UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
BETHESDA, MD 20814

This document has been electronically approved and signed.

DATE: January 17, 2017

THIS MATTER IS NOT SCHEDULED FOR A BALLOT VOTE.
A DECISIONAL MEETING FOR THIS MATTER IS SCHEDULED ON:

TO: The Commission
Todd A. Stevenson, Secretary

THROUGH: Mary T. Boyle, General Counsel
Patricia H. Adkins, Executive Director

FROM: Patricia M. Pollitzer, Assistant General Counsel
Hyun S. Kim, Attorney, OGC

SUBJECT: Proposed Rule: Safety Standard Addressing Blade-Contact Injuries on Table Saws

Staff is forwarding to the Commission a briefing package recommending that the Commission issue a notice of proposed rulemaking (NPR), pursuant to the Consumer Product Safety Act (CPSA), to address the risk of blade-contact injuries associated with table saws. The Office of the General Counsel is providing for the Commission's consideration a draft NPR that would establish a performance requirement for table saws.

Please indicate your vote on the following options:

I. Approve publication of the attached document in the *Federal Register,* as drafted.

______________________________ ______________
(Signature) (Date)

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

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(Signature) (Date)

III. Do not approve publication of the attached document in the *Federal Register*.

(Signature) (Date)

IV. Take other action. (Please specify.)

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(Signature) (Date)

Attachment: Draft *Federal Register* Notice: Proposed Rule to Establish a Safety Standard Addressing Blade-Contact Injuries on Table Saws.

Billing Code 6355-01-P

CONSUMER PRODUCT SAFETY COMMISSION

16 CFR Part 1245

[RIN 3041-AC31]

Docket No. CPSC-2011-0074

Safety Standard Addressing Blade-Contact Injuries on Table Saws

AGENCY: Consumer Product Safety Commission.

ACTION: Notice of proposed rulemaking.

SUMMARY: The U.S. Consumer Product Safety Commission has determined preliminarily that there may be an unreasonable risk of blade-contact injuries associated with table saws. In 2015, there were an estimated 33,400 table saw, emergency department-treated injuries. Of these, CPSC staff estimates that 30,800 (92 percent) are likely related to the victim making contact with the saw blade. CPSC staff's review of the existing data indicates that currently available safety devices, such as the modular blade guard and riving knife, do not adequately address the unreasonable risk of blade-contact injuries on table saws. To address this risk, the Commission proposes a rule that is based, in part, on work conducted by Underwriters Laboratories Inc. The proposed rule would establish a performance standard that requires table saws, when powered on, to limit the depth of cut to 3.5 millimeters when a test probe, acting as surrogate for a human body/finger, contacts the spinning blade at a radial approach rate of 1 meter per second (m/s). The proposed rule would address an estimated 54,800 medically treated blade-contact injuries annually. The Commission estimates that the proposed rule's aggregate net benefits on an annual basis could range from about $625 million to about $2,300 million.

DATES: Submit comments by [INSERT DATE 75 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**]**.

ADDRESSES: You may submit comments, identified by Docket No. CPSC-2011-0074, by any of the following methods:

Electronic Submissions: Submit electronic comments to the Federal eRulemaking Portal at: http://www.regulations.gov. Follow the instructions for submitting comments. The Commission does not accept comments submitted by electronic mail (e-mail), except through www.regulations.gov. The Commission encourages you to submit electronic comments by using the Federal eRulemaking Portal, as described above.

Written Submissions: Submit written submissions by mail/hand delivery/courier to: Office of the Secretary, Consumer Product Safety Commission, Room 820, 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 that you do not want to be available to the public. If furnished at all, 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, and insert the docket number CPSC-2011-0074, into the "Search" box, and follow the prompts.

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

SUPPLEMENTARY INFORMATION:

I. Background

On April 15, 2003, Stephen Gass, David Fanning, and James Fulmer, *et al.* (petitioners) requested that the CPSC require performance standards for a system to reduce or prevent injuries from contact with the blade of a table saw. The petitioners are members of SawStop, LLC, and its parent company, SD3, LLC (collectively, SawStop). On October 11, 2011, the Commission published an advance notice of proposed rulemaking (ANPR) to consider whether there may be an unreasonable risk of blade-contact injuries associated with table saws. 76 FR 62678. The ANPR began a rulemaking proceeding under the Consumer Product Safety Act (CPSA). The Commission received approximately 1,600 public comments. The Commission is now issuing a notice of proposed rulemaking (NPR) to address an unreasonable risk of blade-contact injuries associated with table saws that would limit the depth of cut to 3.5 mm or less when a test probe, acting as surrogate for a human body/finger, contacts the spinning blade at a radial approach rate of 1 meter per second (m/s). The information discussed in this preamble is derived from CPSC staff's briefing package for the NPR, which is available on CPSC's website at: [**INSERT LINK**].

II. Statutory Authority

Table saws are "consumer products" that can be regulated by the Commission under the authority of the CPSA. *See* 15 U.S.C. 2052(a). Section 7 of the CPSA authorizes the Commission to promulgate a mandatory consumer product safety standard that sets forth performance requirements for a consumer product or that sets forth requirements that a product be marked or accompanied by clear and adequate warnings or instructions. A performance, warning, or instruction standard must be reasonably necessary to prevent or reduce an unreasonable risk or injury. *Id.*

Section 9 of the CPSA specifies the procedure that the Commission must follow to issue a consumer product safety standard under section 7. In accordance with section 9, the Commission may commence rulemaking by issuing an ANPR; as noted, the Commission issued an ANPR on table saws in October 2011. (76 FR 62678 (October 11, 2011)). Section 9 authorizes the Commission to issue an NPR, including the proposed rule and a preliminary regulatory analysis, in accordance with section 9(c) of the CPSA and request comments regarding the risk of injury identified by the Commission, the regulatory alternatives being considered, and other possible alternatives for addressing the risk. *Id*. 2058(c). Next, the Commission will consider the comments received in response to the proposed rule and decide whether to issue a final rule, along with a final regulatory analysis. *Id.* 2058(c)-(f). The Commission also must provide an opportunity for interested persons to make oral presentations of their data, views, or arguments, in accordance with section 9(d)(2) of the CPSA. *Id.* 2058(d)(2).

According to section 9(f)(1) of the CPSA, before promulgating a consumer product safety rule, the Commission must consider, and make appropriate findings to be included in the rule, on the following issues:

- the degree and nature of the risk of injury that the rule is designed to eliminate or reduce;
- the approximate number of consumer products subject to the rule;

- the need of the public for the products subject to the rule and the probable effect the rule will have on utility, cost, or availability of such products; and
- the means to achieve the objective of the rule while minimizing adverse effects on competition, manufacturing, and commercial practices.

Id. 2058(f)(1). Under section 9(f)(3) of the CPSA, to issue a final rule, the Commission must find that the rule is "reasonably necessary to eliminate or reduce an unreasonable risk of injury associated with such product" and that issuing the rule is in the public interest. *Id.* 2058(f)(3)(A)&(B). Additionally, if a voluntary standard addressing the risk of injury has been adopted and implemented, the Commission must find that:

- the voluntary standard is not likely to eliminate or adequately reduce the risk of injury, or that
- substantial compliance with the voluntary standard is unlikely. *Id.* 2058(f)(3(D).

The Commission also must find that expected benefits of the rule bear a reasonable relationship to its costs and that the rule imposes the least burdensome requirements which prevent or adequately reduce the risk of injury for which the rule is being promulgated. *Id.* 2058(f)(3)(E)&(F).

III. The Product

A. Types of Table Saws

Table saws are stationary power tools used for the straight sawing of wood and other materials. The basic design of a table saw consists of a motor-driven saw blade that protrudes through a flat table surface. To make a cut, the operator places the workpiece on the table and, using a rip fence or miter gauge as a guide, pushes the workpiece into the blade (see Figure 1.)

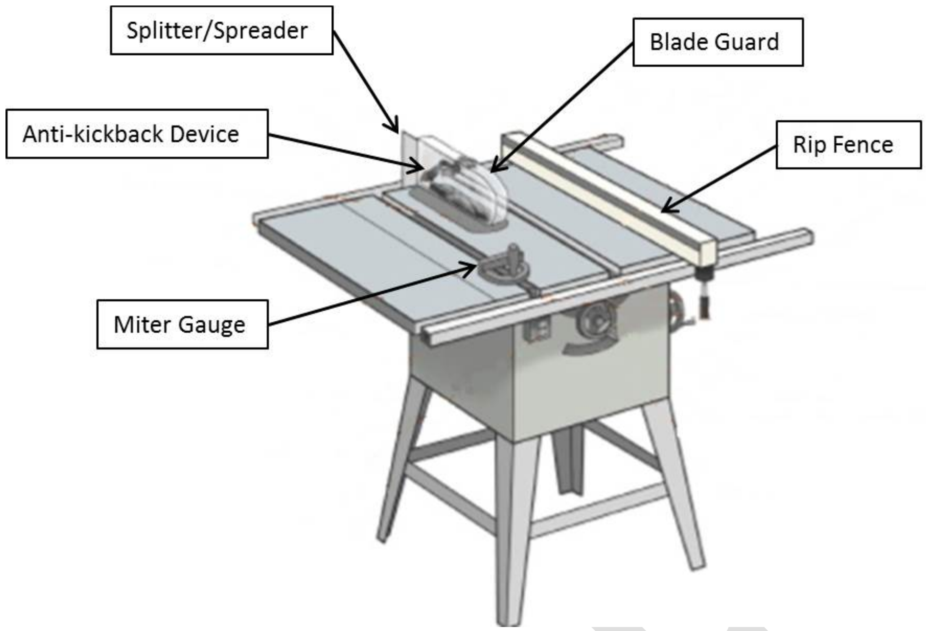

Figure 1. Typical table saw components

Table saws generally fall into three product types**:** bench saws, contractor saws, and cabinet saws.[1] Although there is no exact dividing line, the distinction among these types of saws is generally based on size, weight, portability, power transmission, and price.[2]

Bench saws are intended to be transportable, so they tend to be small, lightweight, and relatively inexpensive. In recent years, bench saw designs have evolved to include saws with larger and heavier-duty table surfaces, with some attached to a folding stand with wheels to maintain mobility. These larger portable saws on wheeled stands are called "jobsite" saws

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[1] Cabinet saws also are referred to as stationary saws because they are not portable.

[2] In addition to these three primary product types, there are also several hybrid saws in the market. This product type blends components of both contractor and cabinet saws. Specifically, hybrid saws have the energy requirements, weight, and mobility of contractor saws with the structure, accuracy, and dust control features of cabinet saws. This product type typically operates in single phase with a voltage range of 110-240 volts, generating 1.75 to two horsepower, depending on the model. There are also sliding saws that are similar to cabinet saws in that they are belt driven, but they are typically equipped with an extension and greater rip- and cross-cutting capacity that allows for cutting large panels. This type of saw can be wired for either single-phase or three-phase operation; however, three-phase wiring is a more common feature for sliding table saws. Sliding saws operate in the 220-440 volt range.

because they are capable of heavier-duty work, but they are still portable enough to move to work sites.

Bench saws generally run on standard house voltage (110-120 volts), use universal motors,[3] drive the saw blade through gears, and range in weight from 34 pounds to 133 pounds. The universal motor and gear drive produce the high decibel noise and vibration that are distinctive characteristics of bench saws. Prices for bench saws range from $129 per model, to as much as $1,499 for a high-end model.

Contractor saws used to be considered portable table saws, but designs have progressed with larger motors and heavier table tops to the point that most contractor saws are considered non-portable. Although a mobile base can be added to the frame to make contractor saws mobile, they are often found in home workshops as non-portable saws that are a less expensive alternative to cabinet saws. Contractor saws generally run on standard house voltage, use induction motors, are belt driven, and range in weight from around 200 pounds to 400 pounds. The induction motor and belt drive result in a table saw that produces less vibration, is quieter, is more accurate, is able to cut thicker pieces of wood, and is more durable than a bench saw. Prices for contractor saws range from around $500 to $2,000.

Cabinet saws are larger, heavier, and more powerful than contractor saws, and their motors are enclosed in a solid base. These saws are typically the highest grade saw found in the home woodworking shop. Cabinet saws generally run on 220-240 volts, use a 1.75-5 hp or stronger motor, are belt driven, and weigh from around 300 pounds to 1,000 pounds. Components in cabinet saws are designed for heavy use and durability, and the greater weight

[3] A universal motor runs on AC or DC power, has high starting torque, can run at high speed, and is lightweight and compact. For these reasons, universal motors are commonly used in portable power tools and equipment.

further reduces vibration so that cuts are smoother and more accurate. Cabinet saws are expected to last a lifetime (with an average product life of 24 years), and prices range from around $1,200 to $5,000.

B. Standard Safety Devices

Common safety devices on table saws are designed to reduce contact between the saw blade and the operator and to reduce kickback, a phenomenon in which the saw blade imparts its kinetic energy to the workpiece and ejects the workpiece back towards the operator. 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. Blade guards generally are designed either as a single-piece unit that covers the saw blade, as shown in Figure 1, or as a modular system with a fixed-top barrier and independent side barriers.

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 already fed through the blade. This prevents the workpiece from closing up on itself after it passes the blade and pinching the blade, which can cause the workpiece to be thrown upwards and back toward the operator. Before 2009, most table saws were designed with a splitter located behind the blade that was attached to the blade guard. If a cut required removal of the splitter or guard, they were removed together.

Riving knives are curved metal plates that are similar to, and perform the same function as, splitters, but are often located closer to the blade, rise no higher than the top of the blade, and attach to the arbor assembly so that they are raised and lowered with the blade.[4] Like splitters, riving knives physically prevent the two halves of the cut workpiece from moving back towards each other and pinching the spinning blade. However, unlike splitters, the riving knife can be left on for non-through cuts.

Anti-kickback pawls are another device designed to help reduce kickback. The pawls are mounted on both sides of the splitter and consist of a pair of spring-loaded pieces of metal with barbed teeth on the bottom edge that allow passage of the workpiece but will dig into it if it begins to move back toward the operator.

The riving knife and modular blade guard represent the latest progression in table saw safety design that have been incorporated into the voluntary standards for table saws. As discussed in section VI of the preamble, under *UL 987 Stationary and Fixed Electric Tools*, the voluntary standard effective dates for riving knives and modular blade guards were January 31, 2014, and January 31, 2010, respectively. However, the industry accelerated compliance with the voluntary standard, and the new guarding system with modular blade guards and riving knives became widely available on table saws in 2008. By 2012, table saw manufacturers introduced more than 900,000 table saws with riving knives and modular blade guards.

C. AIM Technology

An active injury mitigation (AIM) system uses technology to actively mitigate or prevent injury of a human body part resulting from contact with a rotating saw blade (*e.g.* by braking,

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

removing, and/or retracting the blade). Thus, any device that detects imminent or actual human contact with the table saw blade and then performs an action that mitigates the severity of the injury is considered to be an AIM system. An AIM system is *active* because it reacts to a blade contact in a way that minimizes the injury. A blade guard is a *passive* system because the guard does not react to a blade contact, but rather, provides a passive barrier between the blade and the user.

CPSC staff considers AIM to be a viable approach to address blade-contact injury in conjunction with existing passive safety strategies (blade guard and riving knife) to prevent blade contact on table saws. AIM systems can provide a layer of safety that can mitigate a blade-contact injury if the blade guard or riving knife are removed or fail to function properly. AIM systems can also protect against blade-contact injuries that can occur when a blade guard and riving knife are in place and functioning properly, but blade contact occurs nonetheless.

An AIM system performs two functions: (1) *detects* contact between the rotating table saw blade and a human body part, and (2) *reacts* to mitigate injury. In a research report issued in March 2015, UL researched developing performance requirements for table saw safety standards to help address finger injuries due to contact with the blade.[5] The report examined performance requirements that consisted of a defined relationship between approach velocity (speed of finger at a specified angle relative to saw blade) and depth of cut to the finger/hand. In addition, the report focused on the use of a surrogate finger. The report determined that, in addition to the proper trigger attributes, the surrogate finger must possess physical properties that allow it to be

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[5] Jiang, H., Tabaddor, M., and He, F. (2015). General Characteristics of a Surrogate Finger for Table Saw Safety Testing. *UL Research Report*. Available at: http://library.ul.com/wp-content/uploads/sites/40/2015/12/UL-Research-Report-on-Finger-Surrogate-Characteristics-for-Table-Saw-Testing-2015.pdf.

cut such that representative, repeatable and reliable measurements of the depth of cut can be recorded.

CPSC staff's review of UL's literature research indicates that detection can be achieved by: (1) sensing electrical properties of the human body/finger; (2) sensing thermal properties of the human body/finger; (3) visual sensing and tracking of the human body/finger; or (4) other methods. Current AIM technologies on the market rely on the first type of detection: electrical sensing of the human body. CPSC staff based its testing of the AIM system on existing technology.

Reaction systems must perform some type of action to limit the severity of injury upon human body/finger contact with the table saw blade. Removing either the spinning blade or the human body/finger from the point of contact is the most logical method to achieve this goal. Current AIM technologies on the market remove the spinning blade from the point of contact quickly enough, within milliseconds, to reduce significantly the severity of injury.

1. Electrical Detection of Human Body

Current AIM technologies available on table saws in the U.S. market rely on electrical detection of contact between a table saw operator and the rotating saw blade to activate the AIM system. One means of detecting body contact is with circuitry that generates a detection signal with defined electrical characteristics (see Figure 2). The signal can then be coupled onto the saw blade through various means, such as conductive, magnetic, or capacitive coupling devices. Additional circuitry continuously monitors the characteristics of the detection signal. The detection signal changes when a human body part comes into contact with the saw blade and the monitoring circuit senses the change in the signal. If the change is beyond a certain limit, the monitoring circuit then activates a reaction mechanism.

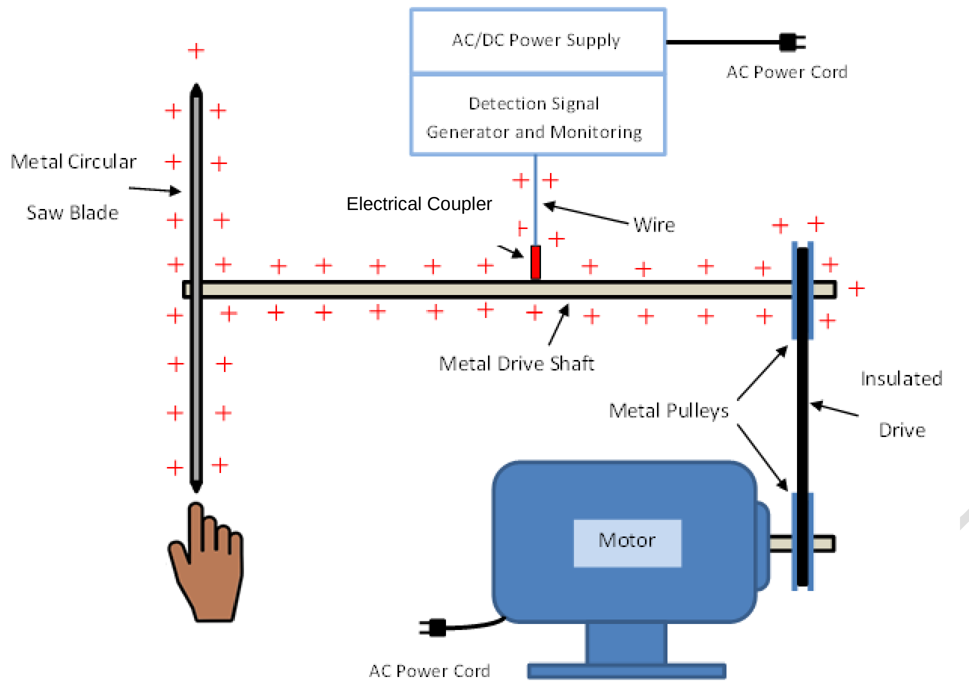

Figure 2. Example of electrical detection of human body

2. Current Products in the Market with AIM Technology

In 2004, SawStop released an industrial table saw featuring AIM technology based on electrical detection of the human body, and a mechanical brake reaction that stops the blade from spinning and moves the saw blade assembly beneath the table top surface. Typically, the reaction occurs in less than 5 milliseconds after contact is detected. Subsequently, SawStop introduced to the market a professional cabinet saw, a contractor saw, and a bench (jobsite) saw with the same AIM technology. The SawStop AIM technology works in three steps:

1. Monitor and Detect
    - The blade carries a small electrical signal.
    - When a person contacts the blade, the signal changes because the human body is conductive.
    - The change to the signal activates the safety system.

2. Brake Activation
    - An aluminum brake block is forced into the spinning blade by a spring released by an electric signal.
    - The blade's angular momentum drives the blade assembly beneath the table top, removing the risk of further contact.
    - Power to the motor is shut off.
3. The AIM system must then be reset by:
    - Shutting off the saw.
    - Removing the brake cartridge and embedded blade.
    - Installing a new blade (if necessary) and brake cartridge.

In 2016, Robert Bosch, LLC (Bosch) released a jobsite table saw featuring AIM technology based on electrical detection of the human body and a combustion-based mechanical reaction that forces the saw blade assembly beneath the table top surface. The Bosch REAXX™ with Active Response Technology™ system (Bosch REAXX™) also works in three steps:

1. Monitor and Detect
    - The blade carries a small low-voltage signal.
    - When a person contacts the blade, the signal changes because the human body is conductive.
    - The change to the signal activates the safety system.
2. Blade Retraction
    - A combustion reaction is triggered in a cylindrical cartridge, which fires a piston at a high rate of speed (this action is similar to the deployment of an air bag in an automobile).

- The piston pushes against a linkage to rapidly rotate the saw blade assembly below the table surface away from the operator.
- The blade assembly remains locked under the table after activation, while the blade coasts to a stop after power to the motor is cut off automatically.

3. The AIM system must then be reset by:
    - Shutting off the saw.
    - Inserting a fresh/new activation cartridge (two cartridges are paired together, so the unactivated side of the same dual-action cartridge may be used).
    - Unlocking the blade assembly and raising it back into place.

Neither the SawStop, nor Bosch AIM technologies, can be used when cutting conductive materials (that allow the flow of an electrical current) because both systems rely on electrical detection of the human body. A person touching the conductive material being cut would allow the detection signal to pass through the conductive material and into the person, activating the system as soon as the material touches the saw blade. For this reason, each product has a bypass mode to allow the user to cut conductive materials. In addition, cutting wet wood that is moist enough to conduct enough electricity to activate the AIM system can cause tripping of the safety system. Accordingly, the AIM system generally must be deactivated while cutting wet wood. The table saw automatically exits the bypass mode and resets to normal mode after the saw is turned off and the blade comes to a complete stop.

The Bosch REAXX™ has been the only non-SawStop model with AIM technology available in the United States. Both the SawStop bench model and the Bosch model with the AIM technology are at the upper end of the bench saw price range. The SawStop bench saw model (which was first marketed in 2015) retails for about $1,300 to $1,400 per unit. The Bosch

REAXX™ model has a retail price of $1,300 to 1,500. However, the future of the Bosch model is unclear. On July 16, 2015, SawStop filed a complaint against Bosch for patent infringement and requested that the U.S. International Trade Commission (ITC) order U.S. Customs to exclude the Bosch REAXX™ saws from entering the U.S. market.[6] On September 9, 2016, an administrative law judge (ALJ) made an initial determination that the Bosch model does infringe on several SawStop patents.[7] Subsequently, on November 10, 2016, the ITC decided not to review the ALJ's initial determination and requested that the interested parties provide written submissions on the issues related to remedies, the public interest, and bonding. The ITC has determined that the target date for completion of the investigation is January 27, 2017.[8]

IV. Incident Data

CPSC staff's incident data are based on data from the National Electronic Injury Surveillance System (NEISS). NEISS is a national stratified probability sample of approximately 100 U.S. hospitals having 24-hour emergency departments (EDs) and more than six beds. Coders in each hospital code data from the ED record for consumer product-related records, and then the data are transmitted electronically to the CPSC. Because NEISS is a probability sample, each case collected represents a number of injuries (the case's weight) in the total estimate of injuries in the United States. Different hospitals carry different weights.

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[6] *In the Matter of Certain Table Saws Incorporating Active Injury Mitigation Technology and Components Thereof*, Investigation No. 337-TA-965.

[7] Specially, infringement was found in U.S. Patent No. 7,895,927 ('927 Patent), titled, "Power Equipment with Detection and Reaction Systems"; and U.S. Patent No. 8,011,279 ('279 Patent) titled, "Power Equipment with Systems to Mitigate or Prevent Injury."

[8]On July 16, 2015, SawStop also filed a complaint against Robert Bosch Tool Corporation in the U.S. District Court for the District of Oregon (*Sawstop, LLC v. Bosch*, CV No. 3:15-cv-1320) (D. Or. filed on July 16, 2015). On September 28, 2015, the Oregon District Court stayed the proceeding in federal court pending final resolution of the ITC's investigation.

There are five strata in the NEISS: children's hospitals, small hospitals, medium hospitals, large hospitals, and very large hospitals. Within each stratum is a sample of hospitals that make up the primary sampling units of the NEISS. For each hospital in the sample, every first-time emergency department visit for an injury associated with a consumer product is recorded.[9] To facilitate injury estimates associated with a product or product group, each injury has a product code that identifies the type of product involved. Other product-specific information, such as the product manufacturer or events leading to the incident, is not recorded in the NEISS. However, information that is recorded for each injury includes sex, age, diagnosis, disposition, and body part. Additional information about the NEISS can be found online at: http://www.cpsc.gov/en/Research--Statistics/NEISS-Injury-Data.

