagout/verify	• Potential impact on the probability of harm (avoidance or exposure) • No impact on severity of harm	
	PPE	• Safety glasses and face shields • Earplugs • Gloves • Protective footwear • Respirators	• Potential impact on the probability of harm (avoidance) • No impact on severity of harm	

Note. Adapted from "Safety of Machinery (ANSI B11.0–2015)," by B11 Standards Inc., 2015.

TABLE 5
EXCERPTED RISK ASSESSMENT OF FLOOR-MOUNTED TABLE SAW

The risk assessment shows that if the risk reduction measures are implemented, the residual risks of harm are low or negligible, which is considered an acceptable risk. In some instances, the residual risk is medium, which can be acceptable provided safe work procedures are diligently followed. As noted in the risk assessment, stationary table saws can be used with acceptable risk if the risk reduction measures provided by the OEM and the employer/sawyer are effectively implemented.

Item ID	User; task	Hazard; failure mode	Initial assessment severity, probability	Risk level	Risk reduction methods/control system	Final assessment severity, probability	Risk level	Status, responsible, comments, reference
1-1-1	Operator; normal operation	Mechanical; cutting/ severing hand moving beyond guard to blade	Serious, likely	High	Fixed enclosures/guards, adjustable enclosures/guards, use jigs and push sticks, standard procedures	Serious, remote	Low	Complete (8/5/2016), sawyer, assumes guarding in place during the cut, ANSI O1.1
1-1-2	Operator; normal operation	Mechanical; cutting/ severing hand moving beyond guard to blade	Serious, likely	High	Fixed enclosures/guards, adjustable enclosures/guards, use jigs and push sticks, standard procedures (guard not installed)	Serious, unlikely	Medium	Complete, sawyer
1-1-7	Operator; normal operation	Mechanical; flying debris wood chips/dust, broken blade	Serious, likely	High	Automatic feed or push stick; fixed enclosures/barriers; adjustable enclosures/barriers; adjustable enclosures/barriers, safety glasses	Minor, unlikely	Negligible	Complete, sawyer
1-2-2	Operator; basic troubleshooting, problem solving	Mechanical; unexpected start bump start switch/ someone plugs in	Serious, unlikely	Medium	Recessed start switch, lockout for repairs, standard procedures	Serious, remote	Low	Complete, sawyer
1-4-3	Operator; adjust guard	Mechanical; machine instability	Moderate, unlikely	Low	Stable installation/mounting	Moderate, unlikely	Low	Complete, sawyer, sawyer, workplace
1-5-1	Operator; remove stuck material, clear jam	Mechanical; cutting/ severing contact with blade	Serious, likely	High	Fixed enclosures/guards, adjustable enclosures/guards, use jigs and push sticks, standard procedures	Serious, remote	Low	Complete, sawyer, sawyer, assumes guarding in place during the cut, ANSI O1.1
1-6-1	Operator; reposition a cut	Mechanical; cutting/ severing contact with blade	Serious, likely	High	Fixed enclosures/guards, use jigs and push sticks, standard procedures	Serious, remote	Low	Sawyer
1-7-1	Operator; rabbet cut, dado cut	Mechanical; cutting/ severing blade guard must be removed	Serious, unlikely	Medium	Standard procedures, restricted users, push sticks, infrequent cuts or jigs if frequent	Serious, Remote	Low	Sawyer
1-8-4	Operator; misuse, operate without guards	Mechanical; flying debris	Serious, likely	High	Install blade guard(s), standard procedures, restricted users, safety glasses	Serious, remote	Low	Sawyer

Note. Table is presented in abbreviated form for example purposes.