UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

The contents of this document will be discussed at the Commission Meeting scheduled for September 21, 2011.

This document has been electronically approved and signed.

THIS MATTER IS NOT SCHEDULED FOR A BALLOT VOTE.

A DECISIONAL MEETING FOR THIS MATTER IS SCHEDULED ON: October 5, 2011

September 14, 2011

TO: The Commission
Todd A. Stevenson, Secretary

THROUGH: Cheryl A. Falvey, General Counsel
Kenneth R. Hinson, Executive Director

FROM: Philip Chao, Assistant General Counsel
Hyun S. Kim, Attorney, OGC

SUBJECT: Table Saws Blade Contact Injuries;
Advance Notice of Proposed Rulemaking

The Office of the General Counsel is providing for Commission consideration the attached draft *Federal Register* notice on an advance notice of proposed rulemaking for performance requirements to address table saw blade contact injuries.

Please indicate your vote on the following options:

I. Approve publication of the draft notice in the *Federal Register*, without changes.

________________________________ ________________
(Signature) (Date)

II. Approve publication of the draft notice in the *Federal Register*, with changes. (Please specify.)

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(Signature) (Date)

III. Do not approve publication of the draft notice in the *Federal Register*.

______________________________ ________________
(Signature) (Date)

IV. Take other action. (Please specify.)

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______________________________ ________________
(Signature) (Date)

Attachments:

Draft *Federal Register* Notice – Table Saw Blade Contact Injuries; Advance Notice of Proposed Rulemaking; Request for Comments and Information

Briefing Package from Caroleene Paul, Directorate for Engineering Sciences, *Recommended Advance Notice of Proposed Rulemaking for Performance Requirements to Address Table Saw Blade Contact Injuries,* dated September 14, 2011.

CONSUMER PRODUCT SAFETY COMMISSION

16 CFR Chapter II

[CPSC Docket No. CPSC-2011-]

Table Saw Blade Contact Injuries; Advance Notice of Proposed Rulemaking; Request for Comments and Information

Information

AGENCY: Consumer Product Safety Commission.

ACTION: Advance notice of proposed rulemaking.

SUMMARY: The Consumer Product Safety Commission ("CPSC" or "Commission" or "we") is considering whether a new performance safety standard is needed to address an unreasonable risk of injury associated with table saws. We are conducting this proceeding under the authority of the Consumer Product Safety Act ("CPSA"), 15 U.S.C. 2051–2084. This advance notice of proposed rulemaking ("ANPR") invites written comments from interested persons concerning the risk of injury associated with table saw blade contact, the regulatory alternatives discussed in this notice, other possible means to address this risk, and the economic impacts of the various alternatives. We also invite interested persons to submit an existing standard, or a statement of intent to modify or develop a voluntary standard, to address the risks of injury described in this ANPR.

DATES: Written comments and submissions in response to this notice must be received by **[**insert date that is 60 days after publication in the FEDERAL REGISTER**]**.

ADDRESSES: You may submit comments, identified by Docket No. CPSC-   , by any of the following methods:

Electronic Submissions

Submit electronic comments in the following way:

Federal eRulemaking Portal: http://www.regulations.gov.   Follow the instructions for submitting comments.

To ensure timely processing of comments, the Commission is no longer accepting comments submitted by electronic mail (e-mail) except through www.regulations.gov.

Written Submissions

Submit written submissions in the following way:

Mail/Hand delivery/Courier (for paper, disk, or CD-ROM submissions), preferably in five copies, to: Office of the Secretary, Consumer Product Safety Commission, Room 502, 4330 East West Highway, Bethesda, MD 20814; telephone (301) 504-7923.

Instructions: All submissions received must include the agency name and docket number for this notice. All comments received may be posted without change, including any personal identifiers, contact information, or other personal information provided, to http://www.regulations.gov. Do not submit confidential business information, trade secret information, or other sensitive or protected information electronically. Such information should be submitted in writing.

Docket: For access to the docket to read background documents or comments received, go to http://www.regulations.gov.

FOR FURTHER INFORMATION CONTACT: Caroleene Paul, Directorate for Engineering Sciences, U.S. Consumer Product Safety Commission, 5 Research Place, Rockville, Maryland 20850; telephone (301) 987-2225; fax (301) 869-0294; e-mail *cpaul@cpsc.gov*.

SUPPLEMENTARY INFORMATION:

A. Background

On April 15, 2003, Stephen Gass, David Fanning, and James Fulmer, *et al.* ("petitioners") requested that we require performance standards for a system to reduce or prevent injuries from contact with the blade of a table saw. The petitioners cited estimates of 30,000 annual injuries involving table saws, with approximately 90 percent of the injuries occurring to the fingers and hands, and 10 percent of the injuries resulting in amputation. The petitioners alleged that current table saws pose an unacceptable risk of severe injury because they are inherently dangerous and lack an adequate safety system to protect the user from accidental contact with the blade.

In the *Federal Register* of July 9, 2003 (68 FR 40912) and September 5, 2003 (68 FR 52753), we invited comments on the issues raised by the petition. We received 69 comments. CPSC staff's initial briefing package regarding the petition is available on the CPSC website at http://www.cpsc.gov/library/foia/foia06/brief/tablesaw.pdf. On July 11, 2006, the Commission voted (2–1) to grant Petition CP03-2 and directed staff to draft an advance notice of proposed rulemaking ("ANPR"). On July 15, 2006, the Commission lost its quorum and was unable to move forward with publication of an ANPR at that time. However, CPSC staff continued to evaluate table saws and initiated a special study from January 2007 to December 2008, to gather more accurate estimates on table saw injuries and hazard patterns related to table saw injuries.

Based on CPSC staff's updated information on blade contact injuries associated with table saw use, and CPSC staff's evaluation of current technologies on table saws, we believe it is appropriate to issue an ANPR on tables saw blade contact injuries at this time. CPSC staff's updated briefing package, which supplements the initial briefing package, is available on the CPSC website at http://www.____________.

B. Statutory Authority

We are conducting this proceeding under authority of the Consumer Product Safety Act ("CPSA"). 15 U.S.C. 2051–2084. The Commission believes it has the statutory authority to move forward with this ANPR because table saws that are used by consumers present risks that may not be eliminated or reduced to a sufficient extent by actions undertaken under the Occupational Safety and Health Act. 15 U.S.C. § 2080(a).

Before adopting a CPSA standard, the Commission may issue an ANPR, as provided in section 9(a) of the CPSA. 15 U.S.C. 2058(a). If the Commission decides to continue the rulemaking proceeding after considering responses to the ANPR, the Commission must then publish the text of the proposed rule, along with a preliminary regulatory analysis, in accordance with section 9(c) of the CPSA. 15 U.S.C. 2058(c). If the Commission thereafter moves forward to issue a final rule, in addition to the text of the final rule, it must publish a final regulatory analysis that includes: (1) a description of the potential benefits and costs of the rule; (2) a summary of any alternatives that were considered, their potential costs and benefits, and the reasons for their rejection; and (3) a summary and assessment of any significant issues raised on the preliminary regulatory analysis that accompanied the proposed rule. 15 U.S.C. 2058(f)(2). In addition, the Commission, among other things, must make findings that an existing or proposed voluntary standard would not be adequate, that the benefits of the rule bear a reasonable relationship to its costs, and that the rule is the least burdensome requirement that prevents or adequately reduces the risk of injury. 15 U.S.C. 2058(f)(3).

C. The Product

Table saws are stationary power tools used for the straight sawing of various materials—but primarily wood. In essence, a table saw consists of a table that sits on a base and through which a spinning blade protrudes. To make a cut, the table saw operator places the workpiece on the table, and, typically guided by a rip fence or miter gauge, slides the workpiece into the blade.

There are three basic table saw categories that comprise the population of table saws used for both consumer and professional use: bench saws, contractor saws, and cabinet saws. Generally, the range of quality and accuracy of a table saw is commensurate with its size, motor horsepower, weight, and, indirectly, price.

Bench saws are lightweight, inexpensive saws, designed to be moved around easily and placed temporarily on a work bench or stand. Prices for bench saws range from $100 to $600. Contractor saws are characterized by a set of light-duty legs and a bigger table and motor than a bench saw. Prices for a contractor saw range from about $500 to $1,800, or more. These saws are generally quieter, more accurate, and able to cut materials up to 2 inches thick. Cabinet saws are heavier than contractor saws because the higher powered motor is enclosed in a solid base. Prices for cabinet saws range from $1,000 to $3,000. These saws are designed for heavy use, and the greater weight reduces vibration so that cuts are smooth and more accurate. These saws are typically the highest grade saw found in the home woodworking shop.

Standard safety devices on table saws are designed to prevent the saw blade from making contact with the operator and to prevent the saw blade from imparting its kinetic energy to the workpiece and throwing the workpiece back toward the operator, a phenomenon known as kickback. The configuration and specific design of safety devices vary from manufacturer to manufacturer, but the safety devices generally fall into two basic categories: blade guards and kickback prevention devices.

Traditionally, table saws sold in the United States have employed a blade guard system that combines a hood-type blade guard, splitter (also known as spreader), and anti-kickback pawls as a single unit that is bolted to the saw's carriage assembly. The hood is a single, rectangular piece of transparent plastic that surrounds the exposed blade with a sloped front to allow the guard to rise and ride over the workpiece as the piece is fed toward the blade during a cut. The splitter generally serves as the main support and connection point for the blade guard and the anti-kickback pawls. Thus, removing the splitter for any reason, necessarily removes the rest of the blade guard system and the protections those devices might offer.

Splitters, riving knives, and anti-kickback pawls are the primary safety devices on table saws that are intended to prevent kickback of the workpiece. Splitters ride within the cut, or kerf, to prevent the workpiece from closing up and pinching the blade, which can cause the workpiece to be thrown back toward the operator. Because the height of the splitter is often taller than the blade, splitters must be removed when making non-through cuts because the top portion of the blade must be exposed to cut into the workpiece. If other safety devices are attached to the splitter, removal of the splitter removes these safety devices as well.

Riving knives are curved steel plates that are similar to, and perform the same function as, splitters, but sit very close to the blade and rise no higher than the top of the saw blade. The riving knife attaches to the arbor assembly so that it moves up and down with the blade. These characteristics allow riving knives to be used while making non-through cuts because the top of the blade is exposed. A properly installed riving knife may be the most effective way to prevent kickback because it limits workpiece access to the rear teeth of the saw blade. Anti-kickback pawls consist of two hinged and barbed pieces of metal that allow passage of the workpiece but will dig into the workpiece if it begins to move back toward the operator.

CPSC staff has identified several characteristics of traditional blade guard systems that are likely to hinder table saw use and motivate consumers to remove them to make performing a cut simpler or easier. These characteristics include:

1) Potential jamming of the workpiece on the guard: Some blade guards may jam on the leading edge of the workpiece, requiring the consumer to push the workpiece forcefully or to raise the guard manually;

2) Poor visibility caused by the guard: Hood guards can limit visibility when lining up cuts and during a cut, especially with sawdust accumulation in the guard;

3) Poor splitter alignment with the blade: A splitter can bend over time with use of the table saw. A blade guard system with a splitter that is not aligned properly with the blade can make feeding the workpiece through the blade increasingly difficult and can actually increase the likelihood of kickback; and

4) Mandatory removal of the blade guard for certain cuts: The splitter and blade guard must be removed for certain oversized cuts, very narrow cuts, and any type of non-through cut.

To switch back to typical through cuts, the splitter and guard must be reinstalled in keeping with manufacturers' recommendations that blade guard systems be used whenever performing a through cut.

D. The Market

CPSC staff has identified at least 15 manufacturers and importers of table saws. According to the Power Tool Institute ("PTI"), its members account for approximately 85 percent of all table saws sold in the United States. Most manufacturers are large, diversified, international corporations with billions of dollars in sales, of which table saws generally make up a relatively small part of their revenue. Several other U.S. corporations manufacture or import smaller numbers of table saws for the U.S. market. According to PTI, estimated annual shipments of table saws have fluctuated widely in recent years. In 2006 and 2007, estimated shipments were 800,000 to 850,000 units. However, estimated shipments declined to 650,000 in 2008, 589,000 in 2009, and 429,000 in 2010.

CPSC staff also obtained information from PTI regarding the expected useful life estimates for different categories of table saws, ranging from 6 years for an inexpensive bench saw, to 17 years for a contractor saw, to 24 years for an expensive cabinet saw. Based on these expected product lives and sales data for the different types of saws, PTI estimated the number of table saws in use at 8.0 million in 2001/2002, and 9.5 million in 2007/2008. CPSC staff believes that this estimate is generally consistent with independent estimates of table saws in use, based upon product population estimates using the CPSC's Product Population Model ("PPM"). The PPM is used by CPSC staff to estimate the number of products in use, given sales estimates and information on expected product life. Assuming an average retail price of $500 per table saw, and average annual shipments of about 700,000 units, CPSC staff believes that annual retail sales may be in the range of $300 to $400 million.

CPSC staff also reviewed tariff and trade data from the U.S. Department of Commerce and the U.S. International Trade Commission, which showed that China and Taiwan together account for more than $150 million dollars in annual imports. Allowing for markups of table saws at the manufacturer/private labeler level and the retail level, CPSC staff found that imports may account for a majority of the estimated $300 million to $400 million in shipments estimated. According to CPSC staff, exports from the United States appear to be minimal, less than $1 million annually.

E. Incident Data

CPSC staff first reviewed the National Electric Injury Surveillance System ("NEISS") data in 2001 and 2002. The data indicated that there were 38,000 total emergency room-treated injuries associated with table saws in 2001, and 38,980 injuries in 2002. In 2001, CPSC staff conducted follow-up investigations on stationary saw-related injuries for NEISS cases treated between October 1, 2001 and December 31, 2001. As a result of the investigations, CPSC staff was able to identify injuries that resulted from previously unspecified saw categories, resulting in more precise injury estimates for 2001 and 2002. Of the 28,300 emergency room-treated injuries in 2001 and 2002 involving table saw operator blade contact, most of the injuries were sustained to the finger(s), and the majority of the injuries were lacerations. Fewer injuries resulted in amputations. The remaining injuries included fractures, avulsions (the forcible separation or tearing away of a part of the body), and crushing.

Since its initial review of table saw blade contact injuries, based on data from NEISS, CPSC staff found that the estimated number of emergency department-treated injuries associated with table saws averaged 36,400 per year from 2001 to 2008. The trend analysis conducted by CPSC staff of the annual estimates for 2001 to 2008, indicated that the number of all saw-related injuries (including table saws, band and radial saws, handheld saws, and saws not specified) was steady during this time.

CPSC staff conducted a follow-up special study on stationary saw-related injuries between January 2007 to December 2008, to gather more accurate estimates on table saw injuries and hazard patterns related to table saw injuries. The special study conducted follow-up interviews on emergency room-treated table saw incidents that were reported through NEISS. The special study allowed more precise table saw injury estimates to be computed for 2007 (38,300 injuries), and 2008 (41,200 injuries). Of the 79,500 total emergency department-treated injuries associated with table saws in 2007 and 2008, an estimated 76,100 injuries were sustained by operators of the table saws. Of the injuries to table saw operators, an estimated 66,900 injuries (88%) involved blade contact, which is the pattern of addressable hazards that this ANPR seeks to address.

CPSC staff estimates that there were approximately 66,900 emergency room-treated injuries involving table saw operator blade contact in 2007 and 2008. Of the 66,900 emergency room-treated injuries involving table saw operator blade contact in 2007 and 2008, the majority (68.5%) of the victims were between the ages of 15 to 64 years old, and 31 percent were 65 years old or older. Among the operator blade contact injuries, laceration was the most frequent (65.9%) form of injury, followed by fractures (12.4%), amputation (12.0%), and avulsion

(8.5%). The rate of hospitalization was 7.1 percent, compared to an average 4 percent rate of hospitalization for all consumer products reported through the NEISS system. Because CPSC staff determined that the injury trend associated with all saws has been relatively stable from 2001 and 2008, and they concluded that the results of the special study represented the most accurate estimates available, CPSC staff relied on the data from the special study for 2007 and 2008 to summarize blade contact injuries and their associated hazard patterns.

Of the 66,900 emergency room-treated injuries involving table saw operator blade contact in 2007 and 2008, approximately 20,700 (30.9%) of the injuries occurred on table saws where a blade guard was in use. Approximately 44,500 (66.5%) of the injuries occurred on table saws that did not have a blade guard attached. The most common reason for absence of the blade guard was removal by the consumer (75.0%). An estimated 23,800 injuries (35.5%) occurred as a result of kickback of the material, including scenarios where kickback of the material caused the operator's hand to be pulled into the blade, resulting in a laceration injury or amputation. Of the 23,800 blade contact injuries that occurred as a result of kickback, lacerations were the most frequent (61.2%) form of injury followed by amputations (15.6%), fractures (14.2%), and avulsions (6.5%). The rate of hospitalization was 9.0 percent.

Of the 66,900 emergency room-treated injuries involving table saw operator blade contact in 2007 and 2008, an estimated 39,600 injuries (59.2%) did not occur as a result of kickback of the material. Non-kickback injury scenarios included situations caused by a lapse in attention of the operator, such as reaching over the blade to retrieve a cut piece or otherwise not being aware of the blade during a cut. Of the 39,600 blade contact injuries that did not occur as a result of kickback, lacerations were the most frequent (69.4%) form of injury, followed by fractures (11.0%), amputations (9.5%), and avulsions (9.5%). The rate of hospitalization was 5.0 percent. CPSC staff did not find sufficient information regarding whether kickback caused operator contact with the blade in approximately 3,500 of the 66,900 operator blade contact injuries.

F. Economic Considerations

The Commission's Injury Cost Model ("ICM") uses empirically derived relationships between emergency department injuries estimated through NEISS and injuries treated in other settings (*e.g.*, doctor's offices, clinics) to estimate the number of injuries treated outside hospital emergency departments. Based on CPSC's 2007–2008 special study, staff estimated that approximately 33,450 emergency department-treated blade contact injuries occurred annually over the 2-year period 2007–2008. From these 33,450 annual injuries, the ICM projects an annual total of 67,300 medically treated blade contact injuries with an associated injury cost of approximately $2.36 billion per year. CPSC staff determined that deaths resulting from blade contact during table saw use are rare and appear to be the result of secondary effects of the injuries (*e.g.*, heart attack) rather than the injuries themselves. Accordingly economic costs from deaths have been excluded.

CPSC staff's preliminary review showed that societal costs per blade contact injury amount to approximately $35,000. This includes costs for medical treatment, lost time from work, product liability litigation , and pain and suffering. The relatively high societal costs, compared to the $22,000 average cost for all medically treated consumer product related injuries, reflect the high costs associated with amputations and the relatively high hospitalization rate associated with these injuries.

CPSC staff's preliminary review also showed that the expected present value of the societal costs of blade contact injuries over the life of a table saw is substantial. Therefore, an effective performance-based table saw standard potentially could result in significant reductions in the injury costs associated with blade contact. However, current systems designed to address blade contact injuries on table saws appear to be costly and could substantially increase the retail cost of table saws, especially among the least expensive bench saws.

G. Existing Standards

The current U.S. voluntary consensus standard for table saws is the seventh edition of UL 987, *Stationary and Fixed Electric Tools*. Underwriters Laboratories Inc. ("UL") published this standard in 1971, and has revised it several times. The original requirement for table saw guarding specified a complete guard that consisted of a hood, a spreader, and some type of anti-kickback device. The requirement further specified that the guard hood completely enclose the sides and top portion of the saw blade above the table and that the guard automatically adjust to the thickness of the workpiece. A blade guard that met this requirement was typically a hinged, rectangular piece of clear plastic.

The sixth edition of UL 987, published in January 2005, added design and performance requirements for a riving knife and performance requirements for anti-kickback devices. This revision essentially required new table saws to employ a permanent riving knife that was adjustable for all table saw operations. The requirement also allowed for riving knife/spreader combination units, where the riving knife could be used as the attachment point for a blade guard during through cuts. The effective date for the riving knife requirement is January 31, 2014, for currently listed products, and January 31, 2008, for new products submitted for listing to the UL standard.

The current edition, the seventh edition of UL 987, published in November 2007, expanded the table saw guarding requirements to include descriptions of a new modular blade guard design developed by a joint venture of the leading table saw manufacturers. The revised standard specified that the blade guard shall consist not of a hood, but of a top-barrier guarding element and two side-barrier guarding elements. The new modular guard design was intended to be an improvement over traditional hood guard designs by providing better visibility, being easier to remove and install, and incorporating a permanent riving knife design. The revised standard also specified detailed design and performance requirements for the modular blade guard, riving knife, and anti-kickback device(s). The effective date for the new requirements was January 31, 2010.

The Occupational Safety and Health Administration ("OSHA") currently has regulations on table saws used in the workplace, which are codified at 29 CFR 1910.213, Woodworking Machinery Requirements. The OSHA regulations require that table saws in the workplace include a blade guard, a spreader, and an anti-kickback device. 29 CFR 1910.213(c)(1)-(3). The OSHA regulations require the saw be guarded by a hood with certain performance standards including, among other things, requirements that the hood be strong enough to withstand certain pressures, be adjustable to the thickness of the material being cut, and be constructed in a way to protect the operator fromflying splinters and broken saw teeth. 29 CFR 1910.213(c)(1). The OSHA regulations also require inspection and maintenance of woodworking machinery. For example, unsafe saws must be removed from service immediately, push sticks or push blocks must be provided at the work place for guiding or pushing material past the blade, and emphasis must be placed on the cleanliness around woodworking machinery and, in particular, the effective functioning of guards and prevention of fire hazards. 29 CFR § 1910.213(s).

CPSC staff found that the primary differences between consumer and professional users of table saws are environment and training/experience. In many work production environments where a specific cut is performed continuously, guards and safety cut-off switches are custom designed for that set up. The area is specifically designed to be as safe as possible and safety is a continuous focus through warning/instruction signs and posters that are often displayed throughout the work area. The workplace is also subject to spontaneous inspection by OSHA inspectors; therefore, the prospect of being fined for safety violations increases the likelihood that workers or supervisors will help ensure safety codes are followed. In addition, professional woodworkers are in an industrial setting where employees often receive training on safety practices and in the proper use of the tool. Professional woodworkers are more likely to have had training and to be experienced in performing any special or complex operations with the saw and are more likely to recognize situations and set-ups that may be dangerous or require extra care and caution.

Amateur woodworkers generally have little or no safety training, nor training in the proper use of the table saw. They may take woodworking classes or watch a training video, but the home users typically have far less experience than professional woodworkers and may discover dangerous or difficult operations only by actually experiencing near accidents or problems. The home woodworker also does not have the same OSHA-regulated protections in the home-based woodshop. The focus on a safe environment in a consumer setting is dependent upon the knowledge and initiative of the home woodworker, but there is no oversight to educate and motivate the consumer to prepare as safe an environment as possible.

CPSC staff also reviewed the 2007-2008 special study of table saw-related injury estimates to assess whether they were work-related. Narratives and responses in the 862 cases in the table saw study were reviewed to identify cases that might be work-related. Four of the cases appeared to be work-related, and another 12 cases appeared to be potentially work-related. Combined, these cases comprised less than 2 percent of the sample data and less than 2 percent of the estimated 79,500 total table or bench saw injuries over the two years 2007-2008. The remaining 846 cases in the special study represented an estimated 78,000 non-work-related injuries.

We believe that OSHA regulations may not adequately reduce the risk of operator blade contact injuries to consumers because these regulations are primarily intended to ensure a safer work environment in the professional workplace setting, rather than the home woodworking environment. OSHA regulations rely on a comprehensive approach to promote safe practices in the workplace. These strategies include training and outreach, as well as mandatory safety standards and enforcement. This approach would not be available to consumers operating table saws in a home woodworking environment. CPSC staff's review showed that less than 2 percent of the estimated 79,500 total table or bench saw injuries over the 2007-2008 period appear to be work-related. Moreover, we note that the OSHA regulations for guarding are essentially identical to the requirements in the now superseded fifth edition of the voluntary standard for table saws, UL 987, *Standard for Stationary and Fixed Electric Tools*. Accordingly, the existing OSHA regulations for table saws do not reflect the latest revisions to UL 987, which require riving knives and the new modular blade guard design developed by the table saw industry. However, even if OSHA incorporates the new UL requirements in its regulations, we believe that current safety devices still may not adequately address the operator blade contact injuries associated with table saw use by consumers.

H. Regulatory Alternatives

One or more of the following alternatives could be used to reduce the identified risks associated with table saw blade contact injuries:

1. Voluntary Standard. If the industry developed, adopted, and substantially conformed to an adequate voluntary standard, we could defer to the voluntary standard, instead of issuing a mandatory rule. The current voluntary standard for table saws includes requirements for a splitter/spreader, blade guard, and anti-kickback device to address the hazard posed by contact with the saw blade. The voluntary standards body only recently has begun to review requirements for a riving knife that may reduce certain kickback conditions that can result in unexpected blade contact. However, a riving knife would not address the blade contact injuries that were not caused by kickback of the material, an estimated 39,600 injuries in 2007 and 2008.

CPSC staff evaluated two new technologies that have been introduced to the table saw market since 2007 to address blade contact injury. Technologies that address blade contact injuries on table saws can be categorized by their main purpose: (1) prevention of the event, and (2) mitigation of the event.

In 2007, a joint venture of the leading table saw manufacturers introduced a new modular blade guard design to the market. The new modular guard, like traditional blade guard systems, is aimed at preventing the event of blade contact. In general, traditional blade guards and the new modular blade guards can effectively prevent most physical side, rear, and downward contact with the table saw blade but will primarily act as a tactile warning for front approach contact with the blade. The new modular blade guard system appears to be a significant improvement over most traditional blade guard systems because it uses a permanent, adjustable riving knife, rather than a removable splitter, as the primary kickback prevention device and support for the guard. However, the new blade guard system still would not prevent blade contact injuries resulting from the hand approaching the front, or leading portion, of the blade. Furthermore, the new blade guard system still can hinder certain table saw tasks, thereby encouraging its removal, and it can prevent certain sawing tasks from being performed unless it is removed. CPSC staff's review showed that removing the blade guard system is easy but installation can be tricky and, if the process is repeated, it can also be time-consuming and burdensome. These characteristics may motivate some consumers—especially experienced or expert woodworkers—not to bother reinstalling the system once it is removed.

In 2008, the petitioners developed a contractor saw with a blade contact detection and reaction system that was introduced to the table saw market as the SawStop system. Blade contact detection and reaction systems function as a secondary safety system to mitigate the event of blade contact. The system is not intended to prevent table saw blade contact incidents, but rather, to lessen the consequences of blade contact when it occurs. The SawStop system includes two components: an electronic detection unit, and a brake. The system induces a small electrical signal onto the saw blade that is partially absorbed by the human body if contact is made. When this reduction in signal is detected, the system applies a brake to the blade that stops and retracts the blade below the table surface within milliseconds. In principle, the only injury likely to be sustained by direct contact with the saw blade when the system functions as intended is a small cut.

The SawStop system reviewed by CPSC staff did not seem to interfere with most sawing operations, and, once installed, the system is essentially invisible to the consumer until it is needed. If the system is activated or the standard 10-inch blade needs to be replaced with a smaller dado blade (a type of saw blade used to cut grooves), the brake cartridge underneath the table surface must be replaced. Removing and reinstalling the brake cartridge when switching to and from dado sets, or once the system has been activated, can be difficult. However, in all likelihood, system activation would occur only after contact with the skin, a situation in which the consumer might have sustained serious injury had the system not been in place.

We are concerned that the requirements in the voluntary standard for table saws, UL 987, Stationary and Fixed Electric Tools, which mandate a permanent riving knife and the new modular blade guard system, may not adequately address the operator blade contact injuries associated with table saw use. While we support the recent progress UL has made in improving the voluntary standard to address blade contact injuries by focusing solely on prevention of skin-to-blade contact, the standard requirements do not appear to address adequately the number or severity of blade contact injuries that occur on table saws, nor do they address the associated societal costs. In addition, while we believe that the new modular guard design is a significant improvement over the old guard design, the effectiveness of any blade guard system depends upon an operator's willingness to use it. Safety equipment that hinders the ability to operate the product likely will result in consumers bypassing, avoiding, or discarding the safety equipment. In addition, of the 66,900 table saw operator blade contact injuries in 2007 and 2008, approximately 20,700 (30.9%) of the injuries occurred on table saws where the blade guard was in use. The current voluntary standard for table saws does not appear to address those types of injuries. Accordingly, we are particularly interested in obtaining information regarding current or developing voluntary standards that would address table saw blade contact injuries.

2. Mandatory rule. We could issue a rule mandating performance requirements on table saws that would address blade contact injuries.

3. Labeling rule. We could issue a rule requiring specified warnings and instructions to address table saw blade contact injuries.

I. Request for Information and Comments

This ANPR is the first step in a proceeding that could result in a mandatory safety standard for table saws to address the risk of injury associated with blade contact from table saws. We invite interested persons to submit their comments on any aspect of the alternatives discussed above in part H of this document. In particular, we request the following additional information:

1. Written comments with respect to the risk of injury identified by the Commission, the regulatory alternatives being considered, and other possible alternatives for addressing the risk;

2. Any existing standard or portion of a standard that could be issued as a proposed regulation;

3. A statement of intention to modify or develop a voluntary standard to address the risk of injury discussed in this notice, along with a description of a plan (including a schedule) to do so;

4. Studies, tests, or surveys that have been performed to analyze table saw blade contact injuries, severity of injuries, and costs associated with the injuries;

5. Studies, tests, or surveys that analyze table saw use in relation to approach/feed rates, kickback, and blade guard use and effectiveness;

6. Studies, tests, or descriptions of new technologies, or new applications of existing technologies that can address blade contact injuries, and estimates of costs associated with incorporation of new technologies or applications;

7. Estimated manufacturing cost, per table saw, of new technologies or applications that can address blade contact injuries;

8. Expected impact of technologies that can address blade contact injuries on wholesale and retail prices of table saws;

9. Expected impact of technologies that can address blade contact injuries on utility and convenience of use;

10. Information on effectiveness or user acceptance of new blade guard designs;

11. Information on manufacturing costs of new blade guard designs;

12. Information on usage rates of new blade guard designs;

13. Information on U.S shipments of table saws prior to 2002, and between 2003 and 2005;

14. Information on differences between portable bench saws, contractor saws, and cabinet saws in frequency and duration of use;

15. Information on differences between saws used by consumers, saws used by schools, and saws used commercially in frequency and duration of use;

16. Studies, research, or data on entry information of materials being cut at blade contact (*i.e*., approach angle, approach speed, and approach force);

17. Information that supports or disputes preliminary economic analyses on the cost of employing technologies that reduce blade contact injuries on table saws;

18. Studies, research, or data on appropriate indicators of performance for blade-to-skin requirements that mitigate injury;

19. Studies, research, or data that validates human finger proxies for skin-to-blade tests;

20. Studies, research, or data on detection/reaction systems that have been employed to mitigate blade contact injuries;

21. Studies, research, or data on the technical challenges associated with developing new systems that could be employed to mitigate blade contact injuries;

22. Studies, research, or data on guarding systems that have been employed to prevent or mitigate blade contact injuries;

23. Studies, research, or data on kickback of a workpiece during table saw use;

24. The costs and benefits of mandating a labeling or instructions requirement; and

25. Other relevant information regarding the addressability of blade contact injuries.

Comments and other submissions should be identified by identified by Docket No. [CPSC-] and submitted in accordance with the instructions provided above. All comments and other submissions must be received by **[insert date that is 60 days after publication in the FEDERAL REGISTER]**

Dated: __________________

____
Todd A. Stevenson, Secretary
Consumer Product Safety Commission.

BRIEFING PACKAGE

RECOMMENDED ADVANCE NOTICE OF PROPOSED RULEMAKING FOR PERFORMANCE REQUIREMENTS TO ADDRESS TABLE SAW BLADE CONTACT INJURIES

September 14, 2011

For Further Information Contact:

Caroleene Paul
Project Manager
Directorate for Engineering Sciences
301-987-2225

Executive Summary

This briefing package provides the Commission with available information about blade contact injuries associated with table saw use, staff evaluation of current table saw safety technologies that address blade contact injuries, and staff analysis used to develop a recommendation to publish an advance notice of proposed rulemaking (ANPR) for table saw safety.

U.S. Consumer Product Safety Commission (CPSC) staff initiated a special study from January 2007 through December 2008, to gather more detailed information about table saw injuries and hazard patterns from individuals who sought emergency department treatment related to saws. The special study conducted follow-up telephone interviews on emergency department-treated table saw injuries that were reported through the National Electronic Injury Surveillance System (NEISS).[1] The estimated number of blade contact injuries to table saw operators during 2007 through 2008, was 66,900 injuries, which represents 88 percent of all table saw injuries during that time. Among the operator blade contact injuries, laceration was the most frequent (65.9%) form of injury, followed by fractures (12.4%), amputation (12.0%), and avulsion (8.5%). The rate of hospitalization was 7.1 percent, compared to an average 4 percent rate of hospitalization for all consumer products reported through the NEISS system.

Of the 66,900 emergency department-treated injuries involving table saw operator blade contact in 2007 through 2008, approximately 20,700 (30.9%) of the injuries occurred on table saws where a blade guard was in use. Approximately 44,500 (66.5%) of the injuries occurred on table saws that did not have a blade guard attached. The status of the blade guard was unknown in approximately 1,700 (2.5%) of the injuries.[2] The most common reason for absence of the blade guard was removal by the consumer (75.0%).

A trend analysis of annual estimates from NEISS for 2001 through 2008 indicates that the number of all saw-related injuries was steady over the years. Because the special study results represent the most accurate estimates available, the annual average of 33,450 emergency department-treated table saw operator blade contact injuries over the 2-year period of 2007 and 2008, was used to determine annual cost estimates for table saw operator blade contact injuries.

The Commission's Injury Cost Model (ICM) uses empirically derived relationships between emergency department treated-injuries estimated through NEISS and injuries treated in other settings (*e.g.*, doctor's offices, clinics) to estimate the number of injuries treated outside hospital emergency departments. Based on the annual estimate of 33,450 emergency department-treated table saw operator blade contact injuries, the ICM projects an annual total of 67,300 medically treated table saw operator blade contact injuries. Additionally, based on ICM estimates, the 67,300 medically treated blade contact injuries had an associated injury cost of $2.36 billion per

[1] The Commission operates the National Electronic Injury Surveillance System (NEISS), a probability sample of about 100 U.S. hospitals with 24-hour emergency departments (EDs) and more than six beds. These hospitals provide the CPSC with data on all consumer product-related injury victims seeking treatment in the hospitals' EDs. Injury and victim characteristics, along with a short description of the incidents, are coded at the hospital and sent electronically to the CPSC.

[2] Percentages may not add up exactly to 100 percent due to rounding.

year. This estimate includes costs for medical treatment, lost time from work, product liability litigation, and pain and suffering.

Since 2005, the voluntary standard that covers table saws, UL 987 *Standard for Stationary and Fixed Electric Tools*, has undergone two major revisions related to table saws. The requirements in the current seventh edition of UL 987 are intended to reduce blade contact injuries on table saws by: (1) reducing the potential for kickback by requiring a permanent riving knife, and (2) increasing blade guard usage by specifying a new blade guard system that was designed by a joint venture of the table saw industry to be more acceptable to consumers.[3]

Currently, the Occupational Safety and Health Administration (OSHA) has regulations on table saw products and the workplace environment in which the products are used.[4] The current OSHA product requirements on table saws are essentially identical to the requirements in the superseded fifth edition of the voluntary standard for table saws, UL 987 *Standard for Stationary and Fixed Electric Tools*. The OSHA regulations for table saws do not reflect the latest revisions to UL 987 that require riving knives and the new modular blade guard design developed by the table saw industry's joint venture.

CPSC staff evaluated two of the most current technologies to address blade contact injury. In 2007, a new modular blade guard design, developed by a joint venture of the leading table saw manufacturers, was introduced to the market and included in the blade guard requirements of the seventh edition of UL 987. The new modular guard, like traditional blade guard systems, is aimed at preventing blade contact. The new modular blade guard system appears to be a significant improvement over most traditional blade guard systems; however, it will not prevent front approach blade contact injuries, and the system must be removed for certain sawing tasks. Removing the blade guard system is easy, but installation can be more difficult; and if the system must be removed and installed frequently, some consumers may not bother reinstalling the system once it has been removed.

In 2008, a contractor saw with a blade contact detection and blade-stopping reaction system developed by SawStop, LLC, was introduced to the table saw market. The system is not intended as a replacement for event prevention technologies, but rather to mitigate the consequences of blade contact when it occurs despite the use of other safety systems. The detection and blade-stopping reaction system detects skin-to-blade contact and applies a brake to the blade that stops and retracts the blade below the table surface within milliseconds. In principle, the only injury likely to be sustained by direct contact with the saw blade when the system functions as intended is a small cut. After the system activates, the brake and saw blade must be removed and replaced. Based on a preliminary evaluation by CPSC staff, the SawStop system does not appear to interfere with most sawing operations, and once it is installed, the system is essentially invisible to the consumer until it is needed. Replacing the system's brake

[3] On October 23, 2003, the Power Tool Institute Joint Venture Project filed written notification with the Attorney General and U.S. Federal Trade Commission that the leading table saw manufacturers were forming a joint venture to research and develop saw blade contact injury avoidance, blade braking systems, and blade guarding systems. Federal Register /Vol. 68, No. 230 /Monday, December 1, 2003 /page 67216.
[4] 29 CFR § 1910.213 Woodworking machinery requirements.

component can be difficult, but the system is designed to be fail-safe in that the table saw motor will not power on unless the system detects that all components are working.

Based on presentations and briefings to CPSC staff, the Power Tool Institute (PTI) and many table saw industry representatives believe that the requirements in the current voluntary standard for table saws, UL 987 *Stationary and Fixed Electric Tools*, will adequately address the operator blade contact injuries associated with table saw use. While CPSC staff supports the recent progress UL has made in improving the voluntary standard to address blade contact injuries by focusing solely on prevention of skin-to-blade contact, staff does not believe the current requirements are adequate to reduce the number or severity of blade contact injuries, or the associated societal costs. The voluntary standard requirements do not adequately address the substantial number of blade contact injuries that: (1) did not occur due to kickback of the material, and/or (2) occurred on table saws where a blade guard was in use.

CPSC staff does not believe deferring to OSHA regulations will adequately address the blade contact hazard to consumers because: (1) OSHA's comprehensive approach to encourage and enforce a safe work environment in the professional workplace setting is not applicable to consumers in a home woodworking environment; and (2) the current OSHA requirements for table saw guarding are essentially identical to the requirements in the superseded edition of the voluntary standard that has not adequately addressed table saw blade contact hazards.

CPSC staff's review of the injury data and hazard patterns suggests that a significant percentage of the operator blade contact injuries on table saws could be addressed by table saw performance requirements that further reduce the likelihood of blade contact injury and prevent or reduce the severity of these injuries. The high societal costs (estimated at $2.36 billion per year) associated with these operator blade contact injuries highlight the severity, as well as the frequency of these injuries. The high societal costs also suggest that an effective remedy could generate net societal benefits over the lifetime of the table saws.

CPSC staff recommends that the Commission proceed with the rulemaking process for table saws by voting to publish an advance notice of proposed rulemaking (ANPR) as drafted by the Office of the General Counsel.

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TABS

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

This document has been electronically approved and signed.

Memorandum

Date: September 14, 2011

TO : The Commission
Todd A. Stevenson, Secretary

THROUGH : Cheryl A. Falvey, General Counsel
Kenneth R. Hinson, Executive Director

FROM : Robert J. Howell, Assistant Executive Director
Office of Hazard Identification and Reduction

Caroleene Paul, Project Manager
Directorate for Engineering Sciences

SUBJECT : Recommended Advance Notice of Proposed Rulemaking for Performance Requirements to Address Table Saw Blade Contact Injuries

I. Introduction

Staff of the U.S. Consumer Product Safety Commission (CPSC) prepared this briefing package for use by the Commission to consider staff's draft advance notice of proposed rulemaking on performance standards for table saws to address blade contact injuries. On April 15, 2003, Messrs. Gass, Fanning, and Fulmer, et al. petitioned the Commission to require performance standards for a system to reduce or prevent injuries from contact with the blade of a table saw.[5] CPSC staff prepared a briefing package in response to the petition, and on July 11, 2006, the Commission voted (2–1) to grant Petition CP 03-2 and directed staff to draft an advance notice of proposed rulemaking (ANPR) (see Tab A).

On July 15, 2006, the Commission lost its quorum and was unable to move forward with publication of an ANPR at that time. However, CPSC staff continued to evaluate table saws and initiated a special study from January 2007 to December 2008, to gather more accurate estimates on table saw injuries and hazard patterns related to table saw injuries.

This package presents information for the Commission to use in considering whether to publish the staff's draft advance notice of proposed rulemaking.

[5] Petition CP 03-2 is available on CPSC's website at: http://www.cpsc.gov/library/foia/foia03/petition/Bladesawpt1.pdf.

II. Product

Table saws are stationary power tools used for the straight sawing of various materials but primarily wood. In essence, a table saw consists of a table that sits on a base, and through the top of which a spinning blade protrudes. To make a cut, the table saw operator places the workpiece on the table, and, typically, guided by a rip fence or miter gauge, slides the workpiece into the blade (see Figure 1).

Standard safety devices on table saws are designed to prevent the saw blade from making contact with the operator and to prevent the saw blade from imparting its kinetic energy to the workpiece and throwing the workpiece back towards the operator, a phenomenon known as kickback. The configuration and specific design of these safety devices vary from manufacturer to manufacturer, but the safety devices generally fall into two basic categories: (1) blade guards, and (2) kickback prevention devices.

Blade guards surround the exposed blade and function as a physical barrier between the blade and the operator. Kickback prevention devices include splitters, riving knives, and anti-kickback pawls (see Figure 1). A splitter, also commonly called a spreader, is typically a flat piece of metal, aligned directly behind the saw blade that rides within the cut, or kerf, of a workpiece that is being fed through the blade. This prevents the workpiece from closing up and pinching the blade, which can cause the workpiece to be thrown back toward the operator. Anti-kickback pawls consist of two hinged and barbed pieces of metal that allow passage of the workpiece but will dig into the workpiece if it begins to move back toward the operator.

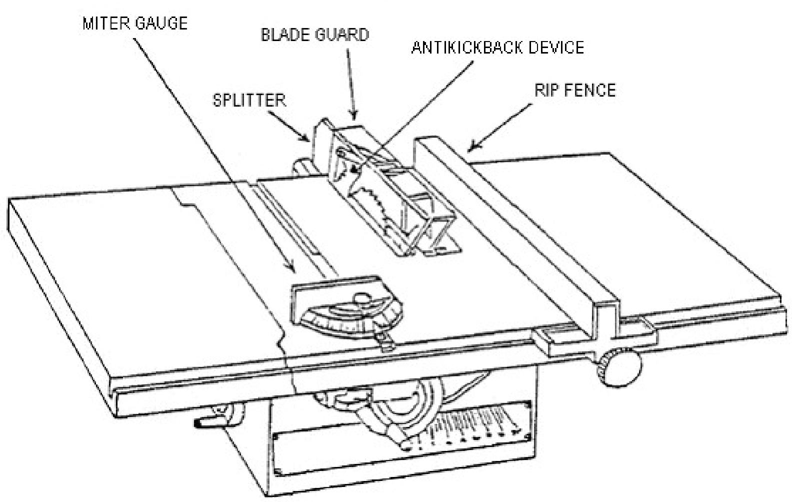


Figure 1. Typical table saw components.

Riving knives are curved metal plates that are similar to, and perform the same function as, splitters, but tend to sit closer to the blade, rise no higher than the top of the blade, and attach to the arbor assembly so that they move with the blade (see Figure 2). [6]

[6] The arbor assembly includes the arbor, which is the metal shaft that holds the saw blade.

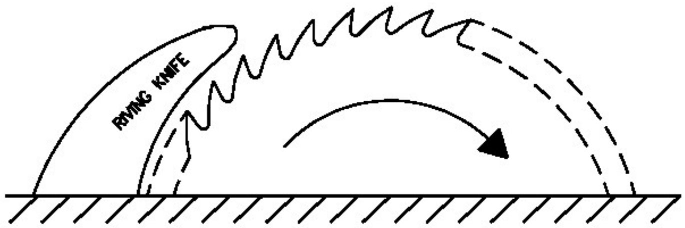


Figure 2. Riving knife.

There are three basic table saw categories that comprise the population of table saws used for both consumer and professional use: (1) bench saws, (2) contractor saws, and (3) cabinet saws. Generally, the range of quality and accuracy of a table saw is commensurate with its size, motor horsepower, weight, and indirectly, price.

Bench saws are lightweight, inexpensive saws designed to be moved around easily and placed temporarily on a work bench or stand (see Figure 3). Prices for bench saws range from $100 to as much as $600 for a professional model.[7]

Figure 3. Typical bench saw.

Figure 4. Typical contractor saw.

Contractor saws are characterized by a set of light-duty legs and a bigger table and motor than a bench saw (Figure 4). Prices for a contractor saw range from about $500 to $1,800 or more. These saws are generally quieter, more accurate and are able to cut materials up to 2 inches thick.

Cabinet saws are heavier than contractor saws because the higher powered motor is enclosed in a solid base (see Figure 5). Prices for cabinet saws range from $1,000 to $3,000. These saws are designed for heavy use, and the greater weight reduces vibration so that cuts are smoother and more accurate. These saws are typically the highest grade saw found in the home woodworking shop.

[7] Prices for table saws are from Tab C, Memorandum from William Zamula, EC, to Caroleene Paul, Project Manager, "Performance Standards for a System to Reduce or Prevent Injuries from Contact With the Blade of a Table Saw: Economic Issues," August 3, 2011.

Figure5. Typical cabinet saw.

III. Incident Data (Tab B)

Based on data from the CPSC's National Electronic Injury Surveillance System (NEISS), the estimated number of emergency department-treated injuries associated with table saws averaged 36,400 per year from 2001 to 2008. A trend analysis of annual estimates for 2001 to 2008 indicates that the number of all saw-related injuries (this includes table saws, band and radial saws, handheld saws, and saws not specified) was steady during this time.

A. Special study

In 2009, CPSC staff conducted a survey of stationary saw-related injuries that were treated in hospital emergency departments that participated in the NEISS program and occurred between January 1, 2007 and December 31, 2008.[8,9] The purpose of the survey was to obtain more detailed information about saw injuries because a high number of the injuries were coded as an unspecified saw type. The special study identified incidents involving table saws that were formerly coded as "power saw, other," or "saw, not specified," as well as incidents that were miscoded as "table or bench saw" but that did not actually involve a table saw. Among the saws in these two categories, 16.4 percent were identified as table/bench saws, and among the table/bench saws, 4.1 percent were recategorized as another product. The results of the special study allowed more precise table saw injury estimates to be computed for 2007 (38,300 injuries), and 2008 (41,200 injuries).[10]

Because (1) the injury trend associated with all saws has been relatively unchanged from 2001 to 2008, and (2) the results of the special study represent the most accurate estimates available, the data from the special study for 2007 and 2008, have been used to summarize blade-contact injuries and their associated hazard patterns.

[8] A similar study was conducted in 2001, where follow-up interviews were conducted on cases treated between October 1, 2001 and December 31, 2001 (Adler, 2003).
[9] Tab B, report of the 2007–2008 special study is available on CPSC's website at: http://www.cpsc.gov/library/foia/foia11/os/statsaws.pdf.
[10] Compared with NEISS estimates of 34,800 injuries in 2007, and 38,100 injuries in 2008, based solely on product code 0841 for table/bench saws.

Of the 79,500 total emergency department-treated injuries associated with table saws in 2007 and 2008, an estimated 76,100 injuries were sustained by operators of the table saws. Of the injuries to table saw operators, an estimated 66,900 injuries (88%) involved blade contact, which is the pattern of particular interest in terms of addressable hazards.

Of the 66,900 total emergency department-treated injuries involving table saw operator blade contact in 2007 and 2008, the majority (68.5%) of the victims were between the ages of 15 to 64 years old, and 31 percent were 65 years old or older. Among the operator blade-contact injuries, lacerations were the most frequent (65.9%) form of injury, followed by fractures (12.4%), amputations (12.0%), and avulsions (8.5%). The rate of hospitalization was 7.1 percent, compared to an average 4 percent rate of hospitalization involving all consumer products reported through the NEISS system.

B. Injuries involving kickback vs. injuries not involving kickback

Of the 66,900 total emergency department-treated injuries involving table saw operator blade contact in 2007 and 2008, an estimated 23,800 (35.6%) injuries occurred as a result of kickback of the material. Sample narratives from Appendix B of the special study describe scenarios where kickback of the material causes the operator's hand to be pulled into the blade resulting in a laceration injury or amputation. Of the 23,800 blade-contact injuries that occurred as a result of kickback, lacerations were the most frequent (61.2%) form of injury, followed by amputations (15.6%), fractures (14.2%), and avulsions (6.5%). The rate of hospitalization was 9.0 percent.

Of the 66,900 emergency department-treated injuries involving table saw operator blade contact in 2007 and 2008, an estimated 39,600 (59.2%) injuries did not occur as a result of kickback of the material. Sample narratives from Appendix B of the special study describe non-kickback-related situations where injury was caused by a lapse in attention of the operator, such as reaching over the blade to retrieve a cut piece or not being aware of the blade during a cut. Of the 39,600 blade-contact injuries that did not occur as a result of kickback, lacerations were the most frequent (69.4%) form of injury, followed by fractures (11.0%), amputations (9.5%), and avulsions (9.5%). The rate of hospitalization was 5.0 percent.

It is not known whether kickback caused operator contact with the blade in approximately 3,500 of the 66,900 operator blade-contact injuries.

C. Injuries with and without blade guard use

Of the 66,900 emergency department-treated injuries involving table saw operator blade contact in 2007 and 2008, approximately 20,700 (30.9%) of the injuries occurred on table saws where a blade guard was in use. Approximately 44,500 (66.5%) of the injuries occurred on table saws that did not have a blade guard attached. The status of the blade guard was unknown in approximately 1,700 (2.5%) of the injuries. The most common reason for absence of the blade guard was removal by the consumer (75.0%).

IV. Table Saw Market Information (Tab C)

CPSC staff has identified at least 15 manufacturers and importers of table saws. The Power Tool Institute (PTI), the primary trade association for table saw manufacturers in the U.S. market, estimates that its members account for 85 percent of all table saws sold in the United States. Most of the manufacturers are large, diversified international corporations with billions of dollars in sales, of which table saws generally make up a relatively small proportion of revenues.

According to PTI, the estimated annual shipments of table saws have fluctuated widely in recent years. In 2006 and 2007 estimated shipments were between 800,000 and 850,000 units. However, as a result of the recession and the decline in residential construction, estimated shipments declined to 650,000 in 2008, 589,000 in 2009, and 429,000 in 2010. PTI estimates that in 2007 and 2008, the number of table saws in use in the United States was about 9.5 million.

V. Economic Cost Analysis (Tab C)

The Commission's Injury Cost Model (ICM) uses empirically derived relationships between emergency department-treated injuries and those treated in other settings (*e.g.*, doctor's offices, clinics) to estimate the number of injuries treated outside hospital emergency departments. Based on the CPSC's 2007–2008 special study, staff estimated that approximately 33,450 emergency department-treated operator blade contact injuries occurred annually over the 2-year period 2007–2008. From these 33,450 annual injuries, the ICM projects an *annual* total of 67,300 medically treated blade contact injuries with an associated injury cost of approximately $2.36 billion per year. Deaths resulting from blade contact during table saw use are rare and seem to be the result of secondary effects of the injuries (*e.g.*, heart attack) rather than the injuries themselves.[11] Economic costs from deaths have therefore been excluded from the analyses.

Societal costs per blade contact injury amount to approximately $35,000. This includes costs for medical treatment, lost time from work, product liability litigation, and pain and suffering. The relatively high societal costs, compared to the $22,000 average cost for all medically treated, consumer product-related injuries, reflect the high costs associated with amputations and the relatively high hospitalization rate associated with these injuries.

As shown at Tab C, the expected present value of blade contact injuries over the product life of various table saw types is substantial. Therefore, an effective performance-based table saw standard that addresses blade contact injuries potentially could result in significant reductions in the injury costs associated with blade contact. However, according to information collected to date, current systems appear to be costly and may substantially increase the retail cost of table saws to the consumer. The increased costs could be enough to reduce table saw sales significantly, especially for the least expensive bench saws, which could more than double in

[11] TAB A, Memorandum from Natalie Marcy, EPHA to Caroleene Paul, ES, "Data Analysis for Petition CP 03-2, Table Saw Blade Contact Deaths and Injuries," April 12, 2005.

price. The industry environment is also complicated because of the ownership of potentially key patents by the petitioner.

VI. Voluntary Standard

The current U.S. voluntary consensus standard for table saws is UL 987, *Stationary and Fixed Electric Tools*. This standard was published by Underwriters Laboratories Inc. (UL) in 1971, and it has undergone several revisions, with the seventh edition being the most current. The original requirement for table saw guarding specified a complete guard that consisted of a hood, a spreader, and some type of anti-kickback device. The requirement further specified that the guard hood enclose completely the sides and top portion of the saw blade above the table and that the guard adjust automatically to the thickness of the workpiece. A blade guard that met this requirement typically consisted of a hinged, rectangular piece of clear plastic.