For the injury estimates in the proposed rule, CPSC staff reviewed all the incident data abstracted from NEISS hospital records for injuries related to product code 0841 (table or bench saws) for 2015. CPSC staff compared the distributions of table saw injury characteristics against all other workshop product-related injuries and consumer product-related injuries for 2015. Staff performed an injury trend analysis, as well as a risk trend analysis for blade-contact injuries from 2004 to 2015. In addition, CPSC staff reviewed all of the incidents in the CPSC's Consumer Product Safety Risk Management System (CPSRMS) database between January 1, 2004 and December 31, 2015. Finally, in addition to reviewing incident data, to obtain additional information regarding consumer modular blade guard use, in 2015, CPSC conducted a survey of

[9] NEISS does not record return visits to the emergency department or other follow-up medical visits for the same injury.

consumers who own table saws with a modular blade guard system (modular blade guard survey).[10]

A. NEISS Data Methodology

The NEISS provides product information associated with each case, by recording up to two product codes associated with a case. CPSC staff's methodology and NEISS estimates are detailed in TAB B of the staff briefing package. Starting with all the NEISS cases associated with product code 0841 (this is, all injuries recorded in the NEISS as associated with a table or bench saw), CPSC staff reviewed and categorized the data, removing any cases that were not related to an operational table saw, and also classified whether the injury could have been due to blade contact. This analysis was completed on every case associated with the product code 0841, with date of treatments recorded as January 1, 2004 through December 31, 2015, resulting in a review of 9,300 NEISS cases.

For each of the 9,300 cases associated with the table saw product code (0841), with treatment years 2004 through 2015, the first level of review involved removing any cases where the injuries were not related to an operational table saw. Thus, cases not saying "table saw" were excluded (*e.g.*, cases that only use the word "saw" not "table saw," cases where the injury was related to a park bench, or cases where the saw was a homemade table saw). Cases indicating a "circular table saw" were removed. Cases where it was unclear that the injury was from a table saw were removed (*e.g.*, cases using wording like "table saw vs. chain saw," where it is not absolutely certain that the saw was a table saw). Cases were removed when a victim tripped over,

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[10] Sherehiy, B. and Nooraddini, I. (2016). Table Saw Blade Guard Survey. Available at: http://www.cpsc.gov/Global/Regulations-Laws-and-Standards/Voluntary-Standards/Voluntary-Standards-Reports/EurekaFactsTableSawBladeGuardSurveyReport(Final6bcleared)updatedcoverpage.pdf.

fell into, or ran into a table saw and the table saw was not operational. Cases were removed when the injury was related to the table saw being transported, such as the table saw being carried or lifted. Finally, cases were omitted that were related to using the product for an extended period of time (overuse injuries), such as sore knees, elbows, backs, and shoulders. There are cases where it is possible that although “table saw” was used to describe the type of saw, narratives also included descriptions such as “table saw which slipped,” which might indicate a circular saw, instead of a table saw; however, because “table saw” is used to identify the saw type, these are included in the table saw category.

Different types of injuries can occur when using a table saw, some of which do not include blade contact, such as injuries related to only kickback of the stock. Thus, the next level of review for each case was to determine whether the case involved blade contact or not. First, diagnoses of lacerations, fractures, amputations, and avulsions[11] that were for body parts below the elbow (not including the elbow), were all classified as blade contact, then staff reviewed the NEISS narratives to determine if any were described as not blade contact. Unless otherwise stated in the NEISS narrative, staff considered these combinations of diagnosis and body part to involve blade contact. CPSC staff reviewed the cases for the remaining combinations of diagnosis and body part for any that could be blade contact. Cases were included from this group only if the NEISS narrative indicated a hazard pattern of blade contact while using a table saw.

Given the limited amount of descriptive information related to the incidents available within the NEISS, staff believes that some cases could have been included that did not involve blade contact within the 0841 product code, leading to overestimates in blade-contact injuries.

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[11] Merriam Webster Dictionary defines “avulsion” as “a tearing away of a body part accidentally or surgically.” https://www.merriam-webster.com/dictionary/avulsion.

On the other hand, staff also believes that table saw blade contact cases may have been excluded within product codes 0845 (saws, not specified) and 0895 (power saws, other or not specified), leading to an underestimate of table saw blade-contact injuries. CPSC staff does not know to what extent either of these caveats affects the results. However, these caveats have been applied to CPSC staff's analysis for both the 2015 injury data and trend analysis results from 2004 through 2015.

B. Emergency Department-Treated, Table Saw Blade-Contact Injury Analysis Results for 2015

In 2015, there were an estimated 33,400 table saw, emergency department-treated injuries. Of these, CPSC staff estimates that 30,800 (92 percent) are likely related to the victim making contact with the saw blade. Of the 30,800 emergency department-treated, blade-contact injuries, an estimated 28,900 injuries (93.8 percent) involved the finger. The most common diagnoses in blade-contact injuries in 2015, are as follows:

- an estimated 18,100 laceration injuries (58.8 percent),
- an estimated 5,900 fractures (19.0 percent),
- an estimated 4,700 amputations (15.2 percent), and
- an estimated 2,000 avulsions (6.5 percent).

An estimated 3,800 (12.3 percent) of the blade-contact injury victims were hospitalized. Table 1 provides the emergency department-treated, blade-contact injury estimates for the NEISS variables for age (provided in age groups in the table), sex, body part injured, diagnosis, disposition, and locale. Males represent the majority of victims with blade-contact injuries (96.4 percent); and an estimated 45 percent of injuries occurred to victims over age 61.

Table 1. Victim and Injury Characteristics of Table Saw Blade-Contact Injuries, 2015.

		Injury Estimate			Percent of Total
	n	Estimate	CV†	95% Confidence Interval	Estimate
Total	**642**	**30,800**	**0.09**	**25,400—36,200**	**100%**
Age Group					
≤20	16	*	*	*	*
21-30	51	2,200	0.16	1,500—2,800	7.0
31-40	76	3,800	0.18	2,500—5,200	12.5
41-50	96	4,100	0.15	2,900—5,300	13.2
51-60	133	6,400	0.14	4,600—8,100	20.7
61-70	153	8,200	0.14	5,900—10,400	26.6
71-80	88	4,300	0.16	3,000—5,600	14.0
81+	29	1,300	0.20	800—1,800	4.1
Sex					
Male	622	29,700	0.09	24,400—34,900	96.4
Female	20	*	*	*	*
Body Part					
Finger	592	28,900	0.10	23,200—34,500	93.8
Hand	46	1,600	0.18	1,100—2,200	5.3
Other	4	*	*	*	*
Diagnosis					
Laceration	372	18,100	0.11	14,200—22,000	58.8
Fracture	112	5,900	0.17	3,900—7,800	19.0
Amputation	119	4,700	0.18	3,000—6,300	15.2
Avulsion	37	2,000	0.24	1,100—2,900	6.5
Other	2	*	*	*	*
Disposition					
Treated and Released	537	26,800	0.10	21,600—32,100	87.1
*Hospitalized***	98	3,800	0.20	2,300—5,300	12.3
Other	7	*	*	*	*
Locale Where Injury Occurred					
Home	416	20,600	0.11	16,200—25,100	67.0
Unknown	223	10,100	0.19	6,400—13,900	32.9
Other	3	*	*	*	*

Cells marked by "*" indicate an estimate that does not meet CPSC reporting limits.
**Hospitalization refers to the combination of two dispositions: treated and transferred, treated and admitted.
†Coefficient of variation (CV) is a measure of the dispersion of the data as a ratio of the standard deviation to the estimate. The higher the CV, the larger the dispersion; for estimates derived from the NEISS, a CV over 0.33 is high.

C. Table Saw Blade-Contact injuries Versus Other Product-Related Injuries for 2015

CPSC staff compared emergency department-treated injuries from table saw blade-contact against all other consumer product-related emergency department-treated injuries, to identify demographic groups and hazard patterns that are specific to table saw blade-contact, emergency department-treated injuries.

CPSC staff's review showed that table saw blade-contact injuries have a much larger proportion of injuries to fingers (compared to all other types of consumer products) and have significantly larger proportions of diagnoses for lacerations and amputations. An estimated 18.6 percent of all amputations in the NEISS are related to table saws. Table 2 compares emergency department-treated injuries from table saw blade contact identified in the 2015 NEISS to all other consumer product-related, emergency department-treated injuries in the same timeframe (January 1, 2015 through December 31, 2015).

Table 2. Comparison of Victim Characteristics for Table Saw Blade-Contact injuries Versus All Other Consumer Product-Related Injuries, 2015

	Domain							
	Table Saws				*All Consumer Products (excluding table saws)*			
	n	Estimate*	% of 30,800		n†	Estimate*	% of 14,098,700‡	Rao-Scott χ^2 p-value
Total	**642**	**30,800**	**100%**		**358,425**	**14,098,700**	**100%**	N/A
Age Group***								
≤20	16	*	*		168,496	5,513,200	39.1	<0.0001
21-30	51	2,200	7.0		40,098	1,709,000	12.1	
31-40	76	3,800	12.5		30,973	1,384,500	9.8	
41-50	96	4,100	13.2		27,878	1,257,700	8.9	
51-60	133	6,400	20.7		29,082	1,290,600	9.2	
61-70	153	8,200	26.6		22,123	1,039,900	7.4	
71-80	88	4,300	14.0		17,817	860,200	6.1	
81+	29	1,300	4.1		21,923	1,042,900	7.4	
Sex**								
Male	622	29,700	96.4		195,134	7,438,000	52.8	<0.0001
Female	20	*	*		163,291	6,660,800	47.2	
Locale								
Home	416	20,600	67.0		161,190	6,564,100	46.6	<0.0001
Unknown	223	10,100	32.9		98,418	3,820,100	27.1	
Other	3	*	*		98,817	3,714,600	26.3	
Body Part								
Finger	592	28,900	93.8		29,987	1,209,800	8.6	<0.0001
Hand	46	1,600	5.3		17,089	732,000	5.2	
Other	4	*	*		311,349	12,157,000	86.2	
Diagnosis								
Laceration	372	18,100	58.8		63,727	2,510,600	17.8	<0.0001
Fracture	112	5,900	19.0		54,210	2,037,500	14.5	
Amputation	119	4,700	15.2		584	20,400	0.1	
Other	39	2,200	7.0		239,904	9,530,200	67.6	
Disposition								
Treated and Released	537	26,800	87.1		323,369	12,768,300	90.6	0.0095
Hospitalized#	98	3,800	12.3		29,203	1,120,300	7.9	
Other	7	*	*		5,853	210,100	1.5	

*CVs for the table saws for reported estimates range from 0.09 to 0.24. CVs for estimates for the other products range from 0.07 to 0.25.
**Two observations are classified as "unknown sex" in the NEISS in the timeframe. These two observations were omitted to facilitate comparisons. This does not affect any conclusions or comparisons.
***To facilitate comparisons, 35 observations with unknown ages are not used in the age group analysis; thus, the statistics provided for age group do not necessarily sum exactly to totals. This does not affect any conclusions.
†This "n" is smaller than all of the NEISS, due to cases omitted from the product code 0841 (see Methodology section) as not related to a table saw or blade contact.
‡Percentages are calculated prior to rounding.
#Hospitalization refers to the combination of two dispositions: treated and transferred, treated and admitted.

CPSC staff's review showed differences in the injury distributions of age groups when comparing table saw blade-contact injuries to all other consumer product-related injuries. Older age groups represent larger proportions in table saw injuries than with all other products. Approximately 75 percent of the estimated table saw blade-contact injuries occur to people within the age range of 41 through 80. The proportion of all other consumer product-related injuries for the 41 through 80 age groups is approximately 30 percent. Almost all injuries involving table saw blade contact involve males; whereas, with all consumer products, there is only a slightly larger male proportion.

CPSC staff also compared table saw blade-contact injuries and all other woodworking workshop, product-related injury estimates to identify any demographic groups and hazard patterns that are specific to table saw blade-contact injuries within groups that are more likely to have been exposed to table saws. Table saws, in particular, table saw blade-contact injuries, represented a larger proportion of injuries to fingers than all other workshop products (which include tools such as radial arm saws, miter saws, circular saws, band saws, and routers, along with other power and manual woodworking tools). In addition, table saw blade-contact injuries have significantly larger proportions of diagnoses for lacerations, fractures, and amputations, than injuries associated with all other workshop products. CPSC staff's review showed that table saws account for an estimated 52.4 percent of all amputations related to workshop products.

Table 3 compares table saw blade-contact, emergency department-treated injuries from the 2015 NEISS to all other workshop product-related, emergency department-treated injuries in the same timeframe (January 1, 2015 through December 31, 2015).

Table 3. Comparison of Victim Characteristics for Table Saw Blade-Contact Injuries Versus All Other Workshop Product-Related Injuries, 2015

	Domain						
	Table Saws			*All Workshop Products (excluding table saws)*			
	n	Estimate*	% of 30,800†	n	Estimate*	% of 270,500†	Rao-Scott χ^2 p-value
Total	**642**	**30,800**	**100%**	**5,313**	**270,500**	**100%**	
Age Group							
≤20	16	*	*	702	29,500	10.9	<0.0001
21-30	51	2,200	7.0	943	46,300	17.1	
31-40	76	3,800	12.5	952	50,400	18.6	
41-50	96	4,100	13.2	979	50,400	18.6	
51-60	133	6,400	20.7	887	46,000	17.0	
61-70	153	8,200	26.6	536	30,000	11.1	
71-80	88	4,300	14.0	243	13,800	5.1	
81+	29	1,300	4.1	71	4,100	1.5	
Sex							
Male	622	29,700	96.4	4,582	234,600	86.7	<0.0001
Female	20	*	*	731	35,900	13.3	
Locale							
Home	416	20,600	67.0	2,976	158,900	58.8	0.0049
Unknown	223	10,100	32.9	2,152	103,300	38.2	
Other	3	*	*	185	8,300	3.1	
Body Part							
Finger	592	28,900	93.8	2,022	101,800	37.6	<0.0001
Hand	46	1,600	5.3	838	44,400	16.4	
Other	4	*	*	2,453	124,300	46.0	
Diagnosis							
Laceration	372	18,100	58.8	2,562	132,100	48.8	<0.0001
Fracture	112	5,900	19.0	378	18,600	6.9	
Amputation	119	4,700	15.2	108	4,200	1.6	
Other	39	2,200	7.0	2,265	115,600	42.8	
Disposition							
Treated and Released	537	26,800	87.1	5,027	258,400	95.5	<0.0001
Hospitalized‡	98	3,800	12.3	219	8,700	3.2	
Other	7	*	*	67	3,300	1.2	

*CVs for the table saws for reported estimates range from 0.09 to 0.24. CV's for estimates for the all other workshop products range from 0.08 to 0.20.
†Percentages are calculated prior to rounding.
‡Hospitalization refers to the combination of two dispositions: treated and transferred, treated and admitted.

When table saw blade-contact injuries were compared to all other workshop product-related injuries, CPSC staff identified differences in the distributions of age groups. Older age groups represented larger proportions of table saw blade-contact injuries than for other workshop products. Approximately 45 percent of the estimated table saw blade-contact injuries occurred to people within the age range of 61 through 80. In comparison, the proportion of all other workshop product-related injuries for the 61 through 80 age groups was approximately 18 percent. Accordingly, the mean age for table saw blade-contact injuries was 55.6 years, in comparison to 42.7 years for all other workshop product-related injuries. This approximate 13-year difference in the mean age of people sustaining injuries is a statistically significant difference (p-value < 0.0001), indicating that table saw blade-contact injuries involve older victims compared to injuries related to all other workshop products.

D. Trend Analysis for Table Saw Injuries

CPSC staff estimated the yearly injuries associated with table saw blade-contact injuries from 2004 to 2015, using estimates from NEISS. As mentioned in section III.B. of the preamble, *UL 987 Stationary and Fixed Electric Tools* includes provisions requiring a riving knife and modular blade guard. The voluntary standard effective dates for riving knives and modular blade guards was January 31, 2014, and January 31, 2010, respectively. The date range for the trend analysis includes a timespan before the voluntary standard required table saws to be equipped with a riving knife and modular blade guard (2004 to 2009) and a timespan after the voluntary standard requirements became effective on most table saws (2010 to 2015). Table saws manufactured before the current voluntary standard remain in use throughout this entire period. However, in more recent years, after the current voluntary standard became effective, an increasing proportion of table saws in use conform to the current voluntary standard. Thus, if the voluntary standard was having an impact on the number or severity of injuries, there would be a steady decrease in the number of injuries or severity of injuries as the proportion of table saws compliant with the new standard increased. However, CPSC staff's analysis shows that the addition of the riving knife and modular blade guard in the voluntary standard has not reduced the number or severity of blade-contact injuries.

CPSC staff performed trend analyses for blade-contact injuries, as well as blade contact amputations, hospitalizations, and finger/hand injuries. CPSC staff concludes that there is no discernible change in the number of blade-contact injuries or types of injuries related to table saw blade contact from 2004 to 2015. Furthermore, CPSC staff concludes that there is no discernible change in the number of blade-contact injuries or types of injuries related to table saw blade contact from the timespan before the voluntary standard was implemented (2004-2009) to the time span after the implementation of the voluntary standard requiring the riving knife and modular blade guard on all table saws (2010-2015). The estimated number of table saw blade-contact, emergency department-treated injuries from 2004 through 2015 is in Table 4.

Table 4. NEISS Estimates for Table Saw Blade-Contact Injuries, 2004-2015.

	Table Saw Blade-Contact Injury Estimates			
Year	**N**	**Estimate**	**CV**	**95% Confidence Interval**
2015	642	30,800	0.09	25,100—36,500
2014	631	30,300	0.08	25,300—35,300
2013	662	29,500	0.09	24,500—34,500
2012	648	29,500	0.09	24,100—34,900
2011	632	29,600	0.09	24,300—35,000
2010	657	30,100	0.10	24,000—36,200
2009	714	33,000	0.10	26,500—39,500
2008	723	34,600	0.09	28,700—40,500
2007	694	31,100	0.09	25,400—36,700
2006	766	34,200	0.09	27,900—40,400
2005	812	34,500	0.09	28,300—40,700
2004	773	36,300	0.09	29,600—43,100

To assess any changes across time in the severity of table saw blade-contact injuries, CPSC staff performed trend analyses for blade-contact amputations, hospitalizations (includes two dispositions: treated with admission and treated with transfer), and finger/hand injuries. No trend was detected in any of these analyses (p-values=0.44, 0.53, and 0.17 for amputations, hospitalizations, and finger/hand injuries, respectively). Table 5 provides the estimated number of blade-contact injuries from 2004 through 2015, for amputations, hospitalizations, and finger/hand injuries from blade contact, with the percentage of each to the total number of estimated blade-contact injuries (Table 4).

Table 5: NEISS Injury Estimates for Table Saw Blade-Contact Amputations, Hospitalizations, and Finger/Hand Injuries, 2004-2015

	Amputations		**Hospitalizations**		**Finger/Hand Injuries**	
Year	*Estimate (95% CI)*	*% of Blade-contact injuries*	*Estimate (95% CI)*	*% of Blade-contact injuries*	*Estimate (95% CI)*	*% of Blade-contact injuries*
2015	4,700 (3,100—6,300)	15.2%	3,800 (2,300—5,300)	12.3%	30,500 (24,900—36,100)	99.1%
2014	4,000 (2,400—5,500)	13.1%	3,100 (1,700—4,400)	10.1%	29,400 (24,600—34,300)	97.2%
2013	3,400 (2,300—4,600)	11.7%	3,000 (1,800—4,200)	10.2%	29,200 (24,300—34,200)	99.2%
2012	4,100 (2,700—5,600)	13.9%	2,900 (1,300—4,400)	9.8%	29,100 (23,700—34,400)	98.7%
2011	3,900 (2,700—5,100)	13.2%	2,900 (1,900—3,900)	9.9%	29,400 (24,200—34,700)	99.3%
2010	3,500 (2,500—4,500)	11.6%	2,800 (2,000—3,600)	9.2%	29,800 (23,700—36,000)	99.2%
2009	4,100 (3,000—5,200)	12.5%	3,000 (2,000—3,900)	9.0%	32,500 (26,100—38,900)	98.5%
2008	3,700 (2,700—4,600)	10.6%	2,600 (1,700—3,400)	7.4%	34,200 (28,300—40,100)	98.7%
2007	3,900 (2,600—5,200)	12.6%	3,000 (1,800—4,100)	9.5%	30,700 (25,100—36,200)	98.7%
2006	4,300 (3,100—5,500)	12.5%	2,700 (1,600—3,800)	7.9%	33,700 (27,500—39,900)	98.7%
2005	4,600 (3,100—6,200)	13.5%	2,800 (2,000—3,600)	8.2%	34,100 (28,000—40,200)	98.9%
2004	5,100 (3,600—6,700)	14.1%	2,900 (1,900—3,900)	8.0%	36,000 (29,300—42,800)	99.2%

CPSC staff also conducted a trend analysis to include the rate of injury (that is, the rate of injury, measured by the numerator as the estimated number of injuries and the denominator as the exposure estimate). Based on the information available, CPSC staff analyzed the risk of blade-contact injury using the estimated number of table saws in use for each year from 2004 to 2015. Table 6 provides the risk of blade-contact injury per 10,000 table saws in use for each year in the analysis. The estimated numbers of table saws in use yearly is provided in TAB C of the staff briefing package.

Table 6: Estimated Table Saw Blade-Contact Injuries per 10,000 Table Saws in Use, 2004-2015

	Table Saw Blade-Contact Injury Estimates		Estimated Number of Table Saws in Use (in 10,000s)*	Estimates** of Table Saw Blade-Contact Injury per 10,000 Table Saws in Use	
Year	Blade-Contact Injury Estimate	95% Confidence Interval	Table Saws in Use Estimate[12]	Estimate[13]	95% Confidence Interval
2015	30,800	25,100—36,500	813.8	37.8	30.9—44.8
2014	30,300	25,300—35,300	818.6	37.0	30.8—43.2
2013	29,500	24,500—34,500	824.0	35.8	29.8—41.8
2012	29,500	24,100—34,900	832.5	35.4	28.9—41.9
2011	29,600	24,300—35,000	838.9	35.3	29.0—41.7
2010	30,100	24,000—36,200	847.7	35.5	28.3—42.7
2009	33,000	26,500—39,500	873.1	37.8	30.3—45.3
2008	34,600	28,700—40,500	881.5	39.3	32.6—45.9
2007	31,100	25,400—36,700	882.5	35.2	28.8—41.5
2006	34,200	27,900—40,400	865.0	39.5	32.2—46.7
2005	34,500	28,300—40,700	846.3	40.8	33.5—48.0
2004	36,300	29,600—43,100	829.4	43.8	35.7—51.9

*CPSC's Directorate for Economics provided the estimated numbers of table saws in use for this analysis.
**Estimates are calculated from the exact number of injuries point estimate, not the rounded estimate.

[12] No estimates of variance or covariance associated with the number of table saws in use were calculated. CPSC staff determined that the ability to detect trend is increased by omission of the variance-covariance associated with the denominator variable (thus, creating a more conservative approach). Variance for will increase if using both numerator and denominator variance and covariance structures; this makes it harder to detect trend mathematically. However, CPSC staff determined that there is minimal impact on the analyses performed, and conclusions are unlikely to change if another method was chosen.

[13] CVs for estimates are equivalent to the CVs for injury estimates, due to no variance estimates being used for the denominator estimates.

CPSC staff's analysis shows that there was no discernible change in the risk of injury associated with blade contact related to table saws from 2004 to 2015. Furthermore, staff concludes that there is no discernible change in the risk of injury associated with blade contact related to table saws from the timespan before the voluntary standard was implemented (2004-2009) to the time span after the voluntary standard's implementation (2010-2015), which required the riving knife and modular blade guard on all table saws.

E. Other Table Saw-Related Injuries

Table saw-related incidents are not commonly reported to CPSC through means other than the NEISS. However, the CPSC received a small number of reports of table saw-related injuries through other means, such as news articles, consumer-submitted reports, attorney-submitted reports, and manufacturer and retailer reports. Reported incidents through means other than the NEISS are entered into the CPSC's CPSRMS database. The CPSRMS database is not a representative sample of all blade-contact injuries, and only injury estimates from the NEISS are used for nationally representative estimates of table saw and/or blade-contact injuries. These are anecdotal reports of blade-contact injuries, and the reports are not intended to be used to understand trends or the magnitude of the number of blade-contact injuries.

CPSC staff reviewed this data to understand the scenarios and the injuries associated with table saw blade-contact injuries, information not typically captured within a NEISS report. CPSC staff reviewed all reports in the CPSRMS associated with the product code 0841 (table saws) with incident dates from January 1, 2004 through December 31, 2015. The incident dates chosen match the trend analysis performed on the NEISS for table saws.

CPSC staff identified 53 incidents in the CPSRMS database that involved blade-contact injury on table saws that occurred between January 1, 2004 and December 31, 2015, and the injuries were reported to CPSC by March 1, 2016. The data collection is ongoing for the years 2013, 2014, and 2015, and it is possible for CPSC staff to receive additional reports of blade-contact injuries that occurred during this timeframe. Of the 53 reported blade-contact injuries, 26 were attributable to bench saws, 22 to contractor saws, 2 to cabinet saws, and 3 were unknown.

CPSC staff reviewed whether there were any incidents with unexpected workpiece movement, such as kickback of the workpiece. Table 7 summarizes incidents by unexpected workpiece movement. For the majority of incidents, it is unknown whether unexpected workpiece movement was involved in the blade contact, thus making conclusions difficult. However, of the incidents where information about the contribution of workpiece movement was known, most blade-contact injuries involved some type of unexpected workpiece movement.

Table 7. Unexpected Stock Movement for Reported Table Saw Blade-Contact Injuries, 2004-2015

Unexpected Workpiece Movement	Frequency	Percent
Yes	20	37.7
No	4	7.5
N/A[14]	1	1.9
Unknown	28	52.8
Total	**53**	**100.0***

* Due to rounding errors, totals may not exactly equal 100.

CPSC staff also reviewed all 53 reported incidents to assess the type of blade guard that came with the saw, as well as information on whether the blade guard was in use at the time of

[14] Stock movement is "N/A" in one incident, where the victim was not performing a cut at the time of blade contact. Reportedly, the victim started the saw accidentally, and a nearby object pulled the victim's hand into the blade.

the incident. Table 8 provides the frequency of the type of blade guard, by the use of the blade guard.

Table 8. Type of Blade Guard by Blade Guard Use for Reported Table Saw Blade-Contact Injuries, 2004-2015

Frequency (Row Percent)	Blade Guard in Use				
Type of Blade Guard	*Yes*	*No*	*Unknown*	*N/A*[15]	**Total**
Modular	1 9.1%	1 9.1%	9 81.8%	0 0.0%	**11**
Traditional	7 19.4%	7 19.4%	19 52.8%	3 8.3%	**36**
Other/Unknown[16]	1 16.7%	2 33.3%	3 50.0%	0 0.0%	**6**
Total	**9**	**10**	**31**	**3**	**53**

CPSC staff noted that although there are large proportions of unknowns for the blade guard use, making conclusions difficult, out of the 53 reported blade-contact injuries, 36 are associated with a traditional blade guard. Of those 36, seven were reported to be using the blade guard at the time of injury, seven were reported to not be using the blade guard, 19 had an unknown guard use status, and three were not able to use the blade guard. Of the 53 reported blade-contact injuries, 11 are associated with a modular blade guard as part of the original equipment on the table saw. Of those 11, one was reported to be using the blade guard at the time of injury, one was reported to not be using the blade guard, and nine have unknown guard use status. Table 9 shows the frequency of the scenarios for the type of blade guard by injury type.

[15] Blade guard use is recorded as "N/A" in three incidents, when blade guard use was either impossible (Dado cut, molding attachment on a saw from the 1950s), or the victim started the saw accidentally, and his hand was pulled into the blade by a nearby object.
[16] For the six incidents in the blade guard type of "Other/Unknown," one incident is in the "other" category, where the blade guard description did not fully meet the traditional description, but the saw was manufactured in the time span of traditional blade guards; the remaining five incidents in this category were classified as "unknown" blade guard type, due to the limited information provided.

Table 9. Injury Description for Reported Table Saw Blade-Contact Injuries, 2004-2015

Injury	Type of Blade Guard*			
	Modular	*Traditional*	*Other/Unknown/NA*	**Total**
Amputation	4	21	4	**29**
Amputation and Laceration	0	3	1	**4**
Fatal Laceration	0	1	0	**1**
Laceration	2	4	1	**7**
Laceration and Fracture	1	0	0	**1**
No Details Provided	4	7	0	**11**
Total	**11**	**36**	**6**	**53**

*Table 8 shows that it is often unknown whether a blade guard was in use at the time of the incident. This table does not break down the type of injury and type of guard according to whether the blade guard was in use or not.

Although for many of these injuries it is unknown whether the blade guard was in use at the time of the injury, CPSC staff's review of the reports indicates that the incident scenarios for table saws with modular blade guards are similar to the incidents for table saws with traditional blade guards, in terms of incidents (amputations and lacerations) occurring with and without the use of blade guards, and incidents occurring with and without unexpected stock movement from kickback of the material.

F. Modular Blade Guard Survey

To obtain additional information regarding modular blade guard use, in 2015, CPSC contracted EurekaFacts, LLC (EurekaFacts) to conduct a survey of consumers who own table saws with a modular blade guard system.[17] The survey instrument was designed to identify the potential reasons that may affect how a consumer uses the blade guard. EurekaFacts completed

[17] Sherehiy, B. and Nooraddini, I. (2016), *supra* note 10.

200 surveys of respondents who owned a table saw manufactured after 2009, or later, that included a modular blade guard. The survey was based on a convenience sample of participants recruited by various advertisement strategies; therefore, no results from the survey are generalized to the population.

Results of the survey indicate that, of the 200 respondents, a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed, and a majority of respondents did not use the blade guard “sometimes” (28%), “often” (17%) or “always” (14%). The results of the survey demonstrate that for woodworkers who participated in the survey, removal of the blade guard, traditional or modular, is a necessary and proper action when making certain cuts on table saws. In addition, many respondents in the survey stated that they chose not to use the modular blade guard at all or only some of the time. CPSC staff believes that any situation in which the blade guard is not used eliminates the effectiveness of the blade guard in preventing blade-contact injuries. Accordingly, use of the blade guard cannot be relied upon to prevent injury.

G. Summary of Incident Data

Based on CPSC staff’s review of the existing data, the Commission does not believe that currently available safety devices, such as the modular blade guard and riving knife, will adequately address the unreasonable risk of blade-contact injuries on table saws. In 2015, there were an estimated 33,400 table saw, emergency department-treated injuries. Of these, staff estimates that 30,800 (92 percent) are likely related to the victim making contact with the saw blade. Of the 30,800 emergency department-treated blade-contact injuries in 2015, an estimated 28,900 injuries (93.8 percent) involved the finger. The most common diagnoses in blade-contact injuries are: an estimated 18,100 laceration injuries (58.8 percent); an estimated 5,900 fractures

(19.0 percent); an estimated 4,700 amputations (15.2 percent); and an estimated 2,000 avulsions (6.5 percent). An estimated 3,800 (12.3 percent) of the blade-contact injury victims in 2015 were hospitalized.

Thousands of amputations occur each year on table saws; an estimated 4,700 amputation injuries occurred in 2015, alone. Compared to all other types of consumer products, table saw-related amputations are estimated to account for 18.6 percent of all amputations in the NEISS in 2015. When compared to all other workshop products, table saws accounted for an estimated 52.4 percent of all amputations related to workshop products in 2015. The estimated mean age for table saw blade-contact injuries is 55.6; whereas, all other workshop product-related injuries have an estimated mean age of 42.7. This approximate 13-year difference in the mean age of injuries is a statistically significant difference (p-value < 0.0001), indicating that table saw blade-contact injuries involve older victims in comparison to injuries related to all other workshop products.

CPSC staff also reviewed table saw-related reported incidents in the CPSRMS database. Staff identified 53 incidents in the CPSRMS database that involve blade-contact injury on a table saw that occurred between January 1, 2004 and December 31, 2015, and were reported to CPSC by March 1, 2016. Of the 53 reported incidents related to table saw blade contact, 36 incidents involved table saws that came equipped with a traditional blade guard, and 11 incidents involved table saws that came equipped with a modular blade guard. Laceration and amputation injuries occurred on table saws equipped with traditional guards and on table saws equipped with modular blade guards. In addition, CPSC staff's review of the reports indicates that the incident scenarios for table saws with modular blade guards are similar to table saws with traditional blade guards in terms of incidents occurring with and without the use of blade guards and incidents occurring with and without unexpected workpiece movement from kickback of the material.

Finally, CPSC staff' review of the modular blade guard survey shows that, for woodworkers who responded to the survey, removal of the blade guard, traditional or modular, is a necessary and proper action when making certain cuts on table saws. In addition, many woodworkers selected in the survey chose not to use the modular blade guard at all or only some of the time.

Based on CPSC staff's review of the incident data, the Commission believes that operator finger/hand contact with the table saw blade is a dominant hazard pattern that presents an unreasonable risk of injury that can be addressed by a performance requirement to reduce the frequency and severity of blade-contact injuries on table saws. The proposed performance requirement is discussed in section VII of the preamble.

H. Special Studies

As discussed in the ANPR, in 2001, CPSC performed a NEISS special study for stationary power saw-related injuries.[18] The purpose of the survey was to collect more specific and accurate information about the type of table saw involved and also to collect more in-depth information about the hazard pattern and contributing factors to the injuries. The results were published in a memorandum, "Injuries Associated with Stationary Power Saws, 2001."[19] In 2007, CPSC staff conducted, through a contractor, another stationary power saw special study, running through 2008. The report, "Survey of Injuries Involving Stationary Saws: Table and Bench Saws, 2007-2008," presented estimates of the numbers and types of emergency department-treated injuries

[18] 76 FR 62680-81.
[19] https://www.cpsc.gov/s3fs-public/pdfs/powersaw.pdf.

related to table saws in this 2-year study, which was published in March 2011.[20] In October 2011, the ANPR used the 2007-2008 special study estimates as the analytical support for the discussion of table saw-related injuries.[21]

However, the public comments submitted to the CPSC in response to the ANPR called attention to a contradiction between the estimated numbers for each type of table saw and the estimated injuries of direct-drive and indirect-drive table saws in the 2007-2008 special study.[22] As a result of these comments, CPSC staff reanalyzed the saw-type and drive-type responses provided by the injury victims in the 2007-2008 special study. CPSC published the results of the reanalysis in June 2014.[23] CPSC staff found that the estimated number of injuries based on the type of saw were inconsistent with the estimated injuries associated with respondent-declared drive type, which indicated that bench saws may be associated with a much larger proportion of the estimated injuries than initially reported.

To address the inconsistencies about the distribution of type of table saw in table saw-related injuries in the 2007-2008 special study, CPSC staff conducted a second special study on table saws in 2014-2015. This study, performed by contractors, collected computer-aided telephone interview (CATI) responses from 275 individuals treated for injuries related to stationary saws (this category includes table saws) and to unidentified types of saws in emergency departments of NEISS member hospitals between July 2014 and December 2015. For

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[20] http://www.cpsc.gov//PageFiles/118311/statsaws.pdf.
[21] 76 FR 62681.
[22] Staff's economic analysis in the ANPR briefing package first noted that there was an apparent inconsistency between some study participants' responses to the type of saw used and their responses about the type of drive system used in the saw.
[23] http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Home%20Maintenance%20and%20Construction/CoverpageandMemoofStaffAnalysisofTableSawTypeinNEISSSpecialStudy.pdf.

injuries determined to be table saw-related, interviewers read definitions to the participants regarding each table saw type, and interviewers asked additional questions when the participant identified a saw and drive type that were not compatible.

As explained in TAB F of the staff briefing package, after the contractors completed the 2014-2015 special study, CPSC staff identified patterns in participant response data across the 275 completed survey responses that indicated that the interviewer may have affected the participants' responses, a phenomenon known as "interviewer effect." Ninety-four percent (259) of the completed surveys were conducted by two interviewers from one company. Statistically significant differences between responses collected by the two interviewers existed for critical questions, such as the type of table saw involved in the injury, use of safety features, and activities preceding the injury. Because the integrity of the responses was indeterminable, CPSC staff did not use the 2014-2015 special study results as a basis for the proposed rule.

In addition, contractor interviewer information from the 2007 to 2008 special study was not available, so CPSC staff was unable to prove or disprove whether interviewer effect impacted that study's responses. Accordingly, CPSC staff did not use the data from either of the prior special studies to inform recommendations in the proposed rule for a performance requirement to address table saw blade-contact injuries.

V. Risk of Injury

A. Description of Hazard

CPSC staff reviewed analyses of finger injuries on table saws conducted by researchers at the University of Michigan in a study titled, "*Table Saw Injuries: epidemiology and a* *proposal for preventive measures*," which was commissioned by UL. [24] UL extracted sections from that study, with some modifications, for its report, "*Table Saw Hazard Study on Finger Injuries Due to Blade Contact.*"[25]

The UL report indicated that lacerations to the finger or hand of varying severity are the most common injury associated with table saw operator blade contact. The severity of injury ranges from minor cuts to severe cuts and injuries resulting in amputation. Finger lacerations can be classified into two categories by the extent of damage to the structures of the finger:

1) simple lacerations involving damage only from the skin surface to a depth of approximately 2 mm to 4 mm, and

2) complex lacerations involving cuts deeper than 4 mm that cause damage to tendons, nerves, and blood vessels.

Simple lacerations can be managed at emergency departments with little expertise or by simple at-home care because these cuts generally heal without complications. Conversely, complex lacerations may require skilled microsurgery to repair damaged tendons, nerves, and vessels, and such care often requires hospital stays, transfer to a hospital with the required expertise, and extensive occupational therapy.

According to the UL report, magnetic resonance imaging (MRI) scans show that critical tissues are deepest at the proximal phalanx of the long finger (base of the middle finger) and most shallow at the distal phalanx of the little finger. The neurovascular bundle, which contains the nerves and arteries, is the structure closest to the skin's surface. The mean distance from the

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[24] Chung, K. and Shauver, M. 2014. Table saw injuries: epidemiology and a proposal for preventive measures. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4154236/.

[25] Table Saw Hazard Study on Finger Injuries Due to Blade Contact, *UL Research Report*, Jan. 2014. Available at: http://library.ul.com/wp-content/uploads/sites/40/2015/02/UL_WhitePapers_Tablesaw_V11.pdf.

surface of the skin to the neurovascular bundle on the tip of the little finger is 4.3 mm.[26] Therefore, UL determined that, based on measurements from the study, a depth of 4 mm is the maximum depth of cut to a finger before serious injury is sustained.[27]

B. Analysis of Operator Behavior in Blade-contact injuries

CPSC staff reviewed operator behavior in blade-contact injuries (TAB E of the staff briefing package). The most basic and common cutting operations performed on a table saw are ripping, which involves narrowing the width of a piece of wood or other "workpiece" by sawing along its length, and crosscutting, which involves shortening the length of a workpiece by sawing across its width. Anecdotally, ripping appears to be the more common of these two operations in the context of table saw use.

1. *Ripping Scenarios*

Blade contact may be more likely to occur while the consumer is ripping a workpiece, rather than crosscutting, because consumers often use just their hands to feed the workpiece into the blade while ripping, except when ripping narrow workpieces. Additionally, ripping has greater potential to result in kickback, compared to crosscutting. "Kickback" can be defined as the binding of a workpiece in the blade and the consequent thrusting of that workpiece back toward the consumer. Ripping involves the cut workpiece passing between the spinning blade and a rip fence, which forms a fixed boundary that constrains the movement of the workpiece. Thus, any lateral movements or rotation of the workpiece (or misalignment of the fence) may cause the workpiece to bind and be thrown or propelled at the consumer. The sudden movement

[26] Staff's analysis of cadaverous tissue data indicates that the measurements presented in UL's research report are relative to the volar (palmar) surface of the skin.
[27] *UL Research Report*, *supra* note 25 at 18.

of the workpiece from kickback can cause the consumer to lose control of the workpiece and lead to blade contact in a number of ways. For example:

- The consumer's hand or push stick can slip off the workpiece, causing the hand to move into the blade.
- The workpiece can strike the consumer's arm or hand, sending the hand into the blade.
- The consumer can reflexively reach for the workpiece to regain control and inadvertently move the hand into the blade.
- The consumer's hand, if positioned behind the blade to hold, support, or remove the workpiece or cutoff, can be "pulled" into the blade with the workpiece.

Many of the scenarios may be possible even when a blade guard is in use, because blade guard systems generally are designed to allow free passage of the workpiece into the blade from the front; therefore, other objects, such as hands and fingers also can move into the blade from this direction. Thus, although blade guard systems can reduce the likelihood of blade contact from certain angles and certain approaches, the potential for contact remains. In addition, hand or finger contact with the blade can occur even without kickback. Possible blade contact scenarios during ripping, unrelated to kickback, include the following:

- The consumer's hand gets too close to the blade while feeding the workpiece, particularly small workpieces, and the fingers contact the blade. In some cases, the consumer may be wearing gloves for protection, or because of cool temperatures, and the blade catches the glove and pulls the hand into the blade.[28]

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[28] For example, IDI nos. 121018CNE1304.

- The consumer reaches near or past the blade to regain control of a workpiece that is slipping, lifting up, falling off the table, or otherwise moving in an unexpected way, and the hand contacts the blade.[29]
- The consumer reaches for a cutoff or brushes debris from the table while the blade is still spinning and the hand contacts the blade. Saw blades can continue spinning for some time after a table saw has been switched off. Accordingly, some consumers might contact the blade after having already switched off the table saw but before the blade has come to a complete stop. Furthermore, consumers who are aware of the potential for kickback might be motivated to remove a cutoff immediately to prevent a cut piece from kicking back or being thrown in some other way.
- The consumer gets distracted and turns or looks away, causing his or her hand to move into the blade. Such a distraction may not be merely daydreaming, but can include cases in which someone enters the room and the operator diverts their attention to make sure the other person is not placing themselves in a hazardous situation. This may be especially likely if the other person is someone for whom the consumer is responsible, such as a child.
- The consumer slips, stumbles, or otherwise loses balance and inadvertently moves a hand into the blade, possibly as a natural motor response to regain balance. Similarly, if a consumer is startled by something or someone, the consumer may move reflexively or jerk a hand toward the blade.

[29] For example, IDI nos. 080415CCC2550 and 141120CNE0001. Note that in IDI no. 141120CNE0001, a blade guard was in use.

- The consumer's hand or push stick slips off the workpiece, causing the hand to move into the blade. This scenario is similar to the one cited earlier in the context of kickback, but it is not necessarily preceded by a sudden movement of the workpiece.

Many of these scenarios may be more likely to occur if the consumer is tired, or if the view of the blade or cut is impaired somehow. Working with a table saw for long periods likely would contribute to fatigue, which in turn, can degrade a consumer's decision-making abilities, judgment, reaction time, and vigilance.[30] Even devices and equipment that are intended to protect consumers may adversely affect consumers' ability to monitor a cutting operation with a table saw, and potentially increase the risk of injury. Blade guard systems might contribute to difficulties in seeing where a cut is being made, and consumers sometimes report this as a reason for removing blade guard systems. Staff also notes that consumers typically are instructed to wear eye protection when operating a table saw.[31] Although proper eye gear can provide important protection from projectiles striking the eye, the eye protection may affect one's ability to see a cut clearly, particularly if the eyewear is scratched or partially covered in debris, such as sawdust.

2. *Crosscutting Scenarios*

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[30] See Sharit, J. (2006). Human Error. In G. Salvendy (Ed.), *Handbook of Human Factors and Ergonomics*, 3rd ed. at 708–760. Hoboken, NJ: Wiley. Staff also notes that, when ripping, consumers must make sure the workpiece maintains contact with the rip fence for the entire cut. Thus, a consumer's attention is likely to be where the workpiece meets the fence, rather than the blade, for at least part of the cut. This necessarily means that adequate attention cannot be given to the position of the hands relative to the blade. If attention is focused, instead, on the fingers relative to the blade, the workpiece may move off the rip fence and lead to kickback, which also can cause the fingers to contact the blade.

31 For example, general safety instructions for all power tools, published by the Power Tool Institute (PTI), states that one should "[a]lways wear eye protection," and the section of the document that is specific to table saws states, in part: "Always wear safety goggles or safety glasses with side shields." *See*, http://www.powertoolinstitute.com/pti-includes/pdfs/Tool-Specific-Files/Table-Saws.pdf.

Blade contact scenarios involving crosscutting are likely similar to those involving ripping because many of the same potential issues can arise, such as the consumer feeding the workpiece with their hand too close to the blade, reaching past the blade for a cutoff, or becoming distracted. Although the potential for kickback seems less likely for crosscutting than for ripping, kickback still occurs, and the consequent loss of workpiece control can result in the hand contacting the blade. In addition, during a crosscut, the workpiece may become “jammed” in the blade guard or anti-kickback device. This may be more likely if the workpiece shifts position or rotates from against the miter gauge. In such a scenario, the consumer may reach toward the blade to adjust the workpiece position or attempt to move the offending portion of the guard system, and inadvertently contact the blade with the fingers.

3. *Adult Aging Issues.* As discussed in section IV of the preamble and TAB B of the staff briefing package, approximately 45 percent of all estimated table saw-related, emergency department-treated injuries that likely related to the victim making contact with the blade involved consumers older than 60 years of age. Although CPSC staff does not know if older consumers have greater exposure to these products, adult aging is associated with declines in many perceptual, cognitive, and physical abilities, as discussed in TAB E of the staff briefing package. Some of these age-related deficits likely contribute to blade contact incidents with table saws.

CPSC staff identified differences in the distribution of age groups when comparing table saw blade-contact injuries to all other workshop product-related injuries. Staff analysis of injuries in 2015 indicates that the mean age for table saw blade-contact injuries is 55.6 years, compared to 42.7 years for all other workshop product-related injuries. This approximately 13-year difference in the mean age of victims of table saw blade-contact injuries is a statistically significant difference and indicates that table saw blade-contact injuries involve older victims compared to victims of injuries from all other workshop products.

VI. Relevant Existing Standards

A. Voluntary Standards

1. *History*

In 1971, Underwriters Laboratories Inc. (UL) published the first edition of UL 987, *Stationary and Fixed Electric Tools*. UL 987 included requirements for table saws that specified the following safety devices: a single-piece blade guard, a spreader, and anti-kickback pawls. In 2005, UL published the sixth edition of UL 987, which added riving knives to the general requirements for table saws. The effective date for the riving knife requirements for products already listed with UL was January 2014. In 2007, UL published the seventh edition of UL 987, which expanded the table saw guarding requirements to include a new modular blade guard design developed by a joint venture of the leading table saw manufacturers. The effective date for the modular blade guard requirements was January 2010. The revised standard specified that the blade guard shall not consist of a hood, but comprise 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, offering easier methods to remove and install the guard, and incorporating a permanent riving knife design. In 2011, UL published the eighth edition of UL 987, which clarified requirements for table saws. The eighth edition remains the current edition of UL 987.

In February 2016, UL balloted a proposal to adopt the first edition of International Electrotechnical Commission (IEC) 62841-3-1, *Standard for Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery – Safety – Part 3-1:*

Particular Requirements for Transportable Table Saws as the first edition of UL 62841-3-1. This effort is part of UL's international harmonization goal to adopt international standards, such as one published by the IEC (International Electrotechnical Commission) or ISO (International Organization for Standardization), into one UL standard that is based on the IEC/ISO standard, with appropriate national differences.[32] The proposal passed, and in August 2016, UL published the first edition of UL 62841-3-1, *Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery Part 3-1: Particular Requirements for Transportable Table Saws*. UL 62841-3-1 is recognized as an American National Standards Institute (ANSI) standard and includes requirements for a modular blade guard, riving knife, and anti-kickback pawls. The effective date for UL 62841-3-1 is August 29, 2019. Until that date, UL 987 remains in effect, and table saw manufacturers can list their products to UL 987 or UL 62841-3-1.

Currently, UL 987 (Section 43.2.2) and UL 62841-3-1 (Section 19.101) specify that table saws shall be provided with a modular blade guard. UL 987 (Section 43.2.3) and UL 62841-3-1 (Section 19.103) specify that table saws shall be equipped with a riving knife. Both voluntary standards include: (1) similar performance requirements to ensure that the modular blade guard prevents incidental contact from the top and from both sides of the saw blade; and (2) similar specifications for the location and rigidity of the riving knife.

2. Recent Developments

In June 2011, UL announced its intention to create a standard that addresses the performance characteristics needed to reduce blade-contact injuries associated with table saws, and UL invited CPSC staff to participate in developing blade-to-skin performance requirements

[32] *See* http://ulstandards.ul.com/about/harmonizing-standards/.

for UL 987. UL formed a working group that met regularly during 2011 to 2015 to develop performance requirements for table saws to address flesh-to-blade-contact injuries. The UL working group developed the term "active injury mitigation" (AIM) to describe any type of safety system that detects an imminent or actual human contact with the table saw blade and then performs an action that mitigates the severity of the injury.

In January 2014, UL published a report titled, *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*.[33] The report provides an in-depth study with hazard analyses, injury classification, and approach speed experiments. The intent of the research was to understand the circumstances that lead to hand/finger contact injuries for table saw operators and to help identify critical parameters to define the hazard level. The report identified the quantitative threshold between a simple and complex laceration of a finger at about 4 mm from the surface of the skin.

In February 2015, UL balloted a proposal to add AIM requirements for table saws to the *Standard for Stationary and Fixed Electric Tools*, UL 987. The performance requirements were based on a defined relationship between approach velocity of a finger to a rotating table saw blade and the depth of cut to the finger once contact has been made. The ballot proposed a performance requirement that introduced a surrogate test finger that demonstrates the proper triggering characteristics particular to the AIM technology to the table saw blade, at an approach rate of 1 m/s, and that limits the depth of cut to 4 mm or less, upon contact with the blade.

CPSC staff sent a letter to UL dated March 24, 2015, expressing staff's support of AIM

[33] *UL Research Report*, 2014, *supra* note 25.

requirements in the voluntary standard.[34] Staff also provided in-depth investigations (IDIs) of five incidents that occurred on table saws that met the UL standard for table saws at the time (and had a riving knife and modular blade guard). In April 2015, the ballot failed to reach consensus; the ballot received 14 votes against (versus 7 votes for) the proposal.

In March 2015, UL published a report titled, *General Characteristics of a Surrogate Finger for Table Saw Safety Testing*.[35] The report discusses the attributes of a human finger that could be used as the basis for triggering an AIM system and identified three primary methods to detect a human finger: visual, electrical, and thermal.