The sixth edition of UL 987, published in January 2005, added design and performance requirements for a riving knife and performance requirements for anti-kickback devices. This revision essentially requires new table saws to employ a permanent riving knife that is adjustable for all table saw operations. The requirement also allows for riving knife/spreader combination units, where the riving knife can be used as the attachment point for a blade guard during through cuts. The effective date for the riving knife requirement is January 31, 2014, for currently listed products, and was January 31, 2008, for new products submitted for listing to the UL standard.

The seventh edition of UL 987, published in November 2007, expanded the table saw guarding requirements to include descriptions of a new modular blade guard design developed by a joint venture of the leading table saw manufacturers. The revised standard specifies that the blade guard shall consist not of a hood, but of a top-barrier guarding element and two side-barrier guarding elements. The new modular guard design is intended to be an improvement over traditional hood guard designs by providing better visibility, offering easier methods to remove and install the guard, and incorporating a permanent riving knife design.[12] The revised standard also specifies detailed design and performance requirements for the modular blade guard, riving knife, and anti-kickback device(s). The effective date for the new requirements was January 31, 2010.

VII. Occupational Safety and Health Administration (OSHA) Regulation

A. Injury data (Tab D)

To address concerns about whether the table and bench saw-related injury estimates generated from the CPSC's 2007–2008 special study were work-related, a review of the 862 cases in the special study was undertaken. Although the study was designed to exclude cases initially known to be work-related, incomplete or inaccurate information can potentially affect classifications. The goal of this assessment was to identify work-related cases and to estimate the percent of injuries work-related cases may represent in the study estimates.

[12] Power Tool Institute presentation to Chairman Tenenbaum and Commissioner Adler, November 2, 2009.

Narratives and responses in the 862 cases in the table saw study were reviewed in order to identify any cases that might be work-related and therefore, possibly subject to OHSA jurisdiction. Although none of the study cases contained the NEISS code indicating that the injury was work-related, some of the case narratives suggest the existence of work-related injuries (4 cases appear to be definitely work-related, and another 12 appear to be potentially work-related). Nevertheless, the hazard patterns in the narratives (blade contact due to inattention or kickback) are similar to the home-related incidents.

Based on staff's review, definitive and possible work-related table saw injuries comprised less than 2 percent of the sample data and less than 2 percent of the estimated 79,500 total table or bench saw injuries over the two years 2007–2008.

B. OSHA regulations relating to blade contact hazard

The question has arisen of whether adopting Occupational Safety and Health Administration (OSHA) regulations related to the blade contact hazard would be a way to address these injuries.

Current OSHA regulations on table saws require that the blades be guarded by a self-adjusting blade guard [29 CFR § 1910.213 (c)(1) and (d)(1)] to address point-of-operation injuries. A spreader [29 CFR § 1910.213 (c)(2)] and anti-kickback devices [29 CFR § 1910.213 (c)(3)] are required to address the kickback hazard.

OSHA regulations also require inspection and maintenance of woodworking machinery. Unsafe saws must be removed from service immediately [29 CFR § 1910.213 (s)(1)]; emphasis must be placed on the effective functioning of guards [29 CFR § 1910.213 (s)(6)]; and push sticks must be provided at the work place [29 CFR § 1910.213 (s)(9)].

In addition to rules specific to table saws, employers must keep their workplaces free of serious recognized hazards, must monitor hazards and keep records of workplace injuries, and they are subject to inspection by OSHA regulators who can issue citations and fines for violations of OHSA standards or serious hazards.[13]

C. Discussion

CPSC staff does not believe that the operator blade contact injuries associated with table saw use would be eliminated or reduced to a sufficient extent by adopting OSHA regulations because:

1) The OSHA regulations rely on a comprehensive approach to promote safe practices. These strategies include training and outreach, as well as mandatory safety standards and enforcement. This approach is not applicable to consumers operating table saws in a home woodworking environment.

2) The OSHA requirements for table saw guarding are essentially identical to the requirements in the superseded fifth edition of the voluntary standard for table saws, UL

[13] http://www.osha.gov/OSHA_FAQs.html.

987, *Standard for Stationary and Fixed Electric Tools*. The OSHA regulations for table saws do not reflect the latest revisions to UL 987 that require riving knives and the new modular blade guard design developed by the table saw industry's joint venture.

VIII. Technologies Intended to Address Blade Contact Injuries (Tab E)

A. Event prevention

Traditional Blade Guard Systems

Traditionally, table saws sold in the United States have employed a blade guard system that combines a hood-type blade guard, splitter, and anti-kickback pawls as a single unit that is bolted to the saw's carriage assembly. The hood is a single, rectangular piece of transparent plastic that surrounds the exposed blade with a sloped front, designed to allow the guard to rise and ride over the workpiece as the piece is fed toward the blade during a cut. The splitter generally serves as the main support and connection point for the blade guard and the anti-kickback pawls. Thus, removing the splitter for any reason, necessarily removes the rest of the blade guard system and the protections those devices might offer.

Splitters, riving knives, and anti-kickback pawls are the primary safety devices on table saws that are intended to prevent kickback of the workpiece. Splitters ride within the cut, or kerf, to prevent the workpiece from closing up and pinching the blade, which can cause the workpiece to be thrown back toward the operator. Because the height of the splitter is often taller than the blade, splitters must be removed when making non-through cuts because the top portion of the blade must be exposed to cut into the workpiece. If other safety devices are attached to the splitter, removal of the splitter removes these safety devices as well.

Riving knives are curved steel plates that are similar to, and perform the same function as, splitters, but sit very close to the blade (see Figure 2), and rise no higher than the top of the saw blade. The riving knife attaches to the arbor assembly so that it moves up and down with the blade. These characteristics allow riving knives to be used while making non-through cuts because the top of the blade is exposed. A properly installed riving knife may be the most effective way to prevent kickback because it limits workpiece access to the rear teeth of the saw blade.

Several characteristics of traditional blade guard systems are likely to hinder table saw use and motivate consumers to remove them to make performing a cut simpler or easier. These characteristics include:

(1) Potential jamming of the workpiece on the guard: Some blade guards may jam on the leading edge of the workpiece, requiring the consumer to push the workpiece forcefully or to raise the guard manually.

(2) Poor visibility caused by the guard: Hood guards can limit visibility when lining up cuts and during a cut, especially with sawdust accumulation in the guard.

(3) Poor splitter alignment with the blade: A splitter can bend over time with use of the table saw. A blade guard system with a splitter that is not aligned properly with the blade can make feeding the workpiece through the blade increasingly difficult and can actually increase the likelihood of kickback.

(4) Mandatory removal of the blade guard for certain cuts: The splitter and blade guard must be removed for certain oversized cuts, very narrow cuts, and any type of non-through cut. To switch back to typical through cuts, the splitter and guard must be reinstalled in keeping with manufacturers' recommendations that blade guard systems be used whenever performing a through cut.

Modular Blade Guard System

In 2007, a new blade guard system entered the U.S. market as part of a commercially available, consumer-oriented table saw. The new guard design represents the efforts of a joint venture group formed by leading table saw manufacturers to address blade contact injuries on table saws. The new blade guard system is a "modular" design that consists of an adjustable riving knife, a removable blade guard assembly, and removable anti-kickback pawls. The riving knife can be locked into high, middle, and "stored" positions, and, when locked into the high position, acts like a splitter that serves as the attachment point for the blade guard assembly and anti-kickback pawls. In the middle position, it acts as a riving knife. The guard assembly consists of a pair of independently hinged, plastic side barriers that attach to a metal upper barrier guard. No tools are required to install or remove this new blade guard system.

Like traditional blade guard systems, the new blade guard design effectively can prevent most side, rear, and downward contact with the blade when used as instructed; however, it cannot physically prevent contact with the blade resulting from front-end approaches toward the blade. The use of two independently hinged side guards can provide considerably more blade coverage than a solid guard during bevel cuts, by allowing one side to cover the blade, while the other side is raised or riding over the workpiece. This is illustrated in Figure 6, which simulates the interaction of a workpiece and the guard system when performing a bevel crosscut.[14]

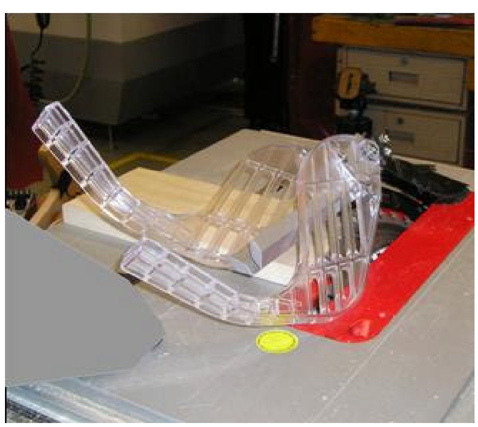
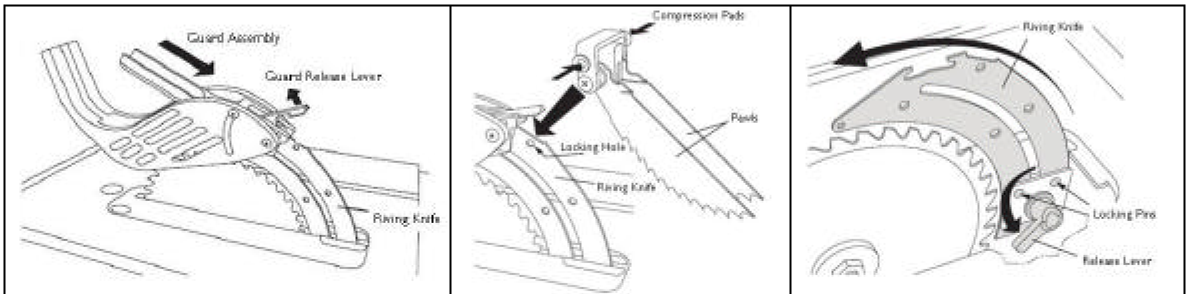


Figure 6. Modular blade guard in bevel cut position.

[14] This figure is intended to illustrate the independent operation of the hinged side guards, not a true bevel crosscut. The miter gauge, which is obscured in the figure, normally would be placed against a workpiece during such a cut.

Another significant advantage of the new blade guard system is the use of a permanent, adjustable riving knife, rather than a removable splitter, as the primary kickback prevention device and support for the blade guard. Because the riving knife cannot be removed, it is likely to remain aligned properly with the blade at all times, thereby avoiding most of the potential for kickback associated with misaligned splitters and riving knives. Its permanence also means that the riving knife cannot be lost and is always available to provide kickback protection in circumstances that allow its use. Because the riving knife can be used for both through and non-through cuts, consumers will not have to remove and reinstall the entire guard system when switching between non-through cuts and standard crosscuts and rip cuts. However, the consumer will still have to remove and reinstall the blade guard assembly and anti-kickback pawls, and they would have to adjust the position of the riving knife (see Figure 7). Although these tasks do not require tools, they do require some amount of time and effort that might become substantial if they must be done repeatedly.



Guard Assembly | Anti-Kickback Pawls | Riving Knife

Figure 7. Installation and removal of modular guarding system

Discussion

In general, traditional blade guards and the new modular blade guards effectively can prevent most physical side, rear, and downward contact with the table saw blade; however, they will act primarily as a tactile warning for front-approach contact with the blade. Ultimately, the effectiveness of any blade guard system depends upon an operator's willingness to use it. Safety equipment that hinders the ability to operate the product—for example, by increasing the time or effort required to perform the desired tasks—effectively "punishes" the operator for choosing to use the equipment and most likely will result in consumers bypassing, avoiding, or discarding it (Cushman & Rosenberg, 1991; Geller, 2001; Nussbaum, 1998; Trump, 1980; Woodson, 1998).[15] This may be especially true for safety equipment that operators would be required to use repeatedly over the life of the product.

The modular blade guard system appears to be a significant improvement over most traditional blade guard systems, but still will not prevent blade contact injuries resulting from the hand approaching the front, or leading portion of the blade. Furthermore, the new blade guard system still can hinder certain table saw tasks, thereby encouraging its removal, and it can prevent

[15] This is similar to the concept of "cost of compliance" in warnings literature. One of the primary factors that affect whether consumers will comply with a recommended behavior in a warning is the cost of compliance, that is, the time, effort, and other "costs" associated with performing that behavior. Research has found that even small inconveniences can have a substantial negative impact on compliance (Riley, 2006).

certain sawing tasks from being performed unless it is removed. Removing the system is easy, but installation can be tricky and, if it can also be repetitive, time-consuming, and burdensome. These characteristics may motivate some consumers—especially experienced or expert woodworkers—to not bother reinstalling the system once it is removed.

B. Event mitigation

Detection and Reaction System

One of the primary functions of blade guard systems is to prevent physical contact with the saw blade. Such systems are not intended to mitigate the often severe consequences of blade contact when it does occur. Recently, SawStop, LLC, developed a blade contact detection and blade stopping reaction system for table saws and, in 2008, released a contractor saw containing this system.

SawStop's blade contact detection and blade stopping reaction systems represent a different approach to injury reduction than systems with a blade guard; and they are not intended as replacements for blade guards and kickback prevention devices. Blade guard systems are intended to reduce a consumer's exposure to the blade, and the systems are important to help prevent kickback and blade contact in the first place. Yet, as noted earlier, sometimes a blade guard system cannot be used, leaving consumers with little to no blade contact protection. Moreover, although systems should be designed to reduce the likelihood of error, total error elimination is unlikely, if not impossible (Hammer, 1972; Senders & Moray, 1991).

The SawStop detection and reaction system includes two components: an electronic detection unit, and a brake. The two components are contained within a brake cartridge, which is positioned under the table and just behind the blade (see Figure 10). The system induces a small electrical signal onto the saw blade. When human skin contacts the blade, the person's body absorbs part of this signal. The system detects the consequent signal reduction and engages the brake. The brake consists of an aluminum pawl that is pushed into the teeth of the spinning blade, stopping it in milliseconds. If the blade is at or near full speed when the brake is activated, the blade also quickly retracts below the table surface. In principle, the only injury likely to be sustained by direct contact with the saw blade when the system functions as intended is a small cut.[16] If the system is activated, a new brake cartridge must be installed before the saw can be used again. To staff's knowledge, SawStop is the only manufacturer currently employing safety technology of this type; however, the Power Tool Institute recently has developed similar technology.[17]

[16] The Human Factors staff presumes that a more substantial injury may be possible if movement into the blade is extremely rapid. The approach speed required for such injury, however, has not yet been determined by staff.
[17] In a meeting with Commission staff in June 2011, the Power Tool Institute discussed and showed video footage of their technology, which also retracts the saw blade upon detecting blade contact with the skin. According to the Power Tool Institute, SawStop has stated that this system likely will infringe SawStop's patents.

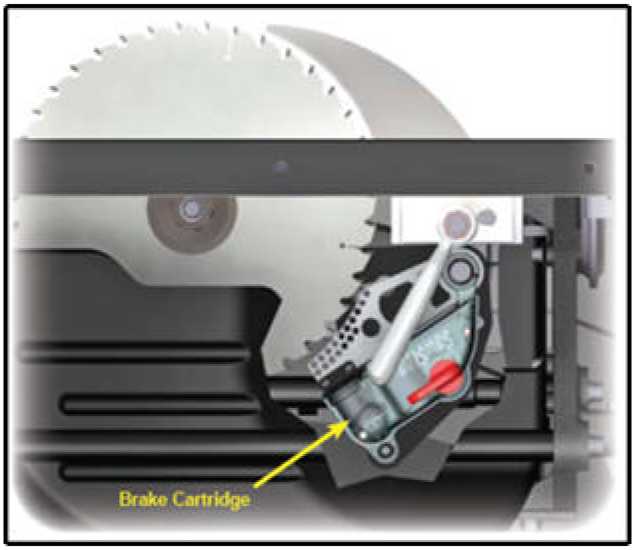


Figure 10. Brake cartridge location.
Reprinted from *10? contractor saw: Owner's manual* (p. 9), by SawStop, LLC, 2008, Tualatin, OR: Author. Copyright 2008 by SawStop, LLC.

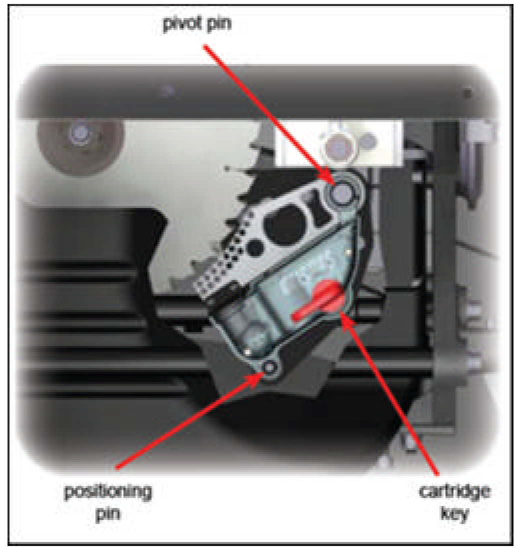


Figure 11. Installed brake cartridge.
Adapted from *10? contractor saw: Owner's manual* (p. 54), by SawStop, LLC, 2008, Tualatin, OR: Author. Copyright 2008 by SawStop, LLC.

SawStop's blade-contact detection and reaction system does not seem to interfere with most saw operations. The system cannot be used when cutting aluminum, brass, or other conductive materials; but in most cases, consumers will not have to cut these materials, and will never have to bypass the system. In the event that they do, consumers must insert a bypass key, pull out the start/stop paddle to the ON position, and hold the key turned for another second after the motor starts. While performing this action repeatedly would be a nuisance for consumers who intend to cut a large amount of conductive materials, most consumers are likely to be unaffected or minimally affected.

The system requires consumers to change the cartridge whenever switching to or from dado sets, which require the use of an optional dado brake cartridge that has a larger brake pawl than is used with 10-inch standard blades. Consumers may find this rather inconvenient if they must perform the switch often. SawStop also recommends that the brake cartridge be replaced if more than a "small amount of dust" can be seen inside the cartridge's clear housing. Consumers are unlikely to take the time to inspect the cartridge regularly; and it is unclear whether consumers, who do take this action, would be able to determine whether the amount of dust present would warrant replacement based on SawStop's recommendation.

<u>Discussion</u>

Unlike blade guard systems, which are intended to reduce consumer exposure to the blade in the first place, blade contact detection and reaction systems, such as the system developed by SawStop, function as secondary safety systems that lessen the consequences of blade contact when it occurs. These systems are not intended to replace blade guards and kickback prevention devices. Blade guard systems are intended to reduce consumer exposure to the blade and are important to help prevent kickback and blade contact in the first place. The SawStop system that staff examined does not seem to interfere with most saw operations; and once it is installed, the system is essentially invisible to the consumer until it is needed. Removing and reinstalling the brake cartridge when switching to and from dado sets, or once the system has been activated, can be difficult. However, in all likelihood, system activation would occur only after contact with the skin, a situation in which the consumer very well might have sustained serious injury had the system not been in place.

IX. Conclusion

While CPSC staff supports the recent progress UL has made in improving the voluntary standard to address blade contact injuries by focusing solely on prevention of skin-to-blade contact, staff does not believe the current requirements are adequate to reduce the number or severity of blade contact injuries, or the associated societal costs. A riving knife will reduce but not eliminate the occurrence of kickback on a table saw. Furthermore, of the 66,900 table saw operator blade contact injuries in 2007 and 2008, an estimated 39,600 (59.2 %) blade contact injuries did not occur as a result of kickback of the material.

CPSC staff believes the new modular blade guard system is a significant improvement over the old guard design; however, the effectiveness of any blade guard system depends upon an operator's willingness to use it. Safety equipment that hinders the ability to operate the product likely will result in consumers bypassing, avoiding, or discarding the safety equipment. In addition, of the 66,900 table saw operator blade contact injuries in 2007 and 2008, approximately 20,700 (30.9 %) of the injuries occurred on table saws when the blade guard was in use. The current voluntary standard for table saws does not address these injuries.

CPSC staff does not believe adopting OSHA regulations will adequately address the blade contact hazard to consumers because: (1) OSHA's comprehensive approach to encourage and enforce a safe work environment in the professional workplace setting is not applicable to consumers in a home woodworking environment;, and (2) the current OSHA requirements for table saw guarding are essentially identical to the requirements in an superseded edition of the voluntary standard that has not adequately addressed table saw blade contact hazards.

CPSC staff's review of the injury data and hazard patterns suggests that a significant percentage of the operator blade contact injuries on table saws could be addressed by table saw performance requirements that further reduce the likelihood of blade contact injury and prevent or reduce the severity of these injuries. The high societal costs (estimated at $2.36 billion per year) associated with these operator blade contact injuries highlight the severity, as well as the frequency of these injuries. The high societal costs also suggest that an effective remedy could generate net societal benefits over the lifetime of the table saws.

CPSC staff recommends that the Commission proceed with the rulemaking process for table saws by voting to publish an advance notice of proposed rulemaking (ANPR), as drafted by the Office of the General Counsel.

TAB A

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

BALLOT VOTE SHEET

DATE: JUN 28 2006

TO: The Commission
Todd A. Stevenson, Secretary

THROUGH: Patricia M. Semple, Executive Director

FROM: Page C. Faulk, General Counsel
Jeffrey R. Williams, Assistant General Counsel for Enforcement and Information
Hyun S. Kim, Attorney, OGC

SUBJECT: Petition CP 03-2, Performance Standards for Table Saws

Ballot Vote Due: JUL - 6 2006

Attached is a briefing memo from the staff concerning a petition from Stephen Gass, David Fanning, and James Fulmer requesting mandatory performance standards to reduce or prevent table saw blade contact injuries. The staff recommends that the Commission grant the petition to the extent it requests the Commission to proceed with a rulemaking process that could result in a mandatory safety standard for table saws to reduce the risk of blade contact injury, and direct the staff to prepare an advance notice of proposed rulemaking (ANPR).

Please indicate your vote on the following options.

I. Grant Petition CP 03-2 and direct staff to draft an ANPR.

____________________ __________
(Signature) (Date)

II. Deny Petition CP 03-2 and direct staff to prepare a letter of denial to the petitioners.

______________________________ ______________
(Signature) (Date)

III. Defer decision on Petition CP 03-2.

______________________________ ______________
(Signature) (Date)

IV. Take other action (please specify):

____

____

____

______________________________ ______________
(Signature) (Date)

Attachment: Briefing memo on Petition CP 03-2.

BRIEFING PACKAGE

PETITION FOR PERFORMANCE STANDARDS FOR TABLE SAWS

June 2006

For Further Information Contact:

Caroleene Paul
Project Manager
Directorate for Engineering Sciences
301-504-7540

Executive Summary

This briefing package provides the Commission with available information about blade contact injuries associated with table saw use and describes options for the Commission to consider in determining whether a rule may be reasonably necessary to eliminate or reduce the risk of table saw blade contact injury.

On April 15, 2003, Messrs. Gass, Fanning, and Fulmer, et al. petitioned the U.S. Consumer Product Safety Commission (CPSC) to require performance standards for a system to reduce or prevent injuries from contact with the blade of a table saw. The petition asserts that technology is available that can detect contact between a person and a saw blade and then react to stop and retract the blade. This technology was invented and patented by Dr. Stephen Gass, one of the primary petitioners.

The petitioners state that current table saws pose an unacceptable risk of severe injury because they are inherently dangerous and lack an adequate safety system to protect users from accidental contact with the blade. The petitioners also state that virtually all table saws sold in the U.S. meet the current safety standard for table saws, UL 987 *Standard for Stationary and Fixed Electric Tools*. The petitioners maintain that accidents continue to occur in large numbers and thus demonstrate the need for more effective safety standards for table saws.

Based on data from CPSC's National Electronic Injury Surveillance System (NEISS) and a NEISS-based special study on stationary saw-related injuries conducted in 2001, CPSC staff estimates that there were 28,300 emergency room treated injuries caused by operator contact with a table saw blade in 2001. Almost all of the table saw operator blade contact injuries analyzed in the special study were sustained by consumers. Most (94%) of the injuries were sustained to the finger(s), and the majority of the injuries (65%) were lacerations. The second largest type of injury sustained by operators was amputation (15%). The remaining injuries (20%) were fractures, avulsions, and crushings. The rate of hospitalization was 11%, and all these hospitalized injuries were related to fingers.

From the 28,300 emergency room treated operator blade contact injuries, the Commission's Injury Cost Model (ICM)[1] estimates 55,300 total medically treated blade contact injuries in 2001 with associated injury costs of $2.13 billion. The estimates for total medically treated injuries include injuries treated in settings other than the emergency room, such as ambulatory surgery centers, physicians' offices, or clinics. The high societal costs are attributed to the large number of amputations (approximately 15% of the operator blade contact injuries) and the 11% rate of hospitalization, which is more than twice the 4.6% average hospitalization rate for all consumer products in 2001. The societal costs associated with these operator blade contact injuries suggest that an effective remedy could generate net societal benefits over the lifetime of the table saws.

Based on available information from the petitioners and the Power Tool Institute (PTI)[2], the retail price impact of the petitioner's particular request may amount to about $100 per table saw.

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[1] The Injury Cost Model is a computerized analytical tool that uses NEISS data to estimate the total number of medically treated injuries. The ICM also estimates the direct and indirect costs associated with those injuries.
[2] PTI represents the majority of table saw manufacturers and/or importers in the U.S. PTI estimated that costs could be higher than $150 per table saw.

In addition, there are unknown maintenance costs that may be associated with components of such a system if it requires replacement after each activation. Also, according to PTI, the costs associated with the proposal could potentially eliminate some of the least expensive table saws from the market. Staff has issues concerning the appropriate blade-approach speed to be used in evaluating this and other approaches to reduce or eliminate blade contact injuries. Nevertheless, CPSC staff review of the injury data from its special study suggests that a large percentage of operator blade contact injuries on table saws could be addressed by table saw performance requirements.

Many industry representatives believe that modification of consumer behavior through information and education campaigns could best address the hazard. Despite efforts by the table saw industry to educate consumers on the safe use of table saws, severe injuries continue to occur at a high cost to society and the victims.

The voluntary standard for table saws was recently revised to include a safety device that may be more effective at preventing kickback of the material during use of a table saw. CPSC staff supports this new requirement as an improvement to table saw safety but does not believe it will adequately address the blade contact hazard. In addition, in June 2006, the Table Saw Mechanical Guarding Joint Venture submitted for consideration to Underwriters Laboratories Inc. (UL) and the Canadian Standards Association (CSA) proposed requirements that would allow for alternative blade guards. PTI has indicated that, assuming the UL and CSA processes proceed smoothly, it is anticipated that implementation by individual manufacturers could begin in 2007.

The Occupational Safety and Health Administration (OSHA) regulates table saw products and the workplace environment in which the products are used. Current OSHA product requirements on table saws are essentially identical to the requirements in the voluntary standard in terms of providing an adjustable blade guard and some type of spreader (device that prevents the cut material from binding the saw blade). CPSC staff does not believe OSHA regulation will adequately address the blade contact hazard to consumers because:

1) Current OSHA requirements for table saws are identical to existing voluntary standard requirements, and
2) OSHA does not have jurisdiction in the home wood working shop and, therefore, cannot enforce a safe work environment and proper safety training for all users of table saws.

CPSC staff recommends granting the petition to the extent it requests the Commission to proceed with a rulemaking process that could result in a mandatory safety standard for table saws to reduce the risk of blade contact injury. Granting a petition in this manner and beginning a rulemaking proceeding does not mean that the Commission would necessarily issue a rule in the specific form requested in the petition.

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TAB A — Memorandum from Robert Ochsman, ESHF, to Caroleene Paul, Project Manager, "Petition Requesting Performance Standards for a System to Reduce or Prevent Injuries From Contact With the Blade of a Table Saw (Petition CP03-02)," June 26, 2006

TAB B — Memorandum from Natalie Marcy, EPHA, to Caroleene Paul, ES, "Data Analysis for Petition CP 03-2, Table Saw Blade Contact Deaths and Injuries," April 12, 2005
- Appendix A: Memorandum from Prowpit Adler, EPHA, to Caroleene Paul, ESME, "Injuries Associated with Stationary Power Saws, 2001," May 5, 2003
- Appendix B: Memorandum from Prowpit Adler, EPHA, to The File, "Adjustment for Table Saw, Band Saw, Miter Saw, and Radial Arm Saw Estimates for Future Use," June 04, 2003
- Appendix C: Table Saw Related Injuries and Fatalities (1991-2000)

TAB C	Memorandum from William Zamula, EC, to Caroleene Paul, Project Manager, "Petition Requesting Performance Standards for a System To Reduce or Prevent Injuries From Contact With the Blade of a Table Saw (Petition CP03-2)," June 15, 2005
TAB D	Memorandum from Caroleene Paul, ESME to Ronald L. Medford, Office of Hazard Identification and Reduction, "Evaluation of Prototype Tablesaw Safety Device," July 19, 2001

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: JUN 28 2006

TO	:	The Commission Todd A. Stevenson, Secretary
THROUGH:		Page C. Faulk, General Counsel Patricia M. Semple, Executive Director
FROM	:	Jacqueline Elder, Assistant Executive Director Office of Hazard Identification and Reduction Caroleene Paul, Project Manager, Table Saw Petition Directorate for Engineering Sciences
SUBJECT	:	Petition CP 03-2, Requesting Performance Standards for a System to Reduce or Prevent Injuries from Contact with the Blade of a Table Saw

1. Introduction

The staff of the U.S. Consumer Product Safety Commission (CPSC) prepared this briefing package for use by the Commission in considering Petition No. CP 03-2: Petition for Performance Standards for Table Saws.* This package provides information on table saws, related injuries and deaths, feasibility of the performance requirements requested in the petition to address table saw hazards, voluntary standards activities, and responses to public comments to the petition. This package also provides options for Commission consideration along with staff's conclusion and recommendation.

2. Background

A. Petition for Rulemaking

On April 15, 2003, Messrs. Gass, Fanning, and Fulmer, et al. requested that the Commission issue a rule prescribing performance standards for a system to reduce or prevent injuries from contact with the blade of a table saw. The Office of the General Counsel (OGC) docketed the request as petition number CP 03-2 on June 10, 2003, under provisions of the Consumer Product Safety Act (CPSA) 15 U.S.C. §§ 2051-2084.

* In accordance with 16 C.F.R. § 1031.11(b), the Commission is advised that Caroleene Paul, the principal author of this memorandum, attended voluntary standard meetings held by Underwriters Laboratories, Inc. (UL), participated in discussions regarding table saw safety, and provided data support for the UL working groups.

The petitioners state that current table saws pose an unacceptable risk of severe injuries that include lacerations and amputations. The petitioners maintain that a system to reduce or eliminate the risk of injury associated with table saws must include the following:

1) A detection system capable of detecting contact or dangerous proximity between a person and the saw blade when the saw blade is –
   (a) spinning prior to cutting,
   (b) cutting natural wood with a moisture content of up to 50%,
   (c) cutting glued wood with a moisture content up to 30%, and
   (d) spinning down after turning off the motor;
2) A reaction system to perform some action upon detection of such contact or dangerous proximity, such as stopping or retracting the blade, so that a person will be cut no deeper than 1/8 of an inch when contacting or approaching the blade at any point above the table and from any direction at a rate of one foot per second;
3) A self-diagnostic capability to verify the functionality of key components of the detection and reaction system; and
4) An interlock system so that power cannot be applied to the motor if a fault interfering with the functionality of a key component in the detection or reaction system is detected.

The petitioners cite CPSC staff estimates of 30,000 annual emergency room treated injuries involving table saws, with approximately 90% of the injuries occurring to the fingers and hands and 10% of the injuries resulting in amputation.[3]

The current safety system on table saws sold in the U. S. includes a blade guard to protect the user from accidental contact with the blade. The petitioners state that blade guards are often removed by consumers because they interfere with the operation of the saw (blade guards must be removed for non-through dado or rabbet cuts), they are often difficult to reinstall once they have been removed, they block the view of a cut, and they interfere with narrow cuts.[4]

The petitioners state that virtually all table saws sold in the U.S. meet the current safety standard for table saws established by Underwriters Laboratories (UL) as UL 987 *Standard for Stationary and Fixed Electric Tools*. They also state that the UL Standards Technical Panel responsible for table saws has not taken action to develop new requirements to address blade contact injuries. The petitioners maintain that accidents continue to occur in large numbers and thus demonstrate the need for more effective safety standards for table saws.

B. Table Saw Description

A table saw is a popular power tool used primarily to cut wood. It consists of a circular saw blade mounted on an arbor that is driven by an electric motor. The blade protrudes through the

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[3] Adler, P. (February 2002). Data Report. Table Saw Related Injuries And Fatalities (1991-2000). U.S. Consumer Product Safety Commission: Bethesda, MD. Data report was cleared and presented to UL table saw working group on February 6, 2002. (TAB C, Appendix C)

[4] Two alternative guard designs have been developed through a joint venture of five table saw manufacturers (Table Saw Mechanical Guarding Joint Venture), and focus group studies comparing the current guard design with the alternative designs have been conducted. Letter from Power Tool Institute, Inc. to Ms. Patsy Semple, U.S. Consumer Product Safety Commission, Table Saw Guarding, April 17, 2006.

surface of a table, and the table provides support for the material being cut. The amount of the blade that protrudes above the table surface is adjustable and determines the depth of cut that will be made. The operator pushes the material to be cut into the saw blade.
There are three basic table saw categories that comprise the population of table saws used for both consumer and professional use: bench saws, contractor saws, and cabinet saws.[5] Generally, the range of quality and accuracy of a table saw is commensurate with its size, motor horsepower, weight and, indirectly, price.

Bench saws are lightweight, inexpensive saws designed to be easily moved around and temporarily placed on a work bench or stand (see Figure 1). Prices for bench saws range from $100 to $500.[6] They are often the first table saw purchased by the inexperienced wood worker but are also used by contractors who have to transport a saw from job to job for light work.

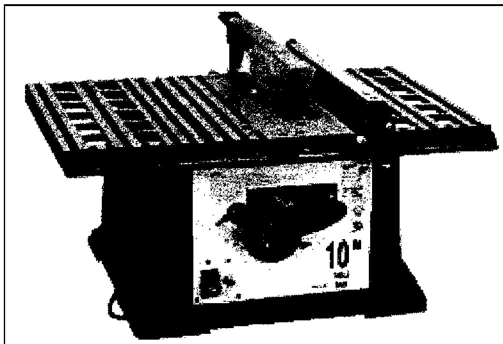

Figure 1. Bench Saw

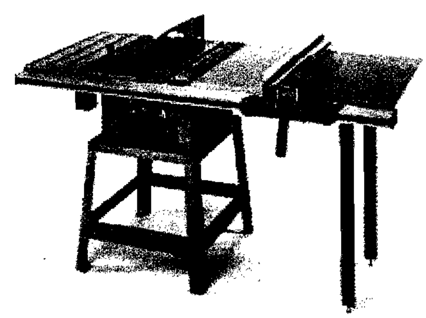
Figure 2. Contractor Saw

Contractor saws are characterized by a set of light duty legs and bigger table and motor than a bench saw (Figure 2). Prices for a contractor saw range from $150 to $1,000 or more.[7] These saws are generally quieter, more accurate, and able to cut materials up to 2 inches thick. Contractor saws are commonly used by the home wood worker because the saws are capable of high quality work and are commonly found at mass merchandisers. Nevertheless, contractor saws are also accurate enough to be used in professional cabinet shops and transportable enough to be used on construction work sites.[8]

Cabinet saws are heavier than contractor saws because the higher powered motor is enclosed in a solid base (see Figure 3). Prices for cabinet saws range from $1,200 to $3,000. These saws are designed for heavy use and the greater weight minimizes vibration so that cuts are smooth and more accurate. These saws are typically the highest grade saw found in the home wood working shop. The higher end cabinet saws are also capable of some light duty production work in a professional shop.

[5] http://www.woodcraft.com/articleprint.aspx?ArticleID=241
[6] http://www1.pricetool.com/xDN-Tools_and_Hardware-table_saw--PG-13~S-2~OR-0
[7] http://www.consumersearch.com/www/house_and_home/table-saw-reviews/fullstory.html
[8] http://www.southern-tool.com/store/powermatic_cabinet_table_saws.html

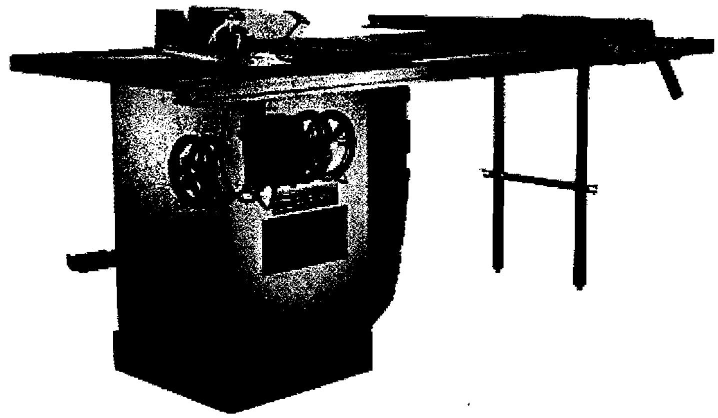

Figure 3. Cabinet Saw

Production table saws are not considered part of the population of table saws used for consumer use. They are typically massive, heavy duty table saws designed with very large working surfaces, 12 inch blades, and 3 phase motors greater than 5 horsepower. Production table saws are used in production facilities, factories, and cabinet shops. They are designed to accommodate power feeds and are robust enough to continuously saw thick wood stock. These saws are not used by consumers in home wood shops.

C. Table Saw Safety Components

Table saws sold in the United States share similar variations of a blade guard assembly that consists of a splitter (also known as a spreader), a blade guard, and an antikickback device (see Figure 4). The splitter is a piece of sheet metal fixed to the top of a table saw and located behind the blade. A splitter prevents the sides of the cut material from pinching or rotating into the saw blade - a situation in which the energy of the spinning blade can be imparted to the material causing it to lift up off the table and eject towards the operator (kickback).

The splitter also serves as the hinged attachment point for the blade guard. The blade guard is typically a rectangular piece of clear plastic that covers the saw blade. The front of the blade guard is tapered so that it lifts over the work piece as it is fed into the blade. A blade guard provides a barrier against inadvertent contact with the saw blade from the back, top, or sides of the blade.

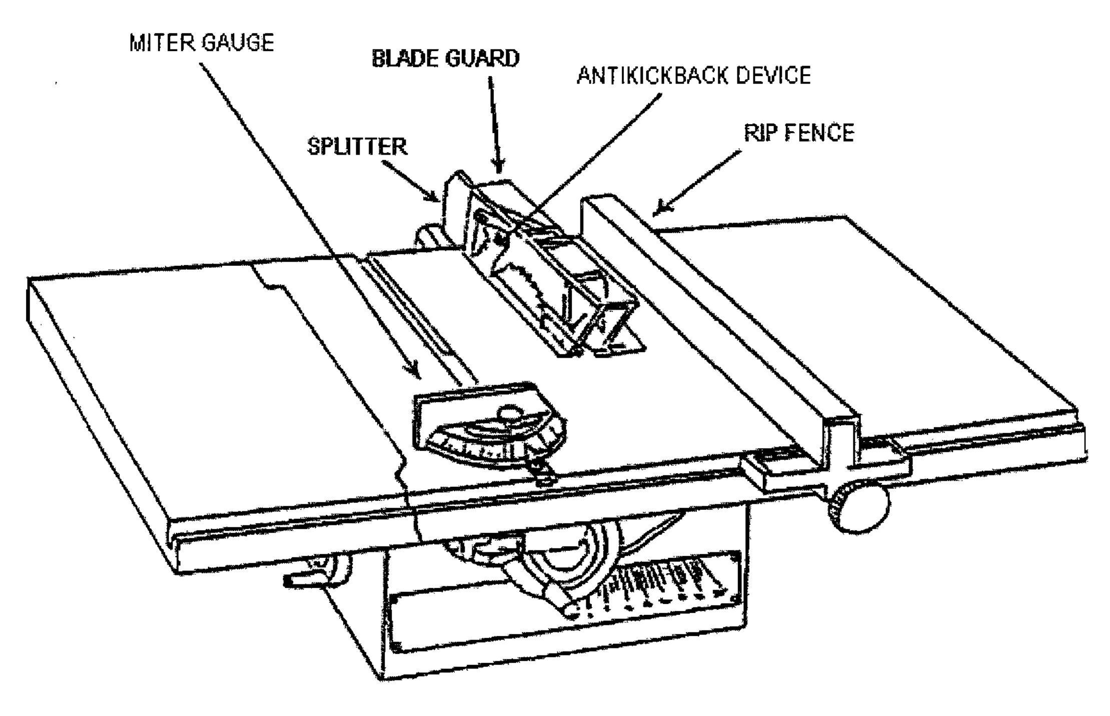

Figure 4. Components of a Table Saw

A typical antikickback device consists of pawls, which have teeth that are designed to grab the work piece if it begins to reverse and prevent it from being thrown back towards the operator. The antikickback pawls are also attached to the splitter (see Figure 4).

Because the splitter is fixed to the table and is set for the highest height of the blade (which means it is often taller than the blade and its distance from the blade varies with the height of the blade), the splitter and attached guard assembly must be removed for cuts that use the top of the saw blade to cut a channel in the material. These "non-through" cuts are common in wood working, and are known as a dado cut (when the channel is cut in the middle of the material) and a rabbet cut (when the channel is cut on the edge of the material). When the splitter and attached guard assembly are removed, there is no protection against blade contact or kickback of the material.

Table saws sold in Europe differ in the type of splitter and blade guard provided with the product (see Figure 5). European table saws use a riving knife, which performs the same function as a splitter. The riving knife is a curved steel plate located a few millimeters behind the saw blade (see Figure 6). Because the riving knife is secured to the same structural member as the saw blade, the riving knife raises and lowers with the blade, maintaining a constant radial distance from the blade. The riving knife does not need to be removed for most non-through cuts because it is located just below the top of the saw blade.

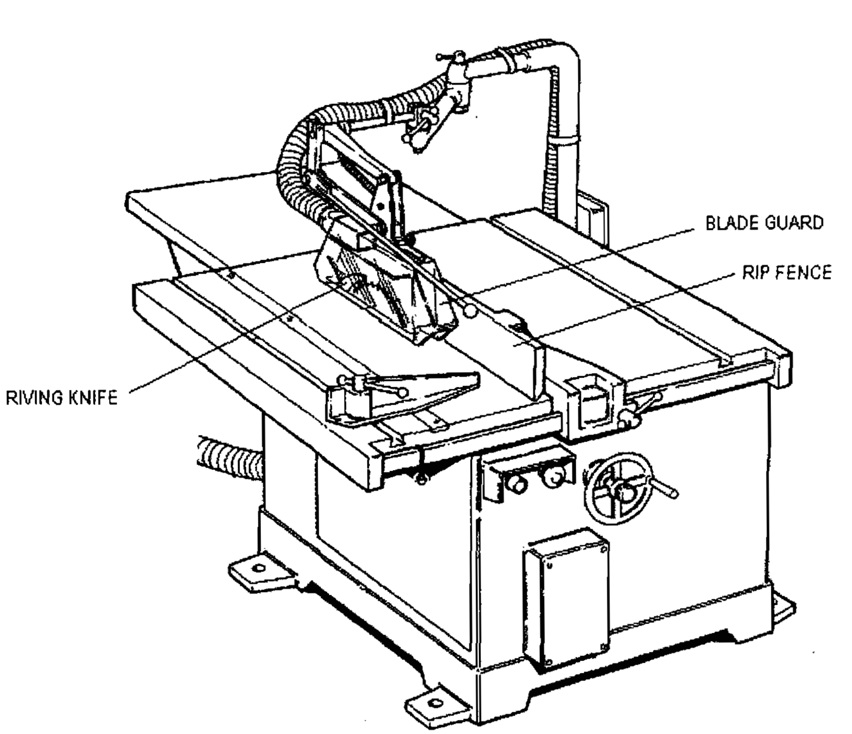

Figure 5. European Table Saw

A blade guard on a European table saw is secured to an arm that is attached to the table top and raises and lowers vertically above the saw blade. This type of blade guard design is available as an aftermarket option to the splitter/guard assembly provided with the typical table saw in the United States and ranges in price from $250 to $500.[9] Aftermarket splitters are also available and range in price from $30 to $150. The aftermarket splitters and blade guards are separate pieces, so if one must be removed, the other device can remain in place.

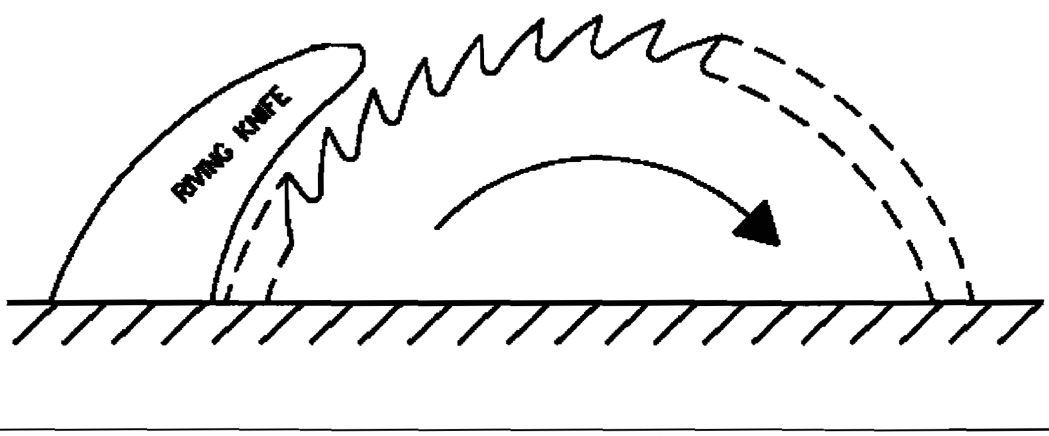

Figure 6. Riving Knife

[9] http://www.taunton.com/finewoodworking/pages/w00130.asp

D. Design of Safety Components

Machine safety features may be classified as active or passive. An active safety device would require the operator to perform some function in order to activate or invoke the safety feature. Users will be more prone to override or somehow deactivate safety features when those features require the operator to perform additional steps, make the operation more difficult or awkward, take more time to do than performing that same operation without the safety device, occlude a clear view of the operation itself, or in any way require more effort. Automobile seat belts are an example of an active safety device.

Safety features that are passive require no active intervention on the part of the user of the device. The operation of the safety feature is invisible to the user and does not impact the speed or ease of performing an operation in any way. An automobile air bag is an example of a passive safety device.

Principles of good safety engineering eliminate hazards from the design of a product whenever possible. If hazards cannot be eliminated from a product, passive safety features should be designed into the product. When this is not possible, active safety features can be designed into the product. Some hazards can only be addressed by warning labels and other materials to alert users to the hazards.

3. Table Saws

A. Consumer Use versus Professional Use of Table Saws (TAB A)

The attributes of each category of table saw lend the tool to both consumer use and professional use. However, the primary function of the table saw in either a work or home setting is to make rip cuts (cutting wood with the grain), cross cuts (cutting wood across the grain), or non-through cuts (cutting a groove into the material). The primary differences between consumers and professional users of table saws are environment and training/experience.

Environment

Professional wood workers are in an environment where Occupational Safety and Health Administration (OSHA) regulations require that table saws have all safety devices installed and in working order. For instance, OSHA regulations specifically state that "[E]mphasis is placed upon the importance of maintaining cleanliness around the woodworking machinery, particularly as regards the effective functioning of guards" [29 CFR § 1910.213 (s)(6)], and require that "[P]ush sticks or push blocks shall be provided at the work place in the several sizes and types suitable for the work to be done" [29 CFR § 1910.213 (s)(9)]. In many production environments where a specific cut is performed continuously, guards and safety cut-off switches are custom designed for that set up. The area is specifically designed to be as safe as possible and safety is a continuous focus through warning/instruction signs and posters that are often displayed throughout the work area. The workplace is subject to spontaneous inspection by OSHA inspectors; therefore, the prospect of being fined for safety violations increases the likelihood that workers or supervisors will ensure safety codes are followed.

The consumer wood worker does not have the same OSHA-regulated protections in the home wood shop. The focus on a safe environment in a consumer setting is dependent on the knowledge and initiative of the home wood worker. Those who are consciously cautious will take the time to verify that the product is in safe working order and that the work area is properly prepared. This primarily involves making sure all the product's safety devices, most notably the blade guard, are intact and working properly. Of additional importance is the need for an uncluttered work area that is well lit and free of distraction. Overall there is no oversight influence to educate and motivate the consumer to prepare as safe an environment as possible.

Training/Experience

Professional wood workers are in an industrial setting where employees often receive training on safety practices and in the proper use of the tool. Professional wood workers will have had training and be experienced in performing any special or complex operations with the saw. Due to their deep experience, they will recognize situations and set-ups that may be dangerous or require extra care and caution.

Amateur wood workers generally have little or no safety training nor training in the proper use of a table saw. They may take wood working classes or obtain a training video, but there is no mechanism to encourage the home wood worker to use a table saw as safely as possible. Home users typically have far less experience than professional wood workers and may discover dangerous or difficult operations only by actually experiencing near incidents or problems.

B. Deaths and Injuries Associated with Table Saws (TAB B)

Deaths

CPSC staff is aware of two deaths involving blade contact on a table saw from 1991 to August 2004. In 1997, a 67-year-old man died from a heart attack after he severed three fingers using a table saw. In 2001, a 52-year-old man died three days after his left hand was amputated while using a table saw.

Injuries

Total Injuries[10]

Based on data from the National Electronic Injury Surveillance System (NEISS), the estimated number of emergency room treated injuries associated with table saws averaged 29,000 per year from 1991 to 2000. This injury trend remained stable during that time period and into 2002. As part of a special study on stationary saw-related injuries, follow-up interviews were conducted on NEISS cases treated between October 1, 2001 and December 31, 2001. The special study identified incidents involving table saws that were formerly coded as "other power saws" or "power saws, not specified." As a result of the follow-up investigations, the injuries involving unspecified saws (43% of the annual stationary saw estimate) were re-distributed among the

[10] The coefficients of variation for injury estimates are provided in TAB C and its appendices.

specified saw categories. The results of the special study allowed more precise injury estimates to be computed for 2001 (38,000 injuries) and 2002 (38,980 injuries).

Since the injury trend associated with table saws has been stable from 1991 to 2002 and the results of the special study represent the most accurate estimates available, the injury statistics for 2001 have been used to summarize blade contact injuries and their associated hazard patterns. Of the 38,000 total emergency room treated injuries associated with table saws in 2001, an estimated 34,000 injuries were sustained by operators of table saws. Of the injuries to table saw operators, an estimated 28,300 injuries (83%) involved blade contact. Virtually all of the table saw operator blade contact-related injuries were sustained by consumers (only 5 cases out of 120 were identified as work-related). However, since both consumers and workers possibly use the same high and low end table saws, potentially in the same manner, work-related injuries were not removed from the injury estimates. The majority of the remaining non-blade contact injuries sustained by table saw operators involved injuries caused by impact with a thrown piece during kickback of the material being cut.

Injuries Due To Blade Contact

Of the estimated 28,300 emergency room treated injuries involving table saw operator blade contact in 2001, the ages of the victims ranged from 15 to 69 years old, but the majority (56%) of the victims were 51 years of age or older. Almost all (94%) of the injuries were sustained to the finger(s). The majority of the blade contact injuries (65%) sustained by table saw operators were lacerations. The second most frequent injury sustained was amputation (15%). The remaining injuries (20%) were fractures, avulsions, and crushings. The rate of hospitalization was 11% (the average rate of hospitalization for all NEISS products in 2001 was about 4.6%), and all of these hospitalized injuries were related to fingers.

C. Hazard Patterns Associated with Table Saws (TAB B)

Of the 28,300 emergency room treated injuries involving table saw operator blade contact in 2001, approximately 9,300 of the injuries occurred as a result of kickback of the material. CPSC staff's review of the investigations from the special study revealed that some victims described a scenario where they were startled by the material being lifted by the blade during kickback, which caused the victim's hand to slide or be "drawn into" the blade. Some victims described pushing a piece of stock with one hand in front of the blade and pulling the stock from behind the blade at the same time. When the stock pinched the blade and kicked back towards the front of the table saw, the hand resting on the stock behind the blade was pulled into the blade. Kickback of material resulted in minor and severe lacerations, amputations, fractures, and avulsions.

Approximately 16,000 of the 28,300 injuries did not occur as a result of kickback of the material. Many of these injuries were caused by a lapse in attention of the operator, such as reaching over the blade to retrieve a cut piece or simply not being aware of the blade during a cut. Non-kickback related incidents resulted in minor and severe lacerations, amputations, fractures, and avulsions. It is not known if kickback caused operator contact with the blade in approximately 3,000 of the 28,300 injuries.

D. Table Saw Market (TAB C)

Manufacturers and/or importers of table saws include Bosch/Skil, Black & Decker/DeWalt, Makita, Ryobi, Delta/Porter-Cable (Pentair Tool Group), Hitachi, Jet/Powermatic (WMH Tool Group), Grizzly, Inca, Jepson, General International, PTS/Rexon/Tradesman, and Emerson Electric/Ridgid. The first seven manufacturers/importers mentioned above probably account for most of the shipments of table saws in the U.S. (The Power Tool Institute comments on the petition state that these seven companies, along with several former members (not specified), account for 95% of all table saws sold in the U.S.)