In February 2016, UL balloted two proposals: (1) to adopt the first edition of International Electrotechnical Commission (IEC) 62841-3-1, *Standard for Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery – Safety – Part 3-1: Particular Requirements for Transportable Table Saws* as the first edition of UL 62841-3-1; and (2) to add AIM system requirements for table saws as part of the adoption of IEC or as part of UL 987 (since UL 987 will be merged with IEC 62841-3-1).

Under the proposal, manufacturers were allowed the maximum latitude to design table saws to meet the requirements. The ballot proposed a performance requirement that introduces a conductive test probe, connected to a circuit, which mimics the electrical properties of a human body, to the table saw blade, at an approach rate of 1 m/s, and limited the depth of cut upon contact with the blade to 4 mm or less. The performance requirement also permitted other test

[34] Letter from Caroleene Paul, CPSC, to John Stimitz, UL, dated March 24, 2015. Available at: https://www.cpsc.gov/s3fs-public/CPSClettertoULcommenttoAIMSproposalwenclosures.pdf.
[35] *UL Research Report*, 2015, *supra* note 5.

probes to be used for AIM technology that depend on visual or thermal detection of finger contact to the blade.

CPSC staff sent a letter of comment to UL, dated March 11, 2016, expressing staff's support of AIM requirements in the voluntary standard for table saws.[36] In April 2016, the UL proposal for adoption of IEC 62841-3-1 reached consensus when the ballot received 15 votes in favor of (versus 2 votes against) the proposal. However, the proposal to add an AIM requirement did not reach consensus; the ballot received 12 votes against (versus 5 votes in favor of) the proposal. The ballots failed, in part, because the table saw industry objected to making AIM requirements part of the UL standard, and because they believed that the proposed requirements were not sufficiently developed.

B. Adequacy of the Voluntary Standards in Addressing Injuries

Currently, no voluntary standard contains any requirements for AIM technology. CPSC staff does not believe the existing requirements for a riving knife and modular blade guard will adequately reduce the number or severity of blade-contact injuries on table saws because table saws have been equipped with these safety devices since 2009, and these safety devices have not been effective in reducing or mitigating blade-contact injuries. In 2011, staff evaluated the modular blade guard system and concluded that it is an improvement over the single hood guard design, but its effectiveness is still limited by users' willingness to use the guard.[37]

As discussed in section IV of the preamble, since the ANPR, CPSC staff has conducted a modular blade guard survey among owners of table saws with modular blade guards in 2015,

[36] Letter from Caroleene Paul ,CPSC, to John Stimitz ,UL, dated March 11, 2016. Available at: https://www.cpsc.gov/s3fs-public/CPSClettertoULcommenttoAIMS.pdf.
[37] 76 FR 62683.

reviewed incidents from the CPSRMS database to identify incidents involving table saws equipped with modular blade guard systems, and performed a trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws from 2004 to 2015.

The modular blade guard survey assessed table saw users who own, or are familiar with, a table saw with the modular guard system.[38] Results of the survey indicate that a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed, and a majority of respondents did not use the blade guard “sometimes” (28%), “often” (17%), or “always” (14%). The results of the survey demonstrate that removal of the blade guard, traditional or modular, is a necessary and proper action when making certain cuts on table saws. In addition, many users choose not to use the modular blade guard at all. CPSC staff believes that any situation where the blade guard is not used eliminates the effectiveness of the blade guard in preventing blade-contact injuries. Accordingly, staff’s review shows that reliance on the blade guard for injury prevention is insufficient because consumers have legitimate reasons for removing the guard or do not use it at all or only some of the time.

CPSC staff is also aware of at least 11 incidents from the CPSRMS database that involve table saws that meet the current voluntary standard requirements for riving knives and modular blade guards. Of those 11 incidents, four incidents involved amputation, two incidents involved laceration, and one incident involved laceration and fracture. These incidents show that blade-contact injuries continue to occur on table saws equipped with riving knives and modular blade guards, with and without the blade guard in use.

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[38] Sherehiy, B. and Nooraddini, I. (2016), *supra* note 10.

Moreover, as discussed above in section IV of the preamble and in TAB B of the staff briefing package, CPSC staff performed a trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws from 2004 to 2015. This trend analysis includes the timespan before the voluntary standard implemented the requirement for riving knives and modular blade guards on table saws (2004 to 2009) and the timespan after the requirements were implemented (2010 to 2015). Staff concludes that there is no discernible change in the number of injuries or types of injuries related to table saw blade contact from 2004 to 2015. CPSC staff also performed a trend analysis for the risk of blade-contact injury per 10,000 table saws and concludes that there is no discernible change in the risk of injury associated with table saw blade contact from 2004 to 2015. Accordingly, the implementation of the riving knives and modular blade guards requirements in the voluntary standards does not appear to have had an impact on the number or extent of blade-contact injuries on table saws.

Based on CPSC staff's evaluation of the data, the Commission concludes that the existing voluntary standard requirements for riving knives or modular blade guards will not prevent or adequately mitigate blade-contact injuries on table saws.

C. OSHA Regulations

In addition to the voluntary standard, several Occupational Safety and Health Act of 1970 (OSHA) regulations apply to table saws that are used in the workplace. Under section 3(a)(5) of the CPSA, 15 U.S.C. 2052, a "consumer product" means, with certain exceptions, any article or component part thereof, produced or distributed for sale to, or use or consumption by, or enjoyment of, a consumer for use in or around a permanent or temporary household or residence, a school, in recreation, or otherwise. Section 31 of the CPSA, 15 U.S.C. 2080, provides that the Commission shall have no authority to regulate any risk of injury associated with a consumer product if such risk could be eliminated or reduced to a sufficient extent by action taken under OSHA. However, if the risk to consumers cannot be sufficiently reduced or eliminated by OSHA's actions, the CPSC has the authority to address that risk of injury associated with the consumer product.

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)&(d). 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 from flying splinters and broken saw teeth. 29 CFR 1910.213(c)(1). The OSHA regulations also require inspection and maintenance of woodworking machinery. 29 CFR 1910.213(s). The existing OSHA regulations for table saws do not reflect the latest revisions to 8th edition of UL 987, which require riving knives and modular blade guards.

As discussed in the ANPR, CPSC staff found that the primary differences between consumer and professional users of table saws are environment and training/experience.[39] In many work production environments where a specific cut is performed continuously, guards and safety cut-off switches are custom designed for that operation. 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

[39] 76 FR 62682.

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.

Conversely, as the ANPR further discussed, amateur woodworkers generally have little or no safety training, nor training in the proper use of the table saw.[40] They may take woodworking classes or obtain a training video, but there is no mechanism to encourage the home woodworker to use a table saw as safely as possible. 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 consumer woodworker also does not have the same OSHA-regulated protections in the home wood shop. The focus on a safe environment in a consumer setting depends on the knowledge and initiative of the home woodworker. For example, in a workplace, regulations require that unsafe saws be removed from service immediately, push sticks or push blocks be provided at the work place for guiding or pushing material past the blade, and emphasis 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).

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[40] *Id*.

We continue to believe that OSHA regulations may not adequately reduce the risk of operator blade-contact injuries to consumers because OSHA's regulations are intended primarily 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, including training and outreach, as well as mandatory safety standards and enforcement. These safeguards are not available to consumers operating table saws in a home woodworking environment.

Although the safety requirements provided in OSHA regulations would not address the home woodworking environment, we note that there is no clear dividing line between consumer and professional saws, except at the very highest levels of price and performance. We have little information on the proportion of occupational purchasers for contractor saws and cabinet saws. However, CPSC staff's review shows that, based on discussions with industry representatives, electrical requirements and power appear to provide the best distinction between table saws typically used by consumers and those used most often in industrial settings. Tables saws operating at 1.75 horsepower or greater likely cannot be run on typical household wiring. Most consumers do not have the necessary electrical wiring, specifically the specialized outlets and adapters, to accommodate power tools with horsepower ratings greater than 1.75 or requiring 220-240 volt power. Sliding table saws and many other cabinet saws require such electrical capabilities and, therefore, are less likely to be used by consumers. However, CPSC staff is aware of the development of a sliding saw aimed at the high-end do-it-yourself (DIY) market, and some serious woodworking hobbyists may wire their home workshops to accommodate the more powerful saws.

Although some of the more expensive, high voltage table saws are used in construction work or by professional wood workers, many of these same saws may also be used in the home, in schools, and in recreation (woodworking workshops and clubs). Therefore, the CPSC staff believes that these types of saws may be used more than occasionally by consumers. We note that the incident data reviewed by staff, as discussed in TAB B of the staff briefing package, excludes occupational injuries from the NEISS data, and are not included in the injury data estimates.

Based on CPSC staff's review, the Commission concludes that current OSHA regulations do not adequately address the unreasonable risk of blade-contact injuries associated with table saws used by consumers, which include cabinet and contractor saws. However, the Commission seeks comment regarding whether the scope of the rule should be modified to exclude certain types of table saws that are primarily used for commercial or industrial use.

VII. Overview and Basis for Proposed Requirements

As discussed in section V of the preamble, CPSC staff reviewed data analyses of finger injuries on table saws conducted by researchers at the University of Michigan in a study titled, "*Table saw injuries: epidemiology and a proposal for preventive measures*," [41] and by UL in a report titled, "*Table Saw Hazard Study on Finger Injuries Due to Blade Contact*,"[42] to assess the extent and severity of lacerations to the finger or hand from table saw operator bade contact. UL determined that, based on measurements from the study, a depth of 4 mm is the maximum depth of cut to a finger before serious injury is sustained.[43]

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[41] Chung, K. and Shauver, M. 2014, *supra* note 24.
[42] *UL Research Report*, 2014, *supra* note 25.
[43] *Id.* at 18.

After conducting a range of tests on sample table saws with AIM technology, CPSC staff developed a proposed performance requirement to reduce the severity of operator blade-contact injuries on table saws. The proposed requirement would require table saws to limit the depth of cut to 3.5 mm or less when a test probe, acting as surrogate for a human finger, contacts the spinning blade at a radial approach rate of 1 meter per second (m/s).

A. CPSC Test Results On Existing AIM Technology

CPSC staff purchased samples of table saws with AIM technology and developed test protocols to evaluate the performance of the existing technology. UL report "*Table Saw Hazard Study on Finger Injuries Due to Blade Contact*" identified critical parameters that would define the hazard associated with a human finger/hand coming into contact with a spinning table saw blade.[44] The two critical parameters identified are:

(1) Approach velocity of the hand/finger when making contact with the table saw blade.

(2) Maximum depth of cut to the hand/finger that would distinguish between simple and complex lacerations.

Due to ethical considerations which prohibit the use of human subjects to test the AIM capability of a table saw to mitigate blade-contact injury, CPSC staff developed a performance test using a suitable test probe to serve as a surrogate for the human finger/hand. In the case of an AIM system that relies on electrical detection, staff developed an electric circuit mimicking human contact to trigger the AIM system. CPSC staff determined that effective injury mitigation can be defined by a maximum depth of cut to the test probe when it is introduced to the table saw blade at a prescribed approach rate. The allowable depth of cut in the probe represents the

[44] *Id*. at 3.

quantitative threshold between a simple and complex laceration, which is the difference between a minor injury and a severe injury to arteries, nerves, or tendons that requires microsurgery to repair. This threshold is 4 mm from the surface of the skin.

CPSC staff focused on test protocols that introduced a probe, as a substitute for a human finger, into the rotating saw blade and measured the resulting depth of cut on the probe after activation of the table saw's AIM system. Staff determined that an AIM system based on electrical detection can be triggered by a conductive test probe that is coupled to an electric circuit that mimics the human body, hereafter referred to as the human body network (HBN).

The test probe requires two properties: 1) electrical conductivity, and 2) volumetric and mechanical properties that allow depth of cut to be measured. The probe is electrically coupled to the HBN, which is a network of resistors and capacitors that approximate how the body would respond to an electrical signal. The body's response is the result of two physical properties of the human body: 1) body resistance, which is a physical property of the human body that limits the flow of electrical current into the body when a voltage source is contacted, and 2) body capacitance, which is a physical property of the human body that allows the body to store electrical charge from a voltage source. A detailed description of staff's development of the HBN for these tests is available in TAB A of the staff briefing package.

CPSC staff used a cuboid-shaped test probe made of conductive silicone rubber because the probe had already been developed by UL in its own testing of AIM technology and the probe was readily available. The test probe, shown in Figure 3, is made of low resistance, conductive silicone rubber measuring 12.5 mm x 12.5 mm x 60 mm. Staff determined that a layer of less conductive material to represent the epidermis (outer layer of skin) of a human finger is not necessary for AIM testing because the system is triggered by contact with conductive "flesh" once the epidermal layer has been broken. Therefore, for test triggering purposes, staff used a test probe that represents the conductive layer of human flesh once the epidermis has been cut by a table saw blade.

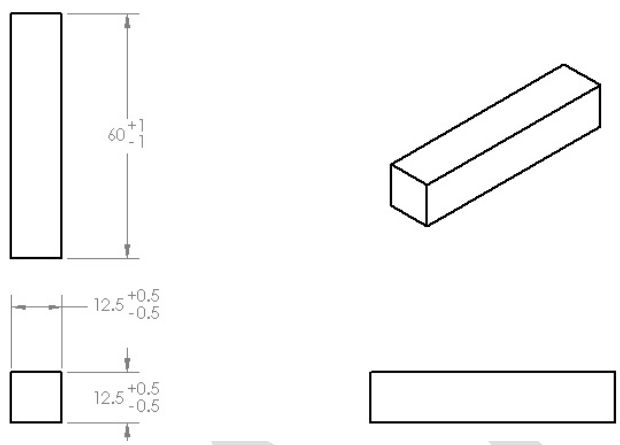

Figure 3. Test Probe (Dimensions in mm).

The quantitative threshold between a simple and complex laceration of a human finger is a 4.0 mm cut from the surface of the skin, and the mean epidermal thickness for a fingertip is 0.369 mm ± 0.112 mm, or a maximum thickness of approximately 0.5 mm.[45] Because the test probe represents human flesh beneath the epidermis, staff subtracted the 0.5 mm thickness of the epidermal layer of skin from the 4.0 mm threshold value to arrive at a 3.5 mm value for the maximum allowable depth of cut to the test probe. This 3.5 mm value represents the quantitative threshold between a simple and complex laceration of a human finger, as measured by the test probe.

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[45] Judi Whitton and J.D. Everall, "The Thickness of the Epidermis," *British Journal of Dermatology*, Vol. 89, Issue 5 (Nov. 1973) at 467-476.

Staff coupled the test probe to the HBN with a wire lead, fixed the probe in a holder attached to a computer-controlled linear actuator, and fastened the actuator to the table saw surface. This test protocol allowed staff to control the approach of the test probe to a rotating saw blade and to measure the depth of cut to the test probe after activation of the table saw's AIM system.

The approach rate of the test probe to the saw blade represents the rate of speed at which a human finger moves toward the saw blade during a blade contact incident on a table saw. However, there is no standard body of data that quantifies finger/hand approach rate to the saw blade in a table saw incident, and CPSC staff analysis of blade contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade. These scenarios are described in detail in TAB E of the staff briefing package. Sudden movement from kickback can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. Hand/finger contact is also possible without kickback in situations where the operator's hand gets too close to the blade while feeding the workpiece or the operator is distracted and inadvertently contacts the saw blade.

In comments to the table saw ANPR published on October 11, 2011, SawStop presented analysis of the company's incident data (over 1,316 table saw incidents), which indicates approach rates to the blade occurred between 3.6 in/s (91 mm/s) and 14.5 in/s (368 mm/s), and 14 percent of the incidents involved kickback of the workpiece.[46] In 2014, UL conducted its own analysis of approach rates and noted the difficulty of taking laboratory measurements of human subjects and translating that information to estimate the approach velocity of an operator's hand

[46] Gass, S. (2012). Comments and Information Responsive to the ANPR for Table Saw Blade-contact injuries By SawStop, LLC. https://www.regulations.gov/document?D=CPSC-2011-0074-1106.

or finger toward the center of the saw blade, or radial component of the approach velocity, in an actual blade contact incident (see Figure 4.)[47] UL considered its own analysis of SawStop's incident data, literature searches, and human subject experiments and determined that 39.4 in/s (1000 mm/s or 1 m/s) is a reasonable first-order estimate of a typical case in which a table saw operator accidentally contacts the saw blade.[48]

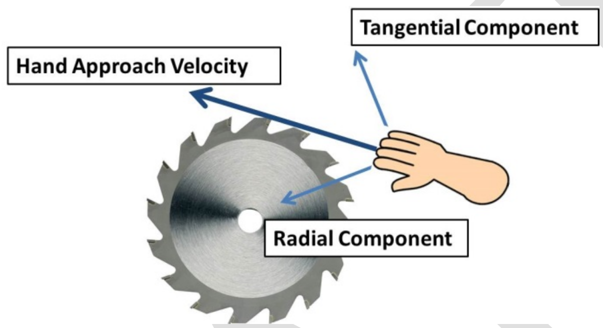

Figure 4. Components of Approach Velocity.

CPSC staff's analysis of operator behavior in table saw blade-contact injuries indicates that blade-contact injuries occur at approach rates that range from slow feeding of the workpiece when the operator's hand is close to the blade and inadvertent contact is made, to faster approach rates that occur when kickback of the workpiece causes the operator's hand to make contact with the blade. Staff concludes that a radial approach rate of 1 m/s is appropriate for a performance test because this is a high rate of speed for the radial component of the hand's approach rate to the saw blade. In addition, this radial approach rate is more than twice as fast as the highest

[47] *UL Research Report*, 2014, *supra* note 25 at 22.
[48] *Id.* at 5.

radial approach rate calculated by SawStop in more than a thousand blade-contact injuries that activated their AIM system. Therefore, staff conducted all tests at an approach rate of 1 m/s.

CPSC staff developed a test method to evaluate various existing AIM systems to compare them to the performance standard limiting the depth of cut after triggering, using a test probe that can be used to evaluate the depth of cut when the probe makes contact with the rotating saw blade while approaching the blade at 1 m/s. Staff has used this test method on currently available AIM systems that use electrical sensing to detect finger contact and injury mitigation after contact. The test method may work if a system were designed using visual tracking, or other means of detection, to mitigate injury after detection. However, the test probe used to test AIM systems based on other methods of detection should have the appropriate properties to trigger the system.

CPSC staff tested a SawStop JSS-MCA jobsite table saw and a Bosch REAXX™ jobsite table saw for AIM technology performance in accordance with the above test protocol. Both saws have 10-inch diameter blades, and the manufacturer's blades were used in all test runs. Staff ran tests with the probe connected to the HBN which was connected to the table saw's ground wire. Staff tested 11 HBN settings/configurations to represent the effect of mutual capacitance between the human body and its surroundings that increases the capacitance of the human body beyond its minimum self-capacitance of 50 pF in 50 pF steps up to 500 pF plus an additional short circuit test.[49] The HBN settings reflect a stepped increase in increments of 50 pF to cover a reasonable range of body capacitance. CPSC staff tested both table saws with 11 test probe activations at an approach rate of 1 m/s, and determined the probe depth of cut for each

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[49] The units for electrical capacitance is the farad (F). For most applications, the capacitance value is very small so the picofarad (pF) is used to denote one trillionth (10^{-12}) of a farad.

test run. For all capacitance values, both the SawStop and Bosch table saws produced cuts that were under the 3.5 mm threshold for allowable depth of cut into the probe. The depth of cut for the SawStop table saw tests ranged from 1.5 mm to 2.8 mm and the depth of cut for the Bosch table saw tests ranged from 1.9 mm to 2.5 mm.

CPSC staff's test results indicate that table saws with AIM systems that rely on electrical detection were able to mitigate injury to a test probe, approaching toward the center of the rotating saw blade at a rate of 1 m/s, upon contact with the blade by limiting the depth of cut to 1.5 mm to 2.8 mm. These table saws limited the depth of cut well below the 3.5 mm threshold between a simple and complex laceration in a human finger, as measured by the test probe.

B. Proposed Requirement

CPSC staff's testing of the current AIM technology available on table saws in the U.S. market demonstrates that blade-contact injuries on table saws would be reduced if table saw manufacturers are required to meet a performance requirement for table saws that limits the depth of cut to the specified test probe, upon making contact with the saw blade at an approach rate of 1.0 m/s, to 3.5 mm. The proposed rule would require a test probe to act as surrogate for the human body/finger contact with the saw blade and to allow accurate measurement of the depth of cut.

Although the test probe and test method described in TAB A of the staff briefing package, are appropriate for the evaluation of AIM systems using an electrical detection system, other test probes and test methods using a different detection system may be developed to detect human body/finger contact with the saw blade and to measure depth of cut. There are many possible methods to detect human contact with a saw blade that range from electrical, optical, thermal, electromagnetic, to ultrasound and others. For example, a detection system could be developed that uses thermal sensing properties of the human body/finger or visual sensing and tracking of the human body/finger. The Commission believes that AIM systems using a different detection approach than what is currently on the market may be developed, based on sound material science and engineering knowledge.

Likewise, there are many different methods to limit the depth of cut to a probe. SawStop removes the blade from contact with the finger by stopping the blade and allowing angular momentum to retract the blade. The Bosch REAXX™ retracts the blade with an explosive discharge. Other ways of retracting the blade could include pneumatic (using high pressure air), or hydraulic (high pressure oil) systems. Another method to minimize blade contact could involve moving the finger or hand away from the blade by projecting the blade away from the hand or projecting the table upwards rather than retracting the blade. The Commission seeks comments on the feasibility of developing new AIM technology on table saws and whether different detection methods may be applied as part of an AIM system.

The proposed rule would establish a performance requirement, but it does not dictate how table saw manufacturers would meet those requirements. Rather, firms would have the flexibility to determine the appropriate technology to meet the specified performance requirement. In the staff's briefing package, CPSC staff has explained the test procedure and equipment that staff would use to assess compliance with an AIM system that uses electrical sensing technology. However, manufacturers need not use this particular test procedure, so long as the test method they use effectively assesses compliance with the standard.

The Commission is aware that, currently, there are only two AIMs systems currently capable of mitigating a blade-contact injury, those used by SawStop and Bosch REAXX™, which operate by sensing electrical properties of the human body/finger and then retracting the blade. Although the Commission believes that new AIM technologies can be developed in addition to the existing AIM technologies to meet the performance requirements, if such new technologies cannot be developed, the Commission has considered the economic impacts on manufacturers who may be required to license the existing technologies. That discussion appears in section XI of the preamble and in TAB C of the staff briefing package.

VIII. Stockpiling

In accordance with Section 9 of CPSA, the proposed rule contains a provision that would prohibit a manufacturer from "stockpiling," or substantially increasing the manufacture or importation of noncomplying table saws between the date that the proposed rule may be promulgated as a final rule and the final rule's effective date. The proposed rule would prohibit the manufacture or importation of noncomplying table saws in any period of 12 consecutive months between the date of promulgation of the final rule and the effective date, at a rate that is greater than 120% of the rate at which they manufactured or imported table saws during the base period for the manufacturer. The base period is any period of 365 consecutive days, chosen by the manufacturer or importer, in the 5-year period immediately preceding promulgation of the rule.

Assuming a promulgation date in 2018, the sales period from 2013-2017 (shipments were 600,000 in 2013 and 625,000 in 2014) would allow manufacturers to produce more than 720,000 saws (600,000 ×120 percent), assuming sales in years 2015 to 2017 are stable. In the longer term of 2002 to 2014, annual shipments averaged 675,000 table saws. The stockpiling limit would thus allow the industry to meet any foreseeable increase in the demand for table saws without allowing large quantities of table saws to be stockpiled.

IX. Response to Comments

In this section, we describe and respond to comments to the table saw ANPR. We present a summary of comments by topic, followed by the Commission's response. The Commission received over 1,600 comments in response to the ANPR. The comments can be viewed on www.regulations.gov by searching under the docket number of the ANPR, CPSC-2011-0074. Approximately 134 commenters supported developing regulatory standards for table saws. The other commenters generally opposed the rulemaking proceeding. These comments are addressed below.

A. Mandatory Standard Would Create Monopoly

Comment: Numerous commenters stated that table saw performance requirements that mitigate blade-contact injuries would force all manufacturers to use the SawStop patented technology. Many commenters stated that mandating the use of the SawStop technology will result in a monopoly and stifle innovation, granting an unfair advantage to one company. Commenters stated that table saw performance requirements would be "a design standard" because SawStop's parent company (SD3, LLC) owns a number of U.S. patents for sensing technology and blade braking and blade retracting technology. Some commenters stated that if the CPSC did not mandate a particular technology, other companies could introduce their own safety technologies, some of which may prove to be better than SawStop's technology. Some commenters predicted that if CPSC did not mandate the SawStop AIM technology, other injury mitigation technologies would be developed and the competition among the technologies would eventually bring down the prices associated with these new technologies.

Response: The proposed performance requirements would not require manufacturers to use the SawStop patented technology. The proposed rule does not mandate a particular detection method or test method to mitigate blade-contact injury. The proposed performance requirement for table saws limits the depth of cut to a test probe, upon making contact with the saw blade at a radial approach rate of 1.0 m/s, to 3.5 mm. Any test probe that is used must act as a surrogate for a human body/finger to ensure that the depth of the cut can be measured properly upon contact with the saw blade. There are many methods to detect human contact with a saw blade that range from electrical, optical, thermal, electromagnetic, to ultrasound and others. Likewise, there are many methods to limit the depth of cut to a probe that would not require retraction of the saw blade. Although all of these different systems do not yet exist, such AIM systems may be developed.