The Power Tool Institute (PTI), the trade association representing the primary table saw manufacturers, estimates shipments of 725,000 table saws in 2002 (which account for approximately 95% of U.S. table saw sales) and estimates that there are approximately 6 million table saws currently in use in the U.S. PTI also estimates the expected useful life of a table saw to be 10 years. Alternatively, a market study conducted in the 1980s estimated the expected useful life of a table saw to be 15 years. Based on estimated shipments from 1983 to 2002, and assuming the longer 15 year expected useful life, the population of table saws would be approximately 10 million table saw units. Therefore, assuming a 10-15 year expected product life, the product population is probably in the range of 6 to 10 million units.

Retail prices range from about $100 for some consumer-oriented table saws to several thousand dollars for professional quality saws. PTI characterizes the consumer price range as $100 to $800 and the professional price range as $500 to $2,500. Assuming an average retail price of $400 to $500 and sales of 725,000 table saws annually, the annual retail sales are in the range of $300 to $400 million.

4. Annual Costs to Society of Table Saw-Related Injuries/Deaths (TABS B and C)

The Injury Cost Model (ICM) is a computerized analytical tool that uses NEISS data to estimate the total number of medically treated injuries. The ICM also estimates the direct and indirect costs associated with the total estimated injuries. NEISS gathers data on nonfatal injury victims treated in or admitted through hospital emergency departments. However, victims could be treated in other settings such as ambulatory surgery centers, physicians' offices and clinics, or company clinics. The ICM uses empirically derived relationships between emergency department injuries and those treated in other settings to estimate the number of injuries treated outside hospital emergency departments.

The ICM cost estimates consist of four parts: medical costs, work losses, quality of life and pain and suffering costs, and product liability insurance administration and litigation costs. Both the petitioner and comments submitted by PTI in response to the petition mention medical costs; but neither addressed other costs such as time lost from work or other activities, permanent disability, pain, and disfigurement. The ICM is structured to estimate these costs using data from surveys dealing with costs of treatment in different medical settings, databases of work loss estimates, and the Jury Verdicts Research data for pain and suffering estimates.

Based on the 2001 Special Study, there were an estimated 28,300 blade contact related injuries experienced by operators of table saws that were treated in emergency rooms. From these 28,300 injuries, the ICM estimates 55,300 total medically treated blade contact injuries with associated injury costs of approximately $2.13 billion (see Table 1). Since injuries have remained relatively constant over the 1991-2002 time period, the injury costs for 2001 have been used in the cost analyses.

Deaths resulting from blade contact during table saw use are relatively rare and seem to be the result of secondary effects of the injury (e.g., heart attack) rather than the injuries themselves. Deaths have therefore been excluded from the cost analyses.

Table 1: Blade Contact-Related Injuries of Table Saw Operators, 2001

	Estimate	95% Confidence Interval[11]
ER-treated injuries	28,300	(19,900, 36,700) [12]
All medically-treated injuries	55,300	(38,800, 71,800)
Total medically-treated injury costs	$2.13 billion	($1.50 billion, $2.76 billion)

Source: CPSC, National Electronic Injury Surveillance System (NEISS) Special Study of Stationary Saws, October 1, 2001 Through December 31, 2001, Directorate for Epidemiology, Hazard Analysis Division.

Of the 28,300 table saw operator blade contact-related injuries treated in emergency rooms:

- 9,300 injuries involved blade contact that was caused by kickback of the material. From these 9,300 injuries, the ICM estimates 17,900 total medically treated table saw operator blade contact-related injuries due to kickback of the material, with associated injury costs of $730 million (see Table 2).

- 16,000 injuries involved blade contact that was not caused by kickback of the material. From these 16,000 injuries, the ICM estimates 32,300 total medically treated table saw operator blade contact-related injuries that were not caused by kickback of the material, with associated injury costs of $971 million (see Table 2).

- 3,000 injuries involved blade contact where it is unknown if kickback of the material caused the operator to contact the blade.

[11] The confidence interval for injury costs is derived by applying an average injury cost to the confidence interval for medically treated injuries.
[12] Coefficient of variation = .152

Table 2: Blade Contact-Related Injuries of Table Saw Operators, 2001

	Estimate	95% Confidence Interval[10]
KICKBACK		
ER-treated injuries	9,300	(5,700, 12,900)[1]
All medically-treated injuries	17,900	(11,000, 24,800)
Total medically-treated injury costs	$730 million	($448 million, $1,012 million)
NON-KICKBACK		
ER-treated injuries	16,000	(11,500, 20,400)[2]
All medically-treated injuries	32,300	(23,300, 41,300)
Total medically-treated injury costs	$971 million	($701 million, $1,241 million)

Source: CPSC, National Electronic Injury Surveillance System (NEISS) Special Study of Stationary Saws, October 1, 2001 Through December 31, 2001, Directorate for Epidemiology, Hazard Analysis Division.

Societal costs per product in use per year range from $213 ($2.13 billion/10 million table saws in use) to $355 ($2.13 billion/6 million table saws in use). Over its 10 to 15 year lifetime, a table saw would generate societal costs of $2,600 to $3,100 at a discount rate of 3%, if all blade contact injuries are included.

In comments submitted in response to the petition, PTI suggests non-kickback injuries are more likely to be addressable than kickback injuries. If only costs from non-kickback injuries are included, the societal costs per product in use per year would range from $97 ($971 million/10 million table saws in use) to $162 ($971 million/6 million table saws in use). Over the 10-15 year product life of a table saw, the present value of the societal costs would be $1,200 to $1,400 per saw.

The societal cost estimates are derived from injury estimates that include a small proportion of occupational injuries. Because of the small sample size (5 cases out of 120 cases), the variance associated with estimates based on occupational injuries alone is large. Estimates of societal costs based on occupational injuries alone also would have a large variance.

For purposes of comparison, if the work-related injuries were removed from the data, the societal costs of all blade contact injuries would be reduced from $2.13 billion for all users to $1.78 billion for consumer users. The societal cost per product in use per year for consumer users would range from $178 (for 10 million total saws in use) to $297 (for 6 million total saws in use), and the present value of societal costs per table saw would be $2,200 and $2,600, respectively. Since all of the occupational injuries in the sample were kickback-related[3], estimates of societal costs for non-kickback injuries for consumer users would be unaffected.

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[1] Coefficient of variation = .191
[2] Coefficient of variation = .142
[3] In this particular sample, all the occupational injuries happen to be kickback-related. It is possible that a larger sample of occupational injuries would contain a mixture of kickback and non-kickback related injuries.

There is no available information that provides an estimate of the number of table saws that are only used for occupational purposes. However, eliminating occupational use table saws from the estimates would reduce the denominator in the cost calculations (6 to 10 million total saws in use) and, therefore, would increase the estimates of societal cost per table saw for consumers. Consequently, assuming all remaining injuries are non-occupational, the present value of the societal costs per table saw for consumers would likely be in excess of $2,200 to $2,600 for all blade contact injuries and in excess of $1,200 to $1,400 for non-kickback injuries.

Whether or not occupational injuries and/or kickback injuries are included, the societal costs suggest that an effective remedy could generate net societal benefits.

5. Voluntary Standard

A. Background

The voluntary standard for table saws is UL 987 *Standard for Stationary and Fixed Electric Tools*, published by Underwriters Laboratories, Inc. (UL) in 1971. In the past, revisions to UL standards were made by UL after conferring with members of the affected industries and interested parties at Industry Advisory Council (IAC) meetings. In June 2000, UL converted to the American National Standards Institute (ANSI) consensus process for review and revision of UL voluntary standards. Under the new system, UL representatives became voting members of Standards Technical Panels (STPs) that were formed for different groups of products to provide consensus forums for all standards activities. The STPs consist of producers, users, and general interests groups, with no category represented by more than 50% of the membership. UL or others may submit proposals to an STP for comment and balloting. Comments are responded to, and proposals are recirculated until a consensus approval is achieved (approval of at least two-thirds of the voting members and approval by a majority of the consensus body). CPSC staff participates as non-voting general interest group members of STPs. Revisions to UL 987 are covered by an STP for electric tools that was formed in June 2002.

B. Past Actions

Table Saw Injuries

In 1998, CPSC staff was concerned that the number of injuries associated with table saws (estimated annual average of approximately 30,000 emergency room treated injuries) outnumbered every other home power tool tracked by the National Electronic Injury Surveillance System (NEISS). A preliminary analysis of the injury data indicated that blade contact was the main hazard pattern and that many incidents involved table saws where the blade guard was removed. CPSC staff presented these concerns to UL in a letter dated April 21, 1998. Subsequently, CPSC staff presented injury data and concerns over blade guarding to industry members at an IAC meeting for stationary electric tools on October 13, 1998.

Industry members responded that product misuse was the primary factor in the incidents and that the current voluntary standard and product guarding system were adequate. The industry members believed an information and education campaign was required to instruct users on the safe operation of a table saw.[16] PTI produced a video on table saw safety for distribution to schools with vocational and technical programs and for interested consumers and users. CPSC staff and UL staff reviewed and made comments to drafts of the PTI video. In addition, CPSC staff continued discussions with UL staff regarding table saw safety. After a meeting in June 2000, it was agreed that UL would encourage the development of performance requirements for increased table saw safety.[17]

Guard Effectiveness

In November 2001, the IAC for stationary electric tools formed a working group to review blade guard requirements and to determine if the continuing blade contact injuries associated with table saws could be better addressed. CPSC staff participated in this working group, which also reviewed and discussed the merits of a detection/reaction technology. CPSC staff provided injury data and hazard analysis support to the working group. Issues discussed by the working group centered on the causes of blade contact injuries, the cause and definition of kickback, the effectiveness of current blade guards, and the merits of alternative systems to reduce blade contact injuries. The discussions regarding a detection/reaction system centered on theoretical and substantiated shortcomings of potential technologies and difficulties associated with a patented technology.[18]

Standards Technical Panel (STP) for Electric Tools

The Standards Technical Panel (STP) for electric tools convened for the first time in February 2003 and was presented with:

1) A proposal by the principals of SawStop™ for a requirement that all table saws have a detection/reaction system, and
2) A proposal by the working group for a requirement that all table saws have a riving knife similar to those required on European table saws.

The proposal for a detection/reaction system was rejected by the STP members due to concerns of reliability, impact of brake forces on small table saws, durability over the lifetime of a table saw, overall feasibility, and the economic benefit to the patent holder of the only technology that would currently meet the proposal. The proposal for a riving knife was discussed and approved.[19]

In addition, in June 2006, the Table Saw Mechanical Guarding Joint Venture submitted for consideration to Underwriters Laboratories Inc. (UL) and the Canadian Standards Association (CSA) proposed requirements that would allow for alternative blade guards. PTI has indicated

[16] Paul, C. (December 1999). Meeting Log. Table Saws (December 8, 1999). U.S. Consumer Product Safety Commission: Bethesda, MD.
[17] Paul, C. (July 2000). Letter. Table Saws (UL 987). U.S. Consumer Product Safety Commission: Bethesda, MD.
[18] Paul, C. (December 2001). Meeting Log. Meeting of the table saw guarding working group for the standard for stationary and fixed electric tools, UL 987 (November 29, 2001). U. S. Consumer Product Safety Commission: Bethesda, MD.
[19] Paul, C. (February 2003). Meeting Log. Standards Technical Panel meeting for Tools February 10-22, 2003. U.S. Consumer Product Safety Commission: Bethesda, MD.

that, assuming the UL and CSA processes proceed smoothly, it is anticipated that implementation by individual manufacturers could begin in 2007.

C. Requirements Relating To Blade Contact Hazard

Section 40A.1. *General [Requirements for Table Saws]* requires that a table saw have a blade guard that automatically adjusts to the thickness of the work piece and completely encloses the top and sides of the saw blade. Current blade guards that meet this requirement are typically a hinged rectangular piece of clear plastic.

Sections 40A.2 *Riving Knife* and 40A.3 *Riving Knife/Spreader Combination* require that a riving knife or a riving knife/spreader combination unit be installed on the table saw, and section 40A.5 *Antikickback Devices* requires that antikickback devices be provided with a table saw. Section 40A.4 *Spreader* provides requirements for a spreader if the blade guard and/or antikickback devices are mounted to a spreader. All these requirements are intended to reduce kickback of the work piece when the sides of the cut piece bind against the saw blade. This indirectly addresses some blade contact injuries that occur during kickback of the work piece. The riving knife requirements were added in the updated 6th edition of UL 987, which was issued in January 2005. The effective date for these new requirements is January 31, 2014 for currently Listed products and January 31, 2008 for new products submitted for investigation.

6. Occupational Safety and Health Administration (OSHA) Regulation

A. Background

The Occupational Safety and Health Administration's (OSHA) mission is to assure the safety and health of America's workers by setting and enforcing standards; providing training, outreach, and education; establishing partnerships; and encouraging continual improvement in workplace safety and health. Products sold in a commercial setting and used by the public only in the course of employment are outside the CPSC's jurisdiction and are regulated under OSHA. If the product is capable of categorization as both a consumer product and a commercial product, the Commission's jurisdiction to regulate a consumer product is limited by section 31(a) of the Consumer Product Safety Act (CPSA) which provides that "[t]he Commission shall have no authority under this Act to regulate any risk of injury associated with a consumer product if such risk could be eliminated or reduced to a sufficient extent by actions under the Occupational Safety and Health Act." 15 U.S.C. § 2080(a). The Office of the General Counsel (OGC) has determined that if the danger created by the use of table saws in the home is unique from the dangers experienced in the work environment, the Commission may act to eliminate or reduce that risk, because such risk could not be eliminated or reduced to a sufficient extent by OSHA.

B. OSHA Requirements Relating To Blade Contact Hazard

Current OSHA regulations on table saws require that the blades be guarded by a self adjusting blade guard [29 CFR § 1910.213 (c)(1) and (d)(1)] to address point of operation injuries. A spreader [29 CFR § 1910.213 (c)(2)] and antikickback devices [29 CFR § 1910.213 (c)(3)] are required to address the kickback hazard.

The OHSA requirements for blade guard, spreader, and antikickback devices are essentially identical to the requirements in UL 987. The OSHA regulations for table saws do not have a requirement for riving knives.

OSHA regulations do require inspection and maintenance of woodworking machinery. Unsafe saws must be immediately removed from service [29 CFR § 1910.213 (s)(1)], emphasis must be placed on the effective functioning of guards [29 CFR § 1910.213 (s)(6)], and push sticks must be provided at the work place [29 CFR § 1910.213 (s)(9)].

7. Evaluation of Petition for Rulemaking

A. Can Hazard Be Addressed by Requested Action

CPSC staff believes the blade contact hazard associated with table saw use can be addressed by performance requirements. Contact with a spinning blade can cause severe injuries such as amputations, bone and tendon damage, nerve damage, and severe laceration. These injuries result in hospitalization rates more than twice the average rate for all consumer products, and they result in high overall cost of injury.

According to a 2001 NEISS-based special study on stationary power saw-related injuries, there were an estimated 16,000 emergency room treated injuries due to table saw operator blade contact where kickback of the material was not involved. From these 16,000 injuries, the Injury Cost Model (ICM) estimates that there are 32,300 total medically treated operator blade contact injuries where kickback of the material was not involved. CPSC staff review of the survey responses in the special study indicates that many victims described blade contact injury caused by a lapse in attention while performing normal operations at a table saw. Some information suggests that a typical feed rate when cutting wood is 10 to 20 feet per minute, or 2 to 4 inches per second -- which is significantly slower than the petitioners' proposed feed rate of 12 inches per second.[20] Therefore, staff believes that most of these injuries could be addressed by performance requirements (see "Feed Rate" discussion in Section 8 of this memorandum).

There were an estimated 9,300 emergency room treated injuries due to table saw operator blade contact where kickback of the material was involved. CPSC staff review of the survey responses in the special study indicates some victims described being startled by material kickback, which caused a hand to slide or be drawn into the table saw blade. Staff believes that many of these injuries could be addressed or appreciably mitigated by performance requirements similar to those proposed in the petition. In addition, there were an estimated 3,000 emergency room treated injuries where it is not known if kickback of the material caused the operator to make contact with the saw blade. Staff also believes that some of these injuries could be addressed or appreciably mitigated by performance requirements.

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[20] Machacek, J. (August 2003). Comment Letter. Comment CC 03-1-37 on Petition Requesting Performance Standards for a System to Reduce or Prevent Injuries from Contact with the Blade of a Table Saw.

B. Feasibility of Performance Requirements

In July 2001, CPSC staff tested and evaluated a prototype table saw equipped with a detection/reaction technology. The staff noted concerns such as false tripping, proof of viability, and robustness of electrical and mechanical parts, but concluded that a performance based concept was technically feasible.[21] A cabinet saw incorporating detection/reaction technology is now available in the marketplace.

C. Will Compliance to the Voluntary Standard Address the Risk

The current voluntary standard for table saws, UL 987 *Standard for Stationary and Fixed Electric Tools*, includes requirements for a splitter, blade guard, and antikickback device to address the hazard posed by contact with the saw blade. To address concerns raised by CPSC staff and others, the voluntary standards body recently added requirements for a riving knife that may reduce certain kickback conditions that can result in unexpected blade contact. However, a riving knife will not address the blade contact injuries that were not caused by kickback of the material, which accounted for an estimated 32,300 total medically treated injuries in 2001 and approximately $971 million in societal costs.[22]

CPSC staff does not believe compliance with the voluntary standard will adequately reduce the risk of operator blade contact injury because: 1) severe injuries continue to occur on table saws that meet the current voluntary standard and, 2) an addition to the standard of a riving knife requirement will not adequately address the blade contact injuries that are not caused by kickback of the material.

D. Can Consumer Blade Contact Injuries Be Reduced To A Sufficient Extent by OSHA

The current OSHA requirements for table saws are essentially identical to those of the current voluntary standard for table saws in regards to mandatory blade guard, splitter, and antikickback device. The OSHA requirements do not require a riving knife (this requirement was recently added to UL 987).

CPSC staff does not believe compliance with the OSHA requirements will adequately reduce the risk of operator blade contact injury because: 1) the requirements are essentially identical to those in the current voluntary standard for consumer table saws, which do not adequately reduce the risk of operator blade contact injury, and 2) the OSHA requirements that do ensure a safer work environment in the professional setting, such as mandatory use of safety devices, are not applicable in the home wood working environment where OSHA does not have jurisdiction.

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[21] Paul, C. (July 2001). Memorandum. Evaluation of Prototype Tablesaw Safety Device. U.S. Consumer Product Safety Commission: Bethesda, MD. (TAB D)

[22] The societal costs may be higher depending on how many of the unknown blade contact injury cases were also not caused by kickback of the material.

8. Comments Received on Petition

The Commission published a Federal Register (FR) notice (68 FR 40912) on July 9, 2003, soliciting written comments from interested parties on the petition. The comment period was extended to November 7, 2003, at the request of the Power Tool Institute.

The Commission received 69 comments in response to the FR notice. Twenty-six comments expressed support for the petition, with many commenters sharing their personal experiences with blade contact injuries. Forty comments expressed opposition to the petition. The most comprehensive comment in opposition to the petition was from the Power Tool Institute (CC 03-1-62). Three comments provided supplementary information to previous comments.

The issues raised in the comments include the following: the veracity of the information in the petition, the Commission's jurisdiction in accordance with the Consumer Product Safety Act (CPSA), the motives of the petitioners, the cost to benefit ratio of the proposal, the role of the voluntary standards, the creation of a monopoly for the petitioners and their resulting financial gain, specific alleged shortcomings of the petitioners' technology, and the necessity of the performance requirements requested by the petition.

A summary of the CPSC staff's responses to the primary issues is included below. The numbers found in parentheses after a comment refer to the comment number assigned by the Office of the Secretary (OS); copies of the comments are available from OS.

1. NEISS Data

Comment: The Power Tool Institute (PTI) (CC 03-1-62) questions the system and methods used to estimate a national average for injuries. Specifically, PTI states that the average of 30,000 injuries associated with table saws in 2001 was based on only 692 actual injuries. PTI asserts that the experience of its members suggests that the actual number of related table saw injuries per year is far less than the totals extrapolated from the NEISS incident reports. In addition, PTI states that of these 692 injuries, 30% did not involve blade contact.

Response: The NEISS data system is a probability sample of hospital emergency departments in the U.S. and its territories. Data collected by NEISS is weighted to produce national estimates of the number of consumer product-related injuries treated in hospital emergency rooms. NEISS uses well-established statistical methods by which estimates are derived from statistical samples and is recognized as an authoritative source of injury estimates in the U.S. Statistical sampling uncertainties or errors, inherent in all sampling systems, are quantified in terms of a coefficient of variation. The coefficient of variation has been provided for all injury estimates in this briefing package.

Additionally, the NEISS data provide a source for follow-up investigations of product-related injuries. The special study on stationary saws that CPSC staff conducted in 2001 provided the most accurate statistics available because it included table saw incidents that were formerly coded as an unspecified power saw. With the additional information from the special study[23], more precise injury estimates for 2001 were computed. The total table saw related injury estimate was 38,000 emergency room treated injuries, the percentage of amputations was 15%, and the percentage of injuries that involved blade contact was 83%.

2. Proposed Requirements

Comment: Several comments (CC 03-1-56; 61; 62; 63) state that the requirements in the petition are design requirements that mandate the use of a particular technology. Commenters further state that the Consumer Product Safety Commission is prohibited from mandating design requirements pursuant to Section 7 of the Consumer Product Safety Act.

Response: Section 7(a)(1) of the Consumer Product Safety Act (CPSA) requires that safety standards issued thereunder be stated as "requirements expressed in terms of performance requirements." Thus, if a mandatory safety rule were promulgated, it would be expressed in terms of performance requirements that could presumably be met in a number of ways.

3. Technology Proposed by Petition

Comment: Several comments (CC 03-1-44; 45; 46; 47; 48; 56; 62; 63; 69) list shortcomings in the SawStop™ technology (a patented detection/reaction technology) - most notably, lack of proof of viability, false tripping of device, potential degradation of electrical and mechanical components, effects of braking force on components and blades, etc. The general argument is that this technology is too new and unknown to be forced onto manufacturers.

Response: The petition is a request for a performance standard to address table saw injuries and deaths and does not require a particular technology.

4. The Voluntary Standards Process

Comment: Several comments (CC 03-1-59; 61; 62; 63) state a voluntary standard exists for table saws and that the established voluntary standards process should be followed to effect any changes to the product. In particular, commenters expressed concern about a precedent of government regulation that dictates market actions.

Response: The Consumer Product Safety Act prohibits the Commission from promulgating a consumer product safety rule if compliance with an existing voluntary standard is likely to result in elimination or adequate reduction of the risk of injury in question. Available data indicate that severe operator blade contact injuries continue to occur on table saws that meet the current voluntary standard, which suggests that compliance with the voluntary standard may not adequately eliminate or reduce the risk of blade contact injury associated with table saws.

In January 2005, a requirement for a riving knife on table saws was added to the voluntary standard, but this safety feature is primarily intended to address kickback injuries. The

[23] Adler, P. (June 2003). Memorandum. Adjustment for Table Saw, Band Saw, Miter Saw, and Radial Arm Saw Estimates for Future Use. U.S. Consumer Product Safety Commission: Bethesda, MD.

requirement does not become effective until January 31, 2014 for currently Listed products and January 31, 2008 for new products submitted for investigation.

5. Patented Technology

Comment: Several comments (CC 03-1-2; 3-7; 11; 15; 16; 23; 39; 42; 44-26; 68-70) state that issuing a mandatory standard, such as that requested in the petition, would force manufacturers to use a patented technology. As such, the patent holders would have a monopoly and would realize a sizeable financial benefit. Many commenters expressed concern that the petitioners are seeking financial gain.

Response: Section 7(a)(1)) of the CPSA , 15 U.S.C. § 2056(a)(1), requires that any safety standard issued by the Commission be stated as "requirements expressed in terms of performance requirements." If the Commission were to find that a mandatory standard is reasonably necessary to reduce the risk of injury associated with table saw blade contact, it would issue performance requirements to address the hazard and would not favor any particular technology, patented or otherwise.

6. Feed Rate

Comment: Three comments (CC 03-1-37; 48; and 62) question the feed rate criteria of the petition. The PTI comment (CC 03-1-62) states that "injuries occurring as a result of kickback or falling into the blade will not be prevented by the proposal." In particular, PTI states that testing by their members indicates the approach velocity of the hand can be as high as 200 inches per second during kickback and as high as 60 inches per second when slipping or reaching over the table saw blade. Furthermore, PTI concludes that "a significant percentage of known table saw injuries will not be lessened or prevented by the proposed technology" because the NEISS data show slightly more than 50% of incidents involved non-kickback injuries and, of those, "many likely occurred under scenarios where the feed rate was more than 12" per second."

Response: CPSC staff recognizes that further study is needed to estimate the feed rate that would be encountered during actual operation of a table saw and the effect this feed rate would have on the efficacy of a performance standard.

A preliminary review of the available injury data indicates that severe injuries occurred in both kickback and non-kickback situations. The descriptions of the incident scenarios do not provide enough detail to ascertain the approach rate of the victims' hands to the saw blade. However, a review of the responses to the CPSC special study survey indicates that many of the victims experienced a lapse in attention while cutting a piece of wood or reaching over the saw blade. These descriptions suggest that the approach rate of the hand to the saw blade was not as extreme as the figures suggested by PTI. It would be misleading to assume that severe and costly injuries only occur in unique situations where the approach rate of the hand to the blade is extremely high and, therefore, would not be addressed. CPSC staff recommends that this issue be subject to further study and request for comment.

7. Cost of Technology

Comment: Several comments (CC 03-1-9; 11; 36; 62; 63; 67; 70) oppose the costs associated with adding a safety system, with many stating that the costs to implement a patented technology will outweigh the benefits of the system. In particular, PTI estimates that the costs for testing, retooling, and redesigning will range from $2 to $10 million per company. In addition to the cost of modifying existing table saw designs, the SawStop™ system, if used, would require replacement of a brake cartridge and possibly the saw blade once the system has been activated. These costs have been estimated at up to $69 for a brake cartridge and $100 for a new blade. Some comments express concern about these replacement costs.

Response: Further study of all elements of costs associated with a potential table saw performance standard will be necessary if the Commission elects to proceed with rulemaking.

8. Necessity of the Petition

Comment: Several comments (CC 03-1-9; 11; 14; 22; 38; 39) state table saw injuries are low or would not occur if proper safety practices were adopted; therefore, there is no need for a detection/reaction safety system.

Response: An estimated 34,000 injuries to operators of table saws were treated in emergency rooms nationwide in 2001, and approximately 28,300 of those injuries were due to blade contact. Lacerations, amputations, fractures, avulsions and crushings comprised the estimated 55,300 total medically treated injuries at a total societal cost of $2.13 billion. The injury trend associated with table saws has been stable from 1991-2002. Therefore, CPSC staff believes current safety practices are not sufficient to prevent costly injuries.

9. Optional Safety Systems

Comment: Several comments (CC 03-1-10; 41; 67) state that a safety system as requested in the petition should be offered as an option so that consumers may decide whether or not they want to pay the additional costs for such a system. One comment states that the SawStop™ system is already available on the market, which should be sufficient in providing consumers access to this safety system.

Response: Even with the safety system already on the market, substantial injury data leads staff to conclude that further investigation is warranted.

10. Alternative Technology

Comment: PTI has indicated in its comment (CC 03-1-62) that its members intend to enter a joint venture agreement to conduct research into the development of technology for a blade contact injury avoidance system for table saws.

Response: The Department of Justice published a notice in the Federal Register on December 1, 2003 stating that the Power Tool Institute Joint Venture Project had filed notifications, pursuant to section 6(a) of the National Cooperative Research and Production Act of 1993, 15 U.S.C.

4301 *et seq.* (68 FR 67216). The stated nature and objective of the venture are "the research and development of technology for power saw blade contact injury avoidance, including skin sensing systems, blade braking systems, and/or blade guarding systems."

PTI indicated that they intend to develop an enhanced safety system to address blade contact injuries. In June 2006, the Table Saw Mechanical Guarding Joint Venture submitted for consideration to Underwriters Laboratories Inc. (UL) and the Canadian Standards Association (CSA) proposed requirements that would allow for alternative blade guards. PTI has indicated that, assuming the UL and CSA processes proceed smoothly, it is anticipated that implementation by individual manufacturers could begin in 2007.

9. Options Available to the Commission

A. Grant the Petition and Initiate Rulemaking

If the Commission concludes that available information indicates that blade contact injuries on table saws may present an unreasonable risk of injury and that a mandatory rule may be required to address the risk, the Commission may grant the petition and begin the rulemaking process by directing the staff to prepare an Advance Notice of Proposed Rulemaking. Granting a petition in this manner and beginning a rulemaking proceeding does not mean that the Commission would necessarily issue a rule in the specific form requested in the petition.

B. Defer the Petition and Initiate a Project

If the Commission concludes that more information is required before a decision can be made to grant or deny the petition, the Commission may defer a decision and direct the staff to establish a project to collect additional information. This could include participation in voluntary standards activities related to development of requirements that would allow the proposed, alternative blade guards developed by the industry consortium and/or an evaluation of the effectiveness of such guards.

C. Deny the Petition

If the Commission concludes that rulemaking as requested in the petition is not reasonably necessary to eliminate or adequately reduce the risk of injury described in the petition, the Commission could deny the petition. If the Commission denied the petition, it would not be precluded from continuing to consider the matter of table saw blade contact injuries, including by mandatory rulemaking.

10. Staff Conclusion and Recommendation

Injuries on table saws that occur when the operator makes contact with the saw blade accounted for approximately 28,300 emergency room treated injuries in 2001. The injury trend associated with table saws has been stable from 1991-2002. From the 28,300 emergency room treated operator blade contact injuries, the Commission's Injury Cost Model (ICM) estimates 55,300 total medically treated blade contact injuries (this includes injuries treated in settings other than the emergency room such as ambulatory surgery centers, physicians' offices, or clinics) in 2001 with associated injury costs of $2.13 billion. The high societal costs are attributed to the large number of amputations (approximately 15% of the operator blade contact injuries) and the 11% rate of hospitalization, which is more than twice the 4.6% average hospitalization rate for all consumer products in 2001.

Many industry representatives believe that modification of consumer behavior through information and education campaigns could best address the hazard. Despite efforts by the table saw industry to educate consumers on the safe use of table saws, severe injuries continue to occur. Industry representatives have recently revised the voluntary standard for table saws to include a safety device that may be more effective at preventing kickback of the material during use of the table saw. CPSC staff supports this new requirement as an improvement to table saw safety but does not believe it will adequately address the blade contact hazard.

CPSC staff review of the injury data from its special study suggests that a large percentage of the operator blade contact injuries on table saws could be addressed by table saw performance requirements. The societal costs associated with these operator blade contact injuries (estimated at $2.13 billion in 2001) suggest that an effective remedy could generate net societal benefits over the lifetime of the table saws.

The Occupational Safety and Health Administration (OSHA) regulates table saw products and the workplace environment in which the products are used. The current OSHA product requirements on table saws are essentially identical to the requirements in the voluntary standard in terms of providing an adjustable blade guard and some type of spreader (device that prevents the cut material from binding the saw blade). CPSC staff does not believe the OSHA regulation will adequately address the blade contact hazard to consumers because: 1) The current OSHA requirements for table saws are identical to existing voluntary standard requirements, and 2) OSHA does not have jurisdiction in the home wood working shop and, therefore, cannot enforce a safe work environment and proper safety training for all users of table saws.

CPSC staff recommends granting the petition to the extent it requests the Commission to proceed with a rulemaking process that could result in a mandatory safety standard for table saws to reduce the risk of blade contact injury.

TAB A

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: June 26, 2006

To	:	Caroleene Paul Project Manager Petition CP03-02 Power Saw Performance Standard
Through		Hugh McLaurin Assistant Executive Director Engineering Sciences
From	:	Robert B. Ochsman, Ph.D., CPE Director Human Factors Division
Subject	:	Petition Requesting Performance Standards for a System to Reduce or Prevent Injuries From Contact With the Blade of a Table Saw (Petition CP03-02)

The objective of this memo is to provide a Human Factors (HF) analysis of table saws related to Petition CP03-02. Specifically, this analysis addresses HF safety-related attributes of table saws, the environment in which table saws are used, and the attributes of typical users of table saws that are relevant to their safe use.

Basic Distinctions between Table Saws

Home table saws may be characterized as either bench top saws, contractor saws, or cabinet saws. However, they are all commonly referred to generically as "table saws."

- ***Bench top saws**:* These are the smallest, lightest, and least expensive type of table saw. They are designed to be easily moved around and temporarily placed on a work bench or stand for use. Bench top saws are often the first table saws purchased by the inexperienced home woodworker but are also used by contractors to haul a saw from job to job for light work.

- ***Contractor saws**:* These saws are characterized by having a set of light duty legs and a bigger table and motor than bench top saws. They are generally quieter, more accurate, and able to cut soft woods up to about two inches thick, hard woods somewhat less. They are still light enough, however, for contractors to haul and set up at job sites. They are commonly used by home wood workers, as these saws are capable of high quality work and are commonly found at mass merchandisers. If these saws are carefully set up and calibrated, they may be used in professional cabinet shops for light duty work.

- ***Cabinet saws:*** Cabinet saws are typically used by the advanced home woodworker. Cabinet saws are heavier than contractor saws, have high quality fences, single phase electric motors, and saw dust ports. They are termed "cabinet" due to the closed structure of the saw base. This construction makes for a more solid and stable saw and is more effective for saw dust collection, as well as minimizing vibration and noise. Also, the saw arbor in a cabinet saw is usually bolted to the cabinet itself facilitating easier and more precise alignment of the arbor as compared to contractor saws in which the arbor is bolted to the saw table. The term "cabinet" does not refer to the type of workplace for which the saw is designed. Cabinet saws in the $1200 to $3000 price range are typically the highest grade saw found in the home woodworking shop. They are capable of performing all table saw operations required by the home woodworker and are capable of some light duty production work in a professional shop.

Production table saws are typically massive, very heavy and not found in the home shop. They are designed with very large extension working surfaces, 12" blades, and heavy duty 3-phase motors greater than 5 horsepower. They are used in production facilities, factories, and cabinet shops. They are designed to accommodate power feeds if needed. They are robust enough to continuously saw very thick wood stock and are designed for continuous operation.

Characteristics of Home Table Saw Users:

The table saw is the one power tool that almost all serious home woodworkers acquire. It is used for more woodworking operations than any other power tool in the home wood shop. Indeed, many home woodworking projects may be completed using only this tool.

Once a homeowner purchases a table saw, there are no controls on the use of the product and no oversight from that point forward. There are no training or experience requirements.

Table Saw User Experience and Training: This tool is often the first or second large power tool purchased by the amateur woodworker. Some common table saw operations such as cross cuts are not particularly complicated, and the new user will probably learn to do these simple operations very quickly. This will quickly engender confidence in one's ability to safely operate the saw. However, increasingly complicated operations such as ripping, cutting tapers, cutting sheet goods, simple and compound miter cuts and dados require more precise set-up and advanced techniques such as the use of jigs. These operations are well within the capabilities of more advanced amateur woodworkers, but they do require some experience or training to perform safely. Very few hobby woodworkers obtain any kind of formal training in table saw use. The potential dangers of some of the more complicated operations, such as kick-back, may not be apparent to the inexperienced user. Therefore, these hidden potential dangers pose a greater threat to the home user than an experienced or professional user.

***User Performance Attributes**:* Woodworking can be a life-long hobby that is attractive for middle age and more senior amateurs. These older wood workers may have sensory, perceptual, or cognitive deficits that will affect their performance with these machines and, therefore, impact safe operation. Safe table saw operation requires healthy vision and depth perception, well functioning eye-hand coordination, complex decision making, accurate memory, hearing, and, at times, moderate or greater strength.

Frequency of Use: The home table saw may be used infrequently or in spurts. It may only be used on weekends or for the occasional project that requires this tool. The essential point is that the home woodworker is rarely a constant, everyday user of the tool. Therefore, most home woodworkers are frequently going to be "rusty," even if they are experienced. When using the tool again after a few weeks or even months have passed, the operator may have lost some of the mental "precision" needed to operate the saw safely, even though the self-perception is one of confidence.

Professional Saw Users versus Home Hobby Users: All of the personal attributes outlined above (experience, training, personal performance attributes, and frequency of use) tend to sharply differentiate the home hobbyist from the professional. Amateur woodworkers will have little or no safety training nor training in the proper use of the table saw. They will typically have far less experience, may have physical attributes that are not conducive to safe operation of the saw, and may use the saw infrequently.

Inexperienced or untrained home users may not comprehend their lack of knowledge or experience in operating their table saw. They may discover dangerous or difficult operations only by actually experiencing near accidents or problems. They may have no or little knowledge about how to properly set up and operate the saw to perform more complex types of operations. Typically, they will have no training or oversight by experienced woodworkers.

Professional wood workers in an industrial setting will typically have been trained extensively on both safety practices and the proper use of the tool. They will have had training and be experienced in performing any special or complex operations with the saw. Due to their deep experience, they will recognize situations and set-ups that may be dangerous or require extra care and attention. Safety equipment such as safety glasses, gloves and boots will be required and available.

Environmental Attributes

Lighting: Home table saws are commonly placed in basements, garages, or small outbuildings. These are locations for which lighting, temperature, ventilation, saw dust control, and adequate space may be compromised. Perhaps the most critical physical attribute of the workplace is lighting. Inadequate lighting may severely compromise safe use of the table saw. Basements and garages may require supplemental lighting for safe table saw use, and older users or any user with poor vision would require even more lighting. Inadequate lighting may make it more difficult for the user to easily see the spinning blade or may require the user to place the eyes close to the spinning blade while sawing.

Clearance: Given the large space requirements for many table saws and the often limited space available in home basement or garage workshops, the tale saw operator may have to operate the saw in cramped conditions. This may force the operator into introducing wood pieces into the blade in orientations that are unsafe. For safest operations, table saws require a rather large footprint around the tool to enable the woodworker to freely manipulate and orient large or awkward pieces of wood.

Distractions: The home work shop in the basement or garage means that other family members and pets will have access to this shared space. The presence of children or pets may significantly draw the operator's attention away from the machine. Safe operation of the saw requires users to concentrate and be fully focused on sawing operations. A moment's distraction can mean contact with the blade.

Industrial Wood Working Settings: The factors described above are more tightly controlled in a professional wood shop or manufacturing setting due to safety codes, laws/regulations, insurance company inspections and, potentially, Occupational Safety and Health Administration (OSHA) inspections. For example, OSHA regulations specifically require that "[E]mphasis is placed upon the importance of maintaining cleanliness around the woodworking machinery, particularly as regards the effective functioning of guards" [§ 1910.213 (s)(6)], and that [P]ush sticks or push blocks shall be provided at the work place in the several sizes and types suitable for the work to be done." [§ 1910.213 (s)(9)]. In many production environments where a specific cut is performed continuously, guards and safety cut-off switches are custom designed for that set up. The area is specifically designed to be as safe as possible, and safety is a continuous focus through warning/instruction signs. Posters are often displayed throughout the work area.

The workplace environment is subject to spontaneous inspections by OSHA inspectors at any time. Violations of OSHA workplace safety regulations carry a heavy fine. These inspections can take place in permanent establishments, such as a cabinet-making shop, and temporary job sites, such as at residential or commercial construction projects. The prospect of being fined for safety violations increases the likelihood that workers or supervisors will ensure that safety systems, such as blade guards, are left in place.

A professional work setting for a table saw most likely will have adequate lighting directed toward the work surface, marked clearance lines around the saw to ensure that the operator has plenty of space to work safely, minimum distractions, and regular policing of the area to ensure a safe tool use environment.

Table Saw Safety Features

Machine safety features may be classified as active or passive. That is, an active safety device would require the machine operator to actually perform some behavior in order to activate or invoke the safety feature. For example, some machines in a production environment require the user to wear special hand or wrist harnesses to literally pull their hands out of the path of moving blades or punches. If the operator fails to put the harness on, the safety feature is completely overridden. Users will be more prone to override or somehow deactivate machine safety features when those features require the operator to perform additional steps, make the operation more difficult or awkward, take more time to do than performing that same operation without the safety device, occlude a clear view of the operation itself, or in any way make the work more difficult or slower.

Safety features that are passive require no active intervention on the part of the user of the device. Their operation is invisible to the user and doesn't impact the speed or ease of performing an operation in any way. An automobile air bag is an example of passive protection.

Most table saw safety features require intervention by the user. The intervention may only be initial set-up and adjustment for some blade guards. Other guards may require removal and replacement, depending on the saw operation being performed.

Principles of good safety engineering eliminate hazards from the design of a product whenever possible. Passive safety features should be incorporated if hazards are not eliminated from a product. Active safety features are less effective as they are totally dependent upon the user, and even the most diligent and highly motivated user may, from time to time, overlook or forget to use such a safety feature. Some hazards will only be addressed by warning labels, training materials, and instructions to alert users to the hazards.

Most home table saws have active safety features in which design and engineering require more operator time, attention, and "fiddling" than would be necessary with more refined designs. Some saw features which contribute to safety, such as inserts, are often not supplied in a range of sizes. Therefore, the user may make do with only one insert and, therefore, subject himself to unnecessary danger. Blade guards may be poorly constructed and time consuming to remove and replace.

The proper set-up, adjustment, and operation of safety features that are supplied with table saws may not be obvious to the inexperienced home craftsman. Often, careful attention to the instructions is necessary for proper use of the safety features on a table saw. Since the saw may be successfully used repeatedly without knowledge of the proper use of the safety features, the home table saw user may come to devalue the need to use these safety features.

Conclusion:

From a Human Factors safety perspective, the use, user, and environment of table saws are significantly different in the home versus the industrial setting. The professional wood worker is trained and experienced in safe table saw practices and uses the tool in a safe environment which expects and monitors safe tool use. By contrast, the home user lacks the experience and focus on safety and may use the saw in situations that detract from safe practices.

TAB B

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: April 12, 2005

TO : Caroleene Paul, ESME
Directorate for Engineering Sciences

THROUGH: Russell Roegner, PhD, RR
Director, Division of Hazard Analysis
Acting Associate Executive Director, Directorate for Epidemiology

FROM : Natalie Marcy NM
Division of Hazard Analysis

SUBJECT : Data Analysis for Petition CP 03-2, Table Saw Blade Contact Deaths and Injuries

This memo was prepared in response to the petition, requesting that the CPSC issue performance standards for a system to reduce or prevent injuries from contact with the blade of a table saw. The primary source of data in this analysis is from the 2001 NEISS based special study of stationary power saw-related injuries. Death reports have also been reviewed.

Special Study on Stationary Saws
(October 1, 2001 – December 31, 2001)

This report on stationary saw-related injuries is based on information gathered from NEISS (National Electronic Injury Surveillance System) between October 1, 2001 and December 31, 2001[1]. NEISS cases reported with product codes for table saws; band saws; radial arm saws; powered hack saws; saws, not specified; other power saws; and power saws, not specified were automatically assigned for follow-up investigations. As a result of the follow-up investigations, the injuries involving unspecified saws (43% of the annual stationary saw estimate) were re-distributed among the specified saw categories. After this re-distribution, table saws accounted for 38,000 injuries (73%) out of 52,000 total stationary saw-related injuries treated in U.S. hospital emergency rooms for the calendar year 2001.

An estimated 34,000 injuries were associated with table saw operators in 2001. Of those, 28,300 injuries (83%) involved blade contact, which is the hazard pattern of particular interest to this petition. Virtually all of the table saw operator blade contact-related injuries were sustained by consumers (only 5 cases out of 120 cases were identified as work-related). However, since both consumers and workers possibly use the same high and low end table saws potentially in the same manner, work-related injuries were not removed from the injury estimates. The majority of the remaining injuries sustained by table saw operators involved kickback of the material being cut.

The majority of the table saw operators who sustained blade contact-related injuries (56%) were 51 years of age or older and the ages of the victims ranged from 15 to 69 years old. Almost all (94%) of the injuries were sustained to the finger(s) and the majority (65%) of the injuries were lacerations. Amputations were the second largest type of injury sustained by the operators (15%). The remaining injuries were fractures, avulsions, and crushings. The rate of hospitalization was 11%[2] and all of these hospitalized injuries were related to fingers. Men accounted for 96% of the injuries. The Injury Cost Model (ICM) was used to generate an estimate of the total number of medically treated injuries and the associated cost components[3] for blade contact-related injuries of table saw operators (Table 1).

Table 1: Blade Contact-Related Injuries of Table Saw Operators, 2001

	Estimate	95% Confidence Interval[4]
ER-treated injuries	28,300	(19,900, 36,700)
All medically-treated injuries	55,300	(38,800, 71,800)
Total medically-treated injury costs	$2.13 billion	($1.50 billion, $2.76 billion)[5]

Source: CPSC, National Electronic Injury Surveillance System (NEISS) Special Study of Stationary Saws, October 1, 2002 Through December 31, 2001, Directorate for Epidemiology, Hazard Analysis Division.

[1] Some of the discussion of the special study is taken from a Memorandum from Prowpit Adler to Caroleene Paul[1]. Some additional analysis was also performed for this memorandum using the data obtained through the special study. This memorandum is included as Appendix A.
[2] The average rate of hospitalization for all NEISS products in 2001 was about 4.6%.
[3] See the methodology section for more information on how these estimates are derived.
[4] CV = .152 [2]
[5] The confidence interval for injury costs is derived by applying an average injury cost to the confidence interval for medically treated injuries.

Of the 28,300 blade contact-related injuries sustained by table saw operators, 16,000 of the injuries do not involve any type of kickback (Table 2). There were 9,300 blade contact-related injuries that did involve kickback. In the remaining 3,000 injuries, the reason why the operator came into contact with the blade is unknown. Amputations and hospitalizations occurred with both kickback and non-kickback related injuries.

Table 2: Blade Contact-Related Injuries of Table Saw Operators, 2001

	Estimate	95% Confidence Interval[6]
KICKBACK		
ER-treated injuries	9,300	(5,700, 12,900)[7]
All medically-treated injuries	17,900	(11,000, 24,800)
Total medically-treated injury costs	$730 million	($448 million, $1,012 million)
NON-KICKBACK		
ER-treated injuries	16,000	(11,500, 20,400)[8]
All medically-treated injuries	32,300	(23,300, 41,300)
Total medically-treated injury costs	$971 million	($701 million, $1,241 million)

Source: CPSC, National Electronic Injury Surveillance System (NEISS) Special Study of Stationary Saws, October 1, 2002 Through December 31, 2001, Directorate for Epidemiology, Hazard Analysis Division.

The adjustment factor used to redistribute the unspecified saw-related injuries in 2001 was also used to redistribute the unspecified saw-related injuries in 2002[3]. Thus, the estimated number of table saw-related emergency room-treated injuries in 2002 is 38,980. Both the 2001 and 2002 estimates increased roughly 6,000 injuries from the original NEISS estimate, as a result of the redistribution. The injury trend associated with tables saws has been stable from 1991 – 2000[9]. This trend continues through 2001 and 2002.

[6] The confidence interval for injury costs is derived by applying an average injury cost to the confidence interval for medically treated injuries.
[7] CV = .191 [2]
[8] CV = .142 [2]
[9] The year-to-year comparisons of injury estimates were not statistically significant. [4]

Fatalities

The Commission has received reports of 10 deaths involving a table saw from 1991 to August 2004. Two of them involved blade contact and are relevant to the petition. A 67 year old man died from a massive heart attack after he severed three fingers using an industrial type table saw (8/13/97). A 57 year old man died three days after the incident in which his left hand was traumatically amputated (12/25/01).

Response to Comment Submitted by PTI

The Power Tool Institute, Inc. (PTI) submitted a comment to petition CP 03-2. Within their comment, they cite a number of injury statistics. They state that there are, on average, 30,000 emergency room-treated injuries related to table saws each year. While this is true according to raw NEISS data, more precise injury estimates for 2001 (38,000) and 2002 (38,980) have been computed as a result of the special study. They stated that 10% of the injuries in 2001 are amputations, which is slightly lower than the proportion found through the special study (15%). PTI states that 30% of the table saw-related injuries do not involve blade contact which is almost twice the proportion found through the special study (17%). They also state that in between 73% and 85% of the table saw hand/arm accidents, the blade guard is not in place. It is unclear where this statistic came from because the special study found that in 50% of the injuries to stationary saw operators, the blade guard was damaged, removed, broken off, or the stationary saw never had a blade guard[1] . In 28% of the injuries, the presence of a blade guard is unknown. The rest of the injuries, 22%, involved stationary saws with a blade guard attached. The presence of a blade guard cannot be determined from the raw NEISS data, so the stationary saw special study is the best statistic available. PTI also brings into question the accuracy of the NEISS estimates because of the sample size. The coefficient of variation (CV) on the NEISS estimates takes the sample size into account and can be used to produce a confidence interval on the estimate. The CV for the blade contact-related injuries of table saw operators was computed and the 95% confidence interval has been provided.

Methodology

National Electronic Injury Surveillance System (NEISS)

The Commission operates the National Electronic Injury Surveillance System, a probability sample of about 100 U.S. hospitals with 24-hour emergency rooms (ERs) and more than six beds. These hospitals provide CPSC with data on all consumer product-related injury victims seeking treatment in the hospitals' ERs. Injury and victim characteristics, along with a short description of the incident, are coded at the hospital and sent electronically to CPSC.

Because NEISS is a probability sample, each case collected represents a number of cases (the case's *weight*) of the total estimate of injuries in the U.S. The weight that a case from a particular hospital carries is associated with the number of hospitals in the U.S. of a similar size. NEISS hospitals are stratified by size based on the number of annual emergency-room visits. NEISS comprises small, medium, large and very large hospitals, and includes a special stratum for children's hospitals[5].

The weights from the cases that were successfully contacted during the follow-up investigations were adjusted for the non-responses using the method of raking. The annual estimates of injuries are based on these adjusted weights.

Injury Cost Model (ICM) [6]

The Injury Cost Model (ICM) is a computerized analytical tool that uses NEISS data to estimate the total number of medically treated injuries and measure the direct and indirect costs associated with consumer product-related injuries. NEISS gathers data on nonfatal injury victims (injury survivors) treated in hospital emergency room departments (ERs) or admitted through the ER. Survivors could be treated in many other settings including ambulatory surgery centers, physicians' offices and clinics, or company clinics. In addition, a few injury survivors are admitted to the hospital directly, by-passing the ER (and the NEISS system). These survivors may be transferred from a walk-in clinic or doctor's office, or they may be triaged by emergency medical services to a specialty hospital that lacks an ER but directly admits victims of severe trauma. The ICM estimates the number of injury survivors who were treated in places other than emergency departments and the costs of their injuries.

ICM cost estimates consist of four parts: medical costs, work losses, quality of life and pain and suffering costs, and product liability insurance administration and litigation costs. These estimates are diagnosis specific (meaning they vary by body part injured and nature of injury diagnosis), vary by age and sex of the victim, and also vary depending on the highest level (also called setting) where medical treatment was received. The intangible cost estimates are based on a statistical analysis of jury verdicts.

Fatalities

CPSC purchases death certificates from all 50 states, New York City, the District of Columbia and some territories. Only those certificates in certain E-codes (based on the World Health Organization's International Classification of Diseases ICD-10 or ICD-9 systems) are purchased. These are then examined for product involvement before being entered into CPSC's death certificate database. The result is neither a statistical sample nor a complete count of product-related deaths. The database provides only counts of product-related deaths from a subset of E-codes. For this reason, these counts tend to be underestimates of the actual numbers of product-related deaths.

Injury or Potential Injury Incident Data Base (IPII) is a CPSC database containing reports of deaths, injuries, or potential injuries made to the Commission. These reports come from news clips, consumer complaints received by mail or through CPSC's telephone hotline or web site, Medical Examiners and Coroners Alert Program (MECAP) reports, letters from lawyers, and similar sources. While the IPII database does not constitute a statistical sample, it can provide CPSC staff with guidance or direction in investigating potential hazards.

To obtain a count of reported fatalities, death certificate data and fatalities reported through IPII are combined and the duplicate records are eliminated.

Investigations from the Special Study Used For This Analysis:
Table saw operator blade contact-related injuries

011208HEP2722	kickback
011212HEP6743	kickback
011218HEP6721	kickback
011007HEP5761	kickback
011029HEP2367	kickback
011104HEP5921	kickback
011108HEP8854	kickback
011113HEP5921	kickback
011210HEP7063	kickback
011221HEP5282	kickback
011127HEP6002	kickback
020106HEP5761	kickback
011007HEP5123	kickback
011010HEP1281	kickback
011022HEP8013	kickback
011023HEP0161	kickback
011023HEP3361	kickback
011028HEP8079	kickback
011029HEP6641	kickback
011101HEP4081	kickback
011102HEP8035	kickback
011102HEP8036	kickback
011106HEP7361	kickback
011108HEP2722	kickback
011119HEP8035	kickback
011125HEP8854	kickback
011204HEP6743	kickback
011215HEP5761	kickback
011222HEP2321	kickback
011227HEP1121	kickback
011227HEP3041	kickback
020102HEP6743	kickback
020102HEP7064	kickback
011214HEP1041	kickback
020107HEP1401	kickback
011105HEP7281	kickback
011204HEP6721	kickback

011115HEP0321	non-kickback
011209HEP6641	non-kickback
020109HEP8141	non-kickback
011016HEP5282	non-kickback
011025HEP5761	non-kickback
011106HEP3361	non-kickback
011107HEP6721	non-kickback
011108HEP0401	non-kickback
011113HEP4081	non-kickback
011126HEP0641	non-kickback
011210HEP8013	non-kickback
011211HEP5041	non-kickback
011215HEP5762	non-kickback
020101HEP0401	non-kickback
011012HEP2721	non-kickback
011003HEP5122	non-kickback
011006HEP0481	non-kickback
011025HEP0721	non-kickback
011113HEP1441	non-kickback
011113HEP7064	non-kickback
011115HEP5761	non-kickback
011119HEP6743	non-kickback
011127HEP6721	non-kickback
011209HEP5121	non-kickback
011227HEP4081	non-kickback
020206HEP6401	non-kickback
011114HEP4801	non-kickback
011005HEP5121	non-kickback
011008HEP8767	non-kickback
011011HEP1121	non-kickback
011011HEP5602	non-kickback
011011HEP8141	non-kickback
011012HEP0641	non-kickback
011016HEP6002	non-kickback
011017HEP2402	non-kickback
011018HEP6721	non-kickback
011019HEP1121	non-kickback

011024HEP0481	non-kickback
011026HEP6001	non-kickback
011026HEP6722	non-kickback
011028HEP4084	non-kickback
011028HEP8854	non-kickback
011105HEP8876	non-kickback
011108HEP2721	non-kickback
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011118HEP6001	non-kickback
011119HEP1121	non-kickback
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011123HEP1761	non-kickback
011125HEP5763	non-kickback
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011129HEP5761	non-kickback
011202HEP6001	non-kickback
011203HEP6983	non-kickback
011205HEP2365	non-kickback
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011228HEP6721	non-kickback
020116HEP6401	non-kickback
011109HEP2241	non-kickback
011207HEP4241	non-kickback
011127HEP1042	unknown
011126HEP6001	unknown
011015HEP0402	unknown
011025HEP2161	unknown

011112HEP6722	unknown
020101HEP8079	unknown
020102HEP8722	unknown
011007HEP5601	unknown

011211HEP6401	unknown
011114HEP1841	unknown
011228HEP2241	unknown
011125HEP0961	unknown

011022HEP6743	unknown

References

1. Memorandum from Prowpit Adler to Caroleene Paul, "Injuries Associated with Stationary Power Saws, 2001" May 5, 2003 (Appendix A)

2. The data analysis and CV's for this paper were generated using SAS software, Version 8.02 of the SAS System. Copyright © 1999-2001 SAS Institute Inc. SAS and all other SAS Institute Inc. products or service names are registered trademarks of trademarks of SAS Institute Inc., Cary, NC, USA.

3. Memorandum from Prowpit Adler to The File, "Adjustment for Table Saw, Band Saw, Miter Saw, and Radial Arm Saw Estimates for Future Use." June 4, 2003 (Appendix B)

4. Prowpit Adler, "Table Saw Related Injuries and Fatalities (1991 – 2000)" February 4, 2002 (Appendix C)

5. Kessler, Eileen and Schroeder, Tom. *The NEISS Sample (Design and Implementation). U.S. Consumer Product Safety Commission.* October 1999

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Appendix A:
Injuries Associated with Stationary Power Saws, 2001

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: May 5, 2003

TO : Caroleene Paul, ESME
Directorate for Engineering Sciences

THROUGH: Susan Ahmed, Ph.D., AED RR for SA
Directorate for Epidemiology
Russell H. Roegner, Ph.D., Director RR
Hazard Analysis Division, EP

FROM : Prowpit Adler, EPHA

SUBJECT : Injuries Associated with Stationary Power Saws, 2001

This memorandum transmits a report on injuries associated with table saws, band saws, miter saws, and radial arm saws. The injury data is based on NEISS and its 2001 Special Study.

The Directorate for Epidemiology estimated that about 52,000 people were treated in U.S. hospital emergency rooms for injuries associated with table saws, band saws, miter saws, or radial arm saws in calendar year 2001. About 98 percent of the victims were saw operators. Contact with the saw blade was the major hazard to the operators followed by being hit by stock or cutting material. Almost all of the injuries were lacerations, amputations, fractures, or avulsions. Injuries to fingers accounted for about 83 percent of the total injuries. The rate of hospitalization was 5 percent. An additional 3 percent of injuries required overnight observation or were transferred to another hospital for observation.

CPSA 6 (b)(1) Cleared 5-13-2003
X No Mfrs/PrvtLblrs or Products Identified
___ Excepted by ___
___ Firms Notified, Comments Processed.

1. Introduction

Based on CPSC's National Electronic Injury Surveillance System (NEISS), an estimated 93,880 saw-related injuries were treated in U.S. hospital emergency rooms for the calendar year 2001. About 36,400 injuries (39%) were associated with stationary saws[1]: table saws were predominant, followed by band saws, radial arm saws, and powered hack saws.[2] About 17,240 injuries (18%) were associated with portable or hand-held saws[3]. The remaining 40,240 injuries (43%) were reported to be associated with unspecified saws. Therefore, the number of injuries associated with stationary saws could have been larger if those unspecified saws were identified. In order to obtain the distribution of stationary saws (from the unspecified saws), follow-up investigations of the injuries were conducted between October 1, 2001 and December 31, 2001. The investigations also included injuries reported in NEISS to be associated with table saws, band saws, radial arm saws, and powered hack saws to obtain the nature and probable causes of the injuries which generally are not available from the NEISS reports.

2. Data Description – National Electronic Injury Surveillance System (NEISS)

NEISS is an injury data collection system. It was comprised of a probability sample of about 100 hospitals stratified into 5 strata - small, medium, large, very large, and children's hospitals (where the first four strata were stratified by hospital size) for the calendar year 2001. The system serves the Commission primarily in two ways. First, the NEISS provides national estimates of the number and severity of injuries associated with, but not necessarily caused by, consumer products and treated in hospital emergency departments. Second, the system serves as a means of locating victims so that further information may be gathered concerning the nature and probable cause of the incident. Information gathered from the NEISS and other sources guides the Commission in setting priorities for selecting types of products for further investigation and/or actions that may eventually lead to product modification or development of safety standards.

The report of stationary saw-related injuries is based on information gathered from NEISS between October 1, 2001 and December 31, 2001. Victims with injuries related to the NEISS product codes: 0841 (table saws), 0842 (band saws), 0843 (radial arm saws), 0844 (powered hack saws), 0845 (saws, not specified), 0863 (other power saws), and 0872 (power saws, not specified) were automatically assigned for the follow-up investigations. Of the total 450 assigned cases, 317 cases (70%) were successfully contacted[4]. Based on the results of the follow-up investigations, "stationary saws" in the report are comprised of table saws, band saws, radial arm saws, and miter saws. Powered hack saws were excluded because the investigations indicated that the injuries associated with this product (during the 3-month investigations) were actually associated with portable, electrical hack saws.

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[1] Excludes jigsaws and sabre saws because NEISS does not distinguish between stationary and portable reciprocating saws.

[2] NEISS does not have a product code for "miter saws" which are relatively new compared to other saws. The number of miter saws in the market has recently increased; they are very popular among non-professional users.

[3] Such as circular saws and reciprocating saws (jig or sabre).

[4] About 81 percent of the respondents participated while the remaining 19 percent only partially participated.

The weights from those cases that were successfully contacted during the follow-up investigations were adjusted for the non-responses (failure-to-contact cases) by stratum and product code. The adjusted weights were computed using the method of raking [1] where the NEISS estimated marginal total (for each product code across strata) was fixed. The annual and the 3-month estimates of injuries are based on these raking adjusted weights.

3. Product Definition [2]

A stationary saw is a powered tool that does not move because of its size or because of its type of operation. It is commonly bolted onto/mounted on/rested upon a stand or a base (as opposed to a hand-held, portable powered tool). The work is either fed into the blade (such as a table saw or a band saw) or the blade is moved onto the work (such as a radial arm saw or a miter saw) during the operation. Figure 1 – Figure 4 present a table saw, a band saw, a miter saw, and a radial arm saw, respectively.

Most power tools, especially stationary ones, are equipped with tool guards or safety devices that should be mounted following the manufacturer's instructions and maintained in good working order. The guard that covers the saw blade should be maintained so it lifts easily and allows work to pass while still covering the saw blade. Often, when a tool is designed for more than one job, the manufacturer makes available special guards to be used under particular circumstances. However, the data showed that the operators usually removed the guards when they did special cuts (other than simple cross cuttings or ripping).

A table saw has a saw blade projecting through a table on which the work is rested. The table has a laterally adjustable rip fence and is slotted to equip a wood rest/miter gauge. The wood rest/miter gauge keeps the stock at the proper angle to the blade during a cut. The operator holds the stock against the wood rest/miter gauge and advances both the gauge and the stock past the blade to make a simple crosscut. The rip fence is used in the procedure described as being a cut made parallel to/with the grain of the wood. A basic rip cut is done by placing the stock on the front edge of the table, flat down and snugly against the fence.

The typical band saw for use in a home workshop mostly has a size range of 10 to 14 inches. This dimension indicates the maximum depth of cut. The second capacity factor is the maximum distance between the table and the upper blade guides when they are at their highest point. This is the maximum thickness (height) of cut which, depending on the tool, can be anywhere between 4 and 6 inches. The saw is equipped with a continuous flexible blade or band, held taught around 2 or 3 wheels driven by a motor.

The typical miter saw is very much like a portable circular saw top mounted on its own stand. A pivot arrangement allows the tool to be swung down to saw material that is on the stand's table. That is why it is often called a "chop" saw. It is a tool usually used in miter cutting. It is not uncommon to find it used in industry and on a construction site to do cutoff on long pieces of material. The saw can be set for left-or right-hand cuts and most units have automatic stops for the most commonly used positions. The machine can be used to saw materials other than wood. With the proper blade, it can be used to cut metals or plastics.

The typical radial arm saw is a combination of a large stationary tool with the flexibility of a portable circular saw. With this machine the operator can swing, tilt, raise, lower the blade, and adjust the tool - stock relationship, comparable to hand held saw applications. On the radial arm saw, the work is set on the table against a fence. The saw blade is pulled through the stock to make all cuts.

Figure 1: Table Saw

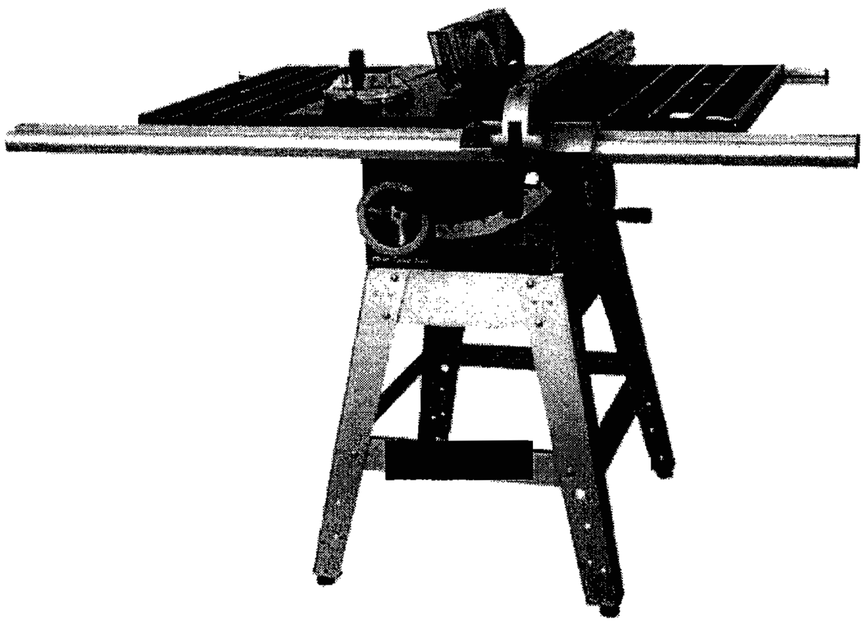


Figure 2: Band Saw

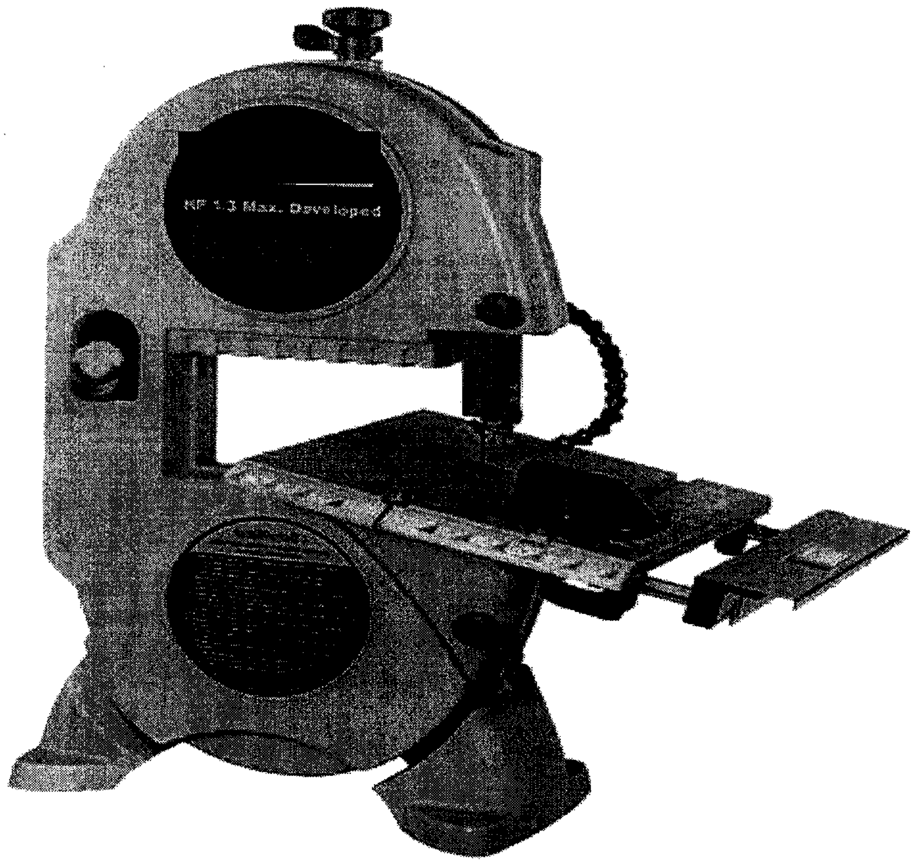


Figure 3: Miter Saw

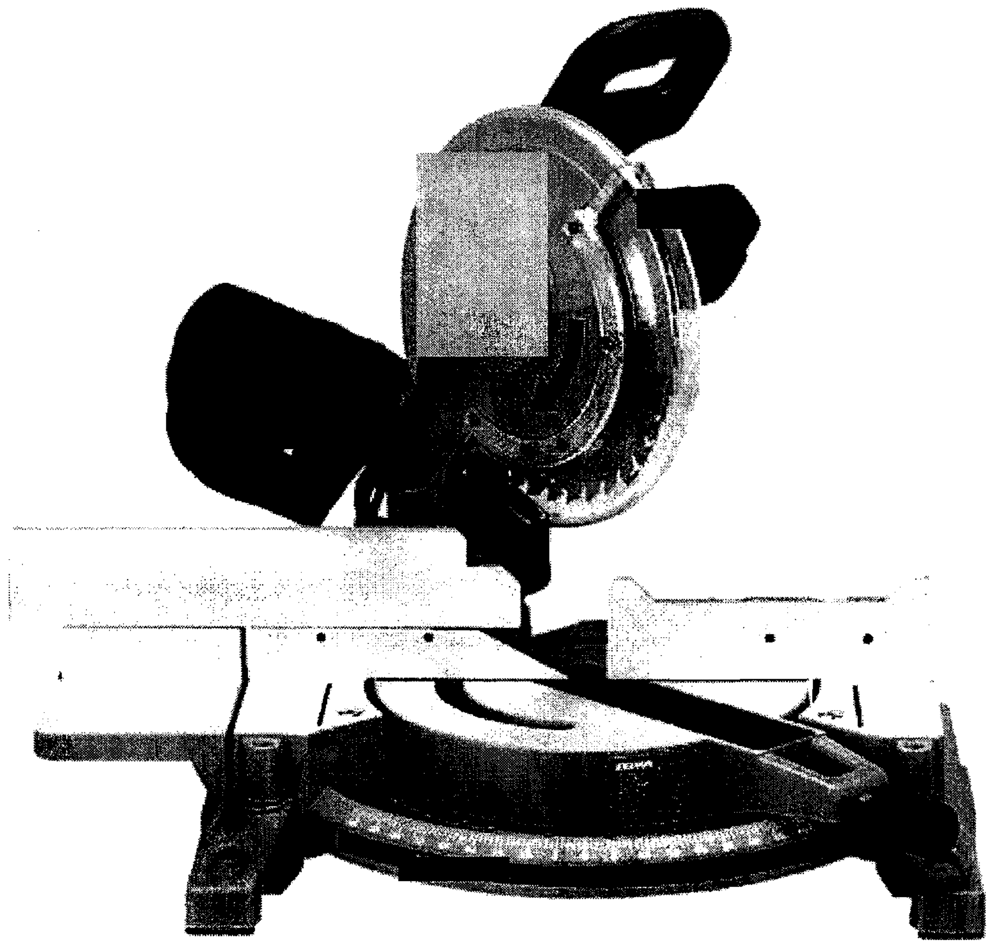
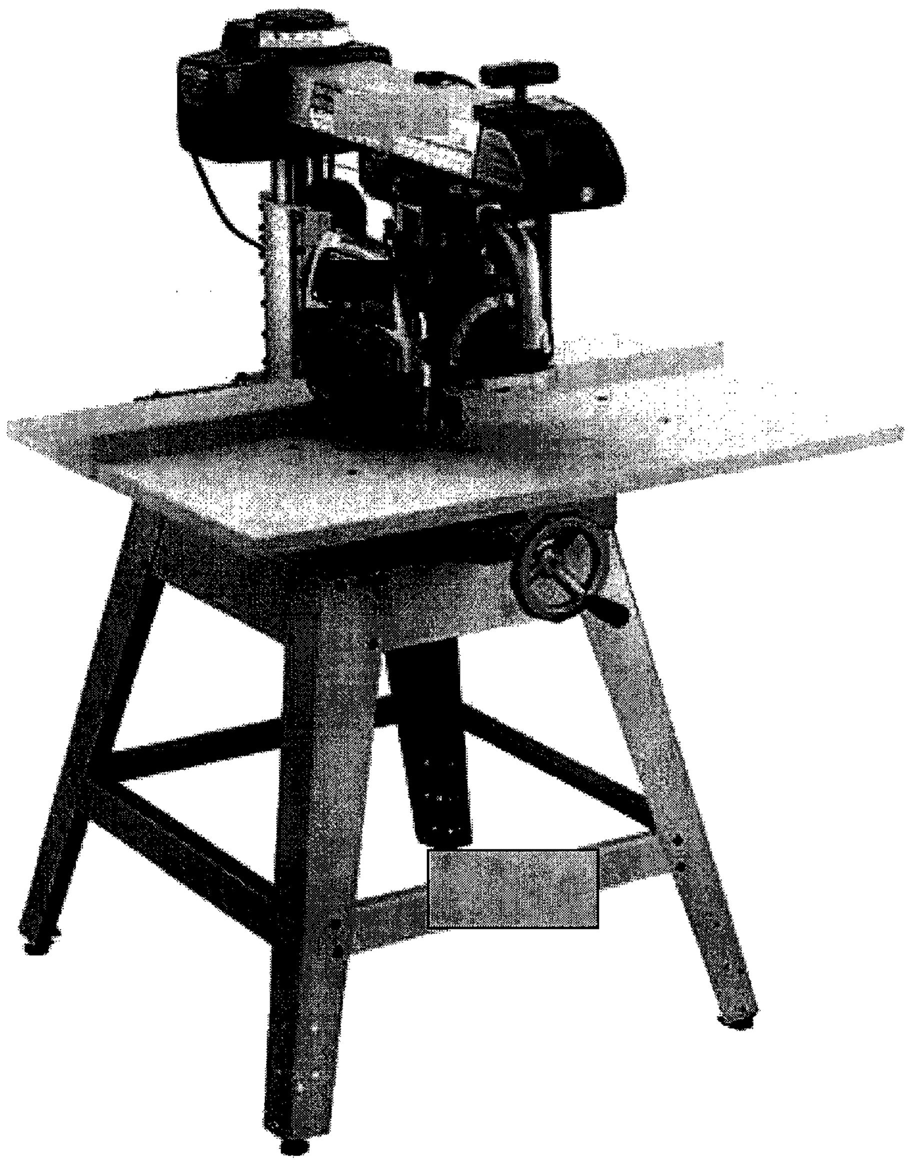


Figure 4: Radial Arm Saw



4. Types of Cuts[2]

A majority of the injuries reported in this study involved crosscutting or ripping; however, there were a few incidents that involved mitering, beveling, and dadoing. With the latter group of incidents, the operator usually took the blade guard off when performing these cuts in order to inspect his/her work closely. A description of the cuts that were performed by the operators (in this report) is presented below.

Crosscutting. A simple crosscut or cutting against the grain of the stock is made by placing the edge of the stock against a miter gauge and moving both the gauge and stock past the saw blade. The operator should be almost directly right behind the miter gauge so he/she will be out of line with the saw blade (as a safety precaution).

Ripping. A rip cut is performed by passing the stock between the blade and rip fence. Often, the procedure is described as being a cut made parallel to or with the grain of the stock. The basic rip cut is performed by placing the stock on the front edge of the saw table snugly against the fence and moving the stock past the saw blade.

Mitering. An angle cut that needs a miter gauge to facilitate the accuracy of the cut, such as cutting the stock for a picture frame. For this type of cut, the miter gauge was usually set at 45° for cutting two matching segments of stock. When two such cuts are matched, the joint is called a miter. The actual cutting may be simple, but a high degree of accuracy is required for a good match.

Beveling. Most bevels are cut using the rip fence as a guide, while the blade (or table) is tilted to the angle required. Sometimes, the miter gauge is used when a cut is performed on a narrow stock because there is a tendency for the stock to move away from the fence.

Dadoing. This is done by setting a regular saw blade to less than the stock thickness and making repeated cuts to widen the normal kerf (channel/cut) and get a U-shaped cut that is a dado when done across the grain, a groove when done with the grain.

5. National Annual Injury Estimates[5]

Based on the investigations of the incidents occurring between October 1, 2001 and December 31, 2001 which allowed for the identification of "unspecified saws", the Directorate for Epidemiology estimated that there were about 52,000 injuries (CV = 0.12, n = 225)[6] treated in U.S. hospital emergency rooms associated with stationary saws for the calendar year 2001. (A data summary of the annual injury estimates and the victims' characteristics are presented in Table 1). About 38,000 injuries (73%) involved table saws, 7,640 injuries (15%) involved miter

[5] The word "injuries" in this report means "injuries treated in U.S. hospital emergency rooms".
[6] The weights from the successfully contacted cases were adjusted for the non-responses (or raked to the fixed marginal totals of the NEISS estimates by product code across strata). SUDAAN (Software for Statistical Analysis of Correlated Data)[3] was used to compute the coefficient of variations (CV).

saws, 4,060 injuries (8%) involved band saws, and 2,300 injuries (4%) involved radial arm saws[7].

Lacerations (68%), amputations (9%), fractures (9%), and avulsions (8%) were predominant and accounted for about 48,880 injuries for the calendar year 2001[8]. Most of the injuries were to fingers which accounted for about 43,160 injuries (83%)[9]. The rate of hospitalization was five percent[10] compared to the average rate of four percent associated with all consumer products reported through the NEISS system.

The average age of the victims was 51 years old with the youngest at 2 and the oldest at 91 years of age. About 7 out of every 10 victims were between 15 and 64 years old. About 1 out of every 4 victims were 65 years or older. Men accounted for about 95 percent of the total injuries. About 51,000 injuries (98%) were associated with the saw operators.

In the following sections, many of the estimates provided for finer characterizations of the data are based on small sample sizes (with asterisk), and therefore have large variability associated with them. However, these estimates provide information which is generally not available from the NEISS reports.

6. Special Study and Specific Information Related to Injuries

Based on the same follow-up investigations (October 1, 2001 – December 31, 2001), an estimated 14,300 injuries (CV = 0.12, n = 225) were treated in U.S. hospital emergency rooms for injuries associated with stationary saws: table saws (74%), miter saws (13%)*, band saws (9%)*, and radial arm saws (4%)* for this 3-month period.

Blade-contact incidents accounted for about 12,300 injuries (86%). The remaining 2,000 injuries (14%) involved incidents such as being hit by the stock/cutting materials (10%), being hit by flying debris (3%)*, and child playing or spurious contacts[11] (1%)*. Within the blade-contact incidents, about 11,800 injuries (96%) occurred while the saws were running, the remaining 500 injuries (4%)* occurred when the saws were just turned on/off or not running. The injuries associated with being hit by the stock/cutting materials or with flying debris occurred while the saws were running. The injuries associated with children playing and with spurious contacts occurred while the saws were not running.

[7] The estimates for band saws and radial arm saws are based on small sample sizes, and therefore have large variability associated with them.

[8] The remaining six percent of injuries were distributed among contusions/abrasions, crushing, internal injuries, and foreign body.

[9] The remaining 8,840 injuries were to the hand, wrist, lower arm, lower trunk, upper leg, lower leg, head, face, eyeball, and neck.

[10] An additional 3 percent of injuries required overnight observation or were treated and then transferred to another hospital for overnight observation.

[11] Such as strains or sprains from using or helping with the saw.

* The asterisks used through out the report indicate that the estimated injuries are based on small sample size and should be used with caution.

Injuries associated with saw operators during the operating sessions accounted for about 12,000 injuries.[12] (A data summary of the injuries is presented in Table 2). The following sections examine this group of injuries with respect to hazard patterns and contributing factors, use patterns, the type of saw used at the time of the incidents, the injured body parts, and the diagnoses.

6.1. Operators During the Operating Session (12,000 injuries, n= 191)

An estimated 9,400 injuries (78%) to the operators were associated with table saws, the remaining 2,600 injuries were associated with band saws (9%)*, miter saws (8%)*, and radial arm saws (5%)*. Contact with the saw blade accounted for about 10,300 injuries (86%), being hit by a stock/cutting material accounted for about 1,430 injuries (12%), and injured from flying debris accounted for about 270 injuries (2%)*.

Most of the injuries to the operators were to lower arms, wrists, hands, or fingers and accounted for about 11,400 injuries (95%). Within this group, fingers were the most frequently injured body parts and accounted for about 10,370 injuries (91%). The remaining 600 injuries (5%)* were to heads, faces, eyeballs, lower trunk, upper legs, and lower legs.

The injuries to fingers were lacerations, amputations, fractures, avulsions, crushing, or contusions/abrasions. However, the injuries to lower arms, wrists, or hands were lacerations only. The injuries to the lower trunk, upper legs, or lower legs were lacerations or contusions/abrasions. Finally, the injuries to heads or faces were internal injuries or contusions/abrasions, and to eyeballs were foreign objects. About 1,050 injuries (9%)* were treated and kept overnight for observation, treated and transferred to another hospital, or hospitalized.

The average age of the operators was 51 years old with the youngest at 12 and the oldest at 91 years of age. About 390 operators (3%)* were between 12 and 14 years old, about 8,480 operators (71%) were between 15 and 64 years old, and about 3,130 operators (26%) were 65 years or older. The operators' age distribution was similar to that of all the victims for the calendar year 2001. This is because most of the injuries associated with the saws were to the operators.

The next sections present detailed information on the incidents to the saw operators. This information is available only from the investigations. It is presented in the following order:

6.1.1. Operational activities at the time of the incidents,
6.1.2. Stock/cutting materials,
6.1.3. Characteristics of saws involved, and
6.1.4. Hazard patterns and the contributing factors.

[12] The remaining 2,300 injuries (16%) were to the operators (not in the operating sessions), helpers, or bystanders.
* The asterisks indicate that the estimated injuries are based on small sample size and should be used with caution.

6.1.1.Operational Activities of the Operators

1. The type of cutting operation the operator had been performing prior to/at the time of the incident and the number of injuries.

- The operator had been cutting the length of stock, with the grain (ripping) - 6,170 injuries (51%).
- The operator had been cutting the width of stock, against the grain (cross cutting) - 2,050 injuries (17%).
- The operator had been cutting at a 45 degree angle, cutting at an angle other than 45 degrees, or performing the dado[13] cut - 970 injuries (8%)*.
- The type of cutting operation was *unknown*[14] in the remaining 2,810 injuries (23%)[15].

2. The type of saw blade being used prior to/at the time of the incident.

- Combination blade (cross cutting or ripping) - 3,000 injuries (25%).
- Crosscut blade, carbide-tip blade[16], continuous flexible blade (for band saws), dado blade[17], and other (fine tooth finishing, plane, and hollow grind blade) - 2,710 injuries (23%).
- Rip blade - 2,400 injuries (20%).
- The type of saw blade was *unknown* -3,890 injuries (32%).

3. The operator had been using a different type of blade for a different type of cutting prior to/at the time of the incident[18].

- The operator used a different type of blade for a different cut - 4,440 injuries (37%).
- The operator used the same blade for a different cut - 3,960 injuries (33%).
- *Unknown* if different blade was used - 3,600 injuries (30%)

4. The position of the saw blade, with respect to the stock/cutting material, prior to/at the time of the accident.

- The blade had been positioned for straight up and down cut - 8,640 injuries (72%).
- The blade had been positioned for bevel (tilted) cut - 240 injuries (2%)*.
- The position of the saw blade was *unknown* - 3,120 injuries (26%).

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[13] See footnote # 17.
[14] The respondents (operators or someone else) did not remember, did not know, or refused to answer.
[15] Does not add up to 100 percent because of rounding.
[16] Carbide-tip blade will stay sharp longer than a steel blade. The teeth of the blade cut smoother than steel blade teeth. There is as much variety in carbide-tip blades as in steel blades (combination, crosscutting, ripping, and even some mitering cut).
[17] Dado blades make a u-shaped cut when done across the grain and a groove when done with the grain.
[18] It was recommended that a certain type of blade should be used for a certain type of cut, for example, a crosscut blade is used for cross cutting while a rip blade is for ripping. Only a combination blade could be used for cross cutting or for ripping.
* The asterisks indicate that the estimated injuries are based on small sample size and should be used with caution.

5. The blade motion, with respect to the stock/cutting material, right before/at the time of the incident.

- Blade was inside a cut - 4,080 injuries (34%).
- Blade hit a knot, kicked wood up, or kicked back - 3,360 injuries (28%).
- Other (blade was above/resting against the stock not yet in a cut, caught on glove hand, or caught on hand that slipped off the stock – 1,890 injuries (16%).
- Blade caught/jammed on the stock - 1,320 injuries (11%)*.
- The blade motion was *unknown* - 1,350 injuries (11%).

6. The position of the left hand or right hand, with respect to the stock/cutting material, prior to/at the time of the incidents.

<u>Table Saws and Band Saws (10,480 Injuries)</u>

- Pushing/feeding the stock into the saw blade - 6,810 injuries (65%).
  Within this activity, a free-hand operation accounted for about 3,710 injuries, using a push block accounted for about 2,370 injuries, using a wood rest/miter gauge accounted for about 120 injuries,* the remaining 610 injuries* were unknown (whether a push block, a wood rest/miter gauge, or a free-hand was used when feeding the stock into the blade).
- Holding the stock, reaching across or over the blade, pulling stock, adjusting the blade/table angle, or turning the saw on/off - 1,830 injuries (17%).
- The position of the hand was *unknown* - 1,840 injuries (18%).

<u>Miter Saws and Radial Arm Saws (1,520 Injuries)</u>

- Holding the stock, lifting the saw arm/stock, pushing stock against the fence, or reaching across/over the blade – 1,170 injuries (77%).
- The position of the hand was *unknown* - 350 injuries (23%)*.

7. The status of the cutting operation, with respect to the stock/cutting materials, prior to/at the time of the incident.

- Part way through the cut - 4,190 injuries (35%).
- Stock coming out at the far end of the blade - 3,620 injuries (30%).
- Start cutting, about to cut, or just about finish cutting - 880 injuries (7%)*.
- The status of cutting was *unknown* - 3,310 injuries (28%).

8. The operators had been working at an average of 1 hour and 18 minutes, with a minimum of zero hour (just about to start cutting) and a maximum of eight hours, with the saw that day.

* The asterisks indicate that the estimated injuries are based on small sample size and should be used with caution.

6.1.2.Stock/Cutting Materials

1. The operator had been cutting the stock/material described below prior to/at the time of the accident.

- Wooden board - 8,520 injuries (71%).
- Paneling/siding, block of wood/log, plastic laminate material, wood molding, pipe/metal, bamboo/stick - 980 injuries (8%)*.
- The stock/material was *unknown* - 2,500 injuries (21%)

2. The shape and size (length, width, and thickness) of the stock/cutting material being cut prior to/at the time of the incident.

Shapes

- Rectangular - 7,200 injuries (60%).
- Square, triangular, octagonal, long and thin, round, or curved - 1,690 injuries (14%).
- The shape of the stock/cutting material was *unknown* - 3,110 injuries (26%).

Sizes

- The average length of the stock/cutting materials was about 2 feet
- The average width of the stock/cutting materials was about 6 inches
- The average thickness of the stock/cutting materials was about 1 inch.

3. The condition of the stock/cutting material being cut prior to/at the time of the incident.

- Nothing Unusual - 2,530 injuries (21%)
- Hard wood (mahogany, oak, or walnut) - 2,520 injuries (21%).
- Dry or wet wood - 2,250 injuries (19%).
- Smooth, soft (cedar or pine), knotty wood - 1,610 (13%).
- The condition of stock/cutting material was *unknown* – 3,090 injuries (26%).

4. How the stock/cutting material was supported prior to/at the time of the incident.

- The stock was resting on a table or on a table with an additional support - 8,160 injuries (68%).
- On a saw base, on a saw base with additional support, on the floor/ground, on a saw horse, or held in hand - 600 injuries (5%)*.
- The support of the stock/cutting material was *unknown* - 3,240 (27%).

5. Whether the whole surface of the stock/cutting material fit on the support.

- The whole surface of the stock fit on support – 5,800 injuries (48%).
- The whole surface did not fit on support - 2,770 injuries (23%).
- *Unknown* whether the whole surface of the stock/cutting materials fit - 3,430 injuries (29%).

6. Whether the stock/cutting material or the support was firmly anchored.

- The stock or the support was firmly anchored - 5,550 injuries (46%).
- The stock or support was loosely held or wobbled – 2,720 injuries (23%).
- *Unknown* whether the stock/cutting material or the support was firmly anchored - 3,730 injuries (31%).

* The asterisks indicate that the estimated injuries are based on small sample size and should be used with caution.

6.1.3 Characteristics of Saws Involved

1. Ownership of the saw.
- The operator owned and purchased saw new (74%) or used (26%) - 10,200 injuries (85%).
- The operator used someone else's saw or rented - 1,800 injuries (15%).

2. Saw Age.
- Ten years old or less (one out of every five saws involved were 1 year old or newer) - 5,050 injuries (42%).
- Over 10 years - 3,510 injuries (29%).
- The age of the saw was *unknown* - 3,440 injuries (29%).

3. Whether the saw had been changed or modified in any way since the operator obtained it.
- No, the saw had not been changed or modified - 8,280 injuries (69%).
- Yes, the saw had been changed or modified (mostly by the operators)[19] - 840 injuries (7%)*.
- *Unknown* whether the saw had been changed or modified - 2,880 injuries (24%).

4. Whether the saw was assembled when purchased or the owner assembled it after purchased.
- Assembled when purchased[20] - 6,240 injuries (52%).
- Assembled by owners/relatives - 1,920 injuries (16%).
- *Unknown* whether the saw was assembled when purchased - 3,840 injuries (32%)

5. Whether the blade had a safety switch (removable or stationary) such as a key lock that must be activated, in addition to the starter switch, before the saw could be turned on.
- Did not have a safety switch - 4,680 injuries (39%).
- Had a safety switch (either removable or stationary types) - 4,080 injuries (34%).
- *Unknown* whether the blade had a safety switch - 3,240 injuries (27%).

6. Whether the blade was sharp or dull[21] during the cutting operation.
- The blade was sharp or moderately sharp – 8,060 injuries (67%).
- Dull - 540 injuries (5%)*.
- *Unknown* whether the blade was sharp or dull - 3,400 injuries (28%).

7. Whether the blade guard was attached to the saw prior to/at the time of the incident.
- The blade guard was damaged, removed (including when making special cut such as dado or bevel cut) or guard broken off – 3,860 injuries (32%).
- The blade guard was attached to the saw – 2,600 injuries (22%).
- The saw never had one – 2,180 injuries (18%).
- *Unknown* whether the blade guard was attached to the saw - 3,360 injuries (28%).

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[19] For example, blade guards had been removed, motors had been replaced, or rip fences had been added on.
[20] Less than one percent were partially assembled.
[21] Dull blades required more feed pressure, which presents a situation where the operator's hands might slip.
* The asterisks indicate that the estimated injuries are based on small sample size and should be used with caution.

8. Whether the anti-kickback[22] assembly attached to the saw prior to/at the time of the incident.
Table Saws or Band Saws (10,480 injuries)

- Did not come with one – 3,720 injuries (35%).
- Removed or did not put one on – 2,310 injuries (22%).
- Equipped with one - 950 injuries (9%)*.
- *Unknown* whether the anti-kickback assembly attached to the saw – 3,500 injuries (33%)[23].

Miter Saws or Radial Arm Saws (1,520 injuries)

Almost half of the saws had no information on the anti-kickback device. Of the ones with information, some were equipped with a device while others either had a device removed or were not equipped with one.

6.1.4. Hazards and the Contributing Factors

Hazards to the operators associated with stationary saws during the operation were contact with a saw blade (blade contact), being hit by stock/cutting material, or being hit by flying debris. The contributing factors to each of these hazards are presented below. The summary of the hazard patterns and their contributing factors are presented in Table 3.

Blade Contact (10,300 injuries)

The contributing factors to blade contact and the number of injuries are presented below.

- Stock/cutting material, tool, and hand interface[24] - 4,230 (41%).
- The saw or stock/cutting material kicked back[25] causing the hand or finger to come in contact with the blade - 2,580 injuries (25%).
- The saw blade jammed in stock/cutting material[26] (without kickback), hand slipped off stock, or the saw blade hit a knot in the stock - 2,100 injuries (20%).
- The operators reached over the blade and hit the blade - 1,390 (13%)[27].

Being Hit By Stock/Cutting Material (1,430 injuries)

The contributing factors to this hazard were the saw or stock/cutting material kicked back causing the stock to hit the operator or the blade jammed in the stock/cutting material causing the stock to buck/bounce and hit the operator.

Frying Debris (270 injuries)*

The contributing factors to flying debris were stock/cutting material breaking during the operation or the cut off piece caught in the saw teeth and was flung back (incidents in which the stock/cutting material split, broke, or fragmented were seen with all the saws). In most cases, eye injuries were sustained as a small piece of flying debris made contact with the eye. In other

[22] A mechanism that prevents the wood from kicking back.
[23] Does not add up to 100 percent because of rounding.
[24] For example, the operators were using a hand to guide the stock and failed to move the hand as it came into the path of the blade or the operators were trying to remove cut pieces without first turning off the saws.
[25] Kickback of the saw resulting in a blade contact is associated with miter saws or radial arm saws. The blades of these saws are mobile along the arm to which they are connected. The incident occurred when the operator held the stock loosely in his hand and when the saw suddenly kicked back, it threw his hand into the blade.
[26] One fatality is reported in the Commission's Injury or Potential Incident File (IPII) for the calendar year 2001.
[27] Does not add up to 100 percent because of rounding.
* The asterisks indicate that the estimated injuries are based on small sample size and should be used with caution.

cases, injuries to upper leg, upper trunk, face, and head were sustained as large pieces split or broke off and were flung away from the saw onto the operator.

6.2. Discussion

As stated in the introduction, the estimated injuries associated with stationary saws could have been larger if unspecified saws were identified. The follow-up investigation shows that the annual estimated injuries associated with stationary saws increased by 43 percent from about 36,400 injuries (identified by NEISS codes) to about 52,000 injuries (after the unspecified saws were identified) in the calendar year 2001.

Blade contact has been identified as a major hazard related to stationary saw use during this study period. Finger contact with the operating blade occurred most often in different scenarios. With table and band saws, the operator used a hand to guide the stock/cutting material; lacerations and sometimes amputations resulted when he failed to move his hand as it came into the path of the blade. In some incidents, the operator was pushing the stock and got too close to the blade and his/her gloved hand was caught in the blade. With miter and radial arm saws, the operator accidentally engaged the operating switch on the saw arm/handle which automatically started the blade, resulting in blade contact to the hand (which was holding the stock/cutting material). With all types of saws, the operator's hand which was holding the stock and/or guiding the stock slipped into the blade when the blade jammed in the stock. Also the blade contact occurred when the operator was trying to remove cut pieces from the table/base without first turning the saw off. In many of the blade contact cases, there was no blade guard in use at the time of the incident. Often the operator had removed the guard to get a clear view of his work, to do a special cut such as a dado, or to cut a very small piece of stock/cutting material.

Stock kickback was reported with some frequency. In these incidents the blade slowed or stopped momentarily as it bound or caught in the stock such as when it hit a knot or when it was pinched or jammed because the cut began to close behind the blade. This caused the stock to bounce out and hit the operator's hand as he tried to stop the stock from flying up and caused his hand to contact the blade. Some injuries occurred when the stock actually struck the operator as it was kicked out from the saw.

Saw kickback is a hazard which is associated with miter and radial arm saws. Saw kickback cases were similar to those that caused stock kickback, but in these cases the saw blade kicked back because it was mobile. The saw has been reported to bounce out of the cut and contact the users. For example, as the operator of the radial arm saw pulled the radial arm onto the stock too fast it bounced back from the stock and contacted the operator's hand (this is because radial arm saws are mobile along the arm).

A majority of the injuries related to the above hazards occurred when ripping hard boards such as mahogany, walnut, or oak. Other common causes of injuries were free-hand operation when guiding the stock into the blade and reaching across/over the spinning blade to remove cut pieces from the table.

Table 1
Estimated Annual Injuries Associated with Stationary Saws
Treated in U.S. Hospital Emergency Rooms Classified
By Products and Victims' Characteristics
January 1, 2001 – December 31, 2001

Description	Injury Estimate	Sample Size (n)
Type of Saw	**Total=52,000**	**n=225**
Table Saws	38,000	164
Miter Saws	7,640	36
Band Saws	4,060	18*
Radial Arm Saws	2,300	7*
Description of Victim and Injury		
Diagnosis	**Total=52,000**	**n=225**
Lacerations, Amputations, Fractures, Avulsions	48,880	212
Contusions/Abrasions, Crushing, Internal Injuries, Foreign Body	3,120	13*
Body Part	**Total=52,000**	**n=225**
Finger	43,160	186
Hand, Wrist, Lower Arm, Lower Trunk, Upper Leg, Lower Leg, Head, Face, Eyeball, and Neck	8,840	39
Disposition	**Total=52,000**	**n=225**
Hospitalizations	2,600	16*
Overnight Observations or Treated and Transferred	1,560	6*
Treated and Released	47,840	203
Victim (Age)	**Total=52,000**	**n=225**
0 –14	1,200	7*
15 – 64	38,300	161
65 or Older	12,500	57
Users	**Total=52,000**	**n=225**
Operator	51,000	218
Non-operator	1,000	7*
Gender	**Total=52,000**	**n=225**
Male	49,600	214
Female	2,400	11*

Source: CPSC, National Electronic Injury Surveillance System (NEISS) and Special Study of Stationary Saws, October 1, 2001 Through December 31, 2001, Directorate for Epidemiology, Hazard Analysis Division.

* Based on small sample size, therefore, the estimate is subject to large sampling variability and should be used with caution.

Table 2
Special Study of Stationary Saws
Operators and Activities During Operating Sessions
October 1, 2001 – December 31, 2001

Description	Injury Estimate	Sample Size (n)
Operator		
Age	**Total=12,000**	**n=191**
12 –14	390	5*
15 - 64	8,480	137
65 and Older	3,130	49
Body Part	**Total=12,000**	**n=191**
Lower Arm, Wrist, Hand, and Finger	11,400	181
Head, Face, Eyeball, Lower Trunk, Upper leg, Lower Leg	600	10*
Diagnosis	**Total=12,000**	**n=191**
Laceration, Amputation, Fracture, Avulsion, or Crushing	11,600	183
Contusion/Abrasion, Internal Injury, or Foreign Object	400	8*
Disposition	**Total=12,000**	**n=191**
Hospitalization, Treated and Overnight Stay, or Treated and Transferred to Another Hospital	1,050	18*
Treated and Released	10,950	173
Hazard Patterns[28]	**Total=12,000**	**n=191**
Blade Contact	10,300	162
Being Hit by Stock/Material	1,430	23
Flying Debris	270	6*
Saw Type	**Total=12,000**	**n=191**
Table Saw	9,400	148
Band Saw	1,080	15*[29]
Miter Saw	960	21
Radial Arm Saw	560	7*

* Based on small sample size, therefore, the estimate is subject to large sampling variability and should be used with caution.

[28] Detailed in Table 3
[29] Involved injuries that were treated in small, medium or large hospitals with large sampling weights.

Description	Injury Estimate	Sample Size (n)
Operational Activities		
Type of Cut	**Total=12,000**	**n=191**
Ripping	6,170	91
Crosscutting	2,050	33
Dadoing, Mitering, or Beveling	970	16*
Unknown	2,810	51
Saw Blade	**Total=12,000**	**n=191**
Combination Blade	3,000	47
Rip Blade	2,400	38
Cross Cut, Carbide-Tip, Continuous Flexible, Dado, and Other (fine tooth, hollow grind) Blade	2,710	40
Unknown	3,890	66
Different Type of Blade for Different Type of Cut	**Total=12,000**	**n=191**
Different Type of Blade	4,440	70
Same Blade	3,960	61
Unknown	3,600	60
Position of Saw Blade	**Total=12,000**	**n=191**
Straight Up and Down Cut	8,640	134
Bevel (Tilted) Cut	240	3*
Unknown	3,120	54
Blade Motion	**Total=12,000**	**n=191**
Inside a Cut	4,080	67
Hit a Knot in Stock, Kicked Wood Up, Kicked Back	3,360	56
Other (Above/Resting Against Stock, Caught Gloved Hand, Hand Slipped into Blade, etc.)	1,890	30
Caught/Jammed in Stock,	1,320	18*
Unknown	1,350	20
Position of Operator's Hands	**Total=12,000**	**n=191**
(1) Table and Band Saws	**Subtotal=10,480**	**n=163**
Pushing/Feeding Stock	6,810	103
Holding Stock, Reaching Over Blade/Pulling Stock, or Adjusting Blade Angle	1,830	26
Unknown	1,840	34

* Based on small sample size, therefore, the estimate is subject to large sampling variability and should be used with caution.

Description	Injury Estimate	Sample Size (n)
(2) Miter Saw and Radial Arm Saw	**Subtotal=1,520**	**n=28**
Holding Stock, Lifting the Saw Arm/Stock, Pushing Stock, or Reaching Across/Over Blade	1,170	21
Unknown	350	7*
Status of Cutting Operation	**Total=12,000**	**n=191**
Part Way Through the Cut	4,190	70
Coming Out At the Other End	3,620	56
Start Cutting or Just About to Finish	880	14*
Unknown	3,310	51
Stock/Cutting Material Type	**Total=12,000**	**n=191**
Wooden Board	8,520	130
Paneling/Siding, Block of Wood/Log, Plastic Laminate Material, Wood Molding, Pipe/Metal, Bamboo/ Stick	980	19*
Unknown	2,500	42
Shape	**Total=12,000**	**n=191**
Rectangular	7,200	108
Square, Triangular, Octagonal, Long & Thin, Round, or Curve	1,690	29
Unknown	3,110	54
Condition of Stock/Material	**Total=12,000**	**n=191**
Nothing Unusual	2,530	41
Hard	2,520	36
Dry or Wet	2,250	25
Smooth, Soft, or Knotty	1,610	23
Unknown	3,090	66
Stock Support	**Total=12,000**	**n=191**
Table or Table and Addition	8,160	122
Base, Base and Addition, Floor, Saw Horse, or Held in Hand	600	11*
Unknown	3,240	58
Stock Fit on Support	**Total=12,000**	**n=191**
Fit	5,800	80
Did Not Fit	2,770	47
Unknown	3,430	64
Stock Firmly Anchored	**Total=12,000**	**n=191**
Firmly Anchored	5,550	79
Loosely Held or Wobbled	2,720	48
Unknown	3,730	64

* Based on small sample size, therefore, the estimate is subject to large sampling variability and should be used with caution.

Characteristic of Saw	Injury Estimate	Sample Size (n)
Ownership	**Total=12,000**	**n=191**
Purchased New or Used	10,200	131
Used Someone Else Saw or Rented	1,800	60
Saw Age	**Total=12,000**	**n=191**
10 Years Old or Newer	5,050	81
Over 10 Years	3,510	54
Unknown	3,440	56
Modified or Changed	**Total=12,000**	**n=191**
No	8,280	128
Yes	840	11*
Unknown	2,880	52
Assembled When Purchased	**Total=12,000**	**n=191**
Yes	6,240	92
No	1,920	33
Unknown	3,840	66
Safety Switch	**Total=12,000**	**n=191**
Did Not Have	4,680	68
Have a Safety Switch	4,080	65
Unknown	3,240	58
Sharp or Dull Blade	**Total=12,000**	**n=191**
Sharp or Moderately Sharp	8,060	123
Dull	540	7*
Unknown	3,400	61
Blade Guard	**Total=12,000**	**n=191**
Damaged, Removed, or Broken off	3,860	62
Attached	2,600	43
Never Had One	2,180	28
Unknown	3,360	58
Anti-Kickback	**Total=12,000**	**n=191**
(1) Table and Band Saws	**Subtotal=10,480**	**n=163**
Did Not Come With Saw	3,720	49
Removed/Did Not Put It On	2,310	34
Equipped With One	950	15*
Unknown	3,500	65
2) Miter and Radial Arm Saws	**Subtotal=1,520**	**n=28**
Equipped, Removed/Didn't Put On/Didn't Come With One, or Unknown	1,520	28

Source: CPSC, National Electronic Injury Surveillance System (NEISS) Special Study of Stationary Saws, October 1, 2001 Through December 31, 2001, Directorate for Epidemiology, Hazard Analysis Division.

* Based on small sample size, therefore, the estimate is subject to large sampling variability and should be used with caution.

Table 3
Hazards and Contributing Factors
During the Operating Session
October 1, 2001 – December 31, 2001

Description	Estimated Injuries	Sample Size (n)
Hazards and Contributing Factors	**Total=12,000**	**n=191**
Blade Contact	**Subtotal=10,300**	**n=162**
Stock, Tool, and Hand Interface	4,230	82
Saw or Stock Kicked Back	2,580	32
Blade Jammed in Stock (no kickback), Hand Slipped Off Stock, or Saw Blade Hit a Knot	2,100	24
Reaching Over Blade	1,390	24
Being Hit By Stock	**Subtotal=1,430**	**n=23**
Saw/Stock Kicked Back or Blade Jammed in Stock	1,430	23
Flying Debris	**Subtotal=270**	**n=6***
Piece of Wood or Saw Dust	270	6*

Source: CPSC, National Electronic Injury Surveillance System (NEISS) Special Study of Stationary Saws, October 1, 2001 Through December 31, 2001, Directorate for Epidemiology, Hazard Analysis Division
* Based on small sample size, therefore, the estimate is subject to large sampling variability and should be used with caution.

References:

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2. "The Complete Book of Stationary Power Tool Techniques", De Cristoforo, R.J., Published 1988 by Stering Publishing Company, Inc., New York.
3. SUDAAN, Software for Statistical Analysis of Correlated Data, User's Manual, Volume 1, Shah, Babubhai V., Barnwell, Beth G., and Bieler, Gayle S.

Appendix B:
Adjustment for Table Saw, Band Saw, Miter Saw, and Radial Arm Saw Estimates for Future Use

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: June 04, 2003

TO : The File
Directorate for Epidemiology

THROUGH : Susan Ahmed, Ph.D., AED
Directorate for Epidemiology
Russell H. Roegner, Ph.D., Director
Hazard Analysis Division, EP

FROM : Prowpit Adler, EPHA
Division of Hazard Analysis

SUBJECT : Adjustment for Table Saw, Band Saw, Miter Saw, and Radial Arm Saw Estimates for Future Use

This memorandum presents the adjustment method for table saw, band saw, miter saw, and radial arm saw estimates for NEISS CY 2002 and after. The adjustment was based on the results of the follow-up investigation of the incidents that occurred between October 1, 2001 and December 31, 2001 and the raking adjusted weights for non-responses.

Using the adjustment factors based on a follow-up investigation to the annual estimates is desirable when there is a high proportion of the NEISS cases with "Not Specified" product codes involved. This is because without the adjustment factors the estimate for stationary saws (table saws, band saws, radial arm saws, and miter saws) was underestimated by about 43 percent in CY 2001 as shown below.