Although the proposed rule does not require a particular AIM technology, the Commission is aware that, currently, there are only two AIMs systems capable of mitigating a blade-contact injury, those used by SawStop and Bosch REAXX™. Both of these systems operate by sensing electrical properties of the human body/finger and limiting the depth of cut by retraction of the blade.

The Commission is also aware of ongoing litigation between SawStop and other table saw manufacturers, including Bosch. For example, on July 16, 2015, SawStop filed a complaint against Bosch at the ITC, requesting an investigation under section 337 of the Tariff Act of 1930, to limit entry into the United States of the Bosch REAXX™ table saws that allegedly infringed on several SawStop patents. *In the Matter of Certain Table Saws Incorporating Active Injury Mitigation Technology and Components Thereof*, Investigation No. 337-TA-965. The status of litigation between Bosch and SawStop is ongoing and has not been resolved. We note that some of the allegedly infringed upon patents may expire in 2020, and 2022, which may resolve the patent issues in the ITC investigation. However, we do not know what other SawStop patents may be impacted by companies that attempt alternative AIM technologies, nor do we know the expiration dates of the other existing SawStop patents given that SawStop filed more than 100 patents with the U.S. Patent and Trademark Office related to SawStop's woodworking safety systems. Therefore, it is possible that any injury mitigation system on a table saw that relies on sensing electrical properties, or other properties of the human body and finger, and engages a reaction system may potentially infringe on a SawStop patent.[50]

The outcome of ongoing lawsuits involving the SawStop technology will determine some of the impacts that may result from a mandatory rule requiring AIM technology for table saws. If the courts determine that the patents covering the SawStop technology allow for companies to manufacture their own saws with alternative AIM technologies (such as the Bosch REAXX™ saw), then some manufacturers may choose to try to develop their own proprietary technology or license the Bosch technology (if available) as an alternative to the SawStop technology.

Alternatively, if the courts decide that other technologies do, in fact, infringe upon SawStop patents, then SawStop may effectively have a monopoly on the technology needed to comply with a mandatory rule, until SawStop's patents expire. However, even if the patents expire, if new AIM technology is not developed, other manufacturers likely would be required to work with SawStop and/or Bosch to license the SawStop or Bosch technologies for use in their saws. Even if all of the relevant patents eventually become public, many manufacturers may not be able to develop their own AIM system, and will either have to license the technology or exit

[50] SawStop has also filed antitrust claims alleging that several major table saws manufacturers conspired to boycott SawStop's safety technology and manipulate safety standards. In *SawStop LLC v. Black & Decker, et. al,* 2015 U.S. App. LEXIS 18834 (4th Cir. 2015), although the court dismissed SawStop's claims concerning standard-setting, the court found that SawStop plausibly alleged that there was agreement by several manufacturers to engage in a group boycott against SawStop and remanded the case for further proceedings.

the table saw market. As discussed in section XI of the preamble and in TAB C of the staff briefing package, the level at which the royalty payments are set will play a significant role in determining the economic impacts that CPSC's rule could have on table saw manufacturers.

B. Voluntary Standard Process

1. Comment: Numerous commenters stated that CPSC staff should work with the table saw industry to offer solutions. The commenters stated that the voluntary standards process is working and has resulted in the addition of a permanent riving knife on all table saws. In addition, other commenters stated that the industry has also required the modular blade guard on all table saws, which has improved the safety of table saws.

Numerous commenters also stated that current table saws (some referring to older table saws with traditional blade guards, and some referring to newer table saws with riving knives and modular blade guards) are safe, if used properly. Many commenters cited their own personal experiences with table saw use and claimed that because they have not had an injury this proves that current table saws are safe.

Response: CPSC staff performed a trend analysis of the annual estimated number of emergency department-treated table saw blade-contact injuries from 2004 to 2015. This trend analysis includes the timespan before the voluntary standard required riving knives and modular blade guards on table saws (2004 to 2009) and the timespan after the requirements were implemented (2010 to 2015). Staff's review shows that there is no discernible change in the number of injuries or types of injuries related to table saws from 2004 to 2015. CPSC staff then analyzed the risk of blade-contact injury per 10,000 table saws in use for each year in the analysis. CPSC staff performed a trend analysis on the risk of blade-contact injuries and found that there is no discernible change in the risk of blade-contact injury associated with table saws from 2004 to 2015.

In addition, staff is aware of at least 11 incidents from the CPSRMS database (2004-2015) that involve table saws that meet the current voluntary standard requirements for a riving knife and modular blade guard. A riving knife may reduce the occurrence of kickback (that can lead to unexpected stock movement and finger/hand contact with the blade) on a table saw, but kickback can still occur on table saws equipped with a riving knife. Furthermore, reducing kickback will not eliminate blade-contact injuries because blade-contact injuries can occur without kickback of the stock.

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. Results of the modular blade guard survey in 2015 of table saw owners with modular blade guards indicate that a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed and a majority of respondents removed the blade guard "sometimes" (28%), "often" (17%) or "always" (14%).[51] The results of the user survey demonstrate that removal of the blade guard is a necessary and proper action when making certain cuts on table saws. In addition, many users choose not to use the modular blade guard at all or only some of the time. Any situation where the blade guard is not used eliminates the effectiveness of the blade guard in preventing blade-contact injuries.

Based on the trend analysis of blade-contact injuries and risk of blade-contact injuries from 2004 to 2015, the CPSRMS incidents, and staff's review of responses to the modular blade

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[51] Sherehiy, B. and Nooraddini, I. (2016), *supra* note 10.

guard survey, the Commission does not see evidence that the voluntary standard requirements have reduced or changed blade-contact injuries on table saws. In addition, CPSC staff has participated with the table saw industry and other stakeholders in UL working groups since September 2011 to develop safety standards for table saws. UL proposed AIM system performance requirements for table saws in February 2015 and February 2016, which indicates that the voluntary standards governing body believes that table saws should exhibit active injury mitigation performance. However, despite these efforts, the AIM requirements have not been adopted in the UL standard. Therefore, the Commission believes that the voluntary standard activities have not been effective at addressing blade-contact injuries on table saws.

C. Consumer Choice

1. Comment: Numerous commenters stated that table saw users should be responsible for their actions, should use common sense when operating the table saw, and should accept the risk of using a table saw. Many commenters stated that SawStop table saws are already available and the free market system should determine whether or not consumers will purchase a table saw with enhanced safety features. Many of these same commenters opposed any mandate from the federal government to make table saws safer. These commenters contended that the federal government should not regulate consumer choice or behavior. Many commenters stated that other products can also cause injury such as knives or band saws and ask if the CPSC will regulate those products as well. Other commenters argued that lawsuits against table saw manufacturers reward users who are irresponsible and use table saws improperly.

Response: CPSC staff's analysis of blade contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade, and there are certain cuts on table saws that require removal of the blade guard. Therefore, an operator's decision to use a table saw without all safety devices does not necessarily indicate intentional neglect or ignorance on the part of the operator. Sudden movement of the workpiece from kickback can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. Hand/finger contact is also possible without kickback, in situations where the operator's hand gets too close to the blade while feeding the workpiece or the operator is distracted and inadvertently contacts the saw blade. In addition, many of the scenarios leading to blade contact may be more likely if the consumer is tired or if the view of the blade, or cut, is impaired in some way.

An estimated 4,700 amputations related to table saws occur each year. When compared to all other types of consumer products, an estimated 18.6 percent of all amputations in the NEISS in 2015 are related to table saws. When compared to all other workshop products, table saws accounted for an estimated 52.4 percent of all amputations related to workshop products in 2015. Based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the risk of injuries associated with blade contact on table saws.

2. Comment: Many commenters supported preserving consumer choice in the table saw market by not mandating AIM technology. Most wanted table saws equipped with AIM technology to be available, and some even stated that they owned a SawStop saw; however, they wanted to preserve the option to purchase less expensive table saws not equipped with an AIM technology. Many commenters stated that the consumer should decide whether table saws equipped with AIM technology are worth the increased cost. Some commenters stated that there are already safety devices, such as splitters, blade guards, and push sticks, which if used properly, will reduce injuries; and therefore, consumers who properly use these devices should not be forced to pay more for saws with AIM technology. Some commenters requested that manufacturers be required to offer at least one table saw with AIM technology, instead of requiring all table saws to be equipped with the technology. Other commenters noted that saws equipped with AIM technology are already available in the marketplace and if consumers wanted these saws, they could purchase them.

Response: We acknowledge that, although some consumers would prefer table saws with the AIM technology, other consumers would prefer to have the option to purchase a table saw without the AIM technology. In addition, some consumers may also prefer the use of passive table saw safety devices, as opposed to the AIM technology. However, the Commission believes that while the proposed rule would prevent consumers from purchasing table saws without some type of AIM technology, the proposed requirement would also substantially reduce the serious b blade-contact injuries involving table saws every year. In addressing the blade contact risk, the Commission must weigh the costs of blade-contact injuries against the cost of limiting consumer choice and the rule's potential effect on the utility, cost, and product availability to consumers.

As discussed in section XI of the preamble and in TAB C of the staff briefing package, the Commission considered the costs and benefits of proposing the rule. Based on estimates from NEISS and the CPSC's Injury Cost Model (ICM), the proposed rule would address an estimated 54,800 medically treated blade-contact injuries annually. The societal costs of these injuries (in 2014 dollars and using a 3 percent discount rate) amounted to about $4.06 billion in 2015. Amputations accounted for about 14 percent of the medically treated blade-contact injuries but almost two-thirds of the injury costs. Overall, medical costs and work losses account for about 30 percent of these costs, or about $1.2 billion. The intangible costs associated with pain and suffering account for the remaining 70 percent of injury costs. Because of the substantial societal costs attributable to blade-contact injuries, and the expected high rate of effectiveness of the proposed requirement in preventing blade-contact injuries, the estimated net benefits (i.e., benefits minus costs) for the market as a whole averaged $1,500 to $4,000 per saw. Aggregate net benefits on an annual basis could amount to about $625 million to about $2,300 million.

However, the Commission also considered alternatives to the rule, including no regulatory action, deferring to the voluntary standard, later effective dates, exempting certain classes or types of table saws, and information and education campaigns. These alternatives are discussed in detail in section XI.J. of the preamble and TAB C of the staff briefing package. The Commission determined preliminarily that the various alternatives would not greatly reduce the number of blade-contact injuries that would be addressed by the proposed rule. Based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on all table saws. However, the Commission seeks comment on various alternatives that would not require all table saws to be produced with the AIM technology.

D. Table Saw Incident Data Analysis

1. Comment: Numerous commenters stated that CPSC staff injury data analysis was faulty because it did not include the effects of the modular blade guard system. Specifically, the commenters argued that a meaningful analysis cannot be completed based on the 2007-2008 Injury Report because it includes data only related to old guard designs rather than the new modular blade guarding system. The Power Tool Industry (PTI) estimated that, in 2012, more than 900,000 table saws had been sold since 2007 that use the modular blade guard. Some commenters stated that CPSC staff failed to estimate the risk of injury associated with table saw use, and that this data is needed to evaluate the effectiveness of the voluntary standard requirements for a riving knife and modular guard on table saws.

Response: For the proposed rule, CPSC staff estimated the yearly table saw blade-contact injuries from 2004 to 2015 by using estimates from NEISS. The date range for the trend analysis includes a timespan before the voluntary standard required table saws to be equipped with a riving knife and modular blade guard (2004 to 2009) and a timespan after the voluntary standard requirements became effective on most table saws (2010 to 2015). A proportion of table saws manufactured before the current voluntary standard became effective is expected to remain in use throughout this whole period. However, in more recent years, after the current voluntary standard became effective, an increasing proportion of table saws in use conforms to the current voluntary standard. Thus, if the voluntary standard was positively impacting the number or severity of injuries, there would be a steady decrease in the number of injuries or severity of injuries as the proportion of compliant table saws increased. However, the data reviewed by CPSC staff do not indicate that requirements in the voluntary standard have had any impact in reducing the number or severity of blade-contact injuries on table saws.

CPSC staff performed trend analyses for blade-contact injuries, as well as blade contact amputations, hospitalizations, and finger/hand injuries from 2004 to 2015. CPSC staff concludes that there is no discernible change in the number of blade-contact injuries or types of injuries related to table saw blade contact from 2004 to 2015. CPSC staff also performed a trend analysis for the risk of blade-contact injury per 10,000 table saws and, likewise, concludes that there is no discernible change in the risk of injury associated with table saws from 2004 to 2015.

CPSC staff has also reviewed incidents reported through means other than the NEISS, which are entered in the CPSC's CPSRMS database. Of the 53 incidents identified in the CPSRMS database that were reported in the period from 2004 to 2015, 36 involved table saws with a traditional blade guard and 11 involved table saws with a modular blade guard. A review of the reports indicates that the incident scenarios for table saws with modular blade guards are similar to incidents involving table saws with traditional blade guards in terms of their use with and without blade guards and accidents occurring with and without unexpected stock movement from kickback of the material. In addition, the modular blade guard survey conducted by the CPSC in 2015 indicates that consumers frequently remove the modular blade guard to perform certain cuts, or do not use the modular blade guard at all or only some of the time.

Based on the trend analysis of blade-contact injuries and risk of blade-contact injuries dating from 2004 to 2015 conducted by staff, plus anecdotal evidence from CPSRMS that blade-contact injuries continue to occur on table saws that meet the current voluntary standards requirements, and results from the modular blade guard survey, the Commission does not see evidence that the voluntary standard requirements for riving knives or modular blade guards have reduced or mitigated blade-contact injuries on table saws. Accordingly, the Commission believes that the proposed performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries associated with table saws.

2. **Comment:** One commenter questioned the results of the 2007-2008 NEISS special study indicating that 68.7 percent of saws involved in incidents were fixed cabinet saws, 18.3 percent were semi-portable contractor saws, and 10.5 percent were portable bench saws. The commenter stated the results were inconsistent with other data in the survey regarding the table saws' characteristics.

Response: CPSC staff conducted a re-analysis of the saw type and drive type responses provided by the injury victims in the 2007-2008 special study and published the results of the re-analysis in June 2014. CPSC staff stated that consideration should be given to staff's finding that the distribution of injuries for different types of saws cannot be based on how respondents answered questions about the type of saw.[52] However, as discussed in section IV of the preamble, the Commission is not relying on any data used in the 2007-2008 special study for the proposed rule.

3. Comment: Several commenters stated that most table saw injuries are caused by kickback of the workpiece and the SawStop system does not prevent kickback. Others stated that riving knives will eliminate kickback and therefore reduce most injuries.

Response: Based on CPSC staff's review of the data, the Commission believes that while the proposed rule would not eliminate kickback, the proposed performance requirement would reduce injuries that occur when kickback results in blade contact. CPSC staff's analysis of blade contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade and there are certain cuts on table saws that require removal of the blade guard. Sudden movement of the workpiece from kickback can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. However, hand/finger contact is also possible without kickback when the operator's hand gets too close to the blade while feeding the workpiece, or when the operator is distracted and inadvertently contacts the saw blade.

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[52] See http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Home%20Maintenance%20and%20Construction/CoverpageandMemoofStaffAnalysisofTableSawTypeinNEISSSpecialStudy.pdf

CPSC staff identified 53 incidents in the CPSRMS database that involve blade-contact injury on a table saw that occurred between January 1, 2004 and December 31, 2015, and were reported to CPSC by March 1, 2016. For the majority of incidents, it is unknown whether unexpected workpiece movement was involved in the blade contact. However, of the incidents where information about the contribution of workpiece movement was known, most blade-contact injuries involved some type of unexpected workpiece movement. In addition, 11 of the 53 incidents involved table saws that meet the current voluntary standard requirements for a riving knife and modular blade guard. CPSC staff believes that the data show that blade-contact injuries continue to occur on table saws equipped with a riving knife and modular blade guard.

4. Comment: One commenter claimed that the full NEISS sample overestimated the number of table saw blade-contact injuries in 2007-2008 based on estimates from the National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP). More specifically, the commenter argued that because the proportion of NEISS-AIP amputations (52%) treated in hospital emergency department(s) (ED) was statistically less than the proportion of ED amputations from the full NEISS estimate, NEISS-AIP is the appropriate and preferable sample to use when making national estimates of table saw ED injuries.

Response: In the proposed rule, CPSC staff has reviewed updated incident data based on estimates from NEISS hospital records for injuries related to product code 0841 (table or bench saws) for 2015. For the ANPR, staff's estimate of ED-treated blade-contact injuries for table saws, including the estimate of ED-treated amputations, was based on the weighted national estimate of actual blade-contact injuries reported through the full NEISS sample of hospitals during 2007-2008. NEISS is a stratified national probability sample of approximately 100 U.S. hospital EDs that allows the CPSC to make statistically valid national estimates of product-related injuries treated in U.S. hospital EDs. The NEISS-AIP is a statistical subsample of the full NEISS sample that is administered by the CDC and consists of approximately two-thirds of the NEISS hospitals in each stratum. This subsample collects information on injuries outside CPSC's jurisdiction, including occupational, motor vehicle, boating, and other injuries.

For table saw injuries (product code = 0841) in 2007-2008, approximately 62 percent of the weighted national estimate comes from the hospitals in the NEISS-AIP subsample. Although the commenter estimated that amputations from the NEISS-AIP subsample accounted for only about 52 percent of amputations from the total NEISS sample and reported that the difference was statistically significant, contrary to the commenter's assertions, the proportion of amputations coming from NEISS-AIP was not, in fact, statistically different than the overall national estimate of table saw injuries that came from the full NEISS sample.

E. Economic Issues

1. Comment: One commenter stated that CPSC staff gives no basis for projecting injury estimates derived from NEISS onto other medically treated injuries to obtain a national injury rate for table saws. The commenter noted that other estimates of table saw-related injuries differ from CPSC's; using the NIOSH hospital sample, the average total number of work-related injuries treated in hospital emergency rooms for table saws was below the CPSC estimate. The commenter asserted that, to the extent that more serious injuries are likely to be treated in emergency rooms, the mix of injury severity based on the NEISS data overstates the severity mix once the injury total is multiplied by a set factor.

Response: The CPSC staff uses the CPSC's ICM to project the number of medically treated injuries treated outside of hospital emergency departments (e.g., non-ED office visits, including medical treatment in doctor's offices, emergency clinics, ambulatory care centers, etc.).[53] As described more fully in section XI of the preamble and TAB C of the staff briefing package, estimates were derived from empirical relationships between ED-treated injuries and injuries treated in other settings, based on National Health Interview Survey records (which provided detailed information on where the injuries were treated) stretching over 10 years.

The estimate of occupational table saw injuries treated in hospital EDs is not relevant for the table saw analysis. The CPSC excludes occupational injuries from the CPSC estimate of consumer injuries whenever possible. Moreover, the NIOSH estimates mentioned by the commenter were not based on a "NIOSH hospital sample." Rather they were based on the NEISS-AIP, a subsample of NEISS hospitals administered by the CDC. The AIP subsample covers a much broader range of injuries, *i.e.* occupational, motor vehicle, boating and other injuries, in addition to injuries that are consumer product related, so the number of records collected is much higher for the AIP subsample. Thus, the results for the CPSC estimate of consumer injuries and the NIOSH estimate of occupational injuries are not inconsistent.

Finally, the mix of injury severities from the NEISS ED injury sample was not simply projected onto the estimate of injuries treated outside of hospital EDs. Rather, the estimates were based on the characteristics of injuries and victims treated outside of hospital EDs. For example, based on information from the National Health Interview Survey, a 40-year-old woman is almost twice as likely to be treated in a doctor's office (or some other non-ED settings) with a fractured

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[53] Miller, Lawrence, Jensen, Waehrer, Spicer, Lestina, Cohen, *The Consumer Product Safety Commission's Revised Injury Cost Model* (Dec. 2000), available at: https://www.cpsc.gov/PageFiles/100269/costmodept1.PDF. Since the table saw ANPR was published, the methodology for projecting the number of non-ED-treated injuries has been updated. It is described in: *Revised Incidence Estimates for Non-Fatal, Non-Hospitalized Consumer Product Injuries Treated Outside Emergency Departments*, Bruce Lawrence, Pacific Institute for Research and Evaluation, Calverton, MD, (April 2013).

clavicle than would a 10-year-old boy.[54] Consequently, for this example, the ICM would estimate more injuries treated outside the emergency room for 40-year-old women and fewer injuries treated outside of hospital EDs for 10-year-old boys. The more serious and life threatening injuries are more likely to be treated in hospital emergency rooms, and this is reflected in the CPSC injury estimates.

2. Comment: Two commenters focused on several aspects of the economic value of injury risks used by the CPSC in its 2011 analysis. One commenter suggested that the CPSC did not provide any supporting data for any of the four cost components of the ICM: medical treatment, lost time from work, product liability costs, and pain and suffering. The commenter suggested that counting product liability costs as well as pain and suffering may lead to double counting. Furthermore, the commenter asserted that the appropriate method for assessing the benefits from public programs is society's willingness to pay to avert small risks, an *ex ante* amount, as opposed to a retrospective piecemeal approach adopted by the CPSC. Finally, this commenter noted that even if jury awards for pain and suffering corresponded to willingness to pay values, there is no justification for applying these rates to all table saw injuries. Another commenter stated that the pain and suffering portion of the ICM injury cost estimates are overstated and inappropriate.

Response: The methodology and data supporting the various components in the ICM are described in section XI of the preamble and in TAB C of the staff briefing package. The societal costs of blade-contact injuries represent the pool from which the benefits of a blade contact rule are derived. The societal costs of these injuries are quantified with the ICM. The ICM is fully

[54] Miller et al., 2000, *supra* note 53, Table 6.

integrated with NEISS, and, in addition to providing estimates of the societal costs of injuries reported through NEISS, it also estimates the costs of medically treated injuries that are treated outside of hospital EDs. The major aggregated societal cost components provided by the ICM include medical costs, work losses, and the intangible costs associated with lost quality of life or pain and suffering. In recent years, CPSC staff has excluded the product liability costs from ICM cost estimates. Although this component was intended to represent the costs of administering the product liability system in the United States, there was the possibility of some double counting, as suggested by the commenter. Accordingly, product liability costs administration costs are not included in the proposed rule.

The commenter also promotes the concept of willingness-to-pay over the method used by CPSC staff to estimate the likely benefits of regulation. CPSC does use willingness-to-pay estimates in valuing fatal injuries. However, such estimates do not generally exist for nonfatal injuries, such as blade-contact injuries on table saws.

3. Comment: One commenter asserted that the injury data used by CPSC's staff to estimate societal costs in its 2011 analysis were based on extrapolations that were imprecise and resulted in greatly overstated societal costs. The commenter based this statement on two factors. First, the commenter asserted that injury costs should be limited to blade-contact injuries reported through hospital emergency rooms. Second, because only about 11 percent of ED-treated injuries resulted in hospitalization, the commenter suggested that inclusion of the ED-treated and released injuries greatly exaggerated the CPSC estimate of societal costs.

Response: CPSC staff uses the ICM to project the number of medically treated injuries treated outside of hospital emergency departments, and the costs of those injuries. Estimates were derived from empirical relationships between ED-treated injuries and injuries treated in other settings, and based on National Health Interview Survey records (which provided detailed information on where the injuries were treated) stretching over 10 years.[55] Cost estimates for the injuries treated outside of hospital emergency departments are generally less than the costs of injuries initially treated in emergency rooms. To exclude injuries treated outside of hospital emergency departments would severely underestimate the types and costs of injuries associated with table saw use.

Moreover, while it is true that costs associated with injuries that were treated and released from emergency departments are substantially less than hospitalized injuries, the costs associated with treated and released injuries can still be substantial. To exclude the treated and released injuries, which typically account for about 90 percent to 95 percent of table saw injuries presenting at hospital EDs, would substantially underestimate the cost of table saw injuries.

4. Comment: One commenter asserted that the methodology CPSC uses to extrapolate from ED-treated injuries to all medically treated injuries does not acknowledge that table saw injuries are likely to be more serious, and thus, more likely to require treatment in a hospital ED, than injuries involving fingers, wrists, hands, and lower arms that are associated with other consumer products. Accordingly, the commenter contended that the ICM overstates the annual number of blade-contact injuries treated during non-ED office visits. The commenter suggested that this purported error would be corrected by reducing CPSC's estimate of non-ED office visits (based on ratios involving rates of hospitalization). The commenter concluded that there were about 42,800 medically attended blade-contact injuries involving table saws annually during 2007-2008, about 36 percent less than CPSC's estimate of 67,300.

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[55] Miller *et al*., 2000, *supra* note 53.

Response: CPSC staff's review of 2015 data, based on estimates from NEISS and the CPSC's ICM, shows that the draft proposed rule would address an estimated 54,800 medically treated blade-contact injuries annually. As described in more detail in section XI of the preamble, and TAB C of the staff briefing package, the ICM uses empirically derived relationships between ED-treated injuries and injuries treated in other settings to estimate the number of injuries treated outside of hospital EDs. The methodology does not use a single 1 to 1 extrapolation factor, as suggested by the commenter. Nor does it estimate non-ED table saw blade-contact injuries by assuming "that the average injury severity (and thus the likelihood of seeking ED treatment) is comparable to that for other types of products," as suggested by the commenter. Rather, based on national survey data from the National Health Interview Survey, the ICM uses information on the age, sex, diagnosis (e.g., fracture, amputation), body part, and injury disposition to estimate injuries treated in non-ED settings. For example, according to national survey data (from the National Health Interview Survey), a 40-year-old woman is almost twice as likely to go to a doctor's office, an emergency clinic, or some other non-ED office setting with a fractured clavicle as a 10-year-old boy. Consequently, as suggested by this example, the ICM estimates more injuries treated outside the emergency room for certain combinations of injury and victim characteristics. For other types of injuries, a greater proportion would be treated in hospital emergency rooms.