Code	Name	CY 2001 NEISS Estimate Before Follow Up	CY 2001 NEISS Estimate After Follow Up	Difference
0841	Table Saw	31,900	38,000[1]	+6,100
0842	Band Saw	3,600	4,060[2]	+460
0843	Radial Arm Saws	500	2,300[3]	+1,800
0844	Hack Saw (power)	400	0[4]	-400
0890[5]	Miter Saws	0,000[6]	7,640[7]	+7,640

[1] From NEISS codes 0841 (0.9731), 0842 (0.0221), 0845 (0.2017), 0863 (0.1325), 0872 (0.1388).
[2] From NEISS codes 0842 (0.8622), 0845 (0.0186), 0872 (0.0495).
[3] From NEISS codes 0843 (1.0), 0845 (0.0418), 0863 (0.0562), and 0872 (0.0425).
[4] Follow-up investigation indicated that the saws were portable.
[5] This is a make-up code for miter saws because there is no NEISS code for the saws.
[6] No NEISS cases were reported under this code.
[7] From NEISS codes 0841(0.005), 0842 (0.0221), 0845 (0.1004), 0863 (0.5115), and 0872 (0.2021).

Each of the annual injury estimates corresponding to codes 0841, 0842, 0843, 0844, and 0890 in column # 3 was obtained from the follow-up investigations which allowed for the identification of "unspecified saws" (see Footnotes # 1, 2, 3, 4, and 7). For example, the annual injury estimate of 38,000 which corresponds to table saws (row # 1, column # 3) was obtained from the following NEISS codes:

- About 97 percent (0.9731) of the injuries reported to be associated with code 0841 were actually involved with table saws.
- About 2 percent (0.0221) of the injuries reported to be associated with code 0842 were actually involved with table saws.
- About 20 percent (0.2017) of the injuries reported to be associated with code 0845 (saws, not specified) were actually associated with table saws.
- About 13 percent (0.1325) of the injuries reported to be associated with code 0863 (other power saws) were actually associated with table saws.
- About 14 percent (0.1388) of the injuries reported to be associated with code 0872 (power saws, not specified) were actually associated with table saws.

The annual injury estimates in rows # 2, 3, and 5 in column #3 follow the same principle as the estimate for table saws.

When staff make an adjustment to NEISS estimates of table saw, band saw, miter saw, and radial arm saw injuries (for calendar years 2002 and after) by following the above method, they must consider that the adjusted estimates may have larger variances than those of the original NEISS estimates. This is because each adjusted estimate is calculated from multiple estimates each with a corresponding variance.

If staff are taking adjustments of several different product codes and then adding them together, they must consider the covariances between the product codes. The formula for the adjusted variance for such an estimate is presented below:

$$\text{ADJ\_VAR} = \Sigma[\,(\text{Ratio}_i)^2 * \text{Var}\,(\text{NEISS}_i)] + 2\,\Sigma[\,(\text{Ratio}_i)*(\text{Ratio}_j)* \text{Cov}\,(\text{NEISS}_i, \text{NEISS}_j)\,] + \Sigma[\,(\text{NEISS}_i)^2 * \text{Var}\,(\text{Ratio}_i)] + 2\,\Sigma\,[\,(\text{Ratio}_i)* (\text{NEISS}_i)* \text{Cov}\,(\text{Ratio}_i, \text{NEISS}_i)]$$

where $i = 1, 2, \ldots, n$ and $i<j$.

Assuming that there is no correlation between the adjustment factors[8] (Ratio_i) and the corresponding NEISS estimates of the following years, the ADJ_VAR will be

$$= \Sigma[(\text{Ratio}_i)^2 * \text{Var}\,(\text{NEISS}_i)] + 2\,[\,\Sigma\,(\text{Ratio}_i)*(\text{Ratio}_j) * \text{Cov}\,(\text{NEISS}_i, \text{NEISS}_j)] + \Sigma\,[(\text{NEISS}_i)^2 * \text{Var}\,(\text{Ratio}_i)],$$ [9]

where the calculations of the variances and covariances in the above equation are obtained by using SUDAAN software for the statistical analysis of correlated data .

[8] Obtained from the follow-up investigation conducted in CY01.
[9] Schroeder, Thomas J., Division of Hazard & Injury Data Systems, CPSC.

For example, the *adjusted* variance for the *adjusted* annual estimate of 38,980 table saw related injuries in calendar year 2002 is

ADJ_VAR =[(0.9731)^2 * Var (code 0841) + (0.0221)^2 * Var (code 0842) + (0.2017)^2 * Var (code 0845) + (0.1325)^2 * Var (code 0863) + (0.1388)^2 * Var (code 0872)] + **2** [(0.9731) (0.0221) * Cov (code 0841, code 0842) + (0.9731)(0.2017) * Cov (code 0841, code 0845) + (0.9731) (0.1325) * Cov (code 0841, code 0863) + (0.9731) (0.1388) * Cov (code 0841, code 0872) + (0.0221) (0.2017) * Cov (code 0842, code 0845) + (0.0221) (0.1325) * Cov (code 0842, code 0863) + (0.0221) (0.1388) * Cov (code 0842, code 0872) + (0.2017) (0.1325) * (code 0845, code 0863) + (0.2017) (0.1388) * (code 0845, code 0872) + (0.1325) (0.1388) * Cov (code 0863, code 0872)] + [(code 0841.)^2 Var (0.9731) + (code 0842.)^2 Var (0.0221) + (code 0845)^2 Var (0.2017) + (code 0863)^2 Var (0.1325) + (code 0872)^{2}Var (0.1388)]

= 11,863,556.44[10]

CV = 0.088362

Based on the above methodology, the adjusted estimate of injuries associated with table saws, ADJ_VAR and CV for CY 2002 are presented below.

Code	Name	CY 2002 NEISS Estimate	VAR	CV	CY 2002 Adjusted Estimate	ADJ_VAR	CV
0841	Table Saw	33,114	8,850,625	0.09	38,980	11,863,556	0.09

Based on the same methodology, the adjusted variances (ADJ_VARs) for the CY 02, adjusted estimates of injuries associated with band saw, radial arm saw, and miter saw injuries are as follows:

Code	Name	CY2002 NEISS Estimate	VAR	CV	CY 2002 Adjusted Estimate	ADJ_VAR	CV
0842	Band Saw	3,397	219,024	0.14	3,750	612,841	0.21
0843	Radial Arm	617	37,249	0.31	2,290	803,810	0.39
0890	Miter Saw	0	0	0	7,400	2,487,527	0.21

As stated earlier, using the adjustment factors (based on a follow-up investigation) with the annual estimates is desirable when there is a high proportion of NEISS cases with "Not Specified" product codes involved.

[10] A SAS program for the adjusted variance is attached as an Appendix.

Appendix

```
data temp;
 input  Code1 NEISS_1 VNEISS_1 Ratio_1 Sratio_1
          Code2 NEISS_2 VNEISS_2 Ratio_2 Sratio_2
           Code3 NEISS_3 VNEISS_3 Ratio_3 Sratio_3
           Code4 NEISS_4 VNEISS_4 Ratio_4 Sratio_4
           Code5 NEISS_5 VNEISS_5 Ratio_5 Sratio_5
  ;

cards;
 0841 0033114 8850625 00.9731 00.0137
 0842 0003397 0219024 00.0221 00.0214
 0845 0023715 5184729 00.2017 00.0391
 0863 0006315 0720801 00.1325 00.1001
 0872 0007660 0753424 00.1388 00.0583
  ;
Data temp; set temp;
Vratio_1 = Sratio_1**2;
Vratio_2 = Sratio_2**2;
Vratio_3 = Sratio_3**2;
Vratio_4 = Sratio_4**2;
Vratio_5 = Sratio_5**2;
adj_var = ((Ratio_1**2)* VNEISS_1)+ ((Ratio_2**2)* VNEISS_2)+
           ((Ratio_3**2)* VNEISS_3)+((Ratio_4)**2 *
           VNEISS_4)+((Ratio_5**2) *
           VNEISS_5)+2*((Ratio_1*Ratio_2)*(1452049/2))+
           2*((Ratio_1*Ratio_3)*(5391754/2))+2*((Ratio_1*Ratio_4)
           *(1770577/2))+
           2*((Ratio_1*Ratio_5)*(1298125/2))+2*((Ratio_2*Ratio_3)
           *(475353/2))+
           2*((Ratio_2*Ratio_4)*(203661/2))+2*((Ratio_2*Ratio_5)*
           (151612/2))+
           2*((Ratio_3*Ratio_4)*(1209641/2))+2*((Ratio_3*Ratio_5)
           *(1477609/2))+
           2*((ratio_4*Ratio_5)*(248776/2))+(NEISS_1)**2 *
           (Vratio_1)+(NEISS_2)**2 * (Vratio_2)+(NEISS_3)**2 *
           (Vratio_3)+(NEISS_4)**2 * (Vratio_4)+ (NEISS_5)**2 *
           (Vratio_5)
 ;
 proc print; var adj_var;
 run;
```

****

Note: $Var(x-y) = Var(x)+Var(y) - 2\ Cov(x,y)$

$Cov(x,y) = [Var(x)+ Var(y)-Var(x-y)]/2$

****

Appendix C:
Table Saw Related Injuries and Fatalities (1991-2000)

Table Saw Related Injuries and Fatalities (1991-2000)

1. Estimated Annual Injuries and Trend

Table 1
Estimated Emergency Room-Treated Injuries
Associated with Table Saws
January 1, 1991 – December 31, 2000

Year	Sample	Estimate	CV[1]	Adjustment Factor	Adjusted Estimate	Adjusted CV
1991	551	30,165	.1194	0.93668	28,255	.1303
1992	676	34,217	.1151	0.92612	31,689	.1306
1993	623	30,743	.1044	0.91557	28,147	.1265
1994	579	30,543	.1014	0.90502	27,642	.1299
1995	604	29,824	.0966	0.89446	26,676	.1329
1996	627	29,040	.0968	0.89446	25,975	.1330
1997[2]	471	23,853	.0854	.	.	.
1998	684	33,590	.0799	.	.	.
1999	683	32,685	.0856	.	.	.
2000	677	32,353	.0839	.	.	.

Source: U.S. Consumer Product Safety Commission (CPSC), National Electronic Injury Surveillance System (NEISS), Directorate for Epidemiology, Hazard Analysis Division.

The adjusted total for table saw-related emergency room-treated injuries for the 10-year period is 290,865. In the same period, the unadjusted total for table saw-related injuries is 307,013. Note that the unadjusted estimates are slightly higher than the adjusted estimates between 1991 and 1996. The injury trend associated with table saws is stable[3] over the past 10 years.

To compute multi-year injury estimates and to compare estimates over time periods with different sampling frames and different samples, CPSC has developed methods to statistically adjust the basic (or historical) NEISS estimates. The adjustments smooth the data across different samples when some discontinuities in the estimates have occurred because of the differences in sampling frames and samples. The adjustment factors were derived from data collected from the overlapping samples of both "old" and "new" hospitals that were in operation in the same period of time[4]. The adjusted estimate is the basic (or historical) estimate multiplied by the adjustment factor. The most recent NEISS update occurred on January 1, 1997. Therefore, all injury estimates prior to this date need adjustments as shown in Table 1, Table 2, and Table 3.

2. Body Parts and Diagnoses

Most of the injuries (95%)[5] associated with table saws were to the wrist, hand, or finger during this period. A majority of these injured body parts (90%)[6] were treated for

[1] A relative measure of the variability in the data.
[2] A few new hospitals were late participating with the NEISS system.
[3] Year-to-year comparisons of injury estimates were not statistically significant.
[4] Marker, D, et al (1999). Comparisons of National Estimates from Different Samples and Different Sampling Frames of the National Electronic Injury Surveillance System (NEISS), Rockville, MD: Westat Inc.
[5] Total adjusted estimated 276,445 injuries were to the wrist, hand, or finger.
[6] Total adjusted estimated 249,041 injuries were lacerations, fractures, or amputations to the wrists, hands, or fingers.

lacerations, fractures, or amputations. The annual estimates of injuries associated with the wrists, hands, or fingers are presented in Table 2. The annual estimates of injuries associated with lacerations, fractures, or amputations to the wrists, hands, or fingers are presented in Table 3. The adjustments were made to the estimates prior to January 1, 1997 in both tables. There is no change in the injury trend based on the estimates in Table 2 or in Table 3.

Table 2
Estimated Table Saw-Related Emergency Room Treated Injuries
To Wrists, Hands, or Fingers
January 1, 1991 – December 31, 2000

Year	Sample	Estimate	CV	Adjustment Factor	Adjusted Estimate	Adjusted CV
1991	524	28,577	.1217	0.95099	27,176	.1337
1992	628	31,803	.1146	0.94282	29,985	.1318
1993	579	28,259	.1047	0.93465	26,412	.1287
1994	550	29,058	.1024	0.92648	26,922	.1331
1995	572	28,141	.0975	0.91831	25,842	.1364
1996	581	26,880	.0953	0.91831	24,684	.1349
1997	444	22,373	.0895	.	.	.
1998	640	31,499	.0817	.	.	.
1999	647	30,926	.0873	.	.	.
2000	637	30,626	.0851	.	.	.

Source: U.S. Consumer Product Safety Commission (CPSC), National Electronic Injury Surveillance System (NEISS), Directorate for Epidemiology, Hazard Analysis Division.

Table 3
Estimated Table Saw-Related Emergency Room Treated Injuries
Lacerations, Fractures, or Amputations
To Wrists, Hands, or Fingers
January 1, 1991 – December 31, 2000

Year	Sample	Estimate	CV	Adjustment Factor	Adjusted Estimate	Adjusted CV
1991	467	25,404	.1198	0.96062	24,404	.1329
1992	563	28,264	.1144	0.95406	26,966	.1329
1993	503	24,423	.1061	0.94749	23,141	.1315
1994	493	26,174	.1068	0.94093	24,628	.1384
1995	503	25,323	.1005	0.93436	23,661	.1407
1996	535	24,799	.0974	0.93436	23,171	.1385
1997	403	20,324	.0944	.	.	.
1998	576	28,183	.0848	.	.	.
1999	580	27,703	.0887	.	.	.
2000	561	26,860	.0896	.	.	.

Source: U.S. Consumer Product Safety Commission (CPSC), National Electronic Injury Surveillance System (NEISS), Directorate for Epidemiology, Hazard Analysis Division.

In order to learn more about the involved table saws, incident scenarios and environment, user's characteristics, and use patterns, the Commission is conducting follow-up telephone investigations of the injuries treated in the U.S. hospital emergency departments between October 1, 2001 and December 31, 2001 (see the attached Questionnaire). The analysis of results of the investigations will take place sometime after March 2002.

3. Reported Fatalities

There were 8 fatalities reported to the Commission during this 10-year period. These reported fatalities do not represent all fatalities that may have occurred in the U.S. during this period. Information concerning the stated fatalities is presented below.

Date of Incidents	City	State	Age	Incidents
04/08/91	Hobart	IN	003	Died after being cut underneath table saw while his parent was using the saw.
01/12/92	Gillette	WY	058	Saw blade separated on a large table saw and struck the victim on left side of his head.
07/26/94	Montfort	WI	018	Electrocuted from using ungrounded table saw on a damp floor.
11/17/94	Independence	MO	076	Feeding a piece of pine wood through the cutting blade of table saw, the wood kicked back and struck his abdomen. He died during the surgery.
04/16/97	Grandview	MO	048	A short in table saw had electrified the metal frame and the victim died when he contacted the frame and a ground point.
07/13/97	Easley	SC	040	Electrocuted while using a table saw that was plugged into an extension cord.
08/13/97	Hialleah	FL	067	Died from a massive heart attack after he had severed three fingers and went into cardiac arrest. He was using an industrial type table saw.
09/22/97	Dallas	OR	073	Died after he had collapsed while using a table saw.

Attachment

TAB C

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: June 15, 2005

TO : Caroleene Paul, Project Manager, Petition CP03-02, Power Saw Performance Standard

THROUGH: Gregory B. Rodgers, Ph.D., AED, EC

Deborah V. Aiken, Ph.D., Senior Staff Coordinator, EC

FROM : William W. Zamula, EC

SUBJECT : Petition Requesting Performance Standards for a System to Reduce or Prevent Injuries From Contact With the Blade of a Table Saw (Petition CP03-02)

The Commission received a petition from an inventor and his associates requesting a performance standard to address injuries resulting from contact with the blade of a table saw. This memorandum provides readily available information on annual sales of table saws, the number of manufacturers, the estimated number of products in use, as well as preliminary information on the societal cost of deaths and injuries associated with the hazard pattern.

Market Information

Manufacturers of and/or importers of table saws include Bosch/Skil, Black & Decker/ DeWalt, Makita, Ryobi , Delta/Porter-Cable (Pentair Tool Group), Hitachi, Jet/Powermatic (WMH Tool Group), Grizzly, Inca, Jepson, General International, PTS/Rexon/Tradesman, and Emerson Electric/Ridgid. The first seven manufacturers/importers mentioned above probably account for most of the shipments of table saws in the U.S. [The Power Tool Institute comments on the Petition (PTI, November, 2003) state that these seven companies along with several former members (not specified) account for 95 percent of all table saws sold in the U.S.] Bosch, Black & Decker, Makita, Ryobi, Emerson Electric, and Hitachi are large, diversified international corporations with billions of dollars in sales. Table saws make up a relatively small part of their revenues.

Data on shipments, exports, and imports of table saws are typically aggregated with a variety of other types of saws, such as reciprocating, saber, and jig saws, making it impossible to derive an estimate of the number of or dollar value of table saw shipments. However, based on a comment on the Petition, the Power Tool Institute (PTI) estimates shipments of 725,000 table saw units in 2002 and an estimated population of 6 million units in use. It also estimates the expected useful life of a table saw at 10 years. This estimate may be low: a market research report on the power tool industry (Marcom, 1983) estimates an expected useful life of 15 years. Based on estimated shipments from 1983-2002 and a 15 year expected useful life, the product population model estimates a population of about 10 million. Consequently, based on the PTI and Product Population Model estimates, the product population is probably in the range of 6 to 10 million. With an expected useful life of 10-15 years, the benefits of any potential safety improvement for table saws would accrue gradually over a long period of time.

Retail prices vary widely from about $100 for some consumer-oriented table saws to several thousand dollars for large, professional quality saws. PTI characterizes the consumer price range as $100 to $800 and the professional price range as $500 to $2,500. With the PTI estimate of 725,000 units shipped, retail sales are probably in the range of $300-$400 million, assuming an average retail price of $400 -$500.

Consumers vs. Professionals

Distinctions between consumer-oriented table saws and saws oriented towards commercial and industrial users are difficult to make. Inexpensive table saws tend to be lightweight and portable, which makes it easier for a carpenter or other craftsman to transport them to a job site. Consequently, substantial numbers of inexpensive bench and table saws may end up being used by professionals. By the same token, some consumers purchase expensive "cabinet" saws to make their own cabinets. Rental centers may offer some professional or "contractor" table saws to consumers, but probably only the portable models. Cabinet saws are heavy and extremely bulky, and are unsuitable for rentals. While some lines of table saws are designated as "professional," such designations are not always meaningful. It may be difficult or impossible to determine the proportion being sold to consumers versus professionals for most table saws, since both are often purchased through the same retail outlets. Generally, we would not expect a consumer to use a table saw with a blade of 12 inches or more, with more than 5 horsepower, or with a 3 phase power supply. Price is not the best criterion for making a distinction, since there is overlap between consumer and professional purchases even in the $2,000-$3,000 range.

Preliminary Societal Cost Estimates of Table Saw Injuries and Deaths

Based on a 2001 Special Study, Epidemiology staff estimate that almost 28,300 emergency room treated blade contact injuries were experienced by operators of table and bench saws in 2001. According to Epidemiology, virtually all of these blade contact injuries involved consumers. From these 28,300 injuries, the Commission's Injury Cost Model projects 55,300 medically treated injuries with associated injury costs of $2.13 billion. Since injuries have remained relatively constant from 1991-2002, we will use injury costs for 2001 throughout this memo. Deaths resulting from blade contact from table saws are relatively rare and seem to be the result of secondary effects of the injuries (e.g., heart attack) rather than the injuries themselves. We have therefore excluded them from the costs.

The high societal costs are accounted for by the high valuation of amputations by the Injury Cost Model and the relatively high hospitalization rate for table saw blade contact injuries. The hospitalization rate for blade contact reported in the Epidemiology memorandum (April 12, 2005) is 11%: this is more than double the average hospitalization rate for all consumer products (4.6 percent in 2001). Furthermore, amputations make up 15 percent of the blade contact injuries.

The societal costs per product in use per year range from $210 ($2.13 billion/10 million table saws in use) to $355 ($2.13 billion/6 million table saws in use). Over the 10-15 year lifetime of a table saw it would generate societal costs of $2,600 to $3,100 at a discount rate of 3 percent, if all blade contact injuries are included.

The PTI comments suggest non-kickback injuries are more likely to be addressable than kickback injuries. If we only include costs from non-kickback injuries, the societal costs per product in use per year would range from $97 ($971 million/10 million table saws in use) to $162 ($971 million/6 million table saws in use). Over the 10-15 year product life of a table saw, the present value of the societal costs would be $1,200 to $1,400 per saw. In either case (i.e., whether or not kickback injuries are included) the societal costs suggest that an effective remedy could generate net societal benefits.

Because of the small sample size for the occupational injuries, the variance associated with these estimates is large. This large variance also applies to the societal cost estimates based on these injuries. Removal of these injuries from the societal costs of all blade contact injuries reduces the societal costs from $2.13 billion for all users to $1.78 billion for consumers. This reduces the societal cost per product in use per year to $178 (for 10 million saws in use) to $297 (for 6 million saws in use), and the present value of societal costs per table saw to $2,200 and $2,600, respectively. Since all of the occupational injuries are kickback-related[1], estimates of societal costs for non-kickback injuries are unaffected.

It would also be appropriate to remove occupational users from estimates of saw users. However, we have no information that would enable us to estimate the number of table saws in use for occupational users. Eliminating occupational users would reduce the denominator (six million and ten million) in our estimates of costs per saw (for both all blade contact and non-kickback categories) and therefore increase the estimates of cost per saw for consumers. Consequently, assuming all remaining injuries are non-occupational, the present value of the societal costs for consumers would likely be in excess of the $2,200 to $2,600 noted above for blade contact injuries and in excess of $1,200 to $1,400 for non-kickback injuries.

Potential Costs to Manufacturers and Consumers

PTI cites a number of potential costs to manufacturers and consumers for the technical remedy proposed by the petitioner. First, there are the capital costs for tooling changes, which it estimates at $2 million to $10 million per company, depending on the number of models involved, or about $70 million in aggregate for all manufacturers (based on the number of manufacturers listed above and an average tooling cost of $5 million). Capital costs are usually amortized over ten or more years of production. Assuming a $70 million cost amortized over ten years production, the capital costs per unit would amount to about $10-12 per saw, depending on

[1] In this particular sample, all the occupational injuries happen to be kickback-related. It is possible that a larger sample of occupational injuries would contain a mixture of kickback and non-kickback related injuries.

sales. These types of costs tend to bear more heavily on smaller companies with fewer resources and smaller sales volume to support these costs.

The next category of costs is the per-unit cost of the remedy, including the electrical and braking hardware and the licensing fee of the petitioner (if their technology is used). The petitioner estimates a retail price impact of $50-100 per saw (including the capital costs mentioned above), while PTI states the retail price increase may be high as $150. If we assume that the retail price impact is $100 per unit (inclusive of the capital costs), then the retail price impact on a year's worth of sales might be approximately $60 million (600,000 units x $100 per unit), assuming a reduction in sales resulting from the price increase. This may be a reasonable estimate of the reduction in sales considering that an increase of $100 would effectively double the price of a $100 bench saw and increase the price of a $400 saw by 25 percent.

Finally, there is the issue of increased costs to use and maintain the saws over the life of the product, either because of false tripping or the need to purchase additional cartridges for special cuts. However, not enough is known about the durability of the safety device or the probability of false tripping to make any projection of costs. According to PTI, a single trip would require replacement of the brake cartridge and probably the blade. A replacement cartridge might cost $60, while the cost of the blades vary greatly from $25-$100. If the user wishes to use a different size blade or make a different cut than the saw is originally equipped for, then the user might have to purchase a new cartridge, at the cost noted above. However, it may be possible, in some instances, for the user to adjust the saw rather than purchase a new cartridge.

Over the lifetime of the product, the additional cost of the proposed remedy and the replacement of brake cartridges and blades might increase the costs of ownership of the product substantially. However, given the high societal costs associated with table saw injuries, an effective method of preventing blade contact injuries might be sufficient to offset these costs to the consumer.

What is less clear is the impact of the proposed remedy on businesses. The costs to businesses would rise if firms have to purchase the blade stop mechanisms. However, there would also be benefits from reduced injuries and reduced worker's compensation costs. Due to differences in training, working conditions, and exposure to saw hazards, the distribution of benefits and costs to employers and workers using table saws is likely to be different than for consumers.

TAB D

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: July 19, 2001

TO : Ronald L. Medford, Assistant Executive Director
Office of Hazard Identification and Reduction

THROUGH: Hugh M. McLaurin, Associate Executive Director
Directorate for Engineering Sciences

FROM : Caroleene Paul, Division of Mechanical Engineering
Roy W. Deppa, Division of Mechanical Engineering
Dean LaRue, Division of Electrical Engineering

SUBJECT: Evaluation of Prototype Tablesaw Safety Device

INTRODUCTION: The Directorate for Engineering Sciences received a sample of a prototype tablesaw safety device, as well as a detailed demonstration from its inventor, on July 11, 2001 to evaluate its potential to address injury. The inventor also provided an information package that combines the extensive technical information of the 26 different patents obtained in designing the safety system. The device consists of a modified commercial consumer-grade tablesaw, including an electrical blade contact detection circuit, logic circuit, and electromechanical device that stops blade rotation and lowers the blade below the table surface upon contact with a human body part. This system is under development and was demonstrated by SawStop LLC. of Wilsonville, OR.

BACKGROUND: Tablesaws account for approximately 30,000 injuries to the hand or finger per year, with approximately 10% of these injuries involving amputation. Tablesaw blades are typically 10 in. in diameter and rotate at about 4,000 rpm. A typical 40-tooth blade's teeth cut at a rate of about 2,700 cuts per second; these saw teeth are travelling at about 120 mph. Resulting injuries are usually severe.

Review of In-Depth Investigations shows that typical incident scenarios involve inadvertent contact with the blade. The operator allows his hand to contact the blade while sawing due to inattention, or the workpiece slips or moves suddenly and the operator reaches, falls, or slips and contacts the blade from the top or rear of the blade. In some cases the work piece is kicked back by the blade and draws the operator's hand into the blade.

Safety engineering on a systematic basis takes a tiered approach to address hazards:

1. The most effective measures are those that design the hazard out of the product. This has not been possible with tablesaws; the operational requirements of tablesaws seem to preclude the possibility of removing the hazard.
2. The second most effective measures are those that guard or shield against the hazard. This is the approach that has been applied to tablesaws, but it has not been effective because the guards are optional and they do not work very well.
3. When design and shielding approaches do not work, the next most effective method is to introduce an intervention strategy in the development of the hazard. That is, allow the events that lead to injury to begin, but introduce some element that stops or diverts the process before the injury occurs, or at least before the injury becomes very severe. This is the philosophical basis for the SawStop. The operator's hand actually contacts the spinning blade, but the device senses this contact and stops the blade and moves it before severe injury occurs. This approach is sophisticated and potentially vulnerable. Timing is everything; the blade begins to cut into the operator's finger before the system can work, and it must work reliably and very quickly to limit the injury.

The SawStop demonstration model is a prototype, therefore issues of reliability and robustness over the life of the product cannot be evaluated. These issues will be dependent upon choices made in the development and manufacture of production products, and they are likely to differ significantly between manufacturers. While the ability of the product to function properly under different conditions, or incident scenarios, can be addressed with a prototype, these factors may differ depending upon the manufacturing design. Consideration of details that are dependent upon design and manufacturing must be evaluated on production products, or may be considered in establishing standards of performance.

What can be evaluated at the prototype stage is whether the basic concept of the device addresses the known hazard pattern in an effective way, and thus can establish whether the device demonstrates the feasibility of eliminating or reducing the hazard. The basic concept of the SawStop is to electrically sense when contact with a body part has been made, and to mechanically remove the cutting hazard before severe injury can occur. In the next three sections, the electrical operation, the mechanical operation, and the testing will be discussed.

Electrical Operation

The theory of operation is based upon the electrical capacitive nature of the human body, or the ability of the human body to store electrical charge. A small electrical field is placed by the SawStop circuitry onto the saw blade by a supply electrode, and a sensing electrode senses the electrical field coming from the saw blade. If a person touches the saw blade, some of the electrical field is redirected into the person's body rather than into the sensing electrode. When the field measured by the sensing electrode drops below a pre-determined percentage of the normal value, the stopping mechanism is activated.

The electrodes are not actually in contact with the saw blade. They are a small distance away from the blade. This is what is called capacitive coupling. Two conductive materials with a dielectric material (in this case air) between them creates a capacitor. Essentially, there is a capacitor created by the supply electrode to the saw blade in series with another capacitor created by the saw blade to the sensing electrode. Electrical energy can therefore flow between the supply electrode to the saw blade and from the saw blade to the sensing electrode.

In the prototype received for evaluation, the supply and sensing electrodes are capacitively coupled to the arbor shaft. In most cases, this is not a problem because the saw blade is electrically connected to the arbor shaft. However, a few saw blades used in the evaluation had plastic hubs. The safety mechanism will not work with these blades because the plastic hub insulates the metal part of the blade from the arbor shaft. In this particular implementation, there is no means to determine whether an appropriate saw blade is attached to the arbor shaft or that the blade is actually coupled to the circuit. This is an issue that will need to be addressed in the development of manufactured products, to ensure that a user knows when they are protected. This does not affect the evaluation of the basic safety mechanisms and principles of this device.

The remainder of the circuitry is designed to detect and react to a person touching the saw blade. The circuitry is controlled by a microcontroller. The microcontroller reads various inputs and makes a decision to activate the saw brake or to allow the saw to keep running. Using the example of the 40-tooth blade operating at 4,000 rpm, one tooth goes by a point every 370 μs. The circuit samples the status and makes a decision every 18 μs, which is more than 20 times per tooth. The circuitry reacts quickly enough to minimize the damage to a person's hand should it come in contact with the saw blade.

The microcontroller is programmed to react quickly to a person touching the saw blade while adjusting itself for scenarios involving wood that may be slightly conductive. Wet green wood or wet pressure treated wood can be conductive and could make the saw brake trip without any danger. Logic has been built into the program to monitor not only the magnitude of the signal but also the rate at which it changes. Conductive wood would cause a slow change in the signal magnitude where a person would generate a quick change in the signal magnitude. If the controller detects a slow change in the signal magnitude, it changes the supply voltage to maintain a relatively constant sensing voltage. However, it is designed so that it cannot change the supply voltage fast enough to miss an actual human event. This is designed to reduce nuisance trips without reducing the protection to people.

There are several self-tests designed into the circuitry to ensure that the safety mechanism will work if needed. If any of these self-tests fail, the saw will either stop if running or will not start if not running. The self-tests are:

1. Watchdog error – this is monitoring the status of the microcontroller.
2. Saw brake triggered or trigger circuit open – this will sense if the saw brake has already been spent or if the electrical connection to the saw brake is missing.
3. Supplies out of regulation – this senses the voltage on the power supply to ensure that it is adequate to operate the circuitry.
4. Capacitor over voltage – this senses the voltage on the capacitor to ensure that the capacitor is working properly.
5. Hall sensor defective – the Hall sensor detects motion of the saw blade. This is used to allow protection during a shut down of the saw. The electronics is capable of activating the saw brake as long as the saw blade is rotating, even after the saw is turned off.
6. Capacitor not charging – senses to see if the capacitor is charging to prevent a misfire.
7. Capacitor under value (discharges too fast) – the system is measuring the time constant during operation to ensure that the capacitor is properly charged.
8. Sense calibration circuit error – the microcontroller monitors the sensing portion of the circuit to verify adequate signal.
9. Sense circuit error – the microcontroller monitors the sensing portion of the circuit to verify it is receiving the signal it expects.

Mechanical Operation

The mechanical theory of operation uses the potential energy stored in a spring to force a plastic brake into the teeth of the rotating saw blade, and the angular momentum of the rotating blade to retract the blade below the surface of the table saw. A brake cartridge consisting of a spring loaded plastic pawl and controller circuitry is positioned on a shaft directly behind the blade arbor. Once a saw blade has been installed, care must be taken to adjust the pawl side of the brake cartridge as closely to the blade as possible without interfering with the blade's free movement. An electrical lead from the microcontroller attaches to the brake cartridge. When the microcontroller determines that a person has touched the saw blade, it sends a signal to discharge a capacitor in the brake cartridge. The capacitor is discharged through a thin wire whose function is to suppress a 100 lb spring against the plastic pawl. When the current from the capacitor goes through the wire, the wire melts and releases the spring. The plastic pawl is then forced into the teeth of the saw blade. The plastic pawl begins to stop the saw blade rotation within milliseconds of when the detection circuitry senses human contact.

The saw blade is raised and lowered by way of a worm screw, keyed to a shaft that is manually rotated by the operator. The worm screw slides freely on this shaft until a U-pin on the worm screw locks into a groove on the shaft. When the worm screw is locked into place, rotation of the worm screw drives the saw blade up and down. The sudden braking of a rotating blade creates so much momentum that the worm screw is knocked loose from its locked position on the shaft. With the worm screw now free to slide on the shaft, the angular momentum of the blade carries the blade straight down below the table saw surface. As with the blade braking, the blade retraction occurs in the time frame of milliseconds.

SawStop Prototype Testing

A table saw is among the most diverse of power tools. A variety of blades can be installed to make straight thru cuts, angled bevel and mitre cuts, or non-thru dado and rabet cuts. The SawStop was tested using a variety of blades to make common cuts. Contact between the saw blade and a finger was simulated using a hot dog in lieu of a finger. The signal change (detected by the SawStop circuitry) caused by contact with a human finger is comparable to the signal change caused by contact with a hot dog that is in contact with a human body. The inventor verified this similarity in signal changes by measuring the signal of a human finger as it was cut on a saw blade and measuring the same on a hot dog as it was cut on a saw blade. The following table summarizes the testing performed on the SawStop.

Trial	Blade		Type Cut	Blade Stop	Hot Dog Damage	Comments
	Type	Teeth				
1	10" carbide	40	straight cut	6 ms	no	slow feed, hot dog on wood piece
2	10" carbide	40	straight cut	4 ms	no	fast feed, hot dog on wood piece
3	10" plywood	250	straight cut	24 ms	no	blade retract prevented injury
4	10" rip	12	straight cut	___	no	blade retracted before stop and prevented injury
5	10" rip	12	straight cut	___	no	blade retracted before stop and prevented injury
6	10" carbide	40	35 deg bevel 60 deg mitre	4 ms	no	average feed, hot dog on wood piece
7	10" carbide	40	kick back into rear of blade	4 ms	no	contact to rear of blade simulated kick back
8	10" carbide	40	contact during coast to stop	1 ms	no	blade stopped immediately contact made approximately 4 seconds after shut off
9	10" carbide	40	straight cut with glove	4 ms	no	cut thru glove, activation upon hot dog contact
10*	7" dado with plastic hub	24	NA	NA	NA	no reaction, blade insulated from arbor
11*	7" dado with plastic hub	8	NA	NA	NA	no reaction, blade insulated from arbor

* These tests were performed with the drive belt removed from the blade and a specialized test box in place of the brake cartridge. The test box simulates braking by cutting power to the motor.

The reaction time of the SawStop system is too fast for the human eye to detect. Each test trial was recorded using a high speed camera at 1000 frames per second. The slowest replay of events possible is 1 frame per second. A typical SawStop reaction to contact with a hot dog resulted in almost immediate retraction of the blade and cessation of the blade rotation within 4 milliseconds. Time for the blade to retract below the surface of the table saw depends on the blade height set for the cut. An important factor is the fact that however long it takes for the blade to stop rotating, the hazardous cutting edge of the blade is already moving away from the contact point.

A 40 tooth, 10" carbide blade stopped in approximately 4 milliseconds. This was true whether it was contact made during a straight cut, during a compound cut, from the rear of the blade, or through a glove. A straight cut made with a 250 tooth, 10" plywood blade resulted in a longer blade stop time of 24 milliseconds. However, despite the longer blade stop reaction time, minimal damage to the hot dog occurred because the blade still retracted from the point of contact almost immediately. Similarly, cuts made with a 12 tooth, 10" rip blade resulted in a blade stop time of approximately 35 milliseconds (the blade retracted below the table saw surface before blade stop), but minimal damage to the hot dog occurred because of the immediate blade retraction.

As stated before, because the prototype design capacitively couples the arbor, conductivity between the blade and the arbor is necessary in order for the system to react to contact between the blade and a body part. Two different blades with plastic hubs were tested and resulted in operation of the table saw in an unsafe condition -- if contact were made, the system would not have worked. The blades were specialized dado blades; however, their use is not uncommon among serious woodworkers.

The limited amount of time allotted for evaluation did not allow for electrical interference testing. Electrical interference transmitted through the electrical supply line or the air could potentially cause nuisance tripping or possibly prevent the circuitry from detecting someone touching the saw blade. If any of these types of interference should cause problems with the circuitry, the problems could likely be remedied by minor changes to the circuitry or how they are shielded from outside interference. Testing for the effects of electrical interference should be conducted in future evaluations of this product.

CONCLUSION

Based upon the evaluation reported here, it appears that the SawStop concept is valid and the prototype impressively demonstrates its feasibility. The electrical and mechanical components operated without failure in a time frame that would greatly reduce blade contact injury. The design concept is very flexible and can be modified to address foreseeable areas of concern.

The device that was evaluated is a prototype, with handmade, non-production components. Production products will include modifications due to design and manufacturing decisions that may result in different performance. In addition, the robustness and life-cycle details of production units will be different from those of the the prototype. The evaluations that were performed therefore concentrated on the validity of the concept and the performance of the components used in the prototype system. A significant amount of further development work may be required before this device could be incorporated into production saws, both because of the need to adapt the concept to mass production, and to address some issues that still require refinement.

Of highest concern are those areas where the SawStop may not perform, and more importantly, may not indicate to the user that it will not perform. As discussed earlier, the device is dependent upon electrical conductivity from the hand through the blade to the saw arbor and thence to the circuitry. There are tablesaw blades that have plastic or other non-conductive hubs or centers, and even a painted or coated metal blade may not make electrical contact with the arbor. In this event, the saw may be operated, but the SawStop will not work as presently configured. This failure may likely be addressed through further design refinement.

Of secondary concern are those areas where the SawStop system may be perceived as a nuisance and therefore a candidate for bypassing by the user. The prototype SawStop uses a brake cartridge that may only be used with a 10 inch blade. The cartridge location does not accommodate smaller diameter blades or thicker specialty blades. In addition, specialized blades such as molding sets, which only have one to three teeth, may not work with the current brake configuration. As stated before, these areas of concern would need to be addressed during production design of each specific table saw.

TAB B

Survey of Injuries Involving Stationary Saws

Table and Bench Saws
2007–2008

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EXECUTIVE SUMMARY

In 2009, U.S. Consumer Product Safety Commission (CPSC) staff conducted a survey of stationary saw-related injuries that occurred between January 1, 2007, and December 31, 2008, and which were treated in one of the hospital emergency departments in the CPSC's National Electronic Injury Surveillance System (NEISS). This was a follow-up survey to a 2003 CPSC staff survey of saw-related injuries occurring in calendar year 2001, and reported through the NEISS. The purpose of the survey was to collect more specific and accurate information about the type of saw (i.e., product code) involved and also to collect more in-depth information about the hazard pattern and contributing factors to the injuries. This report presents the results from that survey for injuries related to table/bench saws.[1]

- Based on the survey and the imputation of missing product data, the estimated total number of hospital emergency department-treated injuries related to table/bench saws in the United States during the calendar years 2007–2008 was 79,500.[2]

- The injuries related to table/bench saws account for 78.0 percent of the survey-based estimated total number of 101,900 injuries associated with all stationary saws (i.e., table/bench saws, band saws, radial arm saws, and miter saws).

- Of all injuries related to table/bench saws, the operator of the saw was the victim in 95.7 percent (76,100) of the cases. The estimated average age of the injured operators was 55.4 years, with the youngest at 11 years and the oldest at 95 years, and 97.2 percent of the operators were male.

- Injuries to operators were due to contacting the blade in 88.0 percent of the cases, and when blade contact caused the injury, the blade was contacted above the top of the cutting surface in 56.9 percent of the cases.

- Lacerations (64.8 percent) followed by fractures (12.2 percent) and amputations (10.5 percent) were the most common forms of injuries to operators. Fingers (89.1 percent) followed by hands (6.8 percent) were the body parts most frequently involved in the injuries.

- In 93.0 percent of the cases, the victim was examined/treated and released from the hospital, and in 6.6 percent of the cases, the victim was treated and either admitted to the same hospital or transferred to another hospital.

- A fixed cabinet saw was in use in the majority of the cases (68.7 percent), followed by a semiportable contractor saw (18.3 percent), and a portable bench saw (10.5 percent). The saw was owned by the operator's household in 86.7 percent of the cases. When the saw was owned, it was acquired new in 82.5 percent of the cases. In 76.7 percent of the cases, the

[1] Since the injuries to operators are of main interest, this report mostly deals with injuries to operators during operation of the saw.

[2] Not all of these incidents are addressable by an action the CPSC could take. It was not the purpose of this report to evaluate the addressability of the incidents, but rather to update estimates of injuries reported to CPSC staff and to analyze associated factors.

operator used the saw more than 10 times during the previous year. The operator had an owner's manual in 64.1 percent of the cases.

- At the time of the injury, the saw did not have a safety switch in 78.7 percent of the cases, and the saw blade was not protected by a blade guard in 65.7 percent of the cases. In most cases, the blade guard was removed (75.0 percent) for operational convenience. A riving knife was attached to the saw in 20.4 percent of the cases, and an anti-kickback pawl or spreader assembly was attached to the saw in 24.4 percent of the cases.

- At the time of the injury, the saw was used for cutting a wooden board in 91.2 percent of the cases. In most cases, the type of cutting operation performed was ripping along the length of the stock (85.7 percent) and primarily for vertically straight cuts (94.7 percent). A rip blade was in use in 70.0 percent of the cases of the injuries and, during the previous year, 67.4 percent of the operators used the saw mostly for ripping. A rip fence was in use at the time of the injury in 85.3 percent of the cases.

- The motor was running in 94.5 percent of the cases at the time of the injury. About 67.1 percent of the injuries happened when the operator was actually cutting or in the middle of a cut; and in 28.9 percent of the cases, injuries happened when the operator was at the end of a cutting operation. The operator was pushing the stock in 76.7 percent of the cases at the time of the injury, and a push stick was used in 35.6 percent of these cases.

- Overall, the stock kicked back or jumped in 40.5 percent of the cases. In 93.7 percent of the cases in which the stock kicked back or jumped, the operator thought that the blade contact was due to the stock kickback. When the stock kickback caused the injury, the operator's hand was pulled into the saw in 65.2 percent of the cases.

1. INTRODUCTION

In 2009, U.S. Consumer Product Safety Commission (CPSC) staff conducted a survey of stationary saw-related injuries that occurred between January 1, 2007, and December 31, 2008, and which were treated in one of the hospital emergency departments in the CPSC's National Electronic Injury Surveillance System (NEISS). This was a follow-up survey to a 2003 CPSC staff survey of saw-related injuries occurring in calendar year 2001, and reported through the NEISS. The purpose of the survey was to obtain more in-depth information about the nature and probable causes of the injuries, and also to verify the types of saws involved, particularly for the injuries in which the types of saws involved were not specified in the NEISS. Collecting more reliable and detailed information on the types of saws involved supports production of more accurate estimates of the number injuries related to the different types of saws.

This report presents the results of that survey. Because CPSC staff is currently evaluating the existing voluntary standard for table/bench saws to determine if performance requirements can be improved to reduce injuries, the report presents the results specifically for table/bench saws.

The remaining sections of the report are organized as follows:

- Section 2 provides some relevant background information about the extent of and trend in saw-related injuries, descriptions of table/bench saws, and types of cutting operations performed by using these saws.
- Section 3 presents the methodology used in designing and conducting the survey, response rates achieved, procedures used in data processing and analysis, and weighting procedures used to produce injury estimates.
- Section 4 is the main section of the report that presents the results obtained from the survey for table/bench saws.
    - Section 4.1 presents the distribution of unspecified saws to specific types of saws as obtained from the survey.
    - Section 4.2 presents estimates that characterize the injuries associated with table/bench saws and the age and disposition of the injured.
    - Section 4.3 presents the estimates of injuries to the operators of the saws. Since the injuries to operators are of main interest, the estimates are arranged in five groups: (1) characteristics of injuries and injured operators; (2) characteristics of saws and blades; (3) characteristics of cutting materials; (4) the operational factors at the time of the injury; and (5) selected characteristics of blade contact injuries.
- Section 5 presents a discussion of hazard patterns and associated risk factors as identified through the survey.
- Appendix A presents the details of estimation methodology used to produce the national estimates from the sample.
- Appendix B includes a sample of respondents' descriptive narratives of how the injuries happened.

2. BACKGROUND

2.1 Saw-Related Injuries and the Survey Objective

The estimates from the CPSC's National Electronic Injury Surveillance System (NEISS) show that the number of emergency department-treated injuries associated with saws is high and not decreasing over the years. An annual average of 94,200 saw-related injuries was treated in U.S. hospital emergency departments during 2001–2008 (Table 1). Of these annual average injuries, 36,400 (38.6 percent) were associated with table/bench saws; 3,900 (4.1 percent) were associated with band and radial arm saws; 20,200 (21.4 percent) were associated with portable or handheld saws; and the type of saw was unspecified for the remaining 33,700 (35.8 percent) injuries.

A trend analysis of annual estimates for 2001–2008 indicates that the number of saw-related injuries was steady over the years. Although the estimated injuries for all saws decreased, and the estimates for table/bench saws increased, neither trend is significant[3] (Figure 1). This confirms at least that the number of injuries associated with saws is not decreasing during this period, especially for injuries associated with table/bench saws.

Moreover, because the types of saws were unspecified for a large proportion of saw-related injuries reported in the NEISS, any estimate or analysis by type of saw from the NEISS is not very reliable. For example, the estimate of the number of injuries associated with stationary saws could have been larger than the current NEISS estimate if some of those unspecified saws were identified as stationary saws.

Table 1. NEISS Estimates of Emergency Department-Treated Injuries Associated with Saws, January 1, 2001 to December 31, 2008

Year	Stationary Saws*		Handheld Saws**	Saws Not Specified ***	Total for All Saw Types	
	Table/ Bench Saws	Band Saw and Radial Arm Saw			Estimate	Coefficient of Variation (CV)
2001	31,900	4,100	17,600	40,300	93,900	0.05
2002	33,100	4,000	17,600	37,700	92,400	0.07
2003	37,000	4,300	18,900	35,100	95,200	0.08
2004	39,900	4,000	22,000	35,600	101,400	0.07
2005	38,200	3,300	20,200	33,800	95,400	0.07
2006	38,100	2,900	22,100	32,200	95,300	0.07
2007	34,800	4,300	20,300	28,300	87,700	0.07
2008	38,100	4,400	22,500	26,700	91,700	0.07
Total	291,000	31,300	161,200	269,500	753,100	0.06
Annual Average	36,400	3,900	20,100	33,700	94,100	-
Distribution by Type of Saw	**38.7%**	**4.1%**	**21.4%**	**35.8%**	**100.0%**	**-**

*Includes table/bench saw (0841), band saw (0842), and radial arm saw (0843). Since miter saw does not have a separate product code, it is categorized as 'saws not specified' in the NEISS. **Handheld saws include hand saw (0830), portable circular saw (0832), saber saw (0864), jigsaw (0875), hacksaw (0894), and power hack saws (0844). Product codes 0844 and 0894 were combined into 0894

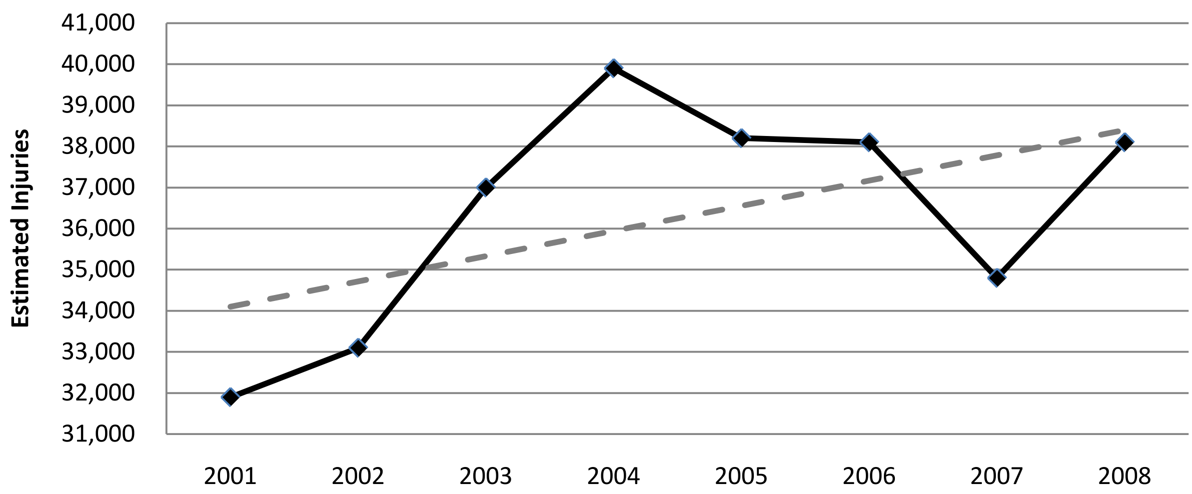
[3] $p = 0.8480$ for all saws and $p = 0.1133$ for stationary saws, where the requirement for significance is $p < 0.05$.

in 2003. ***Includes 'saws, not specified' (0845), 'power saws, other or not specified' (0895), other power saws (0863), and 'power saws, not specified' (0872). Product codes 0863 and 0872 were combined into 0863 in 2003.

This survey was conducted with two main objectives. The first objective was to identify the types of saws involved in incidents that were unspecified in the NEISS and also to verify the types of saws that were incorrectly specified in NEISS. That would allow distributing the incidents associated with unspecified saws to various types of saws to produce more accurate estimates of the number of injuries by types of saws. The second objective was to collect more detailed information about the nature and probable causes of the injuries related to stationary saws to have a better understanding of hazard patterns to support development of mitigation strategies. A similar survey was conducted in 2001 (Adler, 2003).

Figure 1

Table/Bench Saw Related Injury Estimates, 2001-2008



2.2 Product Description

A table saw is a popular power tool used primarily to cut wood. It consists of a circular saw blade mounted on an arbor, which is driven by an electric motor. The blade protrudes through the surface of a table, and the table provides support for the material being cut. The amount of the blade that protrudes above the table surface is adjustable and determines the depth of cut that will be made. The operator pushes the material to be cut into the saw blade.

There are three basic table saw categories that comprise the population of table saws used for both consumer and professional use: bench saws, contractor saws, and cabinet saws.[4] Generally, the range of quality and accuracy of a table saw is commensurate with its size, motor horsepower, weight, and indirectly, price.

[4] http://www.woodcraft.com/articleprint.aspx?ArticleID=241.

Bench saws are lightweight, inexpensive saws designed to be moved around easily and placed temporarily on a work bench or stand (see Figure 2). Prices for bench saws range from $100 to $500.[5]

Figure 2. Typical Bench Saw

Figure 3. Typical Contractor Saw

Contractor saws are characterized by a set of light duty legs and a bigger table and motor than a bench saw (Figure 3). Prices for a contractor saw can range from about $150 to $1,000, or more. These saws are generally quieter and more accurate than bench saws, and able to cut materials up to two inches thick. Contractor saws are commonly used by the home woodworker because the saws are capable of high quality work and are commonly found at mass merchandisers.

Cabinet saws are heavier than contractor saws because the higher powered motor is enclosed in a solid base (see Figure 4). Prices for cabinet saws range from $1,200 to $3,000. These saws are designed for heavy use, and the greater weight minimizes vibration so that cuts are smooth and more accurate. These saws are typically the highest grade saw found in the home woodworking shop.

Figure 4. Cabinet Saw

[5] http://www.nextag.com/10-inch-bench-top-table-saw/products-html.

2.3 Types of Cutting Operations

Descriptions of the cutting operations that are usually performed using a table/bench saw are discussed below and shown in Figure 5.

Ripping: A rip cut is performed by passing the stock between the blade and the rip fence. Often, the procedure is described as a cut made parallel to or with the grain of the stock. The basic rip cut is performed by placing the stock on the table in front of the blade snugly against the fence, and moving the stock past the saw blade.

Crosscutting: A simple crosscut, or cutting against the grain of the stock, is made by placing the edge of the stock against a miter gauge and moving both the gauge and stock past the saw blade. The operator should be almost directly behind the miter gauge so he/she will be out of line with the saw blade (as a safety precaution).