The ICM uses a classification tree that takes into account age, gender, body part, and injury diagnosis in determining the ratios of non-ED office visits to ED-treated injuries. Thus, for example, estimates of non-ED doctor-treated finger amputations involving table saws are not product specific, but rather, are based on general ratios of finger amputations involving all consumer products in each of the medical treatment settings (*i.e.*, the ratio of finger amputations treated in the EDs to amputations treated in non-ED office visits), with adjustments for the other factors noted above. At the time of the ANPR, these estimates were based on an analysis of 10 years of data from the National Health Interview Survey (NHIS, 1987 to 1996) which provided information on the proportion of finger amputations initially treated in the ED relative to the proportion of finger amputations initially treated outside of the ED during non-ED office visits. The current version of the ICM uses data from the 1996-2007 Medical Expenditure Panel Survey (MEPS) using the same classification tree methodology to estimate the proportion of injuries treated outside the ED.[56]

The hospital admitted injuries that the commenter discussed are used by the ICM only to estimate the injuries that bypass the emergency room and are admitted directly to the hospital. Injuries that bypass the ED, but result in hospitalization would, for example, include cases in which an injury is initially treated in a doctor's office, but the doctor decides that the victim should be hospitalized immediately. One medical facility, the Maryland Institute for Emergency Medical Services Systems (MIEMSS) also directly admits trauma victims. The ratio used for estimating these direct admissions was computed with data from the National Ambulatory Medical Care Survey and the National Hospital Discharge Survey.[57]

The commenter points out that, when compared to injuries involving other products, a higher proportion of table saw blade-contact injuries that are treated initially in hospital EDs result in hospital admission. Based on NEISS estimates, this statement is correct. It may also

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[56] Lawrence, 2013, *supra* note 53.

[57] Since the ANPR was published, the methodology for projecting the number of admitted injuries bypassing the emergency room has been updated and is described in Bhattachara, S., Lawrence, B., Miller, T.R, Zaloshnja, E., Jones, P.R., *Ratios for Computing Medically Treated Injury Incidence and Its Standard Error from NEISS Data* (Contract CPSC-D-05-0006, Task Order 8). Calverton, MD: Pacific Institute for Research and Evaluation, (Aug. 2012).

suggest that, relative to other product-related hazards, a higher proportion of blade-contact injuries is likely to be treated initially in hospital EDs as opposed to non-ED settings (a conclusion that is fully consistent with the staff's ICM estimates of table saw blade-contact injuries). However, this conclusion is not sufficient to allow us to quantify directly the proportion of blade-contact injuries treated outside the ED. Nor does it imply, by itself, that the ICM has overestimated the number of table saw injuries initially treated in non-ED office visits or that the number of injuries treated outside of hospital EDs should be lowered. The ICM bases estimates of non-ED office visits on 10 years of NHIS data showing the relationship between injuries treated in the ED and injuries treated elsewhere.

To estimate the number of injuries treated in non-ED settings, the commenter applied diagnosis-specific ratios of the hospitalization rate for table saw injuries to the hospitalization rate for other products. However, this appears to be an *ad hoc* procedure for reducing non-ED office visits (which the commenter had already concluded, without supporting data, to be too high). Moreover, the commenter presented no empirical basis for estimating (or reducing) the number of injuries treated in non-ED office visits based solely on information from ratios of hospitalized injuries. While the severity of an injury may affect where an injury is treated, the number of table saw injuries treated in doctors' offices cannot be determined directly and solely from estimates of injuries that are hospital admitted.

5. Comment: One commenter stated that the approach CPSC uses to value the intangible costs of injuries is based on estimates from an unrepresentative sample of jury awards and settlements involving unrelated products, motor vehicles, and premises liability. Moreover, the commenter stated that inflators used to "roll-forward" older ICM model values to estimate 2008 dollar costs produce much higher unit cost estimates than if reasonable alternative methods were used to adjust for changes in prices and wages over time.

Response: CPSC staff's evaluation of the intangible cost estimates in the ICM in the proposed rule is based on 2014 dollars and the methodology for the injury cost estimates has changed since the ANPR was issued. Using regression analysis allowed CPSC staff to adjust the pain and suffering awards by a number of relevant factors, including the injury diagnosis and body part affected, the sex of the victim, and the medical costs and work losses resulting from the injury. This process allowed the staff to provide specialized estimates of the intangible costs based on the characteristics of the injury. Additionally, because some of the awards involved motor vehicles and premises liability, the regression analysis also adjusted for these factors to isolate and exclude their impacts from the pain and suffering estimates attributable to consumer products.

Although the commenter criticizes the jury verdict methodology for estimating lost quality of life, and presents alternative valuations based on reductions in quality-adjusted life years, if these estimates are adjusted using indices that reflect actual changes in price levels, rather than changes in the "real wage cost" (RWC) used by the commenter, then the estimates of costs associated with the lost quality of life would result in costs per table saw injury that are comparable to, or higher than, CPSC's estimates.

The commenter's approach for inflating non-medical costs for changes in the nominal price level is not appropriate because it provides estimates of changes in real wages, but does not adjust for changes in the price level. (The change in the RWC index is computed by dividing the changes in wages by the CPI-All Items index, and measures changes over and above inflation.) As a consequence, the commenter's approach using the RWC to inflate non-medical costs substantially underestimates the actual change in the nominal price level.

6. Comment: One commenter suggested that the tangible and intangible societal costs associated with table saw blade-contact injuries amounted to about $1.39 billion, less than 60 percent of the CPSC societal cost estimate of $2.36 billion used by CPSC staff in its 2011 analysis.

Response: The commenter's two adjustments to the table saw blade-contact injury estimates are the principal reason for the difference between the commenter's estimates of injury costs and the ANPR estimates. First, the commenter's use of the NEISS-AIP subsample proportions to adjust the estimate for non-admitted injuries, has no statistical justification. Second, the commenter's assertions that the CPSC underestimated the proportion of table saw injuries that were treated in a hospital setting (and hence the CPSC's estimate of other medically attended injuries is over estimated) is not supported by any empirical data. These two issues are discussed in greater detail in the responses to comments above. In contrast, CPSC's analysis is based on 10 years of the National Health Interview Survey which was used to calculate the ratios between injuries treated and released from the emergency department and those treated in doctors' offices and clinics. Correcting for these two injury adjustments would raise the commenter's cost estimate by 31.7 percent to about $1.83 billion. Additionally, correcting both injury and inflator estimates would raise the injury cost estimate to approximately $2.2 billion, roughly comparable to the $2.36 billion estimate in the ANPR. As discussed in section XI of the preamble, and TAB C of the staff briefing package, estimates of societal costs calculated for the proposed rule are substantially higher, approximately $4.06 billion in 2014 dollars, based on more recent data and analyses.

7. Comment: One commenter asserted that an economic justification for product safety regulation requires some kind of fundamental market failure. The commenter noted that in the absence of such a failure the usual assumption is that consumers will purchase products that offer the mix of characteristics and product price that best match their preferences. The major types of market failure mentioned by the commenter include: (1) inadequate or asymmetric information about risks; (2) externalities that impose costs on non-table saw users; and (3) market power that would allow firms some control over market prices. The commenter concluded that there was no economic justification for a possible table saw rule; in other words, none of the market failures was present or was not present to such a degree as to require a regulatory fix.

Response: According to the Office of Management and Budget's (OMB) Circular A-4 (2003)[58] which provides OMB's guidance on regulatory analyses, a key element of a good regulatory analysis is a statement of the need for such a rule and a description of the problem that the rule is intended to address.[59] If improved safety is needed, and private markets have been unable to efficiently provide it, such a market failure provides an economic justification for regulatory intervention. The major types of market failure, as described in *Circular A-4*, concern (1) inadequate or asymmetric information, (2) externalities, or (3) market power. Inadequate or asymmetric information would exist when consumers underestimate or are generally unaware of the risks posed by risky products or are unable to interpret or adequately process the risk information. Externalities would exist in the market place when one party's actions impose uncompensated benefits or costs on another party. Market power would exist when firms can

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[58] See https://www.whitehouse.gov/omb/circulars_a004_a-4.
[59] *Id.* at 3-7.

exercise market power to reduce output below what would be offered in a competitive industry to obtain higher prices.

Inadequate or asymmetric information. Many of the risks associated with the use of table saws, as well as the potential severity of injuries when users come into contact with a moving blade, are obvious. However, some risks associated with the use of table saws may be poorly understood by consumers, such as sudden movement of the workpiece from kickback which can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. Saw blades are jagged and rotate rapidly, and because the blades are used to cut wood their impact on fingers or hands is readily imaginable. Table saws also come with extensive warnings and safety devices (such as blade guards, riving knives, and anti-kickback pawls) that are intended to reduce the risk of blade contact. Hence, it would be difficult to argue that the risks of table saws use are unknown or somehow hidden from the consumer.

On the other hand, it is possible that some of those injured have not been trained in proper table saw use or have not paid close attention to product warnings. Non-occupational users may use table saws only sporadically and forget or simply neglect safety procedures. Fatigue is known to have played a role in some incidents, and the risk of fatigue due to extended periods of cutting may not be obvious to all consumers. Some of those injured may be adolescents or seniors who are either undergoing cognitive development or cognitive decline and may not fully appreciate the dangers posed by table saws. This is not to suggest that users are unaware of the obvious risks. However, casual users may be unaware of how quickly and how violently an injury can occur, if, for example, a cut results in kickback. Consequently, some consumers could underestimate the actual risks they face. It also may be difficult for occasional users to interpret or process the risk information in a way that allows them to take the appropriate level of safety precautions.

Externalities. Externalities exist when one party's actions impose uncompensated benefits or costs on another party. In the case of table saws, the externalities would generally be financial. If, for example, medical treatment costs are not borne by the injured party, but rather shifted to the public at large, there is a financial externality that the purchaser may not take into account when buying or using a table saw. Based on the injury cost data reviewed by staff for the proposed rule, medical costs and lost wages amounted to roughly $160 million and $1,040 million, respectively. Some proportion of these medical costs and work losses are shifted to the public at large by means of insurance premiums and unemployment compensation.

Market Power. Market power exists when one or more firms can exert some control over the price of the product (by limiting production), or create barriers that prevent other firms from entering the market. For table saws, patents acquired by one firm (*i.e.*, SawStop) regarding their AIM technology, combined with efforts to prevent patent infringement, appear to have provided that firm with sufficient market power to exert some control over the price of the technology (by means of licensing agreements) and to limit the ability of other firms to develop and market similar technology. The emergence of a second firm (*i.e.*, Bosch) that began producing and selling a table saw model with the AIM technology in 2016 does not preclude or negate the existence of market power for one or both of these firms. Moreover, litigation over the alleged patent infringement of the second firm is ongoing.

In summary, there could be several market impediments to a more widespread adoption of the AIM system technology by table saw purchasers. These impediments are discussed further in section XI of the preamble and at TAB C of the staff briefing package.

8. Comment: Based on an evaluation of information provided in the ANPR, and the methodology used in Dr. John Graham's economic analysis of AIM technology,[60] one commenter concluded that mandating the SawStop technology for the bench-top category of table saws is not economically justifiable. Numerous other commenters also stated that the costs of regulation to increase table saw safety are not justified.

Response: The proposed rule would not mandate the SawStop technology for the table saw industry. However, the economic impact of the proposed rule, including potential royalty payments and licensing fees, is addressed in section XI of the preamble and in TAB C of the staff briefing package. Staff's review of the potential benefits and costs of the proposed rule shows that the proposed rule would address roughly 54,850 medically treated blade-contact injuries annually. The societal costs of these injuries amount to about $4.06 billion annually. Based on CPSC staff's benefit and cost estimates, the net benefits (i.e., benefits minus costs) of the proposed rule would amount to an average of $1,500 to $4,000 per saw for the market as a whole.

9. Comment: Some commenters asserted that a standard mandating the AIM technology will increase the price of table saws and will make table saws unaffordable for many individuals and small businesses. Similarly, some said that mandating the AIM technology would increase the price of table saws to the point that it prohibits people from purchasing a table saw for home hobby use or for starting a small business. One commenter equated the increased cost of buying a table saw with AIM technology with having to pay for someone else's stupidity. Another

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[60] Graham, John D., and Chang, Joice, 2014. Reducing the risk of injury from table saw use: The potential benefits and costs of automatic protection. *Risk Analysis*, *35*(2) at 307-317.

commenter opposed mandating the AIM technology because requiring automatic detection and blade retraction in the case of body-contact would eliminate the sub-$1,000 saw segment.

Response: The Commission is aware that the proposed rule would be costly and would result in disruption of the table saw market. In addition, the Commission has to balance the number and severity of blade-contact injuries and the impact of the proposed rule on the product's utility, cost and availability to the consumer. While the proposed rule would substantially reduce blade-contact injuries and the societal costs associated with those injuries, CPSC staff's review showed that the impact of increasing table saw production costs on consumers also would be considerable. The prices for the least expensive bench saws now available are expected to more than double, to $300 or more. In general, the retail prices of bench saws could increase by as much as $200 to $500 per unit, and the retail prices of contractor and cabinet saws could rise by as much as $350 to $1,000 per unit. These higher prices may be mitigated in the longer run, but the extent of any future price reductions is unknown. However, given that the least expensive bench saws currently cost about $129, and the least expensive contractor saws are priced at about $529, CPSC staff expects that some bench and contractor saws will retail for under $1,000.

In addition, because of the likely decline in sales following the promulgation of a rule, consumers who choose not to purchase a new saw due to the higher price will experience a loss in utility by forgoing the use of table saws, or because they continue to use older saws which they would have preferred to replace.

There also may be some other utility impacts. The inclusion of the AIM technology may, for example, increase the weight and (potentially) the size of table saws to accommodate the new technology, to allow access to change the brake cartridge, and to mitigate the effects of the force associated with the activation of the brake cartridge. Although this factor may have a relatively small impact on the heavier and larger contractor and cabinet saws, the impact on some of the smaller and lighter bench saws could markedly reduce their portability.

CPSC staff found no evidence to suggest that the proposed rule will eliminate table saws from home hobby use or for starting small businesses. However, there will be significant impacts on the cost, utility and availability of table saws in the near term. In its preliminary regulatory analysis staff clearly sets out all these considerations. After careful review, the Commission has decided that issuing the proposed rule is appropriate.

10. Comment: Some commenters expressed concern about the effects of the proposed rule on small businesses, such as construction contractors, small woodworking shops, cabinet makers, and wood furniture shops. Concerns were raised about the ability of small businesses to afford new table saws and whether they would go out of business. Two commenters suggested that unemployment would increase due to these small businesses closing.

Response: As discussed in the initial regulatory flexibility analysis in section XII of the preamble, and TAB D of the staff briefing package, CPSC staff believes that the proposed rule will have an impact on small businesses. The price of table saws will increase significantly. However, staff believes that even if the increased cost of a new table saw was $800, and a firm purchased a new table saw each year, the impact on the firm is unlikely to be significant unless the firm had annual receipts of less than $80,000. Nevertheless, staff believes that it is possible that a small number of small businesses might lay off a small number of employees.

11. Comment: Some commenters stated that the SawStop technology is expensive given the cost of the cartridges and blades that would have to be replaced when the technology is triggered. One commenter noted that his blades cost about $100 each and his dado set costs about $300. The commenter expressed concern that the need to replace the cartridge when changing between saw blade and dado set would also increase the set-up time when making such transitions. Some commenters were concerned with false-positive detection with the SawStop systems, especially when cutting pressure-treated wood or metal, increasing their costs. One commenter claimed to have "managed medium size shops where the technology probably saved a finger" but also where "accidental tripping of the mechanism cost thousands of dollars annually." Another commenter expressed some concerns about the availability of replacement cartridges and whether they would be interchangeable among different brands or models of table saws. If replacement cartridges were specific to the brand or model of table saw, it could limit the availability and add to the cost of activation.

Response: CPSC staff is aware of two table saw AIM technologies that have been developed; the first requires replacement of an activation cartridge and, almost always, the repair or replacement of the blade once the system has been activated (SawStop). The second only requires replacement of the activation cartridge after two activations (Bosch REAXX™). However, the future availability of the second system is questionable due to ongoing patent litigation. Although conductive materials or wet wood that is moist enough to conduct enough electricity could activate the AIM system and trip the safety system, both the AIM systems currently in use allow bypass of the system which can be deactivated while cutting conductive materials or wet wood. Accordingly, replacement costs would generally be incurred only if the user's hand or arm came into contact with an operating table saw blade. On average, the replacement cost for the average blade and/or cartridge is expected to amount to roughly $11 to $14 annually over the life of the saw, which would be far below the cost of a blade-contact injury that could amount to tens of thousands of dollars. CPSC staff acknowledges that if a different cartridge is required for use with a dado set, then switching between a regular blade and a dado set may require more time and expense than required in the absence of an AIM system. This may affect productivity in some shops that do a large volume of dado cuts.

12. Comment: One commenter stated that the increased cost of table saws that incorporate an AIM technology will not increase the likelihood that people will purchase table saws but it will likely reduce the demand for table saws and harm table saw manufacturers.

Response: A mandatory standard would increase the manufacturing cost of table saws and manufacturers would attempt to pass on the increased costs to consumers in the form of higher prices. Although some consumers might be more likely to purchase the safer table saws with the AIM technology, the expected price increase likely will result in a significant decrease in the quantity of table saws demanded. CPSC staff estimates that the number of table saws sold annually could decrease by about 90,000 to 250,000 units, at least initially. Because of the expected higher costs and reduced sales, some table saw manufacturers are likely to be adversely affected by a mandatory standard.

13. Comment: One commenter compared a potential regulation requiring an AIM technology in table saws to regulations requiring the use of seat belts. The commenter stated that a person who injures a finger with a table saw is unlikely to become a burden to society at large, which the commenter states is often the case with victims of automobile accidents. Therefore, the commenter stated, the decision of whether to purchase a table saw equipped with AIM technology versus one without it should be left up to the consumer. Another commenter implied, however, that taxpayers will either pay for table saw injuries on what the commenter called the front end, due to the additional cost of a table saw equipped with AIM technology, or the tail end due to the disability of consumers injured in accidents involving table saws. The commenter stated that he preferred paying the additional cost on the front end.

Response: These commenters appear to be discussing the issue of externalities that might be associated with table saw injuries. Externalities would be the costs of injuries that are borne by third parties, people other than users or suppliers of table saws. The existence of externalities may provide a justification for regulation, if the purpose of the regulation is to reduce the costs that fall on third parties not engaged in the activity (*i.e.,* supplying or using table saws). For table saws, the externalities are largely financial and would exist when the costs of medical treatment and work losses resulting from blade contact are shifted to the public through medical insurance premiums and unemployment compensation. However, these externalities constitute a relatively small proportion of the societal costs associated with table saw blade-contact injuries. As described in the preliminary regulatory analysis, the primary cost of injury is associated with the intangible costs of injury, or pain and suffering. These costs are largely borne by the injury victims, rather than third party bystanders. Therefore, although some of the medical costs and some of lost productivity costs associated with table saw injuries could be considered externalities, most of the societal costs associated with table saw injuries are borne by the injured person and do not, therefore, constitute externalities.

F. Unintended Consequences

1. Comment: Numerous commenters stated that adding AIM technology to table saws will give users a false sense of security and will increase unsafe behavior in users that will translate to injuries on other power tools. Many commenters felt that users will not learn to respect the dangers of table saws and power tools in general. Some asserted that excessive reliance on safety devices can lead to complacent behavior, which will inevitably result in an accident. One commenter suggested that mandating the AIM technology on all saws would result in additional non-blade contact and kickback injuries because consumers would be less likely to use other safety technology such as blade guards and riving knife/splitter combinations.

Response: As described in TAB E of the staff briefing package, consumer behaviors may adapt if an AIM system is installed on a table saw. CPSC staff agrees that reliance on the AIM safety technology could lead some users to reduce their use of other safety technology, such as blade guards or riving knife/splitter combinations, thereby increasing exposure and risk of operator blade contact. However, as discussed in section IV of the preamble, a review of incidents from the NEISS data and CPSRMS database that involve table saws indicates that blade-contact injuries continue to occur on table saws originally equipped with riving knives and modular blade guards. In addition, results of the modular blade guard survey indicate that a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed and a majority of respondents did not use the blade guard all of the time. Accordingly, consumers appear to already take actions that reduce the efficacy of safety devices, such as the removal of the blade guard or not choosing to use the modular blade guard at all.

Based on CPSC staff's analysis, the Commission cannot predict whether consumers will take less care when using a table saw with an AIM system relative to current table saws, but some consumers might be even less inclined to use blade guards, which many consumers already remove even in the absence of an AIM system. However, a key factor in assessing the ultimate effect of an AIM system is not simply whether consumers will be less careful when cutting with a table saw employing the system, or even whether the incidence of blade contact is likely to increase, but whether such changes likely will result in a decrease in serious injuries. If the system is effective and works as intended, the severity of an injury resulting from blade contact will be lessened, which likely would reduce the overall number of severe injuries associated with table saws.

2. **Comment:** Several commenters suggested that some users might modify the saws to bypass the safety mechanism, especially in the case of false activations, which users will perceive as a nuisance.

Response: Although some consumers might attempt to bypass the AIM safety technology, CPSC staff believes that consumers would have little reason to bypass it once it is already on the table saw. Because the AIM technology is not generally expected to interfere with the normal use of the table saw and can be used with most types of cuts (with the possible exception for dado cuts on some table saws), there would be no incentive to alter or bypass the safety mechanism. Moreover, staff does not believe there is a high rate of false activations. Based on reports of sales of replacement brake cartridge on the SawStop system, which requires replacement of the brake cartridge and blade after an activation of the system, SawStop estimates that the AIM system may activate about once every nine years of use.

3. **Comment:** Numerous commenters also stated that to avoid paying for a table saw with additional safety features, consumers will pursue more dangerous methods to cut wood by using other tools, such as circular saws, buying used products, or continuing to use an older table saw past its safety life.

Response: CPSC staff agrees that the proposed rule would increase the price of table saws, and that these price increases are likely to reduce sales. We do not know how consumers, who would have purchased a new table saw had the price not increased, would respond. Some may hire professionals instead of doing some projects themselves. Others might borrow or rent table saws, or use an older table saw that they would have preferred to replace. Some might also attempt to use other tools in the place of table saws, as the commenters suggest. If the substitute tools are risky, then the estimated benefits attributed to the proposed rule would be reduced. The Commission seeks comment on the likelihood that consumers will pursue more dangerous methods to cut wood if table saws are equipped with AIM technology and the alternatives consumers will use to do so.

4. **Comment:** A couple of commenters expressed concern for the impact of the proposed rule on the ShopSmith multi-tool system. The commenters stated that the ShopSmith equipment could not be redesigned to allow for the installation of a SawStop system. One commenter expressed concern that the proposed rule could force the company out of business.

Response: Incorporating an AIM technology on some table saws may present some especially difficult challenges that are not faced by other table saw manufacturers. Although the engineering challenges can be resolved, the upfront costs for incorporating the AIM system on some table saws may be substantial for a small business. As discussed in sections XI and XII of the preamble and TAB C and TAB D of the staff briefing package, it is possible that some small manufacturers would reduce their table saw offerings or even exit the table saw market if the proposed rule is issued as a final mandatory standard.

G. Training and Warnings

1. **Comment:** Several commenters stated that table saw injuries are best reduced by training and educating users on safe practices and operation of table saws. Many believed mandatory training in the form of certification is needed while others believed that instructional videos should be provided with every table saw purchase. Other commenters stated that only warnings or instruction labels are required to reduce injuries.

Response: As discussed in TAB E of the staff briefing package, CPSC staff agrees that warnings, instructions, and other methods of educating consumers about the proper use of table saws are important. However, the effectiveness of such approaches is known to be limited. For example, safety and warnings literature consistently identify a classic hierarchy of approaches that should be followed to control hazards. The use of warnings is viewed universally as less effective at eliminating or reducing exposure to hazards than designing the hazard out of a product or guarding the consumer from the hazard. Therefore, the use of warnings is lower in the hazard control hierarchy than these other two approaches. Warnings are less effective because they do not prevent consumer exposure to the hazard, and instead, they rely on educating consumers about the hazard and persuading consumers to alter behavior to avoid the hazard. In addition, to be effective, warnings rely on consumers behaving consistently, regardless of situational or contextual factors that influence precautionary behavior, including fatigue, stress, or social influences. Thus, CPSC staff believes that warnings should be viewed as “last resort” measures that supplement, rather than replace, redesign or guarding, unless these higher level hazard-control efforts are not feasible.

Educational programs may offer more opportunities to present hazard information in varied ways and in greater detail than is possible on a warning label. However, CPSC staff believes that educational programs suffer from limitations similar to those associated with warnings because, like all hazard communications, the effectiveness of such programs depends on affected consumers not only receiving and understanding the message, but also being persuaded to heed the message. Mere knowledge or awareness of a hazard is not necessarily enough. Some versions of the hazard control hierarchy, particularly those in the context of industrial or organizational settings, include training as a separate approach at the same approximate level as warnings because training also involves educating consumers about potential hazards and proper actions or procedures to avoid those hazards. In fact, instructional materials that accompany products can be viewed as a form of training. Thus, warnings, instructions, educational programs, and training serve similar functions and have similar weaknesses.