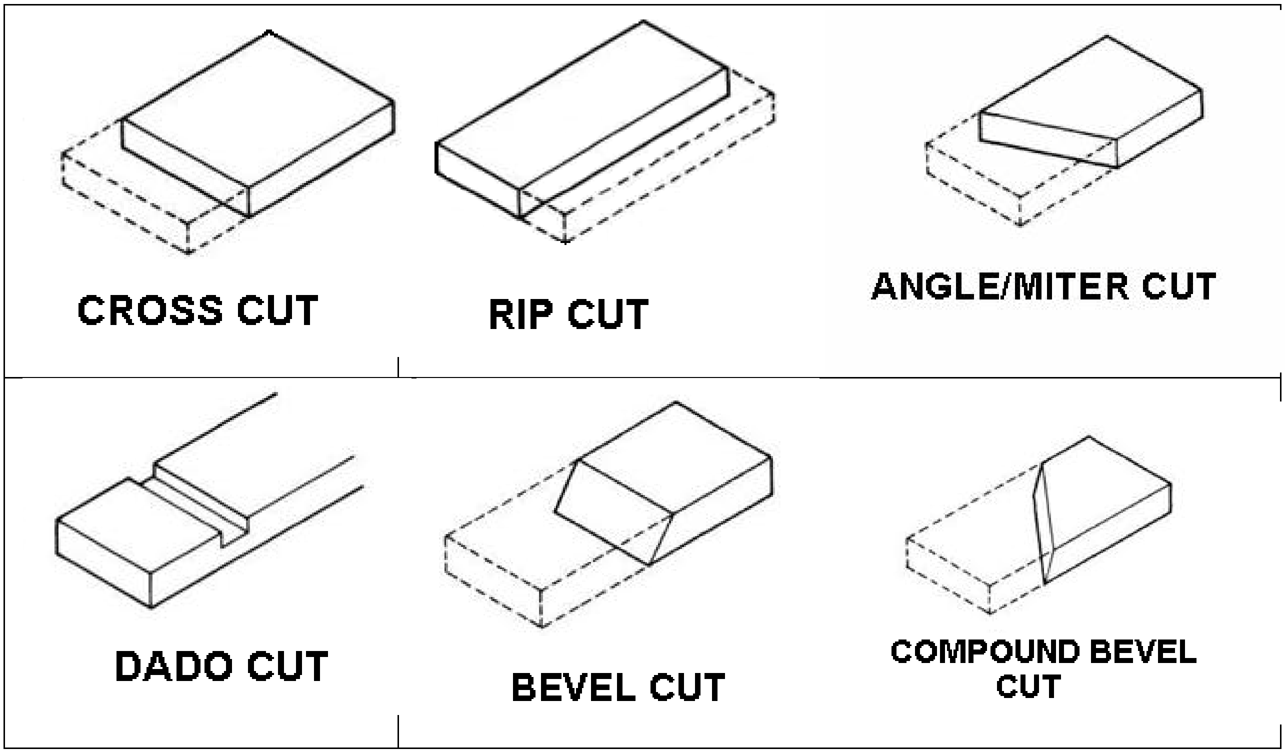
Mitering: An angled crosscut that needs a miter gauge to facilitate the accuracy of the cut (e.g., cutting the stock for a picture frame). For this type of cut, the miter gauge is usually set at a 45-degree angle for cutting two matching segments of stock. When two such cuts are matched, the joint is called a miter. The actual cutting may be simple, but a high degree of accuracy is required for a good match.

Beveling: Most bevels are rip cuts using the rip fence as a guide, while the blade (or table) is tilted to the angle required. Sometimes, the miter gauge is used when a cut is performed on a narrow stock because there is a tendency for the stock to move away from the fence.

Dadoing: A dado cut is done by setting a regular saw blade to a cutting depth less than the stock thickness and making repeated cuts, or using a special blade to widen the normal kerf[6] to get a U-shaped cut that creates a dado when done across the grain, or a groove when done with the grain.

[6] The space or channel created in the stock by the blade during cutting.

Figure 5: Types of Cutting Operations



3. METHODOLOGY

3.1 Sample Frame: National Electronic Injury Surveillance System (NEISS)

The saw-related injuries reported to U.S. hospitals with emergency departments served as the frame from which the sample was selected for the survey. The NEISS is an electronic system that collects consumer product-related injury data from a nationally representative sample of hospital emergency departments in the United States. The NEISS sample is comprised of a probability sample of 96 hospitals stratified into five strata—small, medium, large, very large, and children's hospitals (where the first four strata were stratified by hospital size). All consumer product-related injuries treated in the sample hospitals are reported to the NEISS. See EPDS (2000) and Marker and Lo (1996) for details about the NEISS and its design.

3.2 Sample Selection

All injuries related to stationary and other unspecified saws that occurred between January 1, 2007 and December 31, 2008, reported to the NEISS were selected for the survey. The product codes used for stationary and unspecified saws in the NEISS are: 0841 (table or bench saws), 0842 (band saws), 0843 (radial arm saws), 0845 (saws, not specified), and 0895 (power saws, other, or not specified). The injuries associated with these product codes were assigned for the investigation.

3.3 Survey Questionnaire

The survey questionnaire was developed by covering a range of questions to characterize injuries, hazard patterns, and human factors associated with saw-related injuries. The questionnaire included questions on the following broad areas:

- verification or specification of saw type;
- nature of injuries;
- demography and disposition of victims;
- saw ownership, assembly, owner's manual, and safety precautions;
- characteristics of saws involved in accidents;
- characteristics of saw blades;
- operational factors related to stage and nature of cutting at the time of injury;
- operational factors related to feeding /supporting the stock; and
- operational factors related to stock kickback and blade contact.

The survey questionnaire was formatted using the Computer Assisted Telephone Interviewing (CATI) software that was used for data collection. The software, which has a built-in facility for managing sequence or skip patterns of the survey questions, was used to format the questions with structured precoded responses. This means that the software controls which subsequent questions are asked a particular respondent depending on their responses to previous questions. For example, if in an earlier question the respondent indicated that the incident happened while using a band saw, then the software only allows asking that respondent questions related to band saws. The CATI system also has some built-in edit features. Thus, the software checks for any inconsistency in responses between related questions, and signals the interviewer to verify the entry at the time of the interview.

3.4 Data Collection

The contact details of the injured persons were obtained from the NEISS hospital that reported the injury. The cases with available telephone numbers were assigned for CATI; the cases that could not be contacted by telephone, or did not have a telephone number, were assigned for a mail survey; and the cases for which no contact details could be obtained from the hospitals remained out of coverage of the survey. However, the contact telephone numbers were available for the majority of the cases, and most of the interviews were conducted by telephone using the CATI system. In more than 95 percent of the cases, the interview was conducted directly with the victim; and in the remaining 5 percent of the cases, the interview was conducted with either the victim's father/mother, or someone who witnessed the incident.

3.5 Response Rate

Of the total 2,991 assigned cases of injuries associated with stationary and unspecified saws, 1,397 cases (46.7 percent) were successfully interviewed. The remaining 1,594 (53.3 percent) cases could not be interviewed (i.e., nonresponse) for various reasons, such as failure to reach (12.5 percent); refusal (11.7 percent); nonresponse to mailed questionnaires (9.7 percent); no identification available/released from the hospital (18.5 percent); or purged[7] (0.9 percent), as shown in Table 3.1. The number of cases assigned, number responded, and the response rates by type of stationary and unspecified saws are presented in Table 3.2.

Table 3.1 Distribution by Response Status of the Cases Assigned for the Survey of Injuries Associated with Stationary Saws

Response Status	Specific Status	Number Assigned	Percent
Respondent	Total	1,397	46.7
Nonrespondent	Total	1,594	53.3
	Failure to reach	374	12.5
	Refusal	350	11.7
	Mailed	289	9.7
	No ID	553	18.5
	Purged	28	0.9
Total	**Total**	**2,991**	**100.0**

[7] Purge–the assignment was made in error due to either a duplicate assignment or the analyst's decision to cancel the assignment.

Table 3.2 Response Rate by NEISS Product Code (Type of Stationary Saw)

NEISS Product Code	Type of Saw (Based on NEISS)	Number Assigned	Number Responded	Response Rate (%)
841	Table/Bench Saws	1,602	815	50.9
842	Band Saws	141	71	50.4
843	Radial Arm Saws	28	20	71.4
845	Saw, not specified	646	229	35.4
895	Power Saw, other or not specified	574	262	45.6
Total	**Total**	**2,991**	**1,397**	**46.7**

3.6 Data Cleaning and Editing

Since the CATI system has the capability for built-in skip patterns and some built-in data edit facility, the survey data was fairly clean at the onset. Moreover, an edit program was applied on the data file produced by the CATI system to check the consistency of data items that are logically interrelated. For example, because a table saw cannot be handheld, the values for these two data items must be consistent, and the edit program ensured that. The edit program also checked the proper implementation of the skip pattern. A few cases failed and were corrected using the responses to related questions by the edit program or by manually checking the completed interview questionnaire.

3.7 Computing National Estimates

To produce national estimates from the sample, the NEISS weights of the responding sampled cases were first adjusted to account for the nonresponding cases. This was done by distributing the weights of the nonresponding cases to those of the responding cases. Then the adjusted weights were benchmarked to the NEISS estimates at some broader levels to ensure that the national estimates produced from the saw survey were consistent with the NEISS estimates. These benchmarked weights were used to produce the national estimates from the saw survey.

One or more variables were missing for a small number of cases, which were otherwise considered complete responses. The missing values of these variables were imputed by using a hot deck imputation scheme.

Specific details of estimation, variance estimation, and imputation procedures used for the survey are presented in Appendix A.

4. RESULTS - ESTIMATES

4.1 Distribution of Unspecified Saws

An important objective of this survey was to verify the type of saw reported in a NEISS incident and to identify the saw type if it was unspecified. Table 4.1 presents the distribution of unspecified saws and table/bench saws as coded in the NEISS to various saw types as identified in the follow-up survey. Among the unspecified saws, 23.6 percent were identified as miter saws; 16.4 percent as table/bench saws; 19.5 percent as various handheld saws; 19.0 percent as other, nonstandard types of saws or remained not specified; 19.4 percent were identified as not a saw or not a powered saw; and 2.1 percent were either band or radial arm saws. Among the table/bench saws, 95.9 percent were verified as table/bench saws, and the remaining 4.1 percent were recategorized as other types of saws or not a saw.

Table 4.1 Distribution of Injuries Associated with Saws Coded as 'Not specified' or 'Table/Bench Saw' in NEISS Based on the Follow-up Survey

Reported in NEISS	Identified in Saw Injury Survey	Sample Count	Weighted Population Count	Percentage Distribution (%)
Power Saw, other or not specified (0895), Saw, not specified (0845)	Table or Bench Saw	73	9,030	16.4
	Band Saw	10	**	1.8
	Radial Arm Saw	3	**	0.3
	Miter Saw	122	12,980	23.6
	Handheld Saw*	95	10,700	19.5
	Saw, other or not specified	92	10,440	19.0
	Not a saw or not a powered saw	96	10,680	19.4
	Total	**491**	**54,980**	**100.0**
Table or Bench Saw (0841)	Table or Bench Saw	782	69,950	95.9
	Band Saw	1	**	0.2
	Radial Arm Saw	1	**	0.1
	Miter Saw	5	**	0.8
	Handheld Saw*	19	1,740	2.4
	Saw, other or not specified	3	**	0.3
	Not a saw or not a powered saw	4	**	0.3
	Total	**815**	**72,960**	**100.0**

*Handheld saw includes hand saw (0830), portable circular saw (0832), saber saw (0864), jigsaw (0875), hacksaw (0894), and chain saw (1411).
**Estimate does not meet reporting requirements.

Table 4.2 presents the estimated number of injuries in 2007–2008 associated with different types of stationary saws after recategorizing the injuries based on the updated information from the survey. The total number of injuries associated with table/bench saws as estimated from the follow-up survey is 79,500, which is 9.1 percent higher than the 72,900 estimated injuries associated with the NEISS product code (0841) for table or bench saws. Table 4.2 also shows that 78.0 percent of all injuries associated with stationary saws are related to table/bench saws.

Table 4.2 Estimated Number of Injuries Associated with Different Types of Stationary Saws in 2007–2008 (Using the Updated Information on Saw Type Based on the Follow-up Survey)

Type of Stationary Saw	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution (%)
Table or Bench Saw	862	79,500	0.09	78.0
Band Saw	70	7,100	0.16	7.0
Radial Arm Saw	20	1,700	0.33	1.7
Miter Saw	128	13,600	0.13	13.3
Total	**1,080**	**101,900**	**0.09**	**100.0**

4.2 All Injuries Associated with Table/Bench Saws

Table 4.3 presents various estimates for all injuries associated with table/bench saws to operators and others, irrespective of whether the saw was in use at the time of the injury. However, because the injuries to operators at the time of operation are of greater interest, Tables 4.4 to 4.12 present extensive analyses of the injuries, after excluding the cases when the saw was not in use, or when the victim was not the operator. For all characteristics, the tables present sample counts of injuries, estimated total number of injuries for calendar years 2007–2008, CV of estimates, and the percentage distribution across categories of each characteristic. In addition to including a row for the overall total number of injuries in each table, a subtotal row has been added to each of those questions/characteristics for which the number of applicable injuries is less than the overall total. The percentages of various responses for such a question/characteristic were calculated using the subtotal instead of the overall total as the denominator because the question/characteristic was not applicable to the remaining cases, and responses were expected only from the number of cases shown as the subtotal. Also, the estimates have been rounded to the nearest 100, and the characteristics with estimates that do not meet the reporting criteria of $n > 20$, or estimate ≧ 1,200, or CV < 33 percent are designated with two asterisks.

Based on the investigations of the incidents occurring between January 1, 2007 and December 31, 2008, which allowed for the identification of unspecified saws, it is estimated that there were about 79,500 injuries treated in U.S. hospital emergency departments associated with table/bench saws. Of these, an estimated 38,300 injuries occurred in 2007, and 41,200 injuries occurred in 2008.

Of the total injuries, the victim was operating the saw in 76,100 (95.7 percent) cases; and in the remaining 3,400 (4.3 percent) cases, the saw was being operated by someone other than the victim; or the saw was not in operation; or was being repaired/maintained.

Lacerations (64.0 percent), fractures (12.5 percent), amputations (10.2 percent), and avulsions (7.9 percent) were predominant and accounted for most (94.6 percent) of the injuries. Most of the injuries were to fingers, which accounted for 69,700 injuries (87.7 percent), followed by 5,400 (6.8 percent) to hands. The percentage of injuries requiring hospitalization was 6.7 percent compared to an average 4 percent of hospitalizations associated with all consumer product-related injuries reported through the NEISS system.

About 68.4 percent of the victims were between 15 and 64 years old, and 30.7 percent were 65 years old or older. About 97.2 percent of the victims were males.

Table 4.3 Characteristics of Victims and Nature of Injuries, Survey of Saw Injuries – Table/Bench Saws, 2007–2008 (Includes All Injuries)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**862**	**79,500**	**0.09**	**100.0**
Year of injury				
2007	413	38,300	0.09	48.2
2008	449	41,200	0.10	51.8
Use of saw at the time of the injury				
Victim was using the saw	821	76,100	0.09	95.7
Someone else was using the saw, repairing/maintaining, or saw was not in use	41	3,400	0.17	4.3
Age group of victim				
0–14	8	**	**	0.9
15–64	571	54,400	0.10	68.4
65 or older	283	24,400	0.11	30.7
Sex of victim				
Male	839	77,300	0.09	97.2
Female	23	2,200	0.26	2.8
Diagnosis				
Laceration	546	50,900	0.10	64.0
Fracture	113	10,000	0.22	12.5
Amputation	97	8,100	0.14	10.2
Avulsion	60	6,300	0.17	7.9
Contusion, Abrasion	21	2,000	0.26	2.5
Other	25	2,200	0.27	2.7
Body part injured				
Finger	756	69,700	0.10	87.7
Hand	54	5,400	0.20	6.8
Eyeball, Face, Head, Wrist	22	2,100	0.26	2.6
Other	30	2,300	0.21	3.0
Disposition				
Treated/examined and released	791	73,900	0.09	93.0
Treated and admitted to hospital	48	3,000	0.25	3.8
Treated and transferred to another hospital	18	2,300	0.27	2.9
Held for observation or left without being seen/left against medical advice	5	**	**	0.4

*Percentages may not add up exactly to 100 percent due to rounding.
**Estimate does not meet reporting requirements.

4.3 Injuries to Operators

As mentioned before, of the total table/bench saw-related injuries, about 95.7 percent were to the operators, and the remaining 4.3 percent were to helpers, to bystanders, or while the saw was being transported, maintained, or repaired. Because the injuries in which the operator was the victim are of greater interest, the rest of this report analyzes only the injuries to operators at the time of operation, and it excludes the 4.3 percent of injuries to others, or the incidents when the saw was not in use. The estimates presented are intended to trace the nature of injuries, operating practices, hazard patterns, and contributing factors. The estimates are presented in five main sections as follows:

- Characteristics of injured operators and injuries;
- Characteristics of saws and blades;
- Characteristics of cutting materials;
- Operational factors at the time of the injury; and
- Characteristics of blade contact injuries.

4.3.1 Characteristics of Injured Operators and Injuries

Table 4.4 and Table 4.5 present various characteristics of injured operators and the nature of their injuries.

The total numbers of injuries to operators in calendar years 2007 and 2008 were 37,100 and 39,000, respectively. The majority of the injuries to operators were due to blade contacts (88.0 percent). Most of the injuries were to fingers and hands, which account for 95.9 percent of the injuries. Fingers were the most frequently injured body parts (89.1 percent), followed by hands (6.8 percent). The remaining 4.1percent of injuries were to eyeballs, lower arms, lower trunks, wrists, heads, faces, and other body parts. Laceration was the most frequent form of injury (64.8 percent), followed by fracture (12.2 percent), and amputation (10.5 percent). The injuries to fingers were lacerations, amputations, fractures, avulsions, crushing, or contusions/abrasions. However, the injuries to lower arms, wrists, or hands were lacerations only. The injuries to lower trunks, upper legs, or lower legs were lacerations or contusions/abrasions. Finally, the injuries to heads or faces were internal injuries or contusions/abrasions; and injuries to eyeballs were due to foreign objects. About 6.6 percent of operators were treated and kept overnight for observation, treated and transferred to another hospital, or hospitalized. (Table 4.4)

The average age of the operators was 55.4 years, with the youngest at 11 years, and the oldest at 95 years of age. About 52,600 operators (69.1 percent) were between 15 and 64 years old, and 23,100 operators (30.4 percent) were 65 years old or older. Most of the operators were males (97.2 percent). About 2.6 percent of operators were ill or were on or under the influence of medication, drugs, or alcohol at the time of the incident. About 38.0 percent of operators were wearing eyeglasses only; 41.5 percent were wearing safety goggles only; 13.1 percent had no protective gear; and the rest had gloves only, gloves with eyeglasses or goggles, or both eyeglasses and goggles. (Table 4.5)

Table 4.4 Nature of Injuries and Disposition, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Year of injury				
2007	399	37,100	0.10	48.8
2008	422	39,000	0.11	51.2
Did blade contact cause injury?				
Yes	724	66,900	0.09	88.0
No or don't know	97	9,200	0.16	12.1
Body part injured				
Finger	733	67,800	0.10	89.1
Hand	51	5,200	0.21	6.8
Eyeball, Face, Head, Wrist, Lower Arm	25	2,200	0.23	2.9
Other	12	**	**	1.2
Diagnosis				
Laceration	525	49,300	0.10	64.8
Fracture	105	9,300	0.22	12.2
Amputation	96	8,000	0.14	10.5
Avulsion	58	6,100	0.17	8.0
Contusion, Abrasion	17	1,600	0.26	2.1
Other	20	1,800	0.31	2.4
Disposition				
Treated/examined and released	753	70,800	0.10	93.0
Treated and transferred to another hospital	16	2,100	0.28	2.8
Treated and admitted to hospital	47	2,900	0.25	3.8
Held for observation, left without being seen/left against medical advice	5	**	**	0.4

*Percentages may not add up exactly to 100 percent due to rounding.
**Estimate does not meet reporting requirements.

Table 4.5 Characteristics of Operators, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Age group of victim				
0–14	4	**	**	0.5
15–64	548	52,600	0.10	69.1
65 or older	269	23,100	0.11	30.4
Sex of victim				
Male	800	74,000	0.09	97.2
Female	21	2,100	0.27	2.8
Race of victim				
White	544	49,800	0.12	65.4
Black	22	1,500	0.35	2.0
Other	32	2,300	0.37	3.0
Not specified	223	22,500	0.23	29.6
Was the operator ill or under any medication, drugs, or alcohol?				
Yes	25	2,000	0.23	2.6
No	796	74,100	0.10	97.4
Was the operator left- or right-handed?				
Left-handed	61	5,400	0.17	7.1
Right-handed	709	66,500	0.10	87.4
Both hands interchangeably (ambidextrous) or don't know	51	4,200	0.17	5.5
Operator's protective gear				
Eyeglasses	313	28,900	0.09	38.0
Safety goggles	344	31,600	0.10	41.5
Eyeglasses and safety goggles, Eyeglasses and gloves, Eyeglasses and some other special clothing	31	3,200	0.19	4.2
Gloves, Safety goggles and gloves, Safety goggles and some other special clothing, Other	29	2,400	0.23	3.2
Nothing	104	10,000	0.18	13.1

*Percentages may not add up exactly to 100 percent due to rounding.
**Estimate does not meet reporting requirements.

4.3.2 Characteristics of Saws and Blades

Tables 4.6 to 4.8 present estimates for various characteristics of saws and blades used at the time of the incident.

The saw was owned by the operator's household in 86.7 percent of the cases; and the saw was already assembled at the time of purchase in 80.8 percent of the cases. Among the saws that were not borrowed or rented, the operator's household got the saw new in 82.5 percent of the cases. The operator had an owner's manual for the saw in 64.1 percent of the cases; and 22.3 percent of those who had an owner's manual remembered a warning or safety precaution printed in the manual about the operation of the saw. About 9.7 percent of all operators reported seeing a label on the saw with a warning or safety precaution. About 76.7 percent of the operators used the saw more than 10 times during the prior year; and 8.0 percent used the saw 1–5 times. The majority of the operators (53.0 percent) used a saw less than one hour per use; and 44.5 percent used a saw one hour or more per use. About 24.6 percent of the operators used different blades for different types of cutting operations. The most frequent types of cutting operations performed using the saw during the previous year were ripping (67.4 percent), followed by a combination of uses (24.1 percent). (Table 4.6)

Of the total number of injuries to operators, the operator was using a fixed cabinet saw in 68.7 percent of the cases, followed by a semiportable contractor saw in 18.3 percent of the cases, and a portable bench saw in 10.5 percent of the cases. In 20.4 percent of the cases, a riving knife[8] was attached to the saw; and in 24.6 percent of the cases, an anti-kickback pawl[9] or spreader[10] assembly was attached to the saw at the time of the injury. Among the cases with an anti-kickback or spreader assembly attached, in 86.6 percent cases the assembly was resting on the stock. The saw was modified only in a very small number of cases (1.7 percent), and the modification was done by the operator in most of the cases. (Table 4.7)

At the time of the injury, the most frequent type of blade used was a rip blade (70.0 percent), followed by a combination blade (16.8 percent). The saw blade was directly mounted on the motor in 59.2 percent of the cases and was indirectly powered by the motor in 33.0 percent of the cases. The blade was sharp in 95.3 percent of the cases, and dull in 2.5 percent of the cases. There was no safety switch for the saw in 78.7 percent of the cases; and of those that had a safety switch, the switch was removable in 46.3 percent of the cases, while the switch was stationary in 50.0 percent of the cases. A blade guard was attached to the saw prior to or at the time of the injury in 31.5 percent of the cases. When a blade guard was attached, 99.6 percent were in good condition, and the guard functioned properly in 93.0 percent of the cases. The most frequent reason for not having a blade guard at the time of the incident was "the guard was removed" (75.0 percent), followed by "the saw never had a blade guard" (19.2 percent). Among all operators, 13.5 percent thought the blade guard could have prevented the injury, while 52.6 percent did not have any opinion about whether the blade guard could have prevented the injury. (Table 4.8)

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[8] A safety device aligned directly behind the saw blade that ensures split of the stock along the kerf (the space or channel created in the stock by the blade during cutting) to prevent stock kickback.

[9] A safety device designed to prevent stock kickback.

[10] A safety device that ensures split of the stock to keep the stock from pinching or contacting the rear teeth of the blade.

Table 4.6 Saw Ownership, Assembly and Use, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Saw ownership				
Operator's household	717	66,000	0.10	86.7
Borrowed	68	6,400	0.17	8.4
Other	36	3,700	0.22	4.9
Rented	0	**	**	0.0
If not borrowed or rented, did the owner get the saw new or used?				
New	623	57,500	0.10	82.5
Used	110	9,700	0.13	13.9
Don't know	20	2,500	0.27	3.6
Subtotal (not borrowed or rented)	**753**	**69,700**	**0.10**	**100.0**
Saw assembly				
Before purchase	667	61,500	0.10	80.8
After purchase	81	7,300	0.15	9.6
Don't know	73	7,300	0.17	9.6
Have owner's manual?				
Yes	531	48,800	0.10	64.1
No	210	19,200	0.12	25.2
Don't know	80	8,100	0.16	10.7
If you have a manual, do you remember any warning or safety precaution in the manual?				
Yes	113	10,900	0.14	22.3
No or don't know	418	37,900	0.11	77.7
Subtotal (with owner's manual)	**531**	**48,800**	**0.10**	**100.0**
Any warning or safety precaution on a label on the saw?				
Yes	87	7,400	0.15	9.7
No	689	65,100	0.10	85.5
Don't know	45	3,600	0.24	4.7
How many times the operator used the saw last year?				
First time or don't know	38	3,500	0.20	4.7
1-5 times	61	6,100	0.21	8.0
6-10 times	81	8,100	0.17	10.6
More than10 times	641	58,400	0.10	76.7
How many hours/minutes per use?				
Less than 1 hour	433	40,300	0.10	53.0
1 hour or more	362	33,900	0.10	44.5
Don't know	26	1,900	0.25	2.5
Operator uses different blades for different types of cutting operations				
Yes	208	18,700	0.12	24.6
No	578	54,200	0.12	71.2
Don't know or not applicable	35	3,200	0.19	4.2

Table 4.6 Saw Ownership, Assembly and Use, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators) (Continued)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Most frequent type of cutting operations performed using the saw during last year				
Crosscutting	32	3,300	0.20	4.3
Ripping	539	51,300	0.13	67.4
Combination of uses	212	18,300	0.13	24.1
Other or don't know	38	3,200	0.18	4.2

*Percentages may not add up exactly to 100 percent due to rounding.

Table 4.7 Characteristics of Saws, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Type of table saw				
Fixed cabinet saw	559	52,300	0.13	68.7
Semi-portable contractor saw	163	13,900	0.14	18.3
Portable bench saw	79	8,000	0.18	10.5
Don't know	20	1,900	0.28	2.5
Was a riving knife attached to the saw?				
Yes	161	15,500	0.14	20.4
No	531	49,500	0.11	65.0
Don't know	129	11,100	0.16	14.6
Was an anti-kickback pawl or spreader assembly attached to the saw?				
Yes	195	18,700	0.13	24.6
No	544	50,500	0.10	66.4
Don't know	82	6,900	0.15	9.1
If an anti-kickback or spreader assembly was attached, was it resting on the stock or not?				
Resting on the stock	169	16,200	0.13	86.6
Not touching the stock or don't know	26	2,500	0.22	13.4
Subtotal (pawl or spreader attached)	**195**	**18,700**	**0.13**	**100.0**
Any modifications to saw?				
Yes	17	1,300	0.27	1.7
No	758	70,000	0.09	92.0
Don't know	46	4,800	0.21	6.3

*Percentages may not add up exactly to 100 percent due to rounding.

Table 4.8 Characteristics of Saw Blades, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Blade type used at the time of the injury				
Crosscut blade	39	3,600	0.19	4.7
Rip blade	563	53,300	0.13	70.0
Combination blade	145	12,800	0.14	16.8
Dado blade or other	30	2,700	0.21	3.6
Don't know	44	3,700	0.20	4.9
Blade directly or indirectly mounted on the motor				
Direct drive (blade mounted directly onto the motor output shaft)	478	45,100	0.10	59.2
Indirect drive (belt or gear driven)	278	25,100	0.13	33.0
Don't know	65	5,900	0.16	7.8
Blade condition				
Sharp	780	72,500	0.10	95.3
Dull	20	1,900	0.27	2.5
Other or don't know	21	1,700	0.25	2.2
Any safety switch on the blade?				
Yes	139	13,400	0.13	17.6
No	652	59,900	0.11	78.7
Don't know	30	2,800	0.21	3.7
If there was a safety switch, was it removable/stationary?				
Removable	58	6,200	0.15	46.3
Stationary	73	6,700	0.12	50.0
Don't know	8	**	**	3.7
Subtotal (safety switch on blade)	**139**	**13,400**	**0.13**	**100.0**
Was a blade guard attached?				
Yes	260	24,000	0.12	31.5
No	535	50,000	0.10	65.7
Don't know	26	2,100	0.23	2.8
Reasons for not having a blade guard				
Guard removed	395	37,500	0.11	75.0
Saw never had a guard	106	9,600	0.13	19.2
Guard broken off or other	34	2,900	0.20	5.8
Subtotal (no blade guard attached)	**535**	**50,000**	**0.10**	**100.0**
If a blade guard was attached, what was the condition?				
In good condition	257	23,900	0.10	99.6
Don't know	3	**	**	0.4
Subtotal (blade guard attached)	**260**	**24,000**	**0.12**	**100.0**
If a blade guard was attached, did the blade guard function properly?				
Yes	241	22,300	0.11	93.0
No or don't know	19	1,700	0.33	7.0
Subtotal (blade guard attached)	**260**	**24,000**	**0.12**	**100.0**
Could blade guard have prevented injury?				
Yes	115	10,300	0.14	13.5
No	286	25,800	0.10	33.9
Don't know	420	40,000	0.13	52.6

*Percentages may not add up exactly to 100 percent due to rounding. **Estimate does not meet reporting requirements.

4.3.3 Characteristics of Cutting Materials

Table 4.9 presents estimates by various characteristics of materials (stocks) being cut at the time of the injury. In most cases, the operator was cutting a wooden board (91.2 percent), and the shape of the stock was mostly rectangular (95.0 percent). The cutting operation was done through the length of the stock in 85.7 percent of the cases, followed by the width of the stock in 6.6 percent of the cases, and at an angle in 2.5 percent of the cases. The condition of the stock was mostly hard and smooth (57.8 percent), followed by "nothing unusual" (13.3 percent), hard (9.1 percent), and/or dry (4.3 percent). In 61.2 percent of the cases, the whole surface of the stock fit on the table, and in 36.4 percent of the cases, the stock extended beyond the table.

Table 4.9 Characteristics of Cutting Materials, Survey of Saw Injuries - Table/Bench Saws, 2007–-2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
What were you cutting?				
Wooden board	746	69,400	0.10	91.2
Other or don't know	75	6,700	0.13	8.8
Shape of stock				
Rectangular	773	72,300	0.10	95.0
Other shape or don't know	48	3,800	0.17	5.0
Type of cutting				
The length of the stock (with the grain, ripping)	698	65,200	0.11	85.7
The width of the stock (against the grain, cross cutting)	57	5,000	0.19	6.6
The stock at an angle	21	1,900	0.30	2.5
Other, don't know, or not applicable	45	4,000	0.17	5.3
Condition of stock[11]				
Hard	82	6,900	0.15	9.1
Smooth	26	2,300	0.21	3.0
Dry	34	3,300	0.22	4.3
Hard and Smooth	461	44,000	0.15	57.8
Smooth and Dry	26	1,800	0.25	2.4
Hard, Smooth, and Dry	25	2,100	0.25	2.8
Nothing unusual	108	10,100	0.15	13.3
Other or don't know	59	5,600	0.15	7.4
Did the whole surface of stock fit on the table or did it extend beyond?				
Fit on the table	512	46,600	0.10	61.2
Extend beyond	292	27,700	0.11	36.4
Don't know	17	1,800	0.25	2.4

*Percentages may not add up exactly to 100 percent due to rounding.

[11] This question allowed the choice of one or more of the following: hard, smooth, dry, green, knotty, nothing unusual, other, or don't know.

4.3.4 Operational Factors at the Time of Injury

Tables 4.10 to 4.12 present estimates by various operational factors at the time of injury. The motor was running at the time of injury in 94.5 percent of the cases; and the motor was just turned on or off, or the status of the motor was not known at the time of injury, for the remaining 5.5 percent of the cases. The operator was actually in the process of cutting in 67.1 percent of the cases, at the end of a cutting operation in 28.9 percent of the cases, and about to start cutting or pausing during a cutting operation, or the stage of cutting was not known in 3.9 percent of the cases. The position of the blade was "inside a cut" in 74.8 percent of the cases involving injuries, and "jumping out of the cut" in 11.6 percent of the cases. If the cutting was already started, the cutting of the stock was "part way through" in 67.3 percent of the cases, "coming out at the other end of the stock" in 28.0 percent of the cases; and in 4.7 percent of the cases "just starting to cut at one end," or the status was reported as unknown. At the time of injury, the blade was vertically straight in 94.7 percent of the cases, and was tilted to the side for a bevel cut in 1.9 percent of the cases. (Table 4.10)

The stock was resting on a table in 97.0 percent of the cases; and in the remaining cases, the stock was on a sawhorse, or supported in some other way, or the stock position was unknown. The stock was firmly anchored in 82.8 percent of the cases. A rip fence was used in 85.3 percent of the cases; of these, the stock was held securely against the fence in 96.3 percent of the cases, and the stock was wobbling, shifting, or other/unknown in 3.7 percent of the cases. If the stock was held securely against the fence, it was held in one hand in 48.8 percent of the cases, and was held in both hands in 47.7 percent of the cases. At the time of injury, the operator was pushing the stock in 76.7 percent of the cases, holding the stock still in 5.8 percent of the cases, pulling the stock or "unknown" in 2.9 percent of the cases, and "none of these" in the remaining cases (14.5 percent). Among the cases where the operator was pushing the stock, a push stick was used in 35.6 percent of the cases; and in 62.0 percent of the cases, neither a push stick nor a miter gauge was used. (Table 4.11)

The stock kicked back[12] or jumped in 40.5 percent of all cases. As mentioned before, the majority of the injuries to the operators were due to blade contacts (88.0 percent). Of the injuries due to blade contacts, in 56.9 percent of the cases, the blade contact was above the cutting surface. For the injuries where the stock kicked back and blade contact occurred, 93.7 percent of the respondents thought that the blade contact was due to the stock kickback. Of the injuries from blade contacts due to stock kickbacks, in 65.2 percent of the cases, the stock pulled the operator's hand into the blade; in 17.0 percent of the cases, the stock moved out from underneath causing the hand to fall into the blade; and in the remaining cases, something else happened, or the cause was unknown. Of the cases where blade contact caused injuries to hands or fingers, in 66.6 percent of the cases, the operator's hand was behind the blade when contact was made; and in 25.3 percent of the cases, the hand was in front of the blade. (Table 4.12)

[12] Kickback occurs when the cutting material wedges against the saw blade and is thrown back in the direction of rotation of the blade, which, in most cases is toward the operator; it causes unexpected movement of the cutting material.

Table 4.10 Operational Factors: Stage and Nature of Cutting at the Time of Injury, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Was the motor running?				
Motor was running	775	71,900	0.09	94.5
Motor was not running, just turned on/off, or don't know	46	4,200	0.17	5.5
Stage of cutting				
At the end of a cutting operation	237	22,000	0.10	28.9
Actually cutting/in the middle of cut	549	51,100	0.11	67.1
About to start cutting, pausing during a cutting operation, or don't know	35	3,000	0.19	3.9
Blade position with respect to stock or motion at the time of injury				
Inside a cut	613	56,900	0.11	74.8
Jumping out of the cut	96	8,800	0.16	11.6
Above the stock	28	2,500	0.23	3.3
Resting on stock but not yet in a cut	9	**	**	1.2
Other or don't know	75	6,900	0.15	9.1
If the blade was in a cut, how much of the stock was cut?				
Part way through	538	50,600	0.12	67.3
Coming out at the other end of the stock	236	21,000	0.10	28.0
Just starting to cut at one end or don't know	38	3,500	0.19	4.7
Subtotal (blade was in a cut)	**812**	**75,100**	**0.09**	**100.0**
Was the blade straight or tilted for bevel cut?				
Vertically straight	772	72,100	0.10	94.7
Tilted for bevel cut	18	1,462	0.26	1.9
Don't know/Not applicable	31	2,576	0.21	3.4

*Percentages may not add up exactly to 100 percent due to rounding.
**Estimate does not meet reporting requirements.

Table 4.11 Operational Factors: Feeding/Supporting the Stock, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
How was the stock supported?				
On a table	792	73,800	0.10	97.0
On a sawhorse, in some other way, or don't know	29	2,300	0.21	3.0
Was the operator pulling, pushing, or holding the stock at the time of the injury?				
Pushing	627	58,400	0.10	76.7
Holding	50	4,400	0.20	5.8
Pulling or don't know	22	2,200	0.25	2.9
None of these	122	11,000	0.12	14.5
If the operator was pushing the stock, was a push stick or miter gauge used to push?				
Push stick used	225	20,800	0.12	35.6
Neither push stick nor miter gauge was used	383	36,200	0.11	62.0
Miter gauge or push stick used, or both used, or don't know	19	**	**	2.4
Subtotal (operator was pushing)	**627**	**58,400**	**0.10**	**100.0**
Was the stock or the support firmly anchored?				
Yes	670	63,000	0.12	82.8
No	112	10,100	0.16	13.3
Don't know	39	3,000	0.18	3.9
Was a rip fence used?				
Yes	694	64,900	0.10	85.3
No	82	7,700	0.16	10.1
Don't know	45	3,500	0.18	4.6
If a rip fence was used, was the stock held securely against the fence?				
Held securely	669	62,500	0.11	96.3
Wobbling or shifting, other, or don't know	25	2,400	0.23	3.7
Subtotal (rip fence used)	**694**	**64,900**	**0.10**	**100.0**
If the stock was held securely against the fence, how was it secured?				
Held with one hand	330	30,500	0.12	48.8
Held with both hands	312	29,800	0.12	47.7
Clamped to the table, other way, or don't know	27	2,200	0.25	3.5
Subtotal (stock was held securely)	**669**	**62,500**	**0.11**	**100.0**

*Percentages may not add up exactly to 100 percent due to rounding.
**Estimate does not meet reporting requirements.

Table 4.12 Operational Factors: Stock Kickback and Blade Contact, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	**821**	**76,100**	**0.09**	**100.0**
Did the stock kick back or jump?				
Yes	330	30,800	0.12	40.5
No	450	41,700	0.09	54.8
Other or don't know	41	3,600	0.18	4.7
Was injury due to contact with the blade?				
Yes	724	66,900	0.09	88.0
No or don't know	97	9,200	0.16	12.1
If blade contact caused the injury, did the blade contact above or below the cutting surface?				
Above	414	38,100	0.09	56.9
Below	268	24,800	0.16	37.0
Don't know	42	4,100	0.19	6.1
Subtotal (blade contact injuries)	**724**	**67,000**	**0.09**	**100.0**
If the stock kicked back or jumped and injury was due to blade contact, was contact caused by the stock kickback?				
Yes	241	22,400	0.12	93.7
No, other, or don't know	15	1,500	0.32	6.3
Subtotal (stock kicked back or jumped and blade contact injury)	**256**	**23,900**	**0.12**	**100.0**
If stock kickback caused blade contact, did the stock move out from under the hand causing blade contact?				
Stock moved out from underneath, causing hand to fall into blade	41	3,800	0.20	17.0
Stock pulled hand into the blade	158	14,600	0.15	65.2
Something else or don't know	43	4,000	0.17	17.9
Subtotal (kickback caused contact)	**242**	**22,400**	**0.12**	**100.0**
If injury was to hands or fingers and due to blade contact, was the hand in front of or behind the blade when contact was made?				
In front of blade	188	16,900	0.11	25.3
Behind blade	479	44,400	0.12	66.6
Don't know	55	5,400	0.19	8.1
Subtotal (hand/finger injury due to blade contact)	**722**	**66,700**	**0.09**	**100.0**

*Percentages may not add up exactly to 100 percent due to rounding.

4.3.5 Selected Characteristics of Blade Contact Injuries

Table 4.13 presents some selected characteristics of injuries to operators due to blade contact. The estimated number of injuries to operators due to blade contact during 2007–2008 was 66,900, which is 84.2 percent of all emergency department-treated injuries associated with table/bench saws. Among the blade contact injuries, the most frequent form of injury was laceration (65.9 percent), followed by fracture (12.4 percent), amputation (12.0 percent), and avulsion (8.5 percent). About 7.1 percent of operators were treated and admitted to a hospital, or treated and transferred to another hospital. A blade guard was attached to the saw prior to or at the time of injury in 30.9 percent of the cases; and the stock kicked back or jumped in 35.6 percent of the cases. A riving knife was attached to the saw in 19.6 percent of the cases, and an anti-kickback pawl or a spreader assembly was attached to the saw in 23.9 percent of the cases at the time of the injury.

Table 4.13 Selected Characteristics of Blade Contact Injuries, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	724	66,900	0.09	100.0
Type of table saw				
Fixed cabinet saw	486	45,500	0.13	68.0
Semiportable contractor saw	150	12,600	0.14	18.8
Portable bench saw	72	7,500	0.18	11.2
Don't know	16	1,300	0.28	1.9
Age group of victim				
0–14	3	**	**	0.5
15–64	479	45,900	0.10	68.5
65 or older	242	20,700	0.10	31.0
Diagnosis				
Laceration	470	44,100	0.10	65.9
Fracture	94	8,300	0.23	12.4
Amputation	94	8,000	0.14	12.0
Avulsion	55	5,700	0.18	8.5
Other	11	**	**	1.2
Disposition				
Treated/examined and released	659	61,800	0.09	92.4
Treated and transferred to another hospital	15	1,900	0.28	2.8
Treated and admitted to hospital	45	2,900	0.25	4.3
Held for observation	2	**	**	0.1
Left without being seen/left against medical advice	3	**	**	0.3
Was a blade guard attached?				
Yes	221	20,700	0.11	30.9
No	481	44,500	0.10	66.5
Don't know	22	1,700	0.25	2.5

Table 4.13 Selected Characteristics of Blade Contact Injuries, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators) (Continued)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	724	66,900	0.09	100.0
Did the stock kickback or jump?				
Yes	256	23,800	0.12	35.6
No	429	39,600	0.09	59.2
Other or don't know	39	3,500	0.19	5.2
Was a riving knife attached to the saw?				
Yes	135	13,100	0.13	19.6
No	474	44,300	0.11	66.2
Don't know	115	9,500	0.16	14.2
Was an antikickback pawl or spreader assembly attached to the saw?				
Yes	165	16,000	0.13	23.9
No	487	44,700	0.10	66.8
Don't know	72	6,200	0.16	9.3
If an antikickback or spreader assembly was attached, was it resting on the stock or not?				
Resting on the stock	142	13,700	0.14	85.6
Not touching the stock or don't know	23	2,300	0.244	14.4
Subtotal (assembly attached)	**165**	**16,000**	**0.125**	**100.0**
Was a rip fence used?				
Yes	606	56,600	0.10	84.6
No	77	7,200	0.17	10.8
Don't know	41	3,100	0.19	4.6
Any modifications to saw?				
Yes	13	**	**	1.6
No	673	62,100	0.09	92.8
Don't know	38	3,700	0.22	5.5

*Percentages may not add up exactly to 100 percent due to rounding.
**Estimate does not meet reporting requirements.

4.3.6 Medical Disposition as Related to Kickback

Table 4.14 presents some medical dispositions of injuries based on whether the stock kicked back or jumped. This is a more detailed breakdown of the blade contact injuries shown in Table 4.13, so most of the estimates do not meet reporting criteria. The highest percentage of treated and released was stock did not kick back or jump up (94.9 percent), followed by injuries from stock that did kick back or jump up (90.2 percent), stock did something other than kick back or jump (83.2 percent), and unknown (76.0 percent). Overall, 92.4 percent of the cases were treated and released.

Table 4.14 Medical Disposition as Related to Kickback, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	724	66,900	0.09	100.0
Stock kicked back or jumped				
Treated/examined and released	226	21,000	0.12	90.2
Treated and transferred	7	**	**	3.3
Treated and admitted to hospital	21	**	**	5.7
Held for observation	1	**	**	0.1
Left without being seen/left against medical advice	1	**	**	0.7
Total	256	24,000	0.12	100.0
Stock did not kick back or jump				
Treated/examined and released	404	38,000	0.10	94.9
Treated and transferred	6	**	**	2.1
Treated and admitted to hospital	18	**	**	2.9
Held for observation	1	**	**	0.1
Total	429	40,000	0.09	100.0
Stock did something other than kick back or jump				
Treated/examined and released	11	**	**	83.2
Treated and admitted to hospital	3	**	**	16.8
Total	14	**	**	100.0
Unknown if stock kicked back or jumped				
Treated/examined and released	18	1,800	0.26	76.0
Treated and transferred	2	**	**	12.7
Treated and admitted to hospital	3	**	**	8.1
Left without being seen/left against medical advice	2	**	**	3.2
Total	25	2,300	0.24	100.0
Total				
Treated/examined and released	659	61,800	0.09	92.4
Treated and transferred	15	1,900	0.28	2.9
Treated and admitted to hospital	45	2,900	0.25	4.3
Held for observation	2	**	**	0.1
Left without being seen/left against medical advice	3	**	**	0.3
Total	724	66,900	0.09	100.0

*Percentages may not add up exactly to 100 percent due to rounding. **Estimate does not meet reporting requirements.

4.3.7 Medical Diagnosis as Related to Kickback

Table 4.15 presents some medical diagnoses of injuries based on whether the stock kicked back or jumped. This is a more detailed breakdown of the blade contact injuries shown in Table 4.13, so most of the estimates do not meet reporting criteria. The most common diagnosis overall was laceration (65.9 percent). The highest percentage of lacerations was stock did not kick back or jump (69.4 percent), followed by injuries from unknown if stock kicked back or jumped (64.6 percent), stock kicked back or jumped (61.1 percent), and stock did something other than kick back or jump (46.4).

Table 4.15 Medical Diagnoses as Related to Kickback, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries, 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Overall Total	724	66,900	0.09	100.0
Stock kicked back or jumped				
Laceration	151	14,541	0.14	61.1
Amputation	41	3,720	0.21	15.6
Fracture	41	3,377	0.32	14.2
Avulsion	16	**	**	6.5
Other	6	**	**	2.0
Contusions, Abrasions	1	**	**	0.6
Total	256	23,813	0.12	100.0
Stock did not kick back or jump				
Laceration	296	27,513	0.10	69.4
Fracture	48	4,368	0.23	11.0
Amputation	46	3,792	0.16	9.6
Avulsion	35	3,756	0.22	9.5
Contusions, Abrasions	3	**	**	0.5
Other	1	**	**	0.1
Total	429	39,644	0.09	100.0
Stock did something other than kick back or jump				
Laceration	7	**	**	46.4
Avulsion	3	**	**	24.8
Amputation	3	**	**	18.3
Fracture	1	**	**	10.6
Total	14	**	**	100.0
Unknown if stock kicked back or jumped				
Laceration	16	**	**	64.6
Fracture	4	**	**	18.4
Amputation	4	**	**	10.6
Avulsion	1	**	**	6.3
Total	25	2,314	0.24	100.0

Table 4.15 Medical Diagnoses as Related to Kickback, Survey of Saw Injuries - Table/Bench Saws, 2007–2008 (Injuries to Operators)

Description	Sample Count of Injuries	Estimated Number of Injuries, 2007-2008	CV of Estimated Number	Percentage Distribution* (%)
Total				
Laceration	470	44,096	0.10	65.9
Fracture	94	8,294	0.23	12.4
Amputation	94	7,974	0.14	11.9
Avulsion	55	5,738	0.18	8.6
Other	7	**	**	0.8
Contusions, Abrasions	4	**	**	0.5
Total	724	66,949	0.09	100.0

*Percentages may not add up exactly to 100 percent due to rounding.
**Estimate does not meet reporting requirements.

6. DISCUSSION

An important objective of this survey of injuries associated with stationary saws was to identify the specific types of saws involved in the incidents when the saw type was unspecified in the NEISS or to verify the types of saws reported in the NEISS so that more accurate estimates of the number of injuries associated with a particular type of saw could be obtained. The results show that the estimated total number of injuries associated with table/bench saws in 2007–2008 was 79,500 (Table 4.2), which is 9.1 percent higher than the NEISS estimate of 72,900 (Table 1). Almost all of the victims were the operators of the saws. In most cases, the victim was examined or treated and released from the hospital on the same day; and in some cases (less than 7 percent), the victim was treated and admitted to the same or another hospital.

An analysis of the estimates by various factors and a review of respondents' narratives of incidents helped characterize the general hazard patterns of the injuries. The hazard patterns appear very similar to those identified in the survey conducted in 2001. Blade contact to fingers appears to be a major hazard related to the use of table or bench saws. In 88.0 percent of the cases, the injuries to operators associated with table or bench saws were due to blade contact; and in the majority of these cases, the blade was contacted above the cutting surface. Laceration, followed by fracture and amputation, were the most common forms of injuries to operators. Fingers followed by hands were the most frequent body parts involved in the injuries. Injuries to fingers were mainly due to contacting the blade. Most often, lacerations and, in some cases, amputations of fingers occurred when the operator did not move his hand when it came close to the blade. Common reasons for blade contact included: trying to reach the stock, operating on a small piece of stock without using a push stick, lack of attention when the hand was close to the saw blade, stock kickback, and the catching of gloves by the blade. Often a lapse in an operator's attention resulted in the operator's hand or fingers contacting the blade. In some situations, the operator was pushing the stock and got too close to the blade, resulting in the catching of gloves by the blade. In some situations, the operator's hand, holding the stock and/or guiding the stock, slipped into the blade when the blade jammed in the stock. In some cases, stock kickback was reported as the cause of blade contact when the blade was contacted above the cutting surface. In these incidents, the blade slowed or stopped momentarily as it bound or caught in the stock, such as when it hit a knot or when it was pinched or jammed, because the cut began too close behind the blade. This caused the stock to bounce out and hit an operator's hand and caused his hand to contact the blade. In some other cases, the stock pulled the operator's hand to the blade. In the majority of the cases, the saw did not have an anti-kickback pawl or spreader assembly attached. In many of the blade contact cases, there was no blade guard in use at the time of the incident. Often the blade guard was removed to get a clear view of the blade; while in some cases, the saw never had a blade guard. The majority of all operators were not sure if a blade guard could have prevented the injury.

In most cases, the operator was cutting a rectangular wooden board through the length of the stock (i.e., ripping). In a majority of the cases, the condition of the stock was hard and smooth, a rip blade was in use, and the blade was direct drive (i.e., mounted directly on the motor output shaft). The saw did not have a safety switch in the vast majority of the cases, and when the saw had a safety switch, the switch was removable in almost half of the cases.

To give an idea of the nature of the incidents based on verbal descriptions, a sample of respondents' narratives about how the incident happened is included in Appendix B.

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APPENDIX A
DETAILS OF ESTIMATION METHODOLOGY

Weighting and Estimation

Since all of the NEISS cases with relevant product codes that occurred within the survey time period were selected for follow up, the base weights of the cases selected for the survey were equal to their NEISS weights.[13] Then the base weights of the cases that were successfully interviewed during the follow-up survey were adjusted to account for the nonresponding cases. The weighting adjustment is done in two steps. Initially, a nonresponse adjustment is applied to distribute the weights of the nonresponding cases to the responding cases by defining adjustment cells that are likely to be homogeneous in terms of injury characteristics of respondents and nonrespondents; and then a raking adjustment is applied to ensure that the marginal totals of the adjusted weights of the responding cases are the same as the corresponding marginal totals estimated from the NEISS. The process of nonresponse and raking adjustments to compute the final weights for the responding sample can be expressed as follows:

If W_i^b is the base weight (equal to the NEISS weight) for the *i*-th case selected for follow-up investigation, then the initial nonresponse adjusted weight, W_i^n, can be defined as

$$W_i^n = W_i^b * \frac{\sum_{i \in c} W_i^b}{\sum_{i \in c \cap r} W_i^b} \qquad \text{if } i \in r$$

$$= 0 \qquad \text{otherwise,}$$

Where, c indicates a nonresponse adjustment cell and r indicates the set of responding cases.

Based on an analysis of the responses, the adjustment cells were defined by the NEISS product codes, the NEISS sampling strata, and the age groups (0–16[14], 17–64, 65+ years) of the victims.

At the next step, the final weight, W_i^f, is derived by applying a raking ratio adjustment (Brackstone and Rao, 1979; Deville and Särndal, 1992) to the nonresponse adjusted weights, W_i^n, using the following raking margins:

a. year of treatment and NEISS stratum,
b. year of treatment and product code, and
c. year of treatment and age group.

The categories of the variables used for defining the raking margins are as follows: year of treatment (2007 and 2008), product code (841, 842, 843, 845, and 895), and age group (0–14, 15–64, and 65+ years).

The final weight, W_i^f, for the *i*-th case can be defined as:

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[13] Because there was no subsampling between the injuries reported to the NEISS and the injuries selected for the survey. In other words, the selection probability is 1, and hence the weight remains the same.
[14] The age group 0–16 years instead of 0–14 years was used here, because the sample size within 0–14 years was not sufficient for a stable nonresponse adjustment.

$$
\begin{aligned}
W_i^{\,f} &= W_i^{\,n} * \phi_i && \text{if } i \in r \\
&= 0 && \text{otherwise,}
\end{aligned}
$$

where, ϕ_i is the raking ratio (adjustment factor) for the *i*-th case as derived through the process of iteration using a raking algorithm.