Although CPSC staff supports the use of these approaches, including providing consumers with instructional videos, human error is inevitable, even among expert woodworkers. Even consumers who are fully aware of the hazards and how to avoid them may suffer from slips or lapses that could lead to blade contact and injury despite the consumer's best intentions to use a product safely. A performance requirement that can detect and react to blade contact in a way that lessens the consequences makes the table saw more forgiving of such errors and expected behaviors, so that the results are not catastrophic. Moreover, mandating a performance requirement for table saws would not preclude manufacturers from encouraging table saw purchasers to become trained on safe table saw practices. Manufacturers can provide additional instruction videos on safe table saw practices or provide free training.

H. Other Comments

1. Comment: Several commenters stated that CPSC should mandate AIM technology on table saws only in industrial or workshop settings or schools.

Response: As discussed in section VI.C. of the preamble, the Commission does not have authority to regulate any risk of injury associated with a consumer product if such risk could be eliminated or reduced to a sufficient extent by action taken by OSHA. However, if the risk to consumers cannot be sufficiently reduced or eliminated by OSHA's actions, the CPSC has the authority to address that risk of injury associated with the consumer product. As discussed in that section, the Commission believes that OSHA regulations do not sufficiently reduce the risk of blade-contact injuries to the consumer. Moreover, the Commission believes that there is no clear dividing line between consumer and professional saws, except at the very highest levels of price and performance. Although some of the more expensive, high voltage table saws may be used in construction work or by professional wood workers, many of these same saws may be also be used in the home, in schools, and in recreation (woodworking workshops, schools and clubs). Therefore, the Commission believes that these types of saws may be used more than occasionally by consumers and fall within the scope of the proposed rule. However, the Commission seeks comment regarding whether the scope of the rule should be modified to exclude certain types of table saws used primarily for commercial or industrial use.

2. Comment: Some commenters stated that the CPSC should provide an "open license" for AIM technology, offer a retrofit option for existing table saws, and encourage AIM technology through tax policy.

Response: The Commission has no authority under the CPSA to mandate an open license for AIM technology, require retrofits on existing table saws, or implement tax policies.

X. Description of the Proposed Requirement \

A. Scope, Purpose and Effective Date - § 1245.1

The proposed rule would apply to all table saws, as defined, including bench saws, contractor saws, and cabinet saws. The proposed rule would include a requirement to mitigate the risk of blade-contact injuries on table saws. Specifically, the proposed rule would establish a performance standard such that table saws, when powered on, must limit the depth of cut to 3.5 mm when a test probe, acting as a surrogate for a human body/finger, contacts a spinning blade at a radial approach of 1.0 m/s.

Under the CPSA, the effective date for a consumer product safety standard must not exceed 180 days from the date the final rule is published, unless the Commission finds, for good cause, that a later effective date is in the public interest. As discussed in section XI of the preamble, and TAB C of the staff briefing package, to meet the proposed performance requirements, it is likely that table saw manufacturers will have to develop new technology or redesign virtually all table saw models, retool production facilities, and enter into licensing arrangements. Because the Commission believes 180 days may not be adequate time to allow for such modifications, it is instead proposing an effective date of three years following publication of a final rule, at which time all table saws would be required to comply with the applicable requirements of the rule.

B. Definitions - § 1245.2

The proposed rule would provide that the definitions in section 3 of the CPSA (15 U.S.C. 2051) apply. In addition, the proposed rule would include the following definition:

- Table saw - a woodworking tool that has a motor-driven circular saw blade, which protrudes through the surface of a table. Table saws include bench saws, contractor saws, and cabinet saws.

The Commission seeks comment on whether the definition of a table saw should be revised or whether additional definitions are necessary.

C. Requirements for Table Saw Blade Contact- §§ 1245.3 and 1245.4

1. Description of Requirement

The proposal would require table saws, when powered on, to limit the depth of cut to 3.5 mm when a test probe, acting as a surrogate for a human body/finger, makes contact with a spinning saw blade at a radial approach rate of 1.0 m/s. The proposal would require that the test probe allow for the accurate measurement of the depth of cut from contact with the saw blade to assess compliance with the proposed requirement. Any test probe that is used should have the appropriate properties (such as electrical, optical, thermal, electromagnetic, ultrasound, etc.) to indicate human body/finger contact with the saw blade and the appropriate physical properties to accurately measure depth of cut. The test probe and test method described in TAB A of staff briefing package, (Appendix A), are considered appropriate for the evaluation of AIM systems using an electrical detection system. This test method may be used for such systems and will be used by CPSC staff in evaluating such systems. However, the Commission does not propose to make this test method mandatory because other AIMS systems may use a different detection approach. For AIM systems using a different detection approach, the method should be modified based on sound material science and engineering knowledge to accurately assess compliance with the proposed requirement.

2. Rationale

The Commission believes that an AIM system can be used to reduce or limit the severity of a table saw blade-contact injury in conjunction with existing table saw voluntary standard requirements for a blade guard and riving knife. AIM systems provide a layer of safety that can mitigate a blade-contact injury if the blade guard or riving knife are removed or fail to function properly, as well as those blade-contact injuries that can occur when a blade guard or riving knife are in place and functioning properly, but where blade contact occurs nonetheless.

A performance requirement that limits the depth of cut to a test probe that contacts a saw blade to 3.5 mm will significantly reduce the severe lacerations, fractures, amputations, and avulsions associated with operator blade contact incidents on table saws because the probe will have the appropriate properties to indicate human body/finger contact with the saw blade and the equivalent injury mitigation on a real human finger will avoid most microsurgery. Most microsurgery will be avoided because the neurovascular bundle in a human little finger, which contains nerves and arteries, is at a depth of approximately 3.5 mm below the 0.5 mm thick epidermal layer of the skin. CPSC staff has determined that a 3.5 mm depth of cut into a conductive test probe is an appropriate surrogate for a 4mm depth of cut into a finger with insulating epidermis over conductive tissue. Additionally, incidents that occur under conditions that increase AIM performance (such as slower approach rate of the hand/finger to the saw blade and/or circumstances that increase detection) may result in minimal injuries.

The Commission recognizes there may be some scenarios, such as kickback, which can cause the operator's hand to be "pulled" into the blade at a high rate of speed or lead the operator to reach as fast as possible for a falling workpiece. There are other scenarios where the radial velocity of the hand/finger may exceed 1 m/s when it contacts the saw blade. At approach speeds greater than 1 m/s, AIM system performance may result in injury severity that requires extensive medical attention. Such incidents may include the microsurgical repair of nerves, blood vessels, and tendons for an incident that might otherwise have resulted in an amputation or could involve injury to several digits or a wider area. Although some incidents may occur under conditions so demanding that AIM performance is unable to prevent a severe injury from occurring, available data on radial approach rates during kickback and non-kickback-related table saw blade contact incidents reviewed by staff indicate that the approach rate does not exceed 0.368 m/s.[61] Thus, CPSC staff's testing and research indicate that the majority of operator blade-contact injuries from table saws can be reduced or mitigated by the proposed performance requirement.

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[61] *See* Gass, S. (2012), *supra* note 46.

D. Prohibited Stockpiling - § 1245.5

In accordance with Section 9 of the CPSA, the proposed rule contains a provision that would prohibit a manufacturer from "stockpiling" or substantially increasing the manufacture or importation of noncomplying table saws between the date of the final rule and its effective date. The rule would prohibit the manufacture or importation of noncomplying table saws in any period of 12 consecutive months between the date of promulgation of the final rule and the effective date, at a rate that is greater than 120 percent of the rate at which they manufactured or imported table saws during the base period for the manufacturer. The base period is any period of 365 consecutive days, chosen by the manufacturer or importer, in the 5-year period immediately preceding promulgation of the rule.

The 5-year period in the anti-stockpiling provision is intended to allow manufacturers and importers sufficient flexibility to meet normal changes in demand that may occur in the period between the promulgation of a rule and its effective date while limiting their ability to stockpile noncomplying table saws for sale after that date. The Commission seeks comments on the proposed product manufacture or import limits and the base period with respect to the anti-stockpiling provision.

E. Findings - § 1245.6

In accordance with the requirements of the CPSA, we are proposing to make the findings required by section 9 of the CPSA. The proposed findings are discussed in section XVIII of the preamble.

XI. Preliminary Regulatory Analysis

The Commission is proposing to issue a rule under sections 7 and 9 of the CPSA. The CPSA requires that the Commission prepare a preliminary regulatory analysis and that the preliminary regulatory analysis be published with the text of the proposed rule. 15 U.S.C. 2058(c).

A. Introduction

The CPSC is issuing a proposed rule to address the unreasonable risk of blade-contact injuries associated with table saws. This rulemaking proceeding was initiated by an ANPR published in the *Federal Register* on October 11, 2016. In 2015, to enhance CPSC's understanding of the market for table saws, CPSC staff entered into two contracts with Industrial Economics, Inc. (IEc) to conduct market research and cost impact analysis on table saws. One report, titled "*Revised Final Table Saws Market Research Report*" (March 28, 2016) (referred to as IEc, 2016a), updates information relied upon in the ANPR and provided in public comments concerning the market for table saws. The report uses publically available information and limited outreach to potentially affected entities. The other report, titled "*Final Table Saws Cost Impact Analysis*" (June 9, 2016) (referred to as IEc, 2016b), estimates the manufacturing and other costs of possible requirements intended to mitigate table saw blade-contact injuries based on previous information collected by the CPSC in the ANPR, public comments, limited interviews with table saw manufacturers, additional research, and the results of IEc, 2016a. In addition to CPSC staff's analysis of existing data, studies, and reports, staff relies on the IEc reports for additional data and information to support the staff's preliminary regulatory analysis (TAB C of the staff briefing package) and initial regulatory flexibility analysis (TAB D of the staff briefing package). These reports are available on the CPSC's website at: ___________.

B. Market Information

1. Manufacturers

A total of 22 firms are known to supply table saws to the U.S. market. This does not include manufacturers of miniature table saws used for constructing doll houses and other hobby products, or tile-cutting table saws. In addition, the 22 firms do not include a number of Asian table saw manufacturers who may have some limited U.S. distribution.

The Power Tool Institute (PTI) estimates that its member companies account for 80 percent of all table saws sold in the United States. Most of these companies are large, diversified international corporations with billions of dollars in sales, such as Stanley Black and Decker, Robert Bosch, Makita, and Techtronic Industries Co., Ltd. These four large, diversified firms are currently supplying table saws to the U.S. market, but table saws make up a relatively small part of their revenues, probably less than one percent. PTI tends to represent the mass market bench table saw manufacturers, while many of the smaller suppliers are primarily in the cabinet and contractor saw market segments.

With the exception of two firms that sell only table saws or multi-purpose tools incorporating table saws (*i.e.*, SawStop and Shopsmith, respectively), anecdotal information provided to CPSC staff suggests that, for the smaller, more specialized firms supplying table saws to the U.S. market, table saws are generally not a large percentage of firms' sales. One company reported that table saw sales contribute a negligible fraction of its $15 million annual revenue. Another company with an annual revenue of $20 to $40 million stated that table saws represent approximately five percent of total sales. Similarly, a third company indicated that only seven to eight percent of total revenue is attributable to table saw sales.[62]

2. Retail Prices of Table Saws

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[62] IEc, 2016a at 12.

The range of prices for table saws generally overlaps for three products: bench, contractor, and hybrid saws. Bench saws are the least expensive, ranging in price from $129 to $975, with a few exceptions. Prices for contractor saws range from $529 to $2,049, and prices for hybrid saws range from $675-$1,595. Generally, cabinet and sliding saws are more expensive. Prices for cabinet saws range from $1,199 to $5,349. The price range for sliding table saws ($2,850-$24,995) overlaps with the range for cabinet saws, but sliding saws are typically more expensive.

The SawStop models containing the AIM technology are consistently priced at the upper end of the price range in each of the three primary table saw categories (bench, contractor, and cabinet). Aside from a couple of bench saws priced at just under $1,500, the SawStop bench saw is next most expensive in the bench saw category at $1,299 -$1,399, depending on the distributor. Similarly, the three SawStop contractor saws, ranging in price from $1,599-$2,049, represent some of the most expensive models in that product category, including the highest-priced offering. The SawStop cabinet models range in price from $2,299-$5,349, depending on power and performance. The SawStop model priced at $5,349 represents the highest priced cabinet saw. The Bosch REAXX™ saw ranges in price from $1,299-$1,499.

3. Types of Table Saws Commonly Used By Consumers

There are three primary categories of table saws: bench, contractor, and cabinet. Bench saws tend to be lightweight, portable, and with several exceptions, generally are priced from about $150 to $1,000. Bench saws generally are intended for consumer use, but also are used at work-sites. Contractor saws are larger, heavier, and more powerful than bench saws, and generally are priced from $500 to $2,000. Cabinet saws (also referred to as stationary saws) weigh from about 300 to 1,000 pounds, are not portable, and generally are priced from about

$1,200 to $5,000. Although these saws all are used by consumers to some extent, contractor and cabinet saws are more likely to be used by professional and occupational users.

Based on staff discussions with industry representatives, electrical requirements and power appear to provide the best distinction between table saws typically used by consumers and those used most often in industrial settings. Two industry representatives indicated to staff that saws operating at 1.75 horsepower or greater likely cannot be run on typical household wiring. Most consumers do not have the necessary electrical wiring, specifically the specialized outlets and adapters, to accommodate power tools with horsepower ratings greater than 1.75 or requiring 220-240 volt power. Sliding table saws and many other cabinet saws require such electrical capabilities and, therefore, are less likely to be used by consumers. However, one manufacturer indicated the firm has begun development of a sliding saw aimed at the high-end do-it-yourself (DIY) market, and a representative from another firm indicated that some serious woodworking hobbyists may wire their home workshops to accommodate the more powerful saws. CPSC staff's review showed that 89 cabinet, hybrid, and sliding models run solely on 220-240 volts. Given wiring requirements, these 89 higher-voltage models are less likely to be used by typical consumers than industrial users.

4. Sales and Numbers in Use

Although the design and engineering of table saws may occur in the United States, most table saws are currently manufactured overseas; several firms staff contacted indicated that their saws are manufactured in Taiwan. For example, one company indicated that it operates quality control offices in Taiwan and China, and imports saws from Asia. This is supported by data from the ITC, which indicates that in 2014 approximately 99 percent of imported table saw units were built in Taiwan and China.[63] Additionally, a small volume of expensive saws most likely intended for industrial use and not intended for consumer use were imported from European and Canadian manufacturers.[64]

The annual number of table saws in use, a measure of risk exposure, was estimated with the CPSC's Product Population Model (PPM), a computer model that projects the number of products in use given estimates of annual product sales and product failure rates.[65] According to PTI, total annual shipments of all table saws to the U.S. market from 2002 to 2014 have ranged from 429,000 to 850,000. Estimates of sales value are not readily available industry-wide. CPSC staff estimated that bench saws account for about 75 percent of the units sold. Staff assumed further that contractor saws (including hybrids) and cabinet saws account for 20 percent and 5 percent, respectively. The failure rate used by staff (*i.e.*, the rate at which table saws go out of use) follows a gamma distribution, a commonly used distribution for the failure of products. That showed an average product life of 10 years for bench saws, 17 years for contractor saws, and 24 years for cabinet saws. Using these parameters, CPSC staff projected a total of about 8.2 million table saws in use in the United States in 2015, including about 5.1 million bench saws, 2.3 million contractor saws, and 0.8 million cabinet saws. Thus, staff estimated that bench, contractor, and cabinet saws account for about 62 percent, 28 percent, and 10 percent of the table

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[63] Data compiled from tariff and trade data from the U.S. Department of Commerce and the ITC for Harmonized Tariff Schedule classification numbers 8465910036 (Tilting arbor table saw, woodworking) and 8465910078 (Sawing machines, woodworking, NESOI). *See* https://dataweb.usitc.gov/scripts/user_set.asp.

[64] For example, a $25,000 computerized numerically controlled (CNC) panel saw designed to cut large pieces of wood, like sheets of plywood is likely only to be used industrially.

[65] Lahr, M.L., Gordon, B.B., 1980. *Product life model feasibility and development study.* Contract CPSC-C-79-009, *Task 6, Subtasks 6.01-6.06).* Columbus, OH: Battelle Laboratories.

saw population, respectively. The Commission seeks comments concerning the proportion of table saw sales by table saw type, or any additional information on the expected product life of table saws.

C. Benefit-Cost Analysis

This section of the analysis consists of a comparison of the benefits and costs of the proposed rule. The analysis is conducted from a societal perspective, considering all of the significant costs and health outcomes. CPSC staff reviewed the characteristics and societal costs of table saw blade-contact injuries. The benefits of the proposed rule are measured as the estimated reduction in the societal costs of injuries resulting from the use of saws containing the AIM technology. The costs of the proposed rule are defined as the added costs associated with the incorporation of the AIM technology in the table saws. Staff calculates the benefits and costs of the proposed rule on a per product in use basis.

Because of the differences in the physical characteristics, the use patterns, and the likely population of users of each of the table saw types (*i.e.*, bench, contractor, and cabinet saws), an independent evaluation of the benefits and costs for each table saw type could be useful. For example, the costs of the proposed rule could exceed the benefits for one or more saw types, even though, in aggregate, benefits could exceed costs for the market as a whole. However, because staff did not have information on the types of saws involved in the injuries, we did not assess the societal costs or benefits of the proposed rule by saw type. Nevertheless, staff has sufficient information on the potential costs of the proposed rule to conduct a breakeven analysis for the various saw types – an analysis that allows us to estimate the number of injuries for each of the saw types that would need to be prevented for the benefits of the proposed rule to equal or exceed the costs. Aggregated estimates of the benefits and cost on an annual basis can be readily calculated given projections of annual table saw sales. CPSC staff also compared breakeven estimates for the various saw types to possible hypothetical distributions of injuries to estimate the number of injuries for each of the saw types that would need to be prevented for the benefits of the proposed rule to equal or exceed the costs.

1. Blade-Contact Injuries

The proposed rule is intended to address table saw injuries resulting from blade contact. As discussed in section IV of the preamble and TAB B of the staff briefing package, an estimated 30,800 injuries reported through NEISS during 2015 were likely to have involved blade contact.

In addition to injuries initially treated in hospital EDs, many product-related injuries are treated in other medical settings, such as, among others, physicians' offices, clinics, and ambulatory surgery centers. Some injuries also result in direct hospital admission, bypassing the hospital ED entirely. The number of table saw injuries treated outside of hospital EDs are estimated with the CPSC's ICM, which uses empirical relationships between the characteristics of injuries (diagnosis and body part) and victims (age and sex) initially treated in hospital EDs and the characteristics those initially treated in other settings.[66] The ICM estimate of injuries treated outside of hospitals or hospital EDs (*e.g.*, in doctors' offices, clinics, *etc*.) is based on data from the Medical Expenditure Panel Survey (MEPS).

The MEPS is a nationally representative survey of the civilian, non-institutionalized population that quantifies individuals' use of health services and corresponding medical expenditures. It combines data from a panel of participants interviewed quarterly over a two-year

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[66] Miller *et al*., 2000, Lawrence, B., 2013, *supra* note 53; Bhattachara, S., *et al*., 2012, *supra* note 57.

time period with data from the respondents' medical providers. The MEPS is administered by the Agency for Healthcare Research and Quality (AHRQ). The ICM uses the MEPS data, in combination with a classification tree analysis technique, to project the number and characteristics of injuries treated outside of hospitals.

To project the number of direct hospital admissions which bypass hospital EDs, the ICM uses data from the Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP-NIS), which was also analyzed using a classification tree analysis technique. HCUP is a family of healthcare databases and related software tools and products developed through a federal-state-industry partnership and sponsored by AHRQ. The HCUP-NIS provides information annually on approximately 3 to 4 million inpatient stays from about a thousand hospitals.

The classification tree analysis technique (also called decision tree) is a statistical tool that divides and sorts data into smaller and smaller groups for estimating the ED share of injuries until no further gains in predictive power can be obtained. This technique allows for more precise estimates of injuries treated in doctor visits or injuries admitted directly to the hospital than other regression techniques. For example, where data is available, the age and sex of the victim can have an influence on the estimates of the number of injuries treated outside the emergency department. When we combine the national estimates of the NEISS with the non-ED estimates from the ICM using classification tree techniques, we obtain a total of medically treated injuries.

Based on the annual estimate of about 30,800 blade-contact injuries initially treated in hospital EDs, the ICM projects approximately 24,050 blade-contact injuries treated in other treatment settings. Combined with the ED-treated injuries, there were an estimated annual total of about 54,850 medically treated blade-contact injuries. About 13.7 percent of the medically treated injuries involved amputations, 56.9 percent involved lacerations, 22.8 percent involved fractures, and 6.1 percent involved avulsions.[67] About 27.5 percent of the amputations resulted in hospital admission, compared to about 4.0 percent of lacerations and 12.1 percent of fractures. About 31.5 percent of the amputations were treated in the doctors' offices/clinics and other non-hospital settings, compared with about 41.0 percent of lacerations, 50.3 percent of fractures, and 38.7 percent of avulsions.

The blade-contact injury rate per 100,000 saws is calculated by dividing medically treated injuries by the estimated number of table saws in use. Overall, the blade-contact injury rate for table saws amounted to about 670 medically treated injuries per 100,000 saws. An approximate 95 percent confidence interval for medically treated injuries, based on estimates of the coefficient of variation (CV) from the NEISS injury estimates, ranges from about 550 to 790 medically treated injuries per 100,000 saws in use.

2. Injury Costs of Blade-Contact Injuries

The societal costs of blade-contact injuries represent the pool from which the benefits of a blade contact rule are derived. The societal costs of these injuries are quantified with the ICM. The ICM is fully integrated with NEISS, and, in addition to providing estimates of the societal costs of injuries reported through NEISS, it also estimates the costs of medically treated injuries that are initially treated outside of hospital emergency departments. The major aggregated

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[67] Medically treated table saw injuries, by injury diagnosis, differ from the NEISS estimates because the NEISS cases are limited to those initially treated in hospital emergency departments.

societal cost components provided by the ICM include medical costs, work losses, and the intangible costs associated with lost quality of life or pain and suffering.[68]

Medical costs include three categories of expenditures: (1) medical and hospital costs associated with treating the injury victim during the initial recovery period and in the long run, including the costs associated with corrective surgery, the treatment of chronic injuries, and rehabilitation services; (2) ancillary costs, such as costs for prescriptions, medical equipment, and ambulance transport; and (3) costs of health insurance claims processing. Cost estimates for these expenditure categories were derived from a number of national and state databases, including the MEPS, the HCUP-NIS, the Nationwide Emergency Department Sample (NEDS), the National Nursing Home Survey (NNHS), MarketScan® claims data, and a variety of other federal, state, and private databases.

Work loss estimates include: (1) the forgone earnings of the victim, including lost wage work and household work, (2) the forgone earnings of parents and visitors, including lost wage work and household work, (3) imputed long term work losses of the victim that would be associated with permanent impairment, and (4) employer productivity losses, such as the costs incurred when employers spend time juggling schedules or training replacement workers. Estimates are based on information from HCUP-NIS, NEDS, Detailed Claims Information (a

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[68]Miller *et al*., 2000, Lawrence, B., 2013 *supra* note 53; *see also*, Lawrence, Bruce, *Impact of alternative discount rates on injury cost model estimates* (Contract CPSC-D-05-0006, Task Order 7). Calverton, MD: Pacific Institute for Research and Evaluation (Nov. 2008); Lawrence, Bruce, *Updated price indexes for the Injury Cost Model* (Contract CPSC-D-0003, Task Order 3, Subtask 4). Calverton, MD: Pacific Institute for Research and Evaluation (Aug. 2015); Lawrence, Bruce, *Update medical costs for ED-treated injuries* (Contract CPSC-D-0003, Task Order 3, Subtask 1). Calverton, MD: Pacific Institute for Research and Evaluation (Jan. 2015); Lawrence, Bruce, *Update medical costs hospital-admitted injuries* (Contract CPSC-D-0003, Task Order 3, Subtask 2). Calverton, MD: Pacific Institute for Research and Evaluation (Jan. 2015); Lawrence, Bruce, *Updated survival probabilities for the Injury Cost Model* (Contract CPSC-D-0003, Task Order 3, Subtask 3). Calverton, MD: Pacific Institute for Research and Evaluation (Aug. 2015).

workers' compensation database), the National Health Interview Survey, U.S. Bureau of Labor Statistics, and other sources.

The intangible, or non-economic, costs of injury reflect the physical and emotional trauma of injury as well as the mental anguish of victims and caregivers. Intangible costs are difficult to quantify because they do not represent products or resources traded in the marketplace. Nevertheless, they typically represent the largest component of injury cost and need to be accounted for in any benefit-cost analysis involving health outcomes.[69] The ICM develops a monetary estimate of these intangible costs from jury awards for pain and suffering. Although these awards can vary widely on a case-by-case basis, studies have shown them to be systematically related to a number of factors, including economic losses, the type and severity of injury, and the age of the victim.[70] Estimates for the ICM were derived from regression analysis of jury awards in nonfatal product liability cases involving consumer products compiled by Jury Verdicts Research, Inc.