The estimates of injuries and relevant characteristics are produced based on these final raking adjusted weights, $W_i^{\,f}$, and include the eligible cases only. The general form of the national estimator of a proportion (or percentage) of injuries presented in the report can be expressed as follows:

$$\hat{P}_c = \frac{\hat{Y}_c}{\hat{T}} \text{ with } \hat{Y}_c = \sum_{i \in E} W_i^{\,f} y_i \text{ and } \hat{T} = \sum_{i \in E} W_i^{\,f}$$

where,

$\hat{P}_c$ is the estimate of a proportion in category, c,

$\hat{Y}_c$ is the estimate of total incidents in category, c,

y_i is a dichotomous variable with $y_i = 1$ if the case belong to category, c, and 0 otherwise,

$\hat{T}$ is the estimate of total number of eligible incidents in the population, and

E represents the set of responding eligible cases.

Although this report is for table/bench saws only, the weighting adjustments included all stationary and unspecified saws because the follow-up survey reclassified some saws to other categories. The tabulation included all table/bench saws as reported in the follow-up survey, irrespective of their NEISS product codes, and hence all cases had to be included during weighting adjustments.

Item Nonresponse and Imputation

Generally, the survey had a very low rate of partial nonresponse. One or more variables were missing for a small number of cases, which were otherwise considered complete responses. The missing values of these variables were imputed by using a hot deck imputation scheme (Ford, 1983; Kalton and Kasprzyk, 1986). Under this scheme, within an imputation class, a donor with a nonmissing value is selected randomly for a case with a missing value and then the missing value is imputed using the corresponding value of the donor. For all imputed variables used in this report, the base imputation class was formed by using the reported product code (i.e., saw type as obtained from the survey). Then, within the base imputation class, some other variables were used to create a finer imputation class as necessary. Often this refinement of imputation class was required to maintain the skip pattern (see p.10) of the variable. As mentioned previously, the extent of such imputation was very low. In most cases, the number of imputed values for a variable was less than 10, and the maximum number of values imputed for a variable was 14.

Variance Estimation

The variances of the estimates were computed (estimated) by using the SAS® Proc SurveyFreq procedure (SAS,® 2004). The variances of estimated counts are presented in the form of coefficient of variations (CV) in the report. A CV is defined as the ratio of the standard error (i.e., the square root of the variance) and the estimate. A 95 percent confidence interval for an estimate can be defined in terms of CV as (Estimate ± 1.96*CV*Estimate) under a normal approximation.[15]

SAS® survey procedures compute variances directly for the estimates of totals, but use the Taylor Series linearization method for proportions (SAS®, 2004; Woodruff, 1971; Fuller, 1975). Because the NEISS design is a cluster sample of injuries within a hospital, hospitals are used as primary sampling units (PSUs), and each NEISS sampling stratum of hospitals is used as a variance stratum. The finite population correction (*fpc*) factors[16] are ignored (i.e., sampling with replacement of hospitals is assumed), given the number of hospitals in the sample compared to the total number of hospitals in a stratum is small, except in the stratum of children's hospitals, which is a negligible contributor to the total estimate.

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[15] A normal approximation can be used in most cases if the sample size is 50 or more. See Cochran (1977), pp. 27–42, for further discussion on confidence limits and normal approximation.

[16] $fpc = (1 - n/N)$, where n/N is the PSU sampling fraction in a stratum. For this survey, n is the number of sampled hospital in a stratum, and N is the total number of hospitals in the stratum.

APPENDIX B
A SAMPLE OF RESPONDENTS' NARRATIVES OF INCIDENTS

Q21. PLEASE DESCRIBE HOW THE ACCIDENT HAPPENED AND WHAT THE INJURIES WERE. THAT IS, WHAT WERE YOU DOING JUST BEFORE, DURING, AND AFTER THE INJURY OCCURRED? PLEASE START WITH WHAT WAS GOING ON JUST BEFORE THE INJURY OCCURRED.
HE WAS USING HIS TABLE SAW TO CUT SMALL PIECES OF WOOD. IT WAS LATE IN THE DAY AND I THINK HE WAS GETTING TIRED. HE WAS USING A PUSH STICK TO PUSH THE WOOD THROUGH AND HE REACHED AROUND TO GET THE WOOD BUT HIS FINGER TIP CAUGHT THE BLADE AND HE WAS CUT. I TOOK HIM TO THE HOSPITAL AND THEY STITCHED HIS FINGER.
THE 59 YO MALE VICTIM WAS WORKING WITH HIS TABLE SAW AT HOME CUTTING BOARDS. SOMEHOW, HIS LEFT HAND CAME INTO CONTACT WITH THE BLADE, LACERATING HIS MIDDLE FINGER AND PARTIALLY AMPUTATING HIS INDEX FINGER. VICTIM TRANSPORTED TO ER BY HIS WIFE. RECEIVED IV ANTIBIOTICS AND 4 STITCHES IN MIDDLE FINGER, TREATED AND RELEASED THE SAME DAY.
VICTIM IS A 66 YEAR OLD MALE WHO WAS USING A FRIEND'S SAW AT A CHURCH TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 15 MINUTES & SUPPORTING THE WOOD WITH BOTH HANDS. VICTIM GOT HIS RIGHT HAND TOO CLOSE TO THE BLADE & CUT HIS INDEX FINGER. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
THE VICTIM WAS CUTTING A 2 X 4 ON HIS TABLE SAW AT HOME. THE STOCK KICKED (HE DOSEN''T KNOW WHY) AND HIS FINGER ROLLED OVER THE BLADE. HE CUT RING THE (4TH) FINGER ON HIS RIGHT HAND. HE WAS TRANSPORTED TO ER BY A FRIEND. HE RECEIVED 38 STITCHES AND WAS DISCHARGED THE SAME DAY.
I HAD COMPLETED SEVERAL CUTS AND I HAD LEFT ONE PIECE TO THE RIGHT OF THE SAW. WHEN I REACHED ACROSS TO GET THE LAST PIECE OF WOOD I HIT THE BLADE AND I CUT MY RIGHT THUMB. THERE MAY HAVE BEEN A KICK BACK, BUT I'M NOT SURE. MY WIFE INSISTED ON TAKING ME TO THE ER.
VICTIM IS A 70 YEAR OLD MALE WHO WAS USING A TABLE SAW TO CUT A SMALL PIECE OF WOOD. VICTIM HAD BEEN CUTTING FOR ABOUT 15 MINUTES WITH A PUSH STICK IN HIS RIGHT HAND & HOLDING THE WOOD WITH HIS LEFT HAND. VICTIM SAID HE JUST GOT HIS LEFT HAND TOO CLOSE TO THE BLADE & CUT HIS LEFT FINGER. VICTIM WAS TAKEN TO THE ER, TREATED, & RELEASED.
I WAS RIPPING 6 FOOT PIECE OF TRIM. I WAS AT THE END OF THE CUT AND PUSHED A LITTLE TOO HARD. I WOUND UP PUSHING MY LEFT HAND INTO THE SAW AND I FRACTURED MY FINGER. I ALSO CUT MY LEFT INDEX AND MIDDLE FINGERS. MY WIFE DROVE ME TO THE HOSPITAL.
VICTIM IS A 57 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM WAS ON HIS 1ST CUT & JUST GOT HIS LEFT FINGERS TOO CLOSE TO THE BLADE & CUT 4 OF THEM. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 48 YEAR OLD MALE WHO WAS MOVING A TABLE SAW THAT HAD BEEN BROKEN DOWN. VICTIM CUT HIS RIGHT FINGER ON THE TOP OF THE TABLE, NOT THE BLADE. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 49 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 15 MINUTES & WAS IN THE MIDDLE OF A CUT WHEN THE CAT JUMPED FROM A SHELF TOWARDS THE SAW. THE VICTIM'S REACTION WAS TO PUSH THE CAT AWAY & IN DOING SO, WHEN HE TURNED HE PUT HIS LEFT THUMB INTO THE BLADE. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 40 YEAR OLD FEMALE WHO WAS USING A FRIEND'S TABLE SAW TO CUT A DOOR. VICTIM HAD BEEN CUTTING ABOUT 5 MINUTES WHEN THE DOOR SLIPPED & SHE WENT TO GRAB IT & PUT HER LEFT MIDDLE FINGER INTO THE BLADE. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 66 YEAR OLD MALE WHO WAS USING A TABLE SAW TO CUT A SMALL PIECE OF WOOD. VICTIM HAD BEEN CUTTING FOR 3 HOURS ON & OFF. VICTIM WAS IN THE MIDDLE OF A CUT & GOT DISTRACTED & JUST GOT HIS LEFT INDEX FINGER TOO CLOSE TO THE BLADE & CUT IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.

APPENDIX B (Continued)
A SAMPLE OF RESPONDENTS' NARRATIVES OF INCIDENTS

Q21. PLEASE DESCRIBE HOW THE ACCIDENT HAPPENED AND WHAT THE INJURIES WERE. THAT IS, WHAT WERE YOU DOING JUST BEFORE, DURING, AND AFTER THE INJURY OCCURRED? PLEASE START WITH WHAT WAS GOING ON JUST BEFORE THE INJURY OCCURRED.
VICTIM IS A 42 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING FOR ABOUT 15 MINUTES & WHEN HE REACHED FOR THE COMPLETED CUT, HE PUT HIS RIGHT THUMB INTO THE BLADE. VICTIM WENT TO THE ER, WAS TREATED,& RELEASED.
VICTIM IS A 74 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ON & OFF FOR ABOUT 5 HOURS. VICTIM HAD COMPLETED A CUT & REACHED FOR THE WOOD & PUT HIS RIGHT THUMB INTO THE BLADE & LACERATED IT. VICTIM STATED HE WAS TIRED. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 25 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 30 MINUTES & COMPLETED A CUT. WHEN THE VICTIM REACHED FOR THE WOOD, HE ACCIDENTALLY CUT HIS LEFT THUMB. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
I WAS CUTTING TOO SHORT OF A PIECE OF WOOD FOR THE TABLE SAW. I WAS RABITTING AN EDGE AND IT KICKED BACK UP AND AS IT SLIPPED THE WOOD WENT INTO THE BOTTOM OF MY FOREARM. IT WAS A GLANCING BLOW ABOUT 1/4' DEEP THAT TOOK OUT A CHUNK OF SKIN ABOUT AN INCH BY A HALF INCH. IT PEELED BACK MAKING A FLAP.
'MY HAND SLIPPED ON A PIECE OF WOOD AND MY THUMB HIT THE BLADE. I WAS AT THE END OF A CUT AND I WAS REACHING DOWN WITH MY LEFT HAND TO TURN THE POWER OFF AND THAT IS WHEN MY RIGHT THUMB HIT THE SAW BLADE.'
VICTIM IS A 20 YEAR OLD MALE WHO WAS AT A FRIEND'S HOUSE & USING HIS TABLE SAW TO RIP PLYWOOD. VICTIM HAD BEEN CUTTING ABOUT 20 MINUTES WHEN THE STOCK KICKED BACK & PULLED HIS LEFT MIDDLE FINGER INTO THE BLADE & CUT IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
I WAS CUTTING A PIECE OF WOOD AND WAS IN A CONFINED AREA WHERE THE TABLE SAW WAS AND I HAD FINISHED CUTTING THE PIECE OF WOOD AND IT WAS LONG. I WENT TO REACH FOR IT TO PICK IT UP AND I TOUCHED THE TIP OF THE BLADE WITH MY THUMB ON MY LEFT HAND AND IT JUST TORE IT TO PIECES. THIS WAS A VERY OLD SAW AND WAS AT MY NEIGHBORS HOUSE. THIS WOULD NOT HAVE HAPPENED WITH A NEWER SAW BECAUSE THEY HAVE A GUARD FOR THE BLADE. THE BLADE WAS SPINNING SO FAST THAT YOU CAN'T SEE THE TIPS OF THE BLADE AND I JUST REACHED OVER TO REMOVE THE WOOD AND NICKED MY THUMB ON THE BLADE. I SHOULD HAVE TURNED THE SAW OFF BEFORE TRYING TO REMOVE THE BOARD SINCE I WAS INDEED DONE WITH THE CUT. WHAT DID I DO? I GRABBED IT AND SAID PRAISE THE LORD THAT I DIDN'T CUT THE WHOLE THING OR THE WHOLE HAND OFF! MY WIFE DROVE ME TO THE HOSPITAL AND THEY FIXED IT UP.
VICTIM IS A 62 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 15 MINUTES WHEN THE STOCK KICKED BACK. THE STOCK HIT HIS LEFT KNUCKLE & FINGER & LACERATED IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
WELL I WAS CUTTING DOWN A PCITURE FRAME. THE FRAME WAS TOO BIG FOR THE NEW PICTURE THAT I WANTED TO PUT IN IT SO I WAS MAKING IT SMALLER. I WAS CUTTING A 45 AND I HAD IT ON THE GUIDE. I THOUGHT I WAS AT LEAST 8 INCHES FROM THE BLADE. IT HAPPENED REALLY FAST AND I REALLY DON'T KNOW WHAT HAPPENED. I THINK THE BOARD JUMPED OR SOMETHING. I HAVE BEEN DOING THIS TYPE OF WORK FOR YEARS AND IT HAS NEVER HAPPENED TO ME BEFORE. I CUT THE FIRST JOINT OF THE LITTLE FINGER OF THE RIGHT HAND. IT CUT THE JOINT OFF COMPLETELY AND WAS HELD ON BY JUST A SMALL PIECE OF SKIN. RIGHT AWAY I WRAPPED IT IN A PAPER TOWEL AND MY WIFE TOOK ME TO THE EMERGENCY ROOM. THE BONE DOCTOR OR WHAT EVER YOU CALL HIM PUT A PIN IN IT AND I GO NEXT WEEK TO GET THE PIN OUT.
'I WAS SAWING A BOARD, A 2X6. I WAS RIPPING THE LENGTH OF THE BOARD. IT CAME OFF THE OTHER END AND IT STARTED TO FALL. I REACHED TO GRAB IT AND SLICED MY LEFT THUMB. I WAS TAKEN TO THE ED, TREATED AND RELEASED.'
VICTIM IS A 51 YEAR OLD FEMALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING 3-4 HOURS WHEN HE HIT A KNOT IN THE WOOD CAUSING HIS LEFT THUMB TO BE PULLED INTO THE BLADE & HE LACERATED IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.

APPENDIX B (Continued)
A SAMPLE OF RESPONDENTS' NARRATIVES OF INCIDENTS

Q21. PLEASE DESCRIBE HOW THE ACCIDENT HAPPENED AND WHAT THE INJURIES WERE. THAT IS, WHAT WERE YOU DOING JUST BEFORE, DURING, AND AFTER THE INJURY OCCURRED? PLEASE START WITH WHAT WAS GOING ON JUST BEFORE THE INJURY OCCURRED.
VICTIM IS A 79 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 3 HOURS & WAS USING HIS LEFT HAND TO SUPPORT THE WOOD. VICTIM GOT HIS LEFT THUMB TOO CLOSE TO THE BLADE & FRACTURED THE TIP OF IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 46 YEAR OLD MALE WHO WAS USING A TABLE SAW TO CUT A CHANNEL IN THE WOOD WITH A DADO BLADE. VICTIM HAD BEEN CUTTING ABOUT 30 MINUTES WHEN HE GOT HIS LEFT HAND TOO NEAR TO THE BLADE. VICTIM AMPUTATED ONE FINGER & CUT SEVERAL OTHERS. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 58 YEAR OLD MALE WHO WAS USING A TABLE SAW TO CUT WOOD. VICTIM HAD BEEN CUTTING 2-3 HOURS & USING A PUSH STICK IN HIS RIGHT HAND & GUIDING THE WOOD WITH HIS LEFT HAND. VICTIM GOT HIS LEFT MIDDLE FINGER TOO CLOSE TO THE BLADE & CUT IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 49 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP 2 X 4'S. VICTIM HAD BEEN CUTTING ABOUT 4 HOURS WHEN HE REACHED WITH HIS LEFT HAND FOR THE PIECE OF WOOD & CUT HIS INDEX FINGER. VICTIM WENT TO THE ER, WAS TREATED,& RELEASED.
VICTIM IS A 70 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP TREATED WOOD. VICTIM HAD BEEN CUTTING ABOUT 45 MINUTES & HAD COMPLETED A CUT, THEN REACHED FOR THE WOOD & PUT HIS LEFT FINGER TIP INTO THE BLADE. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
I WAS CUTTING TRIM FOR A WINDOW AND WHILE I WAS PUSHING THE WOOD THROUGH, ONE PIECE OF WOOD LIFTED AND I PUSHED IT DOWN. I THOUGHT MY FINGERS WERE FAR ENOUGH BACK BUT IT CUT A PIECE OFF MY LEFT THUMB ABOUT ONE INCH LONG AND REQUIRED 11 STITCHES. I WAS DRIVEN TO THE ED, TREATED AND RELEASED.
I WAS RIPPING A 10 FOOT BOARD THAT I HAD JUST RUN THRU THE PLANER. I WAS RIGHT AT END OF THE BOARD AND I HAD A SET OF ROLLER HOLDDOWNS WHICH HOLD THE BOARD DOWN ON THE SAW TABLE AND AGAINST THE RIP FENCE, AND I WAS USING A PUSH STICK. THE WAY I HAD THE HOLDDOWNS ON THE TABLE WAS BACK TOO FAR AND I COULDN'T PUSH THE STICK FOR THE REMAINDING 3 INCHES OF THE BOARD. I REACHEED OVER THE TOP AND I HEARD A PING AND IT WAS MY THUMB. IT WAS A DUMB THING TO DO. I GUESS IT WAS JUST A MENTAL LAPSE. I CUT THE TIP OF MY RIGHT INDEX FINGER. I HAD TO GET 2 STITCHES. IT IS ALL TAKEN CARE OF NOW AND I WILL BE BACK TO NEW SOON. I TURNED THE SAW OFF, TURNED THE DUST COLLECTOR OFF. I HAVE A BOX OF RAGS, WHICH ARE LIKE A THICK ROLL OF PAPER TOWELS AND I WRAPPED THEM AROUND MY HAND, TOOK MY SHOP APRON OFF TURNED THE LIGHT OFF AND WENT UP AND SAID TO MY WIFE 'HONEY, I THINK WE NEED TO TAKE A TRIP TO THE HOSPTIAL.'
'MY HUSBAND HAD JUST GOTTEN THE SAW BACK. IT WAS BEING REPAIRED. HE DECIDED TO TRY THE SAW OUT, SINCE HE HAD JUST GOTTEN IT BACK. WHILE HE WAS CUTTING A PIECE OF WOOD IT WOUND UP BREAKING THE PIECE OFF INSTEAD OF CUTTING THE PIECE OFF. WHEN MY HUSBAND SAW WHAT IT DID HE TURNED THE SAW OFF. BEING 85 YEARS OLD HE DID NOT HAVE THE REACTION TIME A YOUNGER MAN WOULD HAVE AND WHEN HE REACHED OVER TO PICK UP THE BROKEN OFF PIECE OF WOOD THE SAW HAD NOT COMPLETLY STOPPED. HE BRUSHED THE BLADE AND CUT AND FRACTURED HIS THUMB, MIDDLE AND INDEX FINGERS. I TOOK HIM TO THE ER.'
I WAS CUTTING TRIM WITH MY NEIGHBOR FOR A NEW STORM DOOR ON THE BACK PORCH. I WAS CUTTING THE LAST PIECE. THE SAW JUST DRUG THE PIECE OF WOOD THRU THE SAW AND MY HAND GOT CAUGHT ON IT SOMEHOW. IT WAS SO FAST, I FELT A LITTLE BURN AND I THOUGHT I JUST NICKED MYSELF. I HELD MY HAND UP AND I NOTICED THAT MY THUMB AND LITTLE FINGER OF MY LEFT HAND WERE GONE. I TURNED THE SAW OFF AND TOLD MY FRIEND THAT I NEEDED TO GO TO THE HOSPITAL. I WRAPPED IT UP WITH AN OLD SHIRT AND THEN I SENT HIM IN FOR A COUPLE OF TOWELS. HE DROVE ME TO THE HOSPITAL.
VICTIM IS A 44 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 3 HOURS & COMPLETED A CUT. VICTIM REACHED FOR THE WOOD & PUT HIS LEFT 2 FINGERS INTO THE BLADE & CUT THEM. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.

APPENDIX B (Continued)
A SAMPLE OF RESPONDENTS' NARRATIVES OF INCIDENTS

Q21. PLEASE DESCRIBE HOW THE ACCIDENT HAPPENED AND WHAT THE INJURIES WERE. THAT IS, WHAT WERE YOU DOING JUST BEFORE, DURING, AND AFTER THE INJURY OCCURRED? PLEASE START WITH WHAT WAS GOING ON JUST BEFORE THE INJURY OCCURRED.
I WAS CUTTING A PIECE OF TRIM MOULDING. IT GOT WEDGED IN THE BLADE AS I WAS PUSHING IT THROUGH. I HAD MADE IT ABOUT 90 PERCENT THROUGH WHEN IT BECAME WEDGED. THEN AS I PUSHED I TRIED PULLING THE WOOD FROM THE BACKSIDE WITH MY OTHER HAND AND THE WOOD KICKED BACK AND PULLED MY FINGER IN WITH THE WOOD. IT CUT MY INDEX FINGER AND I WENT TO THE ER.
I HAD AN ATTACHMENT CALLED A SHAPER HEAD ON THE SAW. IT IS USED TO PUT DECORATIVE EDGES ON WOOD. THE WOOD SLIPPED AND GOT MY FINGERS. IT IS OLDER MACHINERY AND DOESN'T HAVE A LOT OF SAFETY PRECAUTIONS. IT PROBABLY WOULDN'T HAVE HAPPENED WITH NEWER EQUIPMENT. ALSO I INJURED MY HAND 12 YEARS AGO AND DON'T HAVE COMPLETE NORMAL FEELINGS IN IT.
VICTIM IS A 69 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING FOR ABOUT 15 MINUTES & WAS IN THE MIDDLE OF A CUT WHEN THE STOCK KICKED BACK. VICTIM CUT 3 FINGERS ON HIS LEFT HAND. VICTIM WAS TAKEN TO THE ER, TREATED, & RELEASED.
VICTIM IS A 59 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM WAS ON HIS 1ST CUT WHEN THE WOOD KICKED BACK & THE WOOD HIT HIS RIGHT THIRD FINGER & BADLY LACERATED IT. VICTIM WAS TAKEN TO THE ER, TREATED, & RELEASED.
VICTIM IS A 53 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING FOR 2 OR 3 HOURS WHEN THE SAW CAUGHT A KNOT & THE STOCK KICKED BACK CAUSING THE VICTIM'S LEFT THUMB TO BE PULLED TO THE BLADE. VICTIM LACERATED HIS THUMB & WAS ADMITTED FOR SURGERY.
VICTIM IS A 64 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 1 HOUR. VICTIM WAS NEAR THE END OF A CUT WHEN THE STOCK KICKED BACK, & THE STOCK HIT HIM IN HIS LEFT WRIST, FRACTURING IT. VICTIM WENT TO THE ER, WAS TREATED & RELEASED.
I WAS CUTTING A SCRAP BOARD TO BE USED AS FIREWOOD. THE BOARD KICKED-BACK AND PULLED MY LEFT HAND INTO THE BLADE CUTTING MY LEFT MIDDLE FINGER AND MY INDEX FINGER. NEVER COULD FIGURE OUT WHY IT KICKED-BACK.
VICTIM IS A 54 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 30 MINUTES & COMPLETED A CUT. VICTIM REACHED FOR THE WOOD & ACCIDENTALLY PUT HIS RIGHT THUMB INTO THE BLADE & LACERATED IT. VICTIM SAID HE WAS PRE-OCCUPIED & NOT FOCUSED ON WHAT HE WAS DOING. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
HE WAS ATTEMPTING TO MAKE A BOARD THINNER, SO IT WAS RIDING ON THE 3/4 INCH SIDE. HE WAS MAKING A TAPERED CUT AND I GUESS HIS FINGERS JUST GOT IN THE WAY AND HE KNICKED HIS INDEX AND MIDDLE FINGERS OF HIS RIGHT HAND. HE FINISHED ALL OF HIS CUTTING AND AFTERWARD WRAPPED HIS FINGERS IN PAPER TOWELS. WHEN HE WAS ALL FINISHED HE WENT HOME AND CLEANED UP. HE THEN LET ME DRIVE HIM TO THE EMERGENCY ROOM. THEY CHECKED TO SEE IF THERE WAS ANY WAY TO STITCH HIM UP, BUT THERE WASN'T. THEY PUT STERI STRIPS ON ONE FINGER AND SOME KIND OF COVERING ON THE OTHER AND SENT US HOME. HE ONLY CUT FLESH, THERE WAS NO BONE INVOLVED AND WE WERE LUCKY BECAUSE IT SEEMS TO BE HEALING UP PRETTY DECENTLY.
VICTIM IS A 57 YEAR OLD MALE WHO WAS HOLDING/GUIDING THE MOULDING AGAINST THE FENCE AS IT EXITED THE BLADE WHILE HIS FRIEND, WHO OWNED THE TABLE SAW, WAS DOING THE ACTUAL CUTTING. THEY HAD BEEN CUTTING ON & OFF ALL DAY (8 HOURS) WHEN THE WOOD JUMPED & PULLED THE VICTIM'S 3 FINGERS INTO THE BLADE, CUTTING THEM. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
'I DID EVERY THING WRONG. FIRST I WAS TIRED, IT WAS AT THE END OF A SHIFT. I WAS CUTTING TRIM FOR VINYL SIDING AND IT NEEDED TO BE CUT AT AN ANGLE SO I REMOVED THE BLADE GUARD BECAUSE IT IS HARD TO CUT TRIM WITH IT ON, IT MAKES CUTTING AWKWARD. I WAS HOLDING THE VINYL WITH MY RIGHT HAND AND I WAS REACHING OVER THE SAW WITH MY LEFT HAND TO BEGIN PULLING THE VINYL BECAUSE IT HAD STRAYED FROM MY LINE. WHEN I REACHED I CUT MY FINGERS WITH MY BLADE. I HAVE WRAPPED MY HAND AND IMMEDIATELY WENT TO THE HOSPITAL. IT WAS STUPIDITY ON MY PART AND I FEEL AS THOUGH I SHOULD HAVE STUPID STAMPED TO MY FOREHEAD. I WAS STUPID AND I AM STILL PAYING FOR IT.'

APPENDIX B (Continued)
A SAMPLE OF RESPONDENTS' NARRATIVES OF INCIDENTS

Q21. PLEASE DESCRIBE HOW THE ACCIDENT HAPPENED AND WHAT THE INJURIES WERE. THAT IS, WHAT WERE YOU DOING JUST BEFORE, DURING, AND AFTER THE INJURY OCCURRED? PLEASE START WITH WHAT WAS GOING ON JUST BEFORE THE INJURY OCCURRED.
I WAS MAKING SOME WOODEN ARM RESTS FOR MY PICK UP TRUCK AND I WAS SAWING A BOARD, RIPPING IT. I HAD A PUSH STICK PUSHING THE WOOD THRU WITH MY RIGHT HAND AND MY LEFT HAND WAS JUST AT MY SIDE, WHEN THE WOOD CAME OUT OF THE BACKSIDE OF THE SAW, TO KEEP IT FROM FALLING ON THE FLOOR I REACHED AROUND THE BLADE WITH MY LEFT HAND, STUPIDLY, AND I CUT MY INDEX AND MIDDLE FINGER. I ACTUALLY BROKE MY MIDDLE FINGER ALSO. WELL, THE FIRST THING I DID WAS REACH AROUND TO MY POTTERY WHEEL AND GOT A WHITE APRON AND WRAPPED MY HAND UP. I AM ON BLOOD THINNERS SO I WANTED TO TRY TO STOP THE BLEEDING AS SOON AS I COULD. I TURNED EVERYTHING OFF IN THE BASEMENT AND WENT OUT AND CALLED MY WIFE IN, SHE WAS PLANTING PETUNIAS. I TOLD HER I CUT MYSELF AND WE HAD BETTER HEAD ON IN TO THE HOSPITAL. MY WIFE DROVE ME THERE.
VICTIM IS A 58 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM WAS ON HIS 1ST CUT WHEN THE STOCK KICKED BACK & PULLED HIS LEFT HAND TO THE BLADE. VICTIM AMPUTATED ONE FINGER, CUT ANOTHER, & ALSO CUT HIS HAND. VICTIM WENT TO THE ER & WAS TRANSFERRED TO THE HOSPITAL FOR SURGERY.
VICTIM IS A 47 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING FOR A FEW MINUTES WHEN THE STOCK KICKED BACK & PULLED HIS RIGHT HAND TOWARDS THE BLADE & HE CUT 2 FINGERS. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 30 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM WAS ON HIS FIRST CUT & USING 2 PUSH STICKS TO HOLD/GUIDE THE WOOD. THE WOOD THAT HE WAS CUTTING GOT CAUGHT IN THE BLADE & THEN PULLED THE PUSH STICK & HIS LEFT INDEX FINGER TO THE BLADE. VICTIM CUT THE TIP OF HIS FINGER. VICTIM WAS TAKEN TO THE ER, TREATED, & RELEASED.
VICTIM IS AN 84 YEAR OLD MALE WHO WAS USING A TABLE SAW TO CUT SMALL PIECES OF WOOD. VICTIM HAD BEEN CUTTING FOR ABOUT 15 MINUTES & THEN TURNED THE SAW OFF. VICTIM REACHED FOR THE CUT WOOD & PUT HIS RIGHT RING FINGER INTO THE BLADE. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.
VICTIM IS A 67 YEAR OLD MALE WHO WAS USING A TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING FOR ABOUT 3 HOURS WHEN THE STOCK KICKED BACK & PULLED HIS LEFT THUMB INTO THE BLADE & FRACTURED IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.

TAB C

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: September 9, 2011

TO : Caroleene Paul, Project Manager, Petition CP03-02, Power Saw Performance Standard

THROUGH : Gregory B. Rodgers, Ph.D., AED, EC

Deborah V. Aiken, Ph.D., Senior Staff Coordinator, EC

FROM : William W. Zamula, EC

SUBJECT : Performance Standards for a System to Reduce or Prevent Injuries from Contact With the Blade of a Table Saw: Economic Issues

On April 15, 2003, the Commission received a request from the principals of SawStop, LLC to require performance standards for a system to reduce or prevent injuries from contact with the blade of a table saw. In 2006, the Commission granted the petition. In 2007 and 2008, CPSC staff conducted an injury special study, which provides the basis for the preliminary information on the societal cost of injuries associated with the hazard patterns in this memorandum. This memorandum also provides readily available information on annual sales of table saws, the number of manufacturers, and the estimated number of products in use.

Market Information

A listing of manufacturers/importers and associated brand names is provided in Table 1, below. This listing does not include manufacturers of miniature table saws used for constructing doll houses and other hobby products, or tile-cutting table saws. This listing is not all-inclusive, because there are a number of Asian table saw manufacturers not included in the list who may have garnered some U.S. distribution.

The Power Tool Institute (PTI) (2009) estimates that its member companies account for 85 percent of all table saws sold in the United States. Most of the companies are large, diversified international corporations with billions of dollars in sales, such as Stanley Black and Decker, Robert Bosch, Hitachi, Makita, and Techtronic Industries Co., Ltd. For these companies, table saws generally make up a relatively small part of their revenues. Current PTI members are denoted with an asterisk on Table 1. PTI tends to represent the mass market table saw manufacturers.

Table 1 – Table Saw Manufacturers and Brand Names

Parent Firm	Type of Firm	Brand Names
General Mfg. Co., Ltd.	Manufacturer	General, General International, Access
Grizzly Industrial, Inc.	Manufacturer	Grizzly, Shop Fox
Hitachi Koki, U.S.A., Ltd.*	Manufacturer	Hitachi
Jepson Power Tools, Inc.	Manufacturer	Jepson
Laguna Tools	Manufacturer	Laguna
Makita U.S.A, Inc.*	Manufacturer	Makita
Robert Bosch Tool Corp.*	Manufacturer	Bosch, Skil
SawStop, LLC	Manufacturer	SawStop
Sears Holdings Corporation	Private Labeler	Craftsman
Shopsmith, Inc.	Manufacturer	Shopsmith
Stanley Black and Decker, Inc.*	Manufacturer	Dewalt, Delta, Porter-Cable, Rockwell
Steel City Tool Works	Manufacturer	Steel City, Orion
Techtronic Industries, Co., Ltd., One World Technologies*	Manufacturer	Ryobi, Milwaukee, Ridgid
True Value Company	Private Labeler	Master Mechanic
WMH Tool Group, Inc.*	Manufacturer	Jet, Powermatic

Source: Power Tool Institute website, individual company websites
*Current PTI member.

Types of Table Saws

There are three general types of table saws: bench saws, contractor saws, and cabinet saws. These categories of saws vary by size, weight, portability, power, power transmission, and price. These factors are all related.

It may be difficult or impossible to determine how many of the various types of table saws are sold to consumers versus professionals, because both groups purchase table saws from the same retail outlets. Substantial numbers of inexpensive bench saws may end up being used by professionals in a work environment. Similarly, some consumers may purchase expensive cabinet saws to make their own cabinets. While some lines of table saws are designated as "professional," such designations are not always meaningful.

PTI places the consumer price range for table saws at $100 to $800, and it estimates the price range for table saws purchased by professionals to be $500 to $2,500. Price is not always the best criterion for making a distinction between the users because there is overlap between consumer and professional table saw purchases, even in the $2,000 to $3,000 price range.

Bench saws tend to be lightweight and portable, weighing as little as 40 pounds (Home Depot, 2011), which makes it easier for carpenters or other professional users to transport them to job sites where they can be placed on a work bench. Bench saws sometimes include folding, removable stands. Prices range from $100 for a consumer saw, to as much as $600 for a professional model. Bench saws run on ordinary 110-volt house current and are often rated by amperage (*e.g.*, 15 amps). Most bench saws are direct drive; that is, no belts are used to transmit power from the electric motor to the blade.

Contractor saws are larger and more powerful than bench saws. Typically, they weigh 200 to 300 pounds with attached legs and wheeled frames. Thus, they may require two persons to load them into a truck. Prices for contractor saws range from $500 (BenchMark, 2011) to $1,800 (Amazon listing, Powermatic 1791228K Model 64 Artisan saw accessed August 15, 2011). Contractor saws are able to run on 110-volt current, but they also can have 230-volt capability. Power ratings are in horsepower, unlike bench saws; and typically, ratings are in the 1 to 2 horsepower range. The blade is usually driven with a single belt.

Cabinet saws are larger, heavier, and more powerful than contractor saws, and their blades are enclosed in a cabinet. Typically, they weigh 400–800 pounds. Prices range from $1,000 to $3,000 (BenchMark, 2011), or more. Cabinet saws usually require 230-volt power supplies, and some require 3-phase, 230-volt power supplies because motors with more than 2 horsepower cannot generally run on 110-volt current. Power ratings are in the 2 to 5 horsepower range. Some cabinet saws can accommodate 12-inch blades. The blade is driven with one or more belts.

Accommodating 230-volt, single-phase or 3-phase power supplies will require the services of an electrician for most consumers, making the purchase of cabinet saws by consumers less likely. The costs for installing the necessary electrical wiring for a 3-phase power supply can exceed the cost of the table saw.

Shipments and Expected Useful Lives of Table Saws

According to PTI, the estimated annual shipments of table saws (U.S. consumption) have fluctuated widely in recent years. In 2002, shipments were estimated at 725,000 units. In 2006 and 2007, estimated shipments were 800,000 to 850,000 units (Power Tool Institute, 2009). As a result of the recession and the decline in residential construction, estimated shipments declined to 650,000 in 2008, 589,000 in 2009, and 429,000 in 2010 (Power Tool Institute e-mail, 2011).

A PTI consultant (Domeny, 2011) provided expected useful life estimates for different categories of table saws, ranging from 6 years for an inexpensive bench saw, to 17 years for a contractor saw, to 24 years for an expensive cabinet saw. Based on these expected product lives and sales data for the different types of saws, PTI estimated the number of table saws available for use at

8.0 million in 2001/2002, and at 9.5 million in 2007/2008. This estimate is generally consistent with independent estimates of table saws in use, based upon product population estimates using the Product Population Model (PPM). The PPM is used by EC staff to estimate the number of products in use, given sales estimates and information on expected product life (Battelle, 1980). Assuming an average retail price of $500 per table saw, and average annual shipments of about 700,000 units, retail sales are probably in the range of $300 million to $400 million.

Imports and Exports

Tariff and trade data from the U.S. Department of Commerce and the U.S. International Trade Commission reveal that China and Taiwan together account for more than $150 million dollars in annual imports for the peak shipment years. Allowing for mark-ups of table saws at the manufacturer/private labeler level and the retail level, imports probably account for a majority of the estimated $300 million to $400 million in shipments estimated above. U.S. exports, on the other hand, appear to be minimal, with less than $1 million annually.

Table Saw Injuries, Expected Useful Lives, Saws in Use, and Injury Rates

Based on a 2007 to 2008 special study (Chowdury, 2009), Epidemiology staff estimates that almost 66,900 emergency room-treated blade contact injuries were experienced by operators of table and bench saws over the 2-year period from January 1, 2007 to December 31, 2008. Thus, there were about 33,450 blade contact injuries on an annual basis. The Commission's Injury Cost Model (ICM)(Miller et al, 2000) uses empirically derived relationships between emergency department-treated injuries and injuries treated in other settings (*e.g.*, doctor's offices, clinics) to estimate the number of injuries treated outside hospital emergency departments. Based on the National Electronic Injury Surveillance System (NEISS) estimate of 33,450 emergency room-treated injuries, the ICM projects a total of 67,300 medically treated blade contact injuries.

Table 2 presents information that allows us to compare the risk of injury associated with different categories of saws. Row 1 shows the expected useful lives of table saws, as estimated by PTI (Domeny, 2011). Row 2 shows PTI's estimates of the saws in use for the various categories (PTI, 2011). Row 3 shows the blade contact injuries allocated between saw categories, according to the proportions found in the 2007 to 2008 special study (Chowdury, 2009). Row 4 shows the rates of blade contact injuries for the saw categories per 100,000 saws in use. The rate is calculated by dividing the number of injuries for the category, by the numbers of saws in use for the category, and multiplying it by 100,000. For example, bench saws have 116.2 injuries per 100,000 saws [(7,672 injuries ÷ 6.6 million saws) * 100,000], while contractor/cabinet saws have 2,053.8 injuries per 100,000 saws [(59,561 injuries ÷ 2.9 million saws) * 100,000]. Thus, the rate of injury for the contractor saw/cabinet saw category is about 17.7 times the rate for bench saws (*i.e.,* 2,053.8 injuries per 100,000 contractor/cabinet saws ÷ 116.2 injuries per 100,000 bench saws).

Table 2: Estimates of the Expected Useful Product Life of Table Saws, the Population of Table Saws in Use, Annual Medically Attended Blade Contact Injuries, and Annual Rates of Injury, by Table Saw Type, 2007–2008

	All Table Saws	Bench Saws	Contractor Saws	Cabinet Saws
(1) Expected Useful Life (years)	6–24*	6–10*	17*	24*
(2) Saws Available for Use (millions)	9.5** 100%	6.6 ** 69%	2.9** 31%	
(3) Medically Attended Blade-Contact Injuries†	67,300 100%	7,672 11.4%	59,561 88.5%	
(4) Blade-Contact Injuries per 100,000 saws [(Row 3 ÷ Row2)*100,000]	708.4	116.2	2,053.8	

* Estimates from Peter Domeny on behalf of PTI at meeting with Commissioner Adler on March 2, 2011.
**PTI estimates for 2007–2008 from PTI FACTS-AT-A-GLANCE, 2011.
† Annual estimates of medically attended blade contact injuries, based on estimates from the ICM.

Preliminary Estimates of Societal Costs

Based on estimates from the Injury Cost Model, the 67,300 medically treated blade contact injuries have associated injury costs of $2.36 billion annually. Societal costs per blade contact injury amount to about $35,000. These costs include medical costs, costs for lost time from work, product liability litigation costs, and pain and suffering. The pain and suffering costs are intangible costs, a measure of the lost quality of life resulting from an injury. Pain and suffering costs account for 77 percent of the injury costs associated with table saw blade contact injuries. Deaths resulting from blade contact from table saws are relatively rare (see Marcy, 2005) and seem to be the result of secondary effects of the injuries (*e.g.*, heart attack) rather than the blade contact injuries themselves. Therefore, we have excluded them from the analysis.

The relatively high societal costs, compared to the $22,000 average cost for all medically treated consumer product related injuries, are due to the high costs associated with amputations and the relatively high hospitalization rate for table saw blade-contact injuries. Amputations make up 12 percent of the blade-contact injuries. The hospitalization rate for blade-contact injuries reported in the 2007 to 2008 special study is 7 percent, compared to the 4 percent hospitalization rate associated with all consumer products reported through the NEISS system.

We used the available information on injury rates and injury costs to estimate the expected present value of the societal costs of blade-contact injuries over the life of the table saw types. These estimates represent the maximum benefits that could be achieved with a performance requirement addressing blade contact, if all blade-contact injuries could be prevented. The annual societal cost for blade-contact injuries amounts to $41 per bench saw [($2.36 billion injury costs * 11.4% of blade-contact injuries) ÷ 6.6 million saws]. Over a 6 to10 year product life the present value of these societal costs (discounted at 3 percent) would range from $228 to $360 per saw. For contractor and cabinet saws the annual societal costs would amount to $720 per saw [($2.36 billion injury costs * 88.5% of blade-contact injuries) ÷ 2.9 million saws)]. Over a 17 to 24 year product life, the costs would range from $9,764 for a contractor saw, to $12,559 for a cabinet saw.

However, not all kickback injuries are likely to be prevented by the kind of system called for by the petition. If we assume the addressable injuries are limited to non-kickback injuries, as suggested by PTI, the annual societal cost for non-kickback blade contact injuries amounts to $22 per bench saw [($1.26 billion injury costs * 11.4% of blade-contact injuries) ÷ 6.6 million saws]. Over a 6 to10 year product life, the costs (discounted at 3 percent) would range from $123 to $193 per saw. For contractor and cabinet saws, the annual societal cost would amount to $385 per saw [($1.26 billion injury costs *88.5% of blade-contact injuries) ÷ 2.9 million saws]. Over a 17 to 24 year product life, the costs would range from $5,221 for a contractor saw, to $6,716 for a cabinet saw.

This analysis of injury costs has assumed that the distribution of table saw injuries reported in the 2007 to 2008, special study provides an accurate reflection of the proportion of injuries occurring on the different types of table saws. However, it should be noted that there is an apparent inconsistency between some study participants' response to the type of saw used and their responses to the question about the type of drive system used in the saw. The less expensive bench saws generally have what are called "direct drive systems," while most contractor and cabinet saws are belt-driven. Based on the respondents' answers to the type of saw used, it is estimated that 11.8 percent of injuries involved bench saws, but about 59.2 percent of the injuries involved saws with a direct drive system. If it could be determined that respondents were more accurate in identifying saw type than drive system, the estimate would likely remain unchanged. If respondents were more accurate in identifying the drive system, then the estimate of bench saw injuries would likely increase.

Existing Approaches to Blade Contact Safety: Economic Considerations

While it is not possible at this point to project all possible technological approaches to meeting any performance-based standard that the Commission may consider in the future, there are several existing technologies that have been developed to address blade contact injuries by preventing them or reducing their severity. In this section, information is presented on the economic issues associated with adopting any of these technologies, either as a means of complying with a mandatory standard or as a voluntary effort on the part of industry members.

The information discussed below has been provided by representatives of SawStop, representatives of PTI, and David Butler, an independent inventor with Whirlwind Tool Company, supplied primarily at the three Table Saw meetings held at the Commission on March 1, and 2, 2011.

One approach to addressing blade contact injuries was put forward by the petitioners. The SawStop technology is a "flesh-sensing" blade retraction system, and SawStop estimated the cost of the additional components to implement its technology at $50 per saw. However, PTI suggested that this estimate did not include an 8 percent royalty on the wholesale price of the saw and costs for redesigning the saw and tooling costs. PTI estimates that the costs of implementing SawStop would more likely be on the order of $100 to $150 per saw.

Currently, SawStop holds extensive patents and has suggested that it would accept a royalty amounting to 8 percent of the wholesale price of the saw, as potential compensation for the use of its patents. To the extent that the SawStop royalty fee applies, the royalty fee for inexpensive saws wholesaling for about $200 would amount to about $16 per saw; for expensive cabinet saws, the royalty fee might exceed $150 per saw.

There are also additional costs to consumers when the SawStop brake is activated, because the brake damages the blade in engaging the teeth of the blade. According to SawStop, a replacement brake cartridge currently costs $69 and the average price of a replacement blade is approximately $30. SawStop predicts that the retail price of brake cartridges can be reduced to between $10 and $20 with design changes and high volume production. SawStop has stated that, based on its sales of replacement cartridges, the blade brake may activate only about once every 9 years of use (SawStop, 2011). If the user wishes to use a different size blade or make a different cut than the saw is originally equipped to cut, then the user might have to purchase a new cartridge, at the cost noted above. However, it may be possible, in some instances, for the user to adjust the saw, rather than purchase a new cartridge.

SawStop's technology has been tested in the marketplace, so there is more information about all of its operational aspects. SawStop has been selling relatively expensive contractor and cabinet saws with retail prices of between $1,600 and $4,200 (Tool King, 2011) since 2004, and it claims to have 28,000 saws in use, with 75 percent sold to commercial users, and about 25 percent sold to schools and consumers (SawStop, 2011). These sales are a small percentage of total sales of table saws, which have ranged from 429,000 to 850,000 units annually in recent years. Given cumulative SawStop sales of 28,000 and PTI estimates of percentages of contractor/cabinet saw sales for the same period, SawStop would account for about 4 percent of contractor/cabinet saws. SawStop has also developed a prototype bench saw, which will probably cost just under $1,000. This is expensive for a bench saw, several hundred dollars more than the most expensive bench saw ($600, according to PTI) currently available.

Four members of PTI formed a joint venture in 2003, to develop their own flesh-sensing, blade retraction system. While the viability of this system is not known, the cost of additional components to implement the explosive system was estimated at approximately $55 (SawStop, 2011). There would also be additional costs for redesign and retooling and royalty costs for table saw manufacturers who are not partners in the joint venture, as well as any royalty payments to

SawStop, if applicable. Projected activation costs for the PTI system are lower than SawStop's because the blade is not damaged when the explosive cartridge is activated. The projected manufacturing cost of a replacement explosive cartridge is $5, with the retail price estimated at $15 (SawStop, 2011).

Finally, Whirlwind Tool Company has developed prototypes of a proximity-sensing, blade retraction system. The estimated cost of the parts purchased at retail to outfit a prototype is $300, but costs for high-volume production could be substantially less. The retraction system may also be subject to SawStop royalty fees, if it infringed on SawStop's patents.

Table saws equipped with SawStop blade brakes could result in some reduced utility to consumers, compared to table saws that are not so equipped. According to the PTI comments, false activations resulting from various common working conditions, such as pressure-treated wood and moist outdoor conditions, could reduce substantially the utility of the table saw to the consumer, apart from the cost of replacing the blade and the cartridge. A switch to temporarily disable the brake would address this concern, but it would not address the blade contact hazard. The enclosures used for the blade brake devices might inhibit some types of cuts, although some of these cuts might go against manufacturers' safety warnings. Finally, the CPSC's Division of Human Factors (Smith, 2011) has determined that replacing the brake cartridge is fairly difficult. Activation of the brake is likely to be a rare event, but users who change blades for dado cuts or who change blades for other reasons frequently may find removing and reinstalling the brake cartridge inconvenient. Almost 25 percent of injury victims in the CPSC's injury survey changed blades for different types of cutting operations. The CPSC has no information on any utility implications of the PTI or Whirlwind systems, although those systems do seem simpler.

The table saw industry has also developed a new standard, contained in the seventh edition of UL 987, under another joint venture. This standard includes improved blade guards, riving knives, and pawls. The standard is being phased in gradually with model changes. Saws with these features are present on about 800,000 saws in use, dating from September 2007; accordingly, it is unlikely that they have had a measurable impact on table saw injuries since the injury special study. Also, as with previous guard designs, they can be removed, so their effectiveness can be compromised.

Summary

Using the CPSC's Injury Cost Model, there were a total of 67,300 medically treated blade contact injuries associated with table saws annually during 2007 and 2008, with total estimated injury costs estimated at $2.36 billion per year. A performance-based standard, which could involve the existing blade retraction systems described above, or some yet undeveloped technology, could potentially result in significant reductions in the injury costs associated with blade contact. However, according to information collected to date, current systems appear costly to implement and could substantially increase the retail cost of table saws for consumers. The increased costs could be substantial enough to reduce table saw sales significantly, especially for the least expensive bench saws, which could more than double in price.

The industry environment is complicated further, due to SawStop's ownership of potentially key patents. Even if an alternative blade retraction system superior to SawStop's were developed, a competitor might be obliged to pay SawStop substantial royalty fees if there were patent infringement issues. Royalty fees may be a barrier to the development and adoption of alternatives to SawStop, and this could limit manufacturer options for meeting any mandatory performance-based standard related to blade contact.

It should also be noted that the SawStop technology is already available to consumers who are willing to purchase it. While the retail prices for the SawStop technology tend to be relatively high, roughly 28,000 contactor and cabinet saws with the SawStop technology have been sold in recent years. In addition, SawStop reportedly has developed a prototype bench saw with the SawStop blade retraction system.

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TAB D

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: May 27, 2011

TO	:	Caroleene Paul ESME, Office of Hazard Identification and Reduction
THROUGH	:	Kathleen Stralka Associate Executive Director, Directorate for Epidemiology
FROM	:	John Topping, Mathematical Statistician, Division of Hazard Analysis
SUBJECT	:	Assessment of Table and Bench Saw Study Cases for Possible Work-Related Activities

To address concerns about whether the table and bench saw-related injury estimates generated from CPSC's 2007–2008 special study[1] were work-related or not, a review was undertaken of the 862 table and bench saw injury cases for which surveys were completed in the special study. The objective was to determine if, in fact, the cases were non-work-related injuries within the jurisdiction of the CPSC and not the Occupational Safety and Health Administration (OSHA). Although the study was designed to exclude cases initially known to be work-related, incomplete or inaccurate information potentially can affect classifications. The goal of this memo's assessment was to identify work-related cases and to estimate the percent of injuries work-related cases may represent in the study estimates.

Narratives and responses in the 862 cases in the table saw study were reviewed to identify any cases that might be work-related. Although none of the study cases contained the NEISS[2] code indicating that the injury was work-related, some of the case narratives suggest the existence of work-related injuries (four cases appear to be definitely work-related, and another 12 appear to be potentially work-related). Combined, these comprise less than 2 percent of the sample data and less than 2 percent of the estimated 79,500 total table or bench saw injuries over the two years 2007–2008. The remaining 846 cases in the special study represent an estimated 78,000 non-work-related injuries.

[1] S. Chowdhury, "Survey of Injuries Involving Stationary Saws; Table and Bench Saws 2007–2008," CPSC March 2011.

[2] The Commission operates the National Electronic Injury Surveillance System (NEISS), a probability sample of about 100 U.S. hospitals with 24-hour emergency departments (EDs) and more than six beds. These hospitals provide the CPSC with data on all consumer product-related injury victims seeking treatment in the hospitals' EDs. Injury and victim characteristics, along with a short description of the incidents, are coded at the hospital and sent electronically to the CPSC.

Findings:

One indicator strongly influencing the assessment of whether a given case might be considered work-related was whether the table or bench saw was owned by a household or by an employer. It is understood that in some cases, work-related activities may be conducted with one's own saw or that one may engage in non-work-related personal projects using a saw owned by an employer. One work-related case was identified in which the injured person was using his own saw, apparently attempting to work on a rental property that he owned. None of the other cases reporting personal ownership (or ownership by friends and/or relatives) were found to offer any evidence establishing work-related activity. Three cases involving employer-owned saws, upon review, were determined to involve work-related activities (as opposed to a personal project). Twelve other cases involved use of an employer-owned saw that may have been work related. However, because the possibility of use for personal projects could not be ruled out, these cases are classified as "potentially work-related."

Case of Household Saw or Self-Owned Saw Used in Work-Related Activity (count=1)

Narrative based on Participants Response	Hospital Case (NEISS) Narrative	dt_trmt
THE 78-YEAR-OLD MALE VICTIM WAS **WORKING** WITH HIS TABLE SAW AT A RENTAL PROPERTY OWNED BY VICTIM. HE PLACED WOOD ON SAW AND SOMETHING DISTRACTED HIM, HE GLANCED AWAY AND RAN HIS LEFT HAND THROUGH THE BLADE ALONG WITH THE STOCK, CUTTING HIS HAND. HE WAS TRANSPORTED TO ER BY CO-**WORKER**. RECEIVED STITCHES AND TREATED AND RELEASED THE SAME DAY.	DX L PALM LAC - REPAIRED/TETAN SAW	5/14/2008

Cases of Employer-Owned Saws Used in Work-Related Activity (count=3)

Narrative based on Participants Response	Hospital Case (NEISS) Narrative	dt_trmt
VICTIM IS A 49 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO CUT OLD BARN WOOD. VICTIM HAD BEEN CUTTING ON & OFF FOR SEVERAL HOURS WHEN THE STOCK KICKED BACK & CAUSED HIM TO CUT HIS LEFT THUMB. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED	49 YOM HAD LAC TO L THUMB FROM	1/9/2007
THE 25 YEAR OLD MALE VICTIM WAS **AT WORK**. HE WAS UTILIZING A TABLE SAW. SOMEHOW HIS RIGHT THUMB CAME IN CONTACT WITH THE BLADE AND SUFFERED A LACERATION. CO-**WORKER** DROVE VICTIM TO ER, RECEIVEED 4 STITCHES AND WAS RELEASED THE SAME DAY.	CUT TO FINGER ON BLADE OF TABL	6/26/2008
VICTIM IS A 54 YEAR-OLD MALE WHO WAS USING A TABLE SAW **AT WORK** TO RIP WOOD. VICTIM HAD BEEN CUTTING ABOUT 5 HOURS WHEN THE STOCK KICKED BACK & PULLING HIS LEFT FINGER TOWARD THE BLADE & IT WAS PARTIALLY AMPUTATED. VICTIM WAS TAKEN TO THE ER, TREATED & RELEASED.	CUT FINGER ON TABLESAW.D X PAR	3/31/2008

Cases of Employer-Owned Saws Used in Activity – Potentially Work-Related (count=12)

Narrative based on Participants Response	Hospital Case (NEISS) Narrative	dt_trmt
VICTIM IS A 64 YEAR OLD MALE WHO WAS USING A TABLE SAW **AT WORK** TO RIP WOOD. VICTIM HAD FINISHED CUTTING, TURNED OFF THE SAW. AS HE WAS DRIVING HOME, HE REALIZED SOME SAW DUST HAD GOTTEN IN HIS EYE. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.	NO EYE PROTECTION WHILE USING OFF CLOTHES. DX FB REMOVED L	1/19/2008
VICTIM IS A 19 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO RIP WOOD. VICTIM TOOK HIS EYE OFF THE SAW & ACCIDENTALLY PUT HIS LEFT INDEX FINGER INTO THE BLADE & PARTIALLY AMPUTATED IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.	STRUCK HAND ACCIDENTALLY AGAIN PUTATION TO SERVERAL FINGERS O	7/18/2008
VICTIM IS A 55 YOM WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO CUT SMALL PIECES OF WOOD. HE HADCOMPLETED A CUT AND REACHED FOR THE WOOD AND ACCIDENTALLY PUT HIS LEFT THUMB INTO THE BLADE ANDCUT IT. HE WENT TO THE ER, TREATED & RELEASED.	CUT THUMB ON A TABLE SAW LEFT THUMB LACERATION	6/5/2007
VICTIM IS A 27 YEAR OLD MALE WHO WAS USING AN **EMPLOY**ER'S TABLE SAW TO CUT PLYWOOD. VICTIM HAD BEEN CUTTING FOR ABOUT 1.5 HOURS WHEN THE STOCK KICKED BACK & PULLED HIS RIGHT HAND TOWARDS THE BLADE & HE FRACTURED HIS RIGHT MIDDLE FINGER. VICTIM WAS TAKEN TO THE ER & ADMITTED FOR SURGERY.	27 YO M OPEN FRACTURE WITH LAC	6/18/2007
VICTIM IS A 19 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW & HAD BEEN CUTTING FOR ABOUT 4-5 HOURS WHEN THE STOCK KICKED BACK & PULLED HIS RIGHT FINGER INTO THE BLADE & SEVERELY CUT IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.	CUTTING WOOD FLOORING WITH TAB	8/1/2007
VICTIM IS A 27 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO RIP WOOD. VICTIM HAD BEEN CUTTING FOR ABOUT 20 MINUTES WHEN HE GOT HIS LEFT FINGER TOO CLSOE TO THE BLADE & CUT IT. VICTIM WAS TAKEN TO THE ER, TREATED, & RELEASED.	PT USING A TABLE SAW AND SUSTA	9/27/2007
VICTIM IS A 54 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO RIP WOOD. AS HE WAS CUTTING, THE STOCK KICKED BACK & PULLED HIS LEFT TWO FINGERS INTO THE BLADE & PARTIALLY AMPUTATED THEM. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.	LEFT THUMB AND INDEX FINGER AM AW.	10/25/2007
VICTIM IS A 33 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S BENCH SAW TO CUT ALUMINUM. VICTIM HAS BEEN CUTTING ABOUT 30 MINUTES WHEN THE BLADE GOT CAUGHT IN THE ALUMINUM CAUSING HIS LEFT HAND TO BE PULLED INTO THE BLADE & CUT IT. VICTIM WENT TO THE ER, WAS TREATED AND RELEASED.	CUT HAND ON A PIECE OF ALUMINU LACERATION LEFT HAND	12/14/2007

VICTIM IS A 26 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO RIP WOOD. VICTIM GOT CARELESS & GOT HIS LEFT FINGER TOO CLOSE TO THE BLADE & CUT IT. VICTIM WAS TAKEN TO THE ER, TREATED, & RELEASED.	PAT SUS LACERATION TO FINGER W	1/15/2008
VICTIM IS A 70 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO RIP WOOD. AS HE WAS CUTTING, THE STOCK KICKED BACK, & THE STOCK HIT HIM IN THE LEFT FINGER, LACERATING IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.	PT **WORKING** WITH A POWER SAW WA ICKED BACK SUSTAINED A LACERAT	4/15/2008
VICTIM IS A 25 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO RIP WOOD. VICTIM SAID THE STOCK KICKED BACK AS HE WAS CUTTING & PULLED HIS LEFT LITTLE FINGER INTO THE BLADE & CUT IT. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.	CUTTING A BOARD WITH A TABLE S DX LACERATION L 5TH FINGER	11/7/2008
VICTIM IS A 32 YEAR OLD MALE WHO WAS USING HIS **EMPLOY**ER'S TABLE SAW TO RIP WOOD. VICTIM SAID HE GOT HIS LEFT MIDDLE FINGER TOO CLOSE TO THE BLADE AS HE WAS CUTTING. HE LACERATED THE FINGER. VICTIM WENT TO THE ER, WAS TREATED, & RELEASED.	32 YOM CUT LEFT MIDDLE FINGER LACERATION FINGERS	12/22/2008

NEISS Cases Supporting Table Saw Estimate

Of the 862 NEISS cases forming the basis of the estimate of injuries on table saws, 97% of the records indicated "Not work-related; did not occur on the job" and in the remaining 3% of the records work involvement was not recorded. None of the NEISS records in the study indicated work-related activity prior to the follow-up interviews completed for these 862 cases.

Distribution by Work-Related Code in NEISS

Code(s)	**Work-Related** Code Definition	Number of Cases	Proportion of Cases
0	Not recorded	27	0.031
1	Work-related; occurred on the job (excluding active military duty)	-	
2	Not work-related; did not occur on the job	835	0.969
3	Work-related; active military duty	-	
0,1,2,3	Total	862	1

A majority of the investigated table saw cases occurred in a home locale, although this does not in itself establish that any given case was not work-related. Almost 17% of the cases (147 cases) did not have a locale recorded in the NEISS system. However of the remainder, 697 were recorded as a home (locale code 1) and only 18 were recorded as some other locale.

Distribution by Incident Locale in NEISS

Code(s)	**Incident Locale Definition**	Number of Cases	Proportion of Cases
1	Home	697	0.809
2	Farm/Ranch	-	0.000
4	Street or highway	-	0.000
5	Other public property	7	0.008
6	Manufactured (mobile) home	-	0.000
7	Industrial place	1	0.001
8	School	10	0.012
9	Place of recreation or sports	-	0.000
0	Not recorded	147	0.171
0,1,...,9	Total	862	1

Locale Code 1 Includes:

- Patient's own home
- Someone else's home
- Rooms inside a home
- Porch or patio of a home
- Yard or garden of a home
- Garage of a home
- Driveway of a home
- Sidewalk of a house
- Farmhouse.

TAB E

HUMAN FACTORS EVALUATION OF TECHNOLOGY INTENDED TO ADDRESS BLADE-CONTACT INJURIES WITH TABLE SAWS

JULY 2011

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This report has not been reviewed or approved by the Commission and may not reflect its views.

CONTENTS

BACKGROUND

Table saws are stationary power tools used for the straight sawing of various materials but primarily wood. In essence, a table saw consists of a table that sits on a base and through which a spinning blade protrudes. To make a cut, the table saw operator places the workpiece on the table, and, typically guided by a rip fence or miter gauge, slides the workpiece into the blade (see Figure 1). According to the Power Tool Institute (2002), an organization that represents members of the power tool industry, table saws are one of the most commonly used stationary power tools in any woodworking shop.

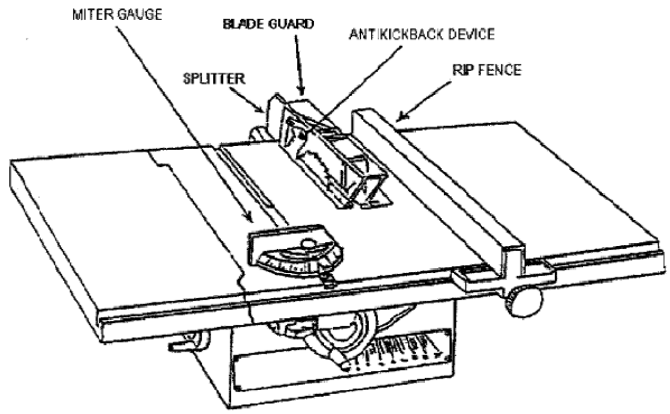

FIGURE 1. Typical table saw components.

Standard safety devices on table saws are designed to prevent the saw blade—or pieces of the blade should it shatter or a tooth become loose—from making contact with the operator and to prevent the saw blade from imparting its kinetic energy to the workpiece and throwing the workpiece back towards the operator, a phenomena known as kickback. These safety devices generally fall into two basic categories: blade guards and kickback prevention devices.

Blade guards surround the exposed blade and function as a physical barrier between the blade and the operator. Kickback prevention devices include splitters, riving knives, and anti-kickback pawls. A splitter, also commonly called a spreader, is typically a flat piece of metal aligned directly behind the saw blade that rides within the cut, or kerf, of a workpiece that is being fed through the blade. This prevents the workpiece from closing up and pinching the blade, which can cause the workpiece to be thrown back toward the operator. Riving knives are curved metal plates that are similar to and perform the same function as splitters, but tend to sit closer to the blade, rise no higher than the top of the blade, and attach to the arbor assembly[1] so that they move with the blade. Anti-kickback pawls—sometimes referred to as anti-kickback fingers or devices—consist of two hinged and barbed pieces of metal that allow passage of the workpiece but will dig into the workpiece if it begins to move back toward the operator.

Traditionally, table saws sold in the United States have employed a blade guard system that combines a blade guard, splitter, and anti-kickback pawls as a single unit that is bolted to the saw's carriage assembly (Adams, 2010; Mehler, 2003; Tolpin, 2004; see Figure 1). The blade guard was a single rectangular piece of transparent plastic often referred to as a "hood." The splitter generally served as the main support and connection point for the blade guard and the anti-kickback pawls. Thus, removing the splitter for any reason necessarily removed the rest of the blade guard system and the protections those devices might offer.

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[1] The arbor assembly includes the arbor, which is the metal shaft that holds the saw blade.

In 2007, a new modular blade guard system was introduced to the U.S. market as part of a commercially available, consumer-oriented table saw.[2] The new guard design represented the efforts of a Joint Venture (JV) group formed by major table saw manufacturers to address blade contact injuries on table saws. The JV group's intention was to increase blade guard usage by improving the functionality and effectiveness of the traditional blade guard.

A table saw with a blade-contact detection and reaction system was introduced to the U.S. market as part of a commercially available, consumer-oriented table saw in 2008. This detection and reaction system stops and retracts the saw blade in milliseconds upon contact with flesh, such as the finger of a table saw operator. The system was introduced to the U.S. market in 2005 by a single company, but at that time the system was only available on professional-level table saws.

CPSC staff was directed to initiate a project to collect information on emerging technologies intended to prevent and reduce blade-contact injuries. In 2009, in support of this project, staff of the CPSC's Division of Human Factors completed informal assessments of the new blade guard design and the blade-contact detection and reaction system. This report describes the results of those assessments and discusses the potential effectiveness of these technologies at addressing blade-contact injuries in general.

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[2] Consumer-oriented table saws are available at home power tool retailers, such as Home Depot and Amazon.com, and are often reviewed by popular trade magazines, such as Fine Woodworking and Popular Woodworking.

BASIC TABLE SAW OPERATIONS

The most basic and common cutting operations performed on a table saw are rip cuts ("ripping") and crosscuts ("crosscutting"). Ripping involves reducing the width of a workpiece by sawing along its length, a cut that is often referred to as sawing "with the grain" (see Figure 2). When ripping, the workpiece is placed flat on the table with one long side against a rip fence (see Figure 1), which is set parallel to the saw blade. The operator then slowly pushes the workpiece against the fence and through the saw blade. A push stick, or pusher, is often used during rip cuts—especially narrow rip cuts—to help keep one's hand away from the blade. By angling the blade relative to the surface of the table, operators can perform "bevel" rip cuts.

Crosscutting shortens the length of a workpiece by sawing across its width, or "across the grain." To perform a crosscut, the workpiece typically is placed against a miter gauge or other sliding jig to keep the workpiece secure (see Figure 1). The miter gauge slides in a track and is slowly pushed forward, feeding the workpiece through the blade. The miter gauge can be angled relative to the blade to perform "miter" cuts. The ability to adjust the angle of the blade relative to the table surface allows for bevel crosscuts, as well as cuts that are simultaneously mitered and beveled, known as "compound" cuts.

Although less common than ripping and crosscutting, other common woodworking cuts that can be performed on a table saw are non-through cuts, which include any cut in which the saw blade does not extend through the top surface of the workpiece. Dadoes and rabbets are the most common forms of these cuts. A dado produces a simple channel or trough in the workpiece; dadoes that run the length of the workpiece rather than across its width are sometimes referred to as grooves (Tolpin, 2004). A rabbet is a similar rectangular non-through cut that is located at the edge or end of a workpiece.

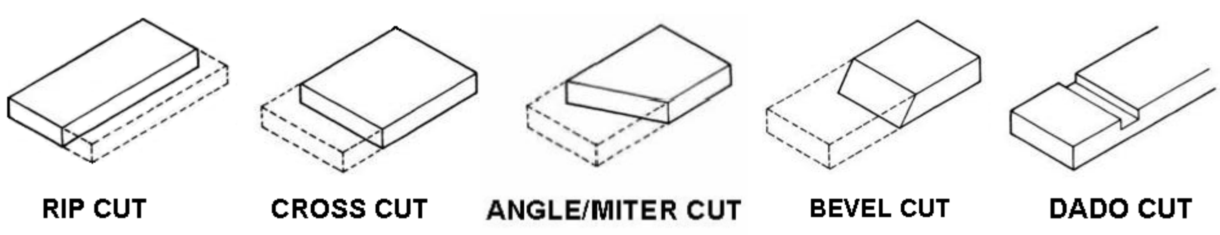

FIGURE 2. Some sample cutting operations.

BLADE-CONTACT INJURIES AND SCENARIOS

One of the primary hazards associated with table saws is direct contact between the operator and the saw blade. Such contact can result in lacerations, amputations, or similar injuries. In 2009, staff of the CPSC's Directorate for Epidemiology, Division of Hazard Analysis (EPHA), completed a survey of injuries that were associated with stationary saws and other unspecified saws and were treated in the emergency departments of National Electronic Injury Surveillance System (NEISS) hospitals between January 1, 2007 and December 31, 2008. Based on this survey, an estimated 66,900 injuries involving contact between the operator and the blade were treated in U.S. hospital emergency rooms during 2007 and 2008 combined (Chowdury & Paul, 2011). The most frequent injuries sustained were lacerations (65.9%), followed by fractures (12.4%) and amputations (12.0%). About two-thirds (66.5%) of the injuries occurred on a table saw without a blade guard attached, and the most common reason reported for the guard's absence was deliberate removal.

Many common and foreseeable scenarios are likely to lead to contact with the saw blade. For example:

- becoming distracted and inadvertently feeding the hand into the blade;
- losing one's balance from slipping, tripping, or overreaching, and inadvertently feeding the hand into the blade;
- reaching over or past an unguarded blade during a cut;
- removing cutoffs or brushing sawdust from the table while the blade is still spinning;
- losing control of slippery, very smooth, warped, or otherwise difficult-to-hold workpieces; and
- catching gloves, loose clothing, or jewelry on the spinning blade, which pulls the operator's hand into the blade.

Another common occurrence that could lead to blade contact is kickback. Based on the previously mentioned survey completed by EPHA staff, about 35 percent of the estimated 66,900 blade-contact injuries reportedly involved the workpiece kicking back or jumping during the cut. Kickback occurs most often when the workpiece binds in the spinning blade or contacts the rear portion of the spinning blade, which propels it back toward the consumer. This sudden movement, or any other unexpected movement of the workpiece, can cause the operator to lose control of the workpiece and to contact the saw blade inadvertently with the hand or arm. Additionally, if kickback occurs while the operator's hand is positioned behind the blade to hold, support, or remove the workpiece or cutoff, it might "pull" the operator's hand into the blade with the workpiece. Some examples of scenarios that could lead to kickback or workpiece ejection include (Adams, 2010; Mehler, 2003; Tolpin, 2004):

- the workpiece closing up on the blade after the cut;
- cutoffs becoming trapped under the guard or between the blade and the rip fence;

- pushing on the cutoff side of the workpiece during a rip cut;
- cutting freehand;
- releasing a workpiece before it has cleared the blade completely;
- stopping a cut midway through the workpiece; or
- making deep, wide non-through cuts, which tend to remove a lot of wood in a single pass.

TABLE SAW STANDARDS

VOLUNTARY STANDARDS

The U.S. voluntary consensus standard for table saws is UL 987, *Standard for Stationary and Fixed Electric Tools*. This standard was published by Underwriters Laboratories, Inc. (UL) in 1971 and has undergone several revisions, including the 7th edition, which is the most current. The original requirement for table saw guarding (section 40.9) specified that the complete guard consist of a hood, a spreader, and an antikickback device. The requirement specified that the guard hood completely enclose the sides and top portion of the saw blade above the table and that the guard automatically adjust to the thickness of the work piece. Blade guards that met this requirement were typically a hinged rectangular piece of clear plastic, as shown previously in Figure 1.

The 6th edition of UL 987, published in January 2005, added requirements for a riving knife and performance requirements for anti-kickback devices on table saws. This change essentially required all new table saws to employ a riving knife that is adjustable for all table saw operations (Section 40A.2). If the blade guard attaches to the riving knife, the device is considered a riving knife/spreader combination unit. This combination unit is considered to be in "spreader position" when the guard is attached and the unit is adjusted to permit through cuts; the unit is considered to be in "riving knife position" when the guard is not attached and the unit is adjusted to a position below the blade height above the table top to allow for non-through cuts.

The 7th edition of UL 987, published in November 2007, specified that the blade guard shall consist not of a hood, but of a top-barrier guarding element and two side-barrier guarding elements, one on each side of the blade (Section 42.2). The revised blade guard requirements reflect the new guard design developed by the Joint Venture. Additional requirements provide guidance on the rip fence, table insert, optional spreader, and instructions on making a push stick.

MANDATORY STANDARDS

Currently, the CPSC does not have any mandatory performance requirements for table saws. The U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) has regulations for table saws sold in commercial settings and used by the public in the course of employment. These regulations are codified at 29 CFR § 1910.213, *Woodworking Machinery Requirements*, and require that table saws include a blade guard, a spreader, and an antikickback device. The OHSA requirements for the blade guard, spreader, and antikickback devices are essentially identical to the requirements in the 5th edition of UL 987 before the revisions to the UL standard added requirements for a riving knife and the new blade guard design.

TRADITIONAL BLADE GUARD SYSTEMS

As noted earlier, prior to adoption of the 7th edition of UL 987, table saws sold in the United States traditionally had employed a blade guard system that combines the blade guard, splitter, and anti-kickback pawls as a single unit that is bolted to the saw's carriage assembly. The splitter generally served as the main support and connection point for the blade guard and the anti-kickback pawls.

BLADE GUARDS

Blade guards surround the exposed blade and function as a physical barrier between the blade and the consumer. These guards often are made of clear plastic but may be made of other materials. OSHA regulations and past editions of UL 987 require that a blade guard, or hood, completely enclose the portion of the saw blade above the table and above the material being cut, and that such a guard automatically adjust itself to the thickness of and remain in contact with the material being cut (29 CFR § 1910.213(c)(1) and (d)(1)).

In general, installed blade guards can effectively prevent most side, rear, and downward contact with the blade when used as instructed. These devices are less effective, and in many cases may be completely ineffective, at preventing contact with the blade resulting from front-end approaches toward the blade because this is the direction of approach of any workpiece that is fed into the blade, and blade guards generally are designed to allow passage of anything moving toward the front of the blade. For example, the fronts of blade guards are often shaped so that a workpiece fed into it causes the guard to rise and ride over the workpiece and allow access to the blade. Therefore, most blade guards will not prevent contact scenarios that involve approaches in this direction and tend to function more as a tactile proximity warning rather than a true guard that would physically prevent contact with the blade. Many non-kickback scenarios that could lead to blade contact, discussed earlier, would seem to involve approaches of this type.

KICKBACK PREVENTION DEVICES

Kickback prevention devices include splitters, riving knives, and anti-kickback pawls. A splitter, also known as a spreader, is typically a flat piece of metal that is aligned directly behind the saw blade. As the workpiece feeds through the blade, the splitter rides within the cut, or kerf, to prevent the cut sides of the workpiece from closing up and pinching the blade, which can cause the workpiece to be thrown back toward the operator. The height of a splitter generally is set based on the highest height of the blade, meaning that the splitter is often taller than the blade. Thus, splitters must be removed when performing non-through cuts, in which the top of the blade is used to cut a channel into the workpiece. Riving knives are curved steel plates that are similar to and perform the same function as splitters, but sit very close to the blade (see Figure 3), rise no higher than the top of the blade, and attach to the arbor assembly so that they move with the blade (Adams, 2010; Mehler, 2003). These characteristics allow riving knives to be used while making non-through cuts. Prior to changes to the UL standard in 2005 that explicitly permitted their use, riving knives were limited primarily to table saws sold in Europe. Anti-kickback pawls—sometimes referred to as anti-kickback fingers or devices—are intended to prevent movement of the workpiece opposite the feeding direction. They consist of two hinged and barbed pieces of metal that allow passage of the workpiece but will dig into the workpiece if it begins to move back toward the operator.

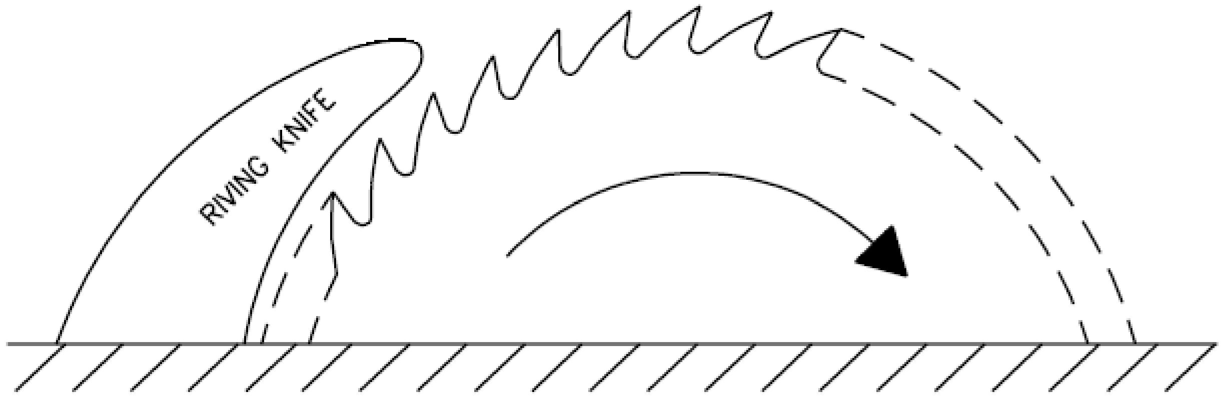

FIGURE 3. Riving knife positioned next to blade.

A properly installed splitter or riving knife may be the most effective way to prevent kickback because it limits workpiece access to the rear teeth of the saw blade (Adams, 2010; Mehler, 2003). Thus, in principle, these devices could address most blade-contact incidents associated with kickback when a splitter or riving knife was not used but could have been. Nevertheless, as mentioned earlier, splitters cannot be used when performing non-through cuts. In contrast, riving knives can rise, fall, and tilt with the blade, allowing them to be used while performing most through and non-through cuts. Moreover, riving knives tend to sit closer to the blade and enter the saw kerf sooner than a splitter, especially when the blade is set low. However, the effectiveness of both devices depends on the workpiece reaching them during the cut; thus, neither device is effective at preventing kickback or ejections associated with cutting short workpieces.

CONSUMER USE OF TRADITIONAL BLADE GUARD SYSTEMS

Ultimately, the effectiveness of any blade guard system depends on an operator's willingness to use it. Safety equipment that hinders one's ability to operate the product—for example, by increasing the time or effort required to perform the desired tasks—effectively "punishes" the operator for choosing to use the equipment and most likely will result in consumers bypassing, avoiding, or discarding it (Cushman & Rosenberg, 1991; Geller, 2001; Nussbaum, 1998; Trump, 1980; Woodson, 1998).[3] This may be especially true for safety equipment with which operators would be required to interact repeatedly over the life of the product.

Several characteristics of traditional blade guard systems are likely to hinder table saw use and motivate consumers to remove them to make performing a cut simpler or easier. Some blade guards may jam on the leading edge of the workpiece, requiring the consumer to push the workpiece forcefully or to raise the guard manually. This scenario may be especially likely for sharply angled bevel cuts, and severe jamming could even drive the blade guard into the spinning blade. Because they act as a barrier between the consumer and the blade, blade guard systems invariably limit the visibility of the workpiece and the blade, to some extent, when the consumer is trying to set up or

[3] This is similar to the concept of "cost of compliance" in warnings literature. One of the primary factors that affect whether consumers will comply with a recommended behavior in a warning is the cost of compliance, that is, the time, effort, and other "costs" associated with performing that behavior. Research has found that even small inconveniences can have a substantial negative impact on compliance (Riley, 2006).

make a cut; and many guards are not designed to stay up and out of the way to set up or align the cut easily. Sawdust also may accumulate in the guard, further restricting visibility. A blade guard system with a splitter that is not properly aligned with the blade can make feeding the workpiece through the blade increasingly difficult and can actually increase the likelihood of kickback by binding the workpiece between the blade and the rip fence (Mehler, 2003; Tolpin, 2004). If the splitter becomes bent, which can occur with use, this alignment is necessarily affected. Anti-kickback pawls can hinder the removal of a cutoff once a cut has been completed.

In addition to the above situations, which may motivate consumers to remove the blade guard system, some circumstances actually require that the guard system be removed to be able to perform the desired task. For example, many traditional blade guard systems limit the size of the workpiece that can be cut and restrict how close the rip fence can be brought to the blade, thereby preventing the use of the guard system with tall or oversized workpieces, or when performing thin rip cuts (Mehler, 2003; Tolpin, 2004). Traditional blade guard systems also typically employ a splitter, which means they cannot be used when performing non-through cuts, such as dadoes and rabbets. Because manufacturers recommend that blade guard systems be used whenever performing a through cut, these devices may have to be removed and reinstalled quite often between cuts. Experts claim that many traditional blade guard systems are difficult and time-consuming to remove and reinstall (Mehler, 2003; Tolpin, 2004), characteristics that are likely to discourage consumers from continuing to use the systems or from reinstalling them after they have been removed. Furthermore, many of the sawing tasks that absolutely require the guard system to be removed, tend to be somewhat more advanced or difficult, which suggests that experienced woodworkers may be more likely to have to remove the system. Because of their expertise and comfort level with table saws, these woodworkers may believe that reinstalling the guard system is not necessary for them, especially if they expect to remove the guard system again shortly thereafter, or they know that the task at hand will require frequent removal of the guard system.

NEWER BLADE GUARD SYSTEMS

In 2007, a new blade guard system that was consistent with the 7th Edition of the UL 987 standard entered the U.S. market as part of a commercially available, consumer-oriented table saw. The new blade guard system is a "modular" design that consists of an adjustable riving knife, a removable blade guard assembly, and removable anti-kickback pawls. The riving knife can be locked into high, middle, and "stored" positions (Robert Bosch Tool Corporation, 2007, p. 44), and, when locked into the high position, serves as the attachment point for the blade guard assembly and anti-kickback pawls. In the middle position, the riving knife acts as a more traditional riving knife. The guard assembly consists of a pair of independently hinged, plastic side barriers that attach to a metal upper barrier guard. The upper barrier guard is shaped similar to a tuning fork. No tools are required to install or remove this new blade guard system.

In 2009, the CPSC's Mechanical Engineering and Human Factors staff obtained and examined a sample of a table saw with this new blade guard system. At the time, this was the only known table saw that employed a blade guard system of this type. Like traditional blade guard systems, the new blade guard design can effectively prevent most side, rear, and downward contact with the blade when used as instructed but cannot physically prevent contact with the blade resulting from front-end approaches toward the blade. The use of two independently hinged side guards can provide considerably more blade coverage than a solid guard during bevel cuts, by allowing one side to cover the blade even while the other side is raised or riding over the workpiece. This is illustrated in Figure 4, which simulates the interaction of a workpiece and the guard system when performing a bevel crosscut.[4] This design is likely to offer similar advantages when cutting thick workpieces.

Another significant advantage of the new blade guard system is the use of a permanent, adjustable riving knife, rather than a removable splitter, as the primary kickback prevention device and support for the blade guard. Because the riving knife cannot be removed, it is likely to remain properly aligned with the blade at all times, thereby avoiding most of the potential for kickback associated with misaligned splitters and riving knives. Its permanence also means that the riving knife cannot be lost, and is always available to provide kickback protection in circumstances that allow its use. Because the riving knife can be used for both through and non-through cuts, consumers will not have to remove and reinstall the entire guard system when switching between non-through cuts and standard crosscuts and rip cuts. However, the consumer still would be required to remove and reinstall the blade guard assembly and anti-kickback pawls, and would

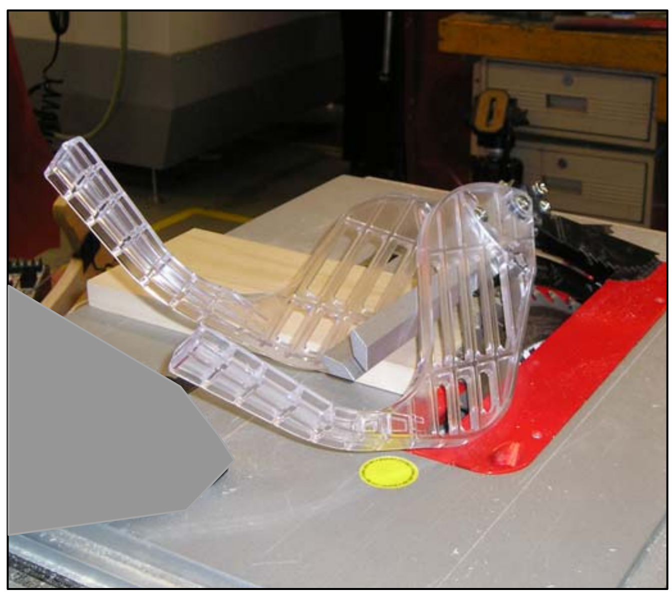

FIGURE 4. New blade guard system in bevel crosscut position.[4]

[4] This figure is intended to illustrate the independent operation of the hinged side guards, not a true bevel crosscut. The miter gauge, which is obscured in the figure, normally would be placed against a workpiece during such a cut.

have to adjust the position of the riving knife. Although these tasks do not require tools, they do require some amount of time and effort that might become substantial if they must be done repeatedly.

SAMPLE SYSTEM INSTALLATION AND REMOVAL

As noted earlier, installing and removing a blade guard system might be one of the more common activities consumers will be required to perform while using a table saw, and these tasks can be difficult and time-consuming with traditional blade guard systems. Installing the new blade guard system involves three basic steps: positioning the riving knife, attaching the guard assembly to the riving knife, and attaching the anti-kickback pawls to the riving knife. Before positioning the riving knife, the consumer must first remove the table insert, or throat plate, raise the blade as high as possible, and set the blade perpendicular to the table. The riving knife locks into position using locking pins and a release lever that is located at its base. To position the riving knife, the consumer rotates the release lever open and slides the riving knife toward the lever to disengage it from the locking pins. The consumer can then raise the riving knife to its highest position, align its locking holes with the locking pins in the release mechanism, and rotate the release lever to lock the riving knife in place (see Figure 5). Once the riving knife is in place, the table insert can be replaced.

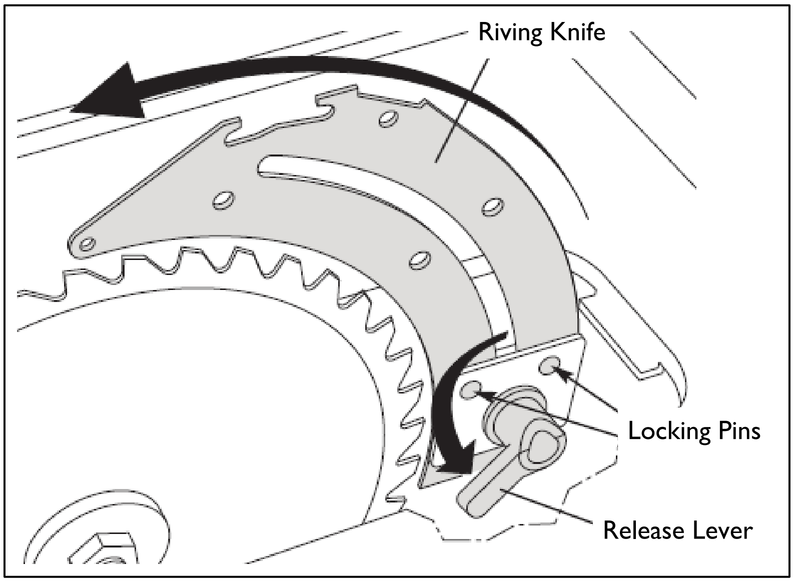

FIGURE 5. Positioning the riving knife of the new blade guard system. Adapted from *Bosch 4100/4100DG operating/safety instructions* (p. 26), by Robert Bosch Tool Corporation, 2007, Prospect, IL: Author. Copyright 2007 by Robert Bosch Tool Corporation. Used with permission.

Although no tools are required to make these adjustments, Human Factors staff found that the release lever requires a considerable amount of force to disengage, and one's hand tends to rub against the blade while performing this action. Visually aligning the locking pins in the release lever with the desired locking holes is difficult, given the release lever's position below the surface of the table. This task can be simplified by applying pressure to the riving knife toward the locking pins while sliding the knife into position because this action causes the pins to naturally pop into the holes at the next position. The operating instructions that accompany the saw, however, do not instruct consumers to adjust the riving knife in this way. Rather, the instructions merely state that consumers should "[a]lign holes in riving knife with pins . . . ." (Robert Bosch Tool Corporation, 2007, p. 26).

Attaching the blade guard assembly to the riving knife requires the consumer to tilt and lower the assembly onto the attachment point so that the cross bar on the assembly hooks into the rear notch, while simultaneously holding the guard release lever up with the other hand (see Figure 6). The consumer then lowers the metal fork of the guard assembly so that it is parallel to the table and presses on the guard release lever to lock the guard assembly in place. The requirement to tilt the rear portion of the guard down to install the guard assembly properly is not immediately obvious, but this task is accurately described in the operating instructions, and consumers should have little difficulty appropriately installing the guard assembly once aware of the proper procedure.

The anti-kickback pawls attach to the riving knife with a locking pin that can be opened or closed using a pair of opposing compression pads on the pawls. To properly install the pawls, the consumer squeezes the compression pads while nesting the device onto a flat recessed portion of the riving knife so that the locking pin aligns with the riving knife's locking hole (see Figure 7). The operating manual suggests that consumers might find this task easier if they position the device behind the recessed area and then slide it forward until it drops into place. Releasing the compression pads engages the locking pin and locks the device in place.

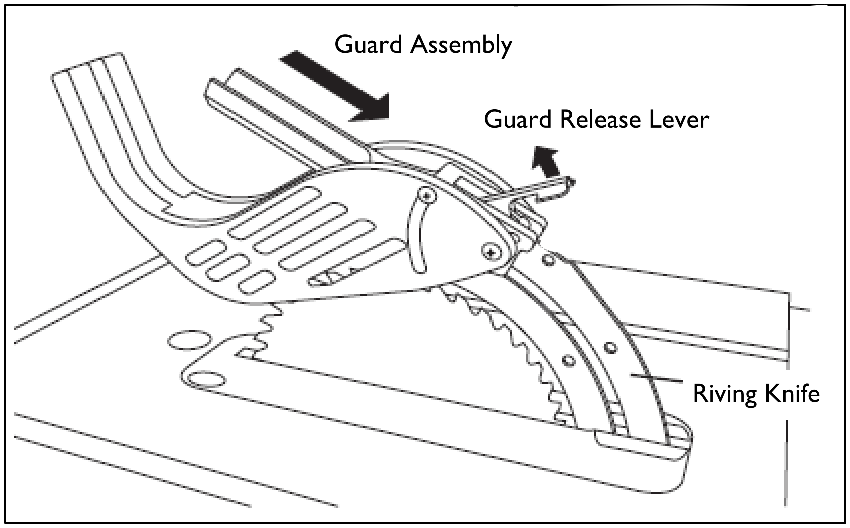

FIGURE 6. Attaching the blade guard assembly.
Adapted from *Bosch 4100/4100DG operating/safety instructions* (p. 28), by Robert Bosch Tool Corporation, 2007, Prospect, IL: Author. Copyright 2007 by Robert Bosch Tool Corporation. Used with permission.

Properly aligning and mounting the anti-kickback pawls onto the riving knife can be difficult initially because placing the pawls in the recessed portion of the riving knife does not automatically seat and align the locking pin with the corresponding locking hole in the riving knife. For proper alignment, the device must be brought to the riving knife at a specific angle, and it appears that consumers must learn the proper angle through trial and error. Nonetheless, installing the anti-kickback pawls becomes easier with practice.

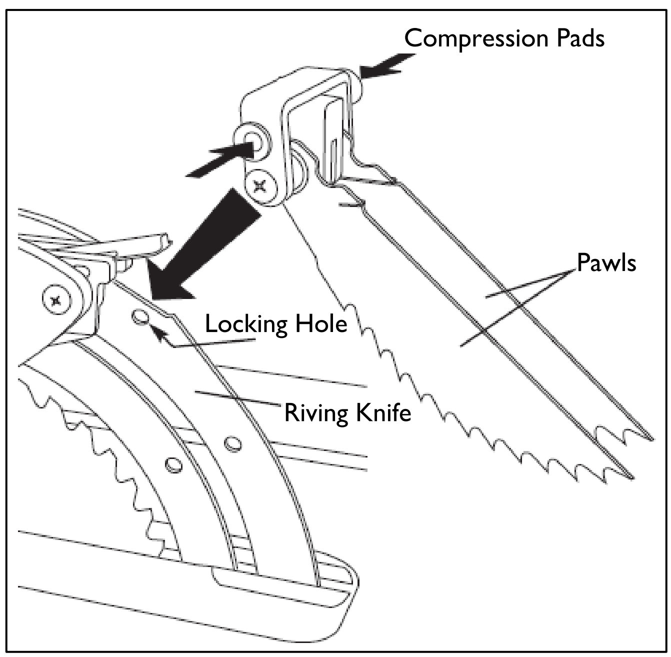

FIGURE 7. Installing the anti-kickback pawls.
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Removing the new blade guard system involves removing the anti-kickback pawls and blade guard assembly; the sequence in which these devices are removed does not matter. To remove the anti-kickback pawls, the consumer squeezes the compression pads shown in Figure 7 and lifts the device from the riving knife. To remove the guard assembly, the consumer pulls up on the blade guard release lever and then lifts the front end of the guard assembly. Removing both devices is very simple. The riving knife can then be adjusted to the middle or stored position.

Sample System Use and Operability

Human Factors staff performed some basic cuts with the sample table saw using various wood workpieces. The new blade guard system generally functioned well when performing basic crosscuts and rip cuts. The leading ends of the side guards did not jam into the front edge of the workpieces and easily rose up and rode over the tops of the workpieces. Because the top portion of the new blade guard system uses a metal fork that is open in the center, consumers have a direct, unobstructed view of the workpiece and blade while making these basic rip cuts and crosscuts. However, the metal fork and slatted plastic side guards still can obstruct one's view during beveled cuts. The side guards can be raised manually and "locked" into this raised position for setting up cuts, but the guards do not get completely out of the way, and their leading ends are quite long. These characteristics can block or interfere with a consumer's ability to get very close to perform precise alignments of the workpiece and the blade. Furthermore, once a cut is set up and the guards are lowered, the side guards still could prevent consumers from adequately observing a cut that is underway. The ability to fine-tune the workpiece position to properly align it with the blade immediately before initiating a cut may be especially important for compound cuts.

Human Factors staff also identified some circumstances in which the new blade guard system interfered with the ability to perform certain cutting operations. For example, the tilt of the guard assembly during bevel cuts can cause the long leading ends of the side guards to interfere with the smooth forward movement of consumers' hands as they feed a workpiece into the blade (see Figure 4, previously). Additionally, the workpiece would occasionally bind on the riving knife during 45-degree miter cuts, preventing consumers from being able to perform these cuts smoothly and avoid burning the workpiece. Like most traditional blade guard systems, the new blade guard assembly and anti-kickback pawls must be removed to cut tall or oversized workpieces. Human Factors staff also found that these components prevented the rip fence from moving very close to the blade to make narrow rip cuts. Thus, there remain circumstances in which a consumer would have to remove the new blade guard system.

INJURY MITIGATION SYSTEMS

One of the primary functions of blade guard systems is to prevent physical contact with the saw blade. Such systems are not intended to mitigate the often severe consequences of blade contact when it does occur. SawStop, LLC, recently developed a blade-contact detection and reaction system for table saws and, in 2008, released a contractor saw containing this system.

SawStop's blade-contact detection and reaction system represents a completely different approach to injury reduction than blade guard systems. Clearly, the SawStop system is not intended as a replacement for blade guards and kickback prevention devices. Blade guard systems, whether the new blade guard system, or the more traditional variety, are intended to reduce consumer exposure to the blade, and are important to help prevent kickback and blade contact in the first place. Yet, as noted earlier, sometimes a blade guard system cannot be used, leaving consumers with no blade-contact protection. Moreover, although systems should be designed to reduce the likelihood of error, total error elimination is unlikely, if not impossible (Hammer, 1972; Senders & Moray, 1991). For example, when ripping, consumers are told to focus their attention on where the workpiece meets the fence, rather than on the blade, because the workpiece must be against the fence for the entire cut (Mehler, 2003). This necessarily means that adequate attention cannot be given to the position of the hands relative to the blade. Even expert woodworkers can err, primarily because of their expertise. Behavior that is practiced over and over again increasingly requires less conscious attention. Thus, as experience and proficiency in a task increase, related behaviors become less deliberate and more automatic (Senders & Moray, 1991; Zimolong & Elke, 2006). As a result, experts can occasionally "slip" and automatically perform a highly learned behavior when such behavior is inappropriate (Nemeth, 2004; Reason, 1990), possibly resulting in blade contact. SawStop's blade-contact detection and reaction system, therefore, is intended to lessen the consequences of blade contact when it occurs, despite the use of the other safety devices present on the saw. This approach is consistent with the concept of making systems more "forgiving" of errors that will occur inevitably, so that the results are not catastrophic (Hammer, 1972; Senders & Moray, 1991; Woodson, 1998).

SawStop's detection and reaction system includes two components: an electronic detection unit and a brake. The two components are contained within a brake cartridge, which is positioned under the table and just behind the blade (see Figure 8). The system induces a small electrical signal onto the saw blade. When human skin contacts the blade, the person's body absorbs part of this signal. The system detects the consequent signal reduction and engages the brake. The brake consists of an aluminum pawl that is pushed into the teeth of the spinning blade, stopping it

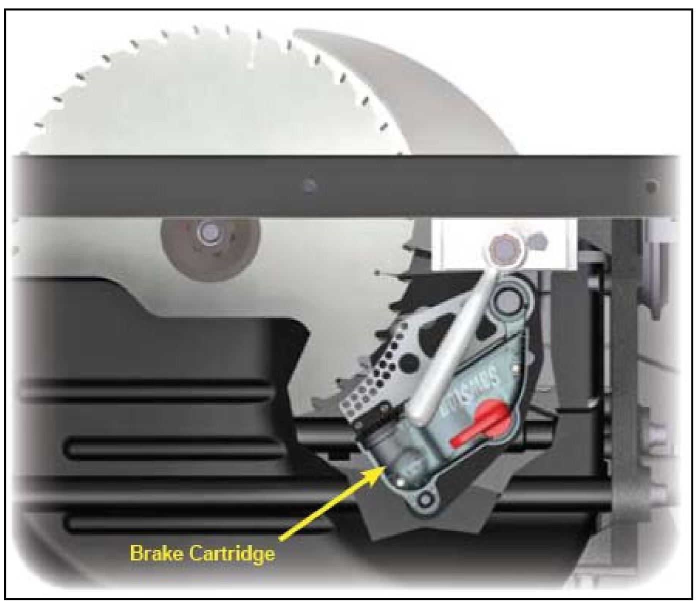

Figure 8. Brake cartridge location.
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in milliseconds. If the blade is at or near full speed when the brake is activated, the blade also quickly retracts below the table surface. In principle, when the system functions as intended, the only injury likely to be sustained by direct contact with the saw blade is a small cut.[5] If the system is activated, a new brake cartridge must be installed before the saw can be used again. To staff's knowledge, SawStop is the only manufacturer currently employing safety technology of this type; however the Power Tool Institute recently has developed similar technology.[6]

SAMPLE SYSTEM INSTALLATION AND REMOVAL

In 2009, the CPSC's Mechanical Engineering and Human Factors staff obtained and examined a sample of a SawStop contractor saw. The saw was received with a brake cartridge preinstalled. If the system activates, this brake cartridge will need to be replaced. Activation of the system will most likely result in the saw blade becoming embedded in the cartridge's brake pawl and the blade retracting below the table. This situation would require the consumer to reset the arbor block into its retraction bracket and remove the saw blade and cartridge together. To reset the arbor block, the consumer must fully lower the blade to the lower elevation limit stop, at which point the arbor block will automatically engage the support mechanism. Then the consumer can raise the blade to maximum height, remove the table insert, and remove the blade guard system to access the blade and brake cartridge.

To remove the blade and the brake cartridge, the consumer must remove the blade nut and washer from the arbor and then remove the red cartridge key that locks the cartridge in place (see Figure 9). The key can be removed by rotating it 90 degrees clockwise and pulling it out. Then the cartridge can be pulled away from its mounting bracket and off its two mounting pins—a large pivot pin and a small positioning pin—while the saw blade is simultaneously pulled off the arbor. CPSC staff found this task to be extremely difficult and time-consuming, with the blade-cartridge "assembly" binding in place. Removal required the use of tools to lever the cartridge off the arbor.

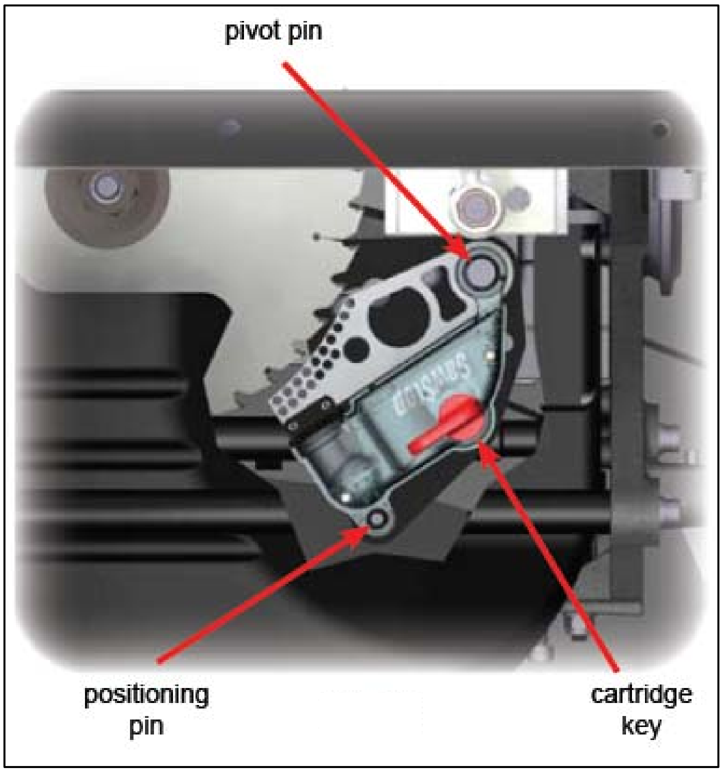

FIGURE 9. Installed brake cartridge.
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[5] Human Factors staff presumes that a more substantial injury may be possible if movement into the blade is extremely rapid. The approach speed required for such injury, however, has not yet been determined by staff.

[6] In a meeting with Commission staff in June 2011, the Power Tool Institute discussed and showed video footage of their technology, which also retracts the saw blade upon detecting blade contact with the skin. According to the Power Tool Institute, SawStop has stated that this system likely will infringe SawStop's patents.

Installing a new brake cartridge requires the consumer to align two mounting holes on the brake cartridge with the two mounting pins in the saw. Once aligned, the cartridge slides onto these pins and is pushed against the mounting bracket. When the cartridge is pushed into place, a computer connector on the side of the cartridge self-aligns with a corresponding computer cable in the saw. Then the cartridge key is inserted into the cartridge and is rotated 90 degrees counterclockwise to lock the cartridge into place. Once the cartridge is installed, the consumer is instructed to check the spacing between the cartridge and the blade and, if necessary, adjust a brake positioning bolt to fine-tune this distance. Consumers must perform this blade-cartridge distance check each time a new blade or cartridge is installed.

Visually aligning the two mounting holes with the mounting pins is difficult, given the mounting location below the surface of the table. To ease alignment, consumers may choose to rely upon the prominent computer connector on the side of the cartridge as a cue to indicate the proper orientation of the cartridge during installation. For example, consumers may partially insert the large pivot pin into the large mounting hole on the cartridge, rotate the cartridge until the computer connector and cable align, and then push the cartridge against the mounting bracket. Human Factors staff was able to install the cartridge fully in this manner, including locking the cartridge key, only to discover that the saw would not start. Although staff has concerns about the ability to fully install the cartridge incorrectly, the system is designed so that the motor will not start unless the cartridge is installed correctly. Staff also notes that there was no information on the brake cartridge, on the cartridge packaging, or within the packaging, regarding how to install the cartridge properly. Given the importance of correctly installing the cartridge, staff believes this information should be provided with every replacement cartridge.

SAMPLE SYSTEM USE AND OPERABILITY

SawStop's blade-contact detection and reaction system does not seem to interfere with most saw operations. The system cannot be used when cutting aluminum, brass, or other conductive materials, but in most cases, consumers will not have to cut these materials, and will never have to bypass the system. In the rare event that they do, consumers must insert a bypass key, pull out the start/stop paddle to the ON position, and hold the key turned for another second after the motor starts. While performing this action repeatedly no doubt would be a nuisance for consumers who intend to cut a large amount of conductive materials, most consumers are likely to be unaffected or minimally affected.

The system does require consumers to change the cartridge whenever switching to or from dado sets, which require the use of an optional dado brake cartridge that has a larger brake pawl than is used with 10-inch standard blades. Consumers may find this rather inconvenient if they must perform the switch often. SawStop also recommends that the brake cartridge be replaced if more than a "small amount of dust" can be seen inside the cartridge's clear housing. Consumers are unlikely to take the time to inspect the cartridge regularly, and it is unclear whether consumers who do take this action would be able to determine whether the amount of dust present would warrant replacement based on SawStop's recommendation.

Conclusions

Newer blade guard systems appear to be a significant improvement over most traditional blade guard systems; however, even the new blade guard systems will not physically prevent all blade-contact injuries that result from the hand approaching the front, or leading portion, of the blade. Furthermore, the new blade guard system that staff examined still can hinder certain table saw tasks and prevent the performance of certain sawing tasks, encouraging removal of the blade guard system. Removing the system is easy, but installation is somewhat trickier, and if repeated installation is necessary, it might be time-consuming and burdensome. These characteristics might motivate some consumers—especially experienced or expert woodworkers—to forego reinstalling the system once removed.

Unlike blade guard systems, which are intended to reduce consumer exposure to the blade in the first place, a blade-contact detection and reaction system such as that developed by SawStop functions as a secondary safety system that lessens the consequences of blade contact when it occurs. This system is not intended as a replacement for blade guards and kickback prevention devices. Blade guard systems, whether the new blade guard system or the more traditional variety, are intended to reduce consumer exposure to the blade and are important to help prevent kickback and blade contact in the first place. The SawStop system that staff examined does not seem to interfere with most saw operations, and once it is installed the system is essentially invisible to the consumer until it is needed. Removing and reinstalling the brake cartridge when switching to and from dado sets, or once the system has been activated, can be difficult. However, in all likelihood, system activation would occur only after contact with the skin, a situation in which the consumer very well might have sustained serious injury had the system not been in place.

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