Based on ICM estimates, the aggregate present value of the injury costs associated with the estimated 54,843 medically-treated table saw injuries amounted to about $4.06 billion (in

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[69] Rice, Dorothy P., MacKenzie, Ellen J., and Associates, 1989. *Cost of injury in the United States: A report to Congress.* San Francisco, CA: Institute for Health & Aging, University of California and Injury Prevention Center, The Johns Hopkins University; Haddix, Anne C., Teutsch, Steven M., Corso, Phaedra S., 2003. *Prevention effectiveness: A guide to decision and economic evaluation* (2nd ed.). New York: Oxford University Press; Cohen, Mark A., Miller, Ted R., 2003. "Willingness to award" nonmonetary damages and implied value of life from jury awards. *International Journal of Law and Economics*, 23 at 165-184; Neumann, Peter J., Sanders, Gillian D,, Russell, Louise B., Siegel, Joanna E. Ganiats, Theodore G., 2016. *Cost-effectiveness in health and medicine*: *Second Edition.* New York: Oxford University Press.

[70] Viscusi, W. Kip, 1988. The determinants of the disposition of product liability cases: Systematic compensation or capricious awards? *International Review of Law and Economics,* 8, at 203-220; Rodgers, Gregory B., 1993. Estimating jury compensation for pain and suffering in product liability cases involving nonfatal personal injury. *Journal of Forensic Economics 6*(3), at 251-262; Cohen, Mark A., Miller, Ted R. (2003). "Willingness to award" nonmonetary damages and implied value of life from jury awards. *International Journal of Law and Economics*, 23, at 165-184.

2014 dollars) when future injury losses (primarily those associated with long term work loss) were discounted at 3 percent. This suggests injury costs of about $74,050 per injury (*i.e.*, $4.06 billion ÷ 54,843 injuries). When future losses were discounted at 7 percent, the aggregated present value amounted to about $3.65 billion, or about $66,650 per injury (*i.e.*, $3.65 billion ÷ 54,843 injuries).

OMB (2003) recommends discounting future benefits (or costs) using both 3 percent and 7 percent discount rates. The 7 percent discount rate is intended to reflect the rate of return to private capital in the U.S. economy. The 3 percent rate is intended to represent what is sometimes called the "social rate of time preference," which is more consistent with the rate which "society" discounts future consumption flows to their present value.[71] Using the lower social discount rate means that future benefits are valued somewhat more highly than they would be with the a higher discount rate. Most sources suggest that the social rate of time preference is more appropriate when evaluating health-related interventions,[72] which is the intended purpose of the proposed rule. Consequently, the 3 percent discount rate is probably the more appropriate discount rate for evaluating the benefits and costs of the proposed rule. Presenting most results using both the 3 percent and 7 percent, as recommended by OMB, shows the sensitivity of the results to variations in the discount rate.

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[71] OMB, 2003. *Circular A-4: Regulatory analysis.* Washington, DC: Office of Management and Budget. https://www.whitehouse.gov/omb/circulars_a004_a-4.

[72] Gold, Marthe R., Siegel, Joanna E., Russell, Louise B., Weinstein, Milton C., 1996. *Cost-effectiveness in health and medicine*. New York: Oxford University Press; Haddix, Anne C., Teutsch, Steven M., Corso, Phaedra S., 2003. *Prevention effectiveness: A guide to decision and economic evaluation* (2nd ed.). New York: Oxford University Press; Neumann, Peter J., Sanders, Gillian D,, Russell, Louise B., Siegel, Joanna E., Ganiats, Theodore, G., 2016. *Cost-effectiveness in health and medicine*: *Second Edition.* New York: Oxford University Press.

The distribution of injury costs, by medical treatment setting (using the 3 percent discount rate) showed that overall, medical costs and work losses accounted for roughly 30 percent of the total, while the non-economic losses associated with pain and suffering accounted for 70 percent. Injury cost estimates for non-hospitalized injuries ranged from about $28,000 for blade-contact injuries treated outside of hospitals and EDs, to about $42,000 for injuries initially treated in hospital EDs (but not admitted). Injury costs for hospitalized injuries, in contrast, averaged about $450,000 per injury.

While amputations accounted for about 13.7 percent of the medically treated blade-contact injuries, they accounted for almost 64 percent of the annual estimate of $4.06 billion in societal costs resulting from blade contact. The average imputed cost per amputation injury amounted to about $345,000, and ranged from $120,000 to $195,000 for non-hospitalized amputations to about $825,000 per hospitalized amputation.[73] If amputations were excluded from the injury cost estimates, the injury costs would have been reduced from about $74,050 per injury to about $31,200 per injury.

In contrast to the average injury cost of about $345,000 per medically treated amputation, the average imputed cost for lacerations (which accounted for about 56.9 percent of medically treated injuries) amounted to about $19,500. The average imputed cost for fractures (accounting for about 22.8 percent of injuries) and avulsions (6.1 percent of injuries) amounted to about $48,250 and $72,900, respectively.

3. Societal Costs, per Table Saw in Use

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[73] About 29.3 percent of the amputation injury costs were attributed to medical costs and work loss; 70.7 percent were attributed to pain and suffering.

Table 10 presents estimates of the present value of societal costs, per table saw in use. Row (a) shows the aggregate annual societal costs, by discount rate. Row (c) shows annual societal costs *per saw*, and the results are calculated by dividing the aggregate annual societal costs (row a) by table saws in use (row b).

Row (e) presents the present value of societal costs, and the results were calculated using the row (c) estimate of annual societal costs and a 3 percent and 7 percent discount rate over the saw's expected useful product life (row d). For this analysis, the expected product life was based on an average for the three saw types, weighted by the proportion of saws in use for each table saw type. The present value figure amounts to about $5,400 per table saw using a 3 percent discount rate and about $3,800 at 7 percent; this present value estimate represents the maximum per unit benefits that could be derived from a rule addressing blade contact if such a rule prevented all blade-contact injuries.

Table 10. Present Value of Societal Costs per Table Saw in Use

	Discount Rate	
	3 Percent	7 Percent
(a) Aggregate Annual Societal Costs (Billions $)	$4.06	$3.65
(b) Table Saws in Use (Millions)	8.2	8.2
(c) Societal Costs per Table Saw [(a) ÷ (b)]	$495	$445
(d) Expected Useful Product Life (years)	13.3	13.3
(e) Present Value of Societal Costs, per Table Saw	$5,366	$3,772

4. Effectiveness and Expected Benefits of the Proposed Rule

The benefits of the proposed rule are measured as the reduction in the societal costs of injuries resulting from the use of the safer saws. Consequently, CPSC staff estimated the expected effectiveness of the proposed rule in preventing blade-contact injuries. Although effectiveness cannot be determined precisely, staff believes that an AIM system can reduce or mitigate a blade-contact injury even if the blade guard or riving knife is removed or fails to function properly. Based on testing experience with existing AIM systems, CPSC staff believes that the proposed performance requirement can significantly reduce the severity of injury involving blade contact.

However, a rule requiring manufacturers to develop an AIM technology to meet the proposed performance requirement will not prevent all blade-contact injuries. It will not prevent blade-contact injuries that occur: (1) when the blade is operating but the AIM system has been deactivated; (2) when the operator's hand is moving into the blade so quickly that contact with the blade cannot be reduced sufficiently to prevent serious injury; and (3) when the AIM technology leads to complacency or reductions in safety efforts by users that result in injury.

Based on CPSC staff's testing of existing AIM systems, we assume that the AIM technology will prevent or substantially or mitigate 70 percent to 90 percent of blade-contact injuries. The estimate of 90 percent effectiveness assumes that all blade-contact injuries, including blade-contact injuries initiated by kickback, will be addressed by the AIM technology, but that about 10 percent of Blade-contact injuries will not be prevented or mitigated because of the reasons given above. The estimate of 70 percent effectiveness assumes that about 40 percent of blade-contact injuries involved kickback, and that only about half of the kickback injuries would be prevented or substantially mitigated. Additionally, we assume that the mitigated accidents that would have resulted in amputations, avulsions, and fractures are not prevented entirely, but become medically treated lacerations, and that accidents that would have resulted in medically treated lacerations are either mitigated to injuries that do not require medical attention or are prevented entirely.

Expected benefit of the rule, per table saw, over the saws expected product life are as follows:

- benefits at 70 percent effectiveness at 3 percent - $3,335
- benefits at 70 percent effectiveness at 7 percent - $2,345
- benefits at 90 percent effectiveness at 3 percent - $4,288
- benefits at 90 percent effectiveness at 7 percent - $3,015

The benefits at 70 and 90 percent effectiveness, result in about a 62 percent and 80 percent reduction, respectively, in the estimated societal costs.

5.. Costs to Meet Performance Requirements

This section discusses the types of costs that would result from a rule that would require an AIM safety technology to meet the proposed performance requirement, and quantifies some estimates of these costs provided by industry participants. Table saw manufacturers are likely to incur three primary types of costs to incorporate AIM technology into their table saws, including:

- *Costs to develop AIM technology***.** Manufacturers would have to either design and develop their own AIM technology or license the AIM technology developed and owned by another party.
- *Redesign and retooling costs*. Incorporating AIM technology into existing models would require manufacturers to redesign each model and retool the facilities where the saws are manufactured. All table saw models not currently incorporating the AIM technology likely would require redesign to provide room for blade retraction, to allow access for users to change the cartridge and, if necessary, the blade, and to withstand the force of the AIM system being triggered.

- *Materials costs*. The combination of the addition of a brake cartridge, or other means of stopping or retracting the blade after contact with flesh, and the redesign of the table saw to accommodate the additional electronic components and wiring, the required clearances, and the weight and dimensions of the AIM technology, would result in increased material costs.

a. Costs to Develop AIM technology

The proposed performance requirement for table saws would limit the depth of cut to a test probe, upon making contact with the saw blade at a radial approach rate of 1.0 m/s, to 3.5 mm. Although the proposed rule would allow for a variety of detection methods (such as electrical, optical, thermal, electromagnetic, ultrasound) to comply with the proposed requirements, the Commission is aware that, currently, only two manufacturers have developed an AIM technology using an electric detection system that is available on the market: SawStop and Bosch REAXX™ table saws.[74] If manufacturers are unable to develop their own AIM system, or if their AIM technology infringes on SawStop patents, we believe that ongoing patent infringement litigation initiated by SawStop may have a bearing on SawStop or other companies' willingness to license their AIM technologies. Various stakeholders have expressed concern that a mandatory rule could impose a monopoly for SawStop technology given the numerous patents that have been filed on its behalf. PTI reports that SawStop has filed more than 140 patent applications, and has over 100 issued patents pertaining to SawStop technology.

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[74] A third company, Whirlwind Tool Company, has developed a "Black Box flesh-sensing prototype," which does not involve a blade retraction system, but uses a fixed protective guard and a very rapid, non-destructive motor-braking to stop the saw blade when the operator's hand is too close to the spinning blade. However, the Whirlwind system is not yet available in the market.

On July 16, 2015, SawStop filed a complaint in the U.S. District Court in Oregon for patent infringement against Bosch. On the same date SawStop also filed a complaint against Bosch with the ITC requesting a permanent order excluding from entry into the United States certain table saws incorporating AIM technology and components that infringe on SawStop's patent claims. The complaint filed in the District Court in Oregon is on hold pending the final decision of the ITC. In the ITC proceeding, an administrative law judge (ALJ) issued an initial determination in September 2016 that the Bosch REAXX™ bench saw infringes on several SawStop patents.[75] Specifically, the ALJ found that Bosch infringes the claims of U.S. Patent No. 7,895,927 ('927 Patent),[76] titled "Power Equipment with Detection and Reaction Systems"; and U.S. Patent No. 8,011,279 ('279 Patent) titled "Power Equipment with Systems to Mitigate or Prevent Injury."[77]

On November 10, 2016, the ITC decided not to review the ALJ's initial determination, and requested that interested parties provide written submissions on the issues of remedy, the public interest, and bonding by November 22, 2016, with reply submissions due December 2, 2016. Although the briefs have been filed, the ITC has not yet issued a final decision. Once the ITC issues a final disposition on the remedies, the U.S. Trade Representative, as delegated by the President, would have sixty days to approve or disapprove the ITC's action.

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[75] *Certain Table Saws Incorporating Active Injury Mitigation Technology and Components Thereof*, USITC, Inv. No. 337-TA-965 (ALJ Thomas B. Pender, Sept. 9, 2016)

[76] As described in ID, the '927 patent generally describes woodworking machine safety systems that include reaction systems designed to retract a cutting tool below a working system with approximately 14 milliseconds after the detection of a dangerous condition. *Id.* at 5-6.

[77] As described in the ID, the '279 patent generally describe woodworking safety systems that include an actuator designed to move a moveable component in order to mitigate injury in response to detection of a dangerous condition. *Id.* at 6.

The outcome of the ongoing lawsuit involving the SawStop technology will determine some of the impacts that may result from a mandatory rule requiring AIM technology in table saws. If the court determines that the patents covering the SawStop technology allow for companies to manufacture their own saws with alternative AIM technologies (such as the Bosch REAXX™ saw), then some manufacturers may choose to try to develop their own proprietary technology or license the Bosch technology (if available) as an alternative to the SawStop technology.

Alternatively, if the court decides that alternative technologies do in fact infringe upon SawStop patents, then SawStop may effectively have a monopoly on the technology needed to comply with a mandatory rule until the patents expire. Other manufacturers likely would be required to work with SawStop to license the SawStop technology for use in their saws, or leave the table saw market. PTI and SawStop agree that this is the case. The level at which the royalty payments are set will play a significant role in determining the economic impacts the CPSC's proposed rule would have on table saw manufacturers. We note that some of the allegedly infringed upon patents may expire in 2020 ('927), and 2022 ('279). However, given the extensive number and reach of the SawStop patents, we do not know how, and to what extent, the SawStop patents may impact companies who attempt to introduce alternative AIM technologies. Nor do we know when the other SawStop patents expire or whether SawStop will file additional patents.

The royalty fee for licensing the AIM technology from SawStop is uncertain. Although Dr. Gass has indicated that SawStop would accept royalty payments of 8 percent of a saw's wholesale price if all table saws are required to use SawStop's AIM technology,[78] there is no certainty that SawStop would actually license the technology under terms that would be acceptable to other manufacturers. Indeed, with the exception of one company,[79] several companies that have attempted to license the SawStop technology thus far have not been successful.[80]

CPSC staff believes that in addition to the direct manufacturing and replacement parts costs and the lost consumer surplus discussed below, approximately $30 million to $35 million annual royalty fees for the AIM technology could accrue to patent holders. This estimate is based on the assumption that royalty fees will amount to about 8 percent of the wholesale costs of table saws when a rule would become effective. However, because royalties represent transfers from manufacturers to a patent holder, they are not included as costs for purposes in the benefit-cost analysis.[81] The rationale for not including royalties is based on the premise that royalty fees represent a transfer from one market segment to another (*i.e.*, from table saw manufacturers to patent holders) and remain available (by a different party) for productive use. Nevertheless, from the point of view of an individual manufacturer who pays the royalty, the payment represents a cost. Table saw manufacturers who would be paying royalties to a competitor would, in effect, be reducing their competitiveness relative to the patent holder receiving the royalties. Consequently, the royalty transfers represent an impact of the proposed rule that needs to be considered, and staff has evaluated the potential costs of royalties as discussed in Table 12.

b. Redesign Costs

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[78] IEc, 2016a at 19.
[79] SawStop and Griggio, an Italian manufacturer collaborated to develop a sliding table saw. IEc, 2016a at 18.
[80] *Id*.
[81] OMB, 2003. Circular A-4, available at: https://www.whitehouse.gov/omb/circulars_a004_a-4.

Interviews with several manufacturers, as well as a review of public comments provided by PTI to the ANPR, revealed general agreement that implementing a rule requiring AIM technology would necessitate a complete redesign of all saws that do not currently incorporate the AIM technology. More specifically, the trunnion system would have to be redesigned, and the cabinet/interior of the saw would need to be modified to incorporate the technology and allow access to change out the brake cartridge or to allow clearance for blade retraction.[82] The support structure, such as the stand, would also likely need to be redesigned to bear the extra weight of the AIM system and to absorb the force applied by the triggering of the AIM mechanism. PTI estimates that the cost to redesign and retool existing table saws would range from \$2 million to \$10 million per company.[83]

SawStop has indicated that SawStop's tooling costs were approximately \$200,000 for its first cast iron (*i.e.*, contractor/cabinet) table saw, and were approximately \$700,000 for its first benchtop table saw.[84] SawStop's estimates are within the range of estimates provided by other firms. In interviews with manufacturers, several companies indicated the cost to redesign saws could be approximately \$500,000 per saw.[85] One company indicated that retooling could cost \$100,000 to \$200,000. An additional cost of several hundred thousand dollars may be necessary depending on the level of engineering required for the redesign. For example, according to one company, a redesign of the trunnion system alone may cost \$200,000.

[82] A trunnion is an assembly that holds a saw's arbor to the underside of the saw table.
[83] Graham, J. 2010. *Expert report of Dr. John D. Graham*. (April 27). Submitted with the PTI public comments (2012) CPSC-2011-0074-1106, available at: regulations.gov.
[84] SawStop Comment to the ANPR, *supra* note 46.
[85] IEc, 2016a at 20.

Several companies suggested that the redesign and retooling of table saws would, at least on the initial models, be expected to take one to three years. However, redesigning and retooling subsequent models would require a shorter period and cost less. Four small firms interviewed indicated that the cost of redesigning their saws to incorporate AIM technology may be too great, relative to their sales volume, to support such a redesign. They indicated that they might respond by reducing or eliminating their offerings of table saws to the U.S. market.[86]

c. Material Costs

In addition to the redesign and tooling costs, additional costs would result from the additional components and the increased use of raw materials associated with inclusion of the AIM system. For SawStop models, the additional costs associated with the AIM system is approximately $58 (including brake cartridge, cartridge key, cartridge cable, cartridge bracket, insulation on arbor, electrode shell assembly, and power supply/motor control). An estimate from another firm suggested $74 (including cartridge, electronics, and mechanical parts).

The AIM technology also will affect the weight of the table saws, adding to material costs. Although the added weight is applicable to all table saws equipped with the AIM technology, the added weight will particularly affect the bench saws, which typically can be transported by a single person. Currently, the lightest bench saws weigh 35 to 40 pounds. While the various components needed for AIM compliance may only weigh a few pounds, the structure of some saws may need to be strengthened to be stable and to withstand the shock of blade braking and/or retraction if those methods are used. This need for strength may contribute substantially to the added weight of some complying saws. Adding the AIM technology

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[86] *Id.*

effectively could double the weight of some of the lightest saws, reducing the portability and utility of lightweight bench saws.

D. Unit Manufacturing Cost Impact

1. Low-End Manufacturing Costs

For bench saws, SawStop has indicated that retail prices for bench saws would increase by no more than $150 per unit as result of the rule.[87] Dr. Gass estimates that in the short-term (*i.e.*, within the first five years following the promulgation of the rule), the cheapest saws available (*i.e.*, inexpensive bench saws that currently cost about $150) will have a price of approximately $299. Thus, SawStop projects a short term cost increase of about $150. In the absence of more specific information about manufacturing costs, CPSC staff uses this figure as the basis for the low-end estimate of manufacturing cost increases for bench saws.

For contractor and cabinet saws, the low-end expected cost impacts were based on discussions with other industry members. One manufacturer estimated that the retail price of the single table saw model that they produce would increase by about 30 percent as a result of the rule, including the cost of royalties. Excluding royalties, this estimate suggested a cost increase associated with redesign, retooling, and materials of about $256.[88] For this analysis, we assume that this $256 low-end cost increase can be applied to all contractor and cabinet saws.

2. High-end Manufacturing Costs

For bench saws, the high-end cost increase is based on information provided by PTI, whose members produce primarily bench saws. PTI estimates that the increase would be $100 to

[87] SawStop, LLC. 2009. Presentation to CPSC, December 8 & 9. See also, *Osorio v. One World Technologies, Inc.*, 659 F.3d 81, 83 (1st Cir. 2011).
[88] IEc, 2016b at 11-12.

$800 per saw, excluding royalties.[89] In the absence of more specific estimates, CPSC staff uses the midpoint of this range, $450 per saw, as the short-term high-end estimate for bench saws.

For contractor and cabinet saw models, we apply the high-end of the range estimated by PTI and other manufacturers. One table saw manufacturer provided an estimate ranging from $500 to $800 for "larger saws," excluding royalties. Another manufacturer estimated that the retail price of saws would increase 20 percent, excluding the cost of royalties.[90] Applying this percentage to the company's cabinet saw models results in added costs of about $260 to $800. Consequently, CPSC staff assumes the high-end incremental cost increase is $800, the upper bound of each range suggested by PTI and these two manufacturers. In the longer term, after about five years, we would expect that the incremental cost would decrease, though the magnitude of such a decrease is uncertain.

3. Replacement Part Costs

In addition to the direct costs of the rule just described, there also will be the added costs of replacement parts related to the AIM system. For purposes of our analysis, we base the cost of replacement parts on the SawStop system, which requires replacement of the brake cartridge and blade after an activation of the system. Replacement part prices are estimated to include $69 for a replacement brake cartridge (based on current online prices), and $30 to $90 for a replacement blade. Based on sales of replacement brake cartridges, SawStop estimates that the AIM system may activate about once every nine years of use. [91] At a replacement rate of once every nine years (and assuming $60 per replacement blade), this results in an annual per-unit replacement

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[89] *Id.* at 12.
[90] *Id.*
[91] *Id.* at 13.

part cost of approximately $14 [($69 + $60) ÷ 9]. However, because blades depreciate and would require periodic replacement even in the absence of an AIM activation, we assume that the need for replacement blades due to an activation costs an average of about $30 every nine years (rather than $60), for an average of about $11 annually [($69 + $30) ÷ 9]. The present value of this expected annual cost of $11 over the life of a typical table saw, and discounted at a rate of 3 percent, would amount to about $94 for bench saws (with a 10-year expected product life), $145 for contractor saws (with an estimated 17-year product life), and $186 of cabinet saws (with an expected 24-year product life). With a discount rate of 7 percent, the present value of expected costs would amount to about $77, $107, and $126 for bench, contractor, and cabinet saws, respectively. For purposes of this cost analysis, we use the midpoint of this range. Hence, we estimate that replacement parts costs for the AIM system would amount to about $86 for bench saws, $126 for contractor saws, and $156 for cabinet saws.

Additionally, the Bosch REAXX™ bench saws, introduced on June 1, 2016, use a $100 cartridge that lasts for two activations. Since the blade is not destroyed by the activation, the Bosch system has lower replacement part costs. However, staff does not have any information on how frequently the cartridge will be activated. If, however, the Bosch cartridge activates once every nine years, based on the SawStop experience, and the cost is $100 for two activations, then the expected annual per-unit replacement cost would be about $5.55 annually (($100/2) ÷ 9). The present value of this expected annual cost of $5.55 over an average product life of 10 years for a bench saw (discounted at a rate of 3 percent) would amount to about $47 per saw, about half the expected costs of the SawStop system. Additionally, the Bosch system does not require any additional dado hardware related to the AIM system. Consequently, if the Bosch REAXX™ stays in the market, our baseline estimates of replacement costs might be reduced.

The direct manufacturing and replacement costs are presented in Table 11, and rely on the low- and high-end direct manufacturing costs and the SawStop replacement costs as described.[92]

Table 11. Direct Manufacturing and Replacement Costs

Table Saw Type	Direct Manufacturing Costs		Replacement Parts Costs	Total Direct + Replacement Costs	
	Low-End Estimates	High-End Estimates		Low-End Estimates	High-End Estimates
Bench	$150	$450	$86	$236	$536
Contractor	$256	$800	$126	$382	$926
Cabinet	$256	$800	$156	$412	$956

Based on the available information, there is considerable uncertainty concerning the per unit manufacturing cost impact of a rule requiring the use of AIM technology on table saws. Accordingly, the Commission seeks any comments that would allow us to make more precise estimates or narrow the range we present regarding the unit manufacturing cost impact of a rule requiring the use of AIM technology on table saws.

4. Impact on Product Usability

The AIM technology will also affect the weight of the table saws, adding to material costs. While the added weight is applicable to all table saws equipped with the AIM technology, the added weight will particularly affect bench saws, which, as currently configured, typically can be transported by a single person. Currently, the lightest bench saws weigh 35 to 40 pounds. While the various components needed for AIM compliance may only weigh a few pounds, the structure of some saws may need to be strengthened to be stable and to withstand the shock of blade braking and/or retraction if those methods are used. This need for strength may contribute

[92] The SawStop AIM system has optional hardware to perform dado cuts which includes an $89 dado brake cartridge. This dado brake system is not included in Table 11.

substantially to the added weight of some complying saws, perhaps as much as an 18 pound increase.

An additional four or five pounds is not a major weight penalty on a forty pound bench saw, but an 18 pound increase would reduce portability. An additional 20 pounds (on top of the 18 pounds) for a more substantial jobsite saw type structure, if necessary, would further decrease portability. For contractor saws, with wheels and stands, the weight penalty would not be substantial. Cabinet saws are not portable at all, so the weight penalty may make no real difference. However, adding the AIM technology could effectively double the weight of some of the lightest saws, reducing the portability and utility of lightweight bench saws. The Commission seeks public comments on the impact of the AIM technology on the utility of table saws, and possible methods of quantifying these impacts.

E. Impact of Higher Prices on Sales and Lost Consumer Surplus

The increasing retail prices of table saws, as costs are passed on to consumers, will result in a reduction in table saw sales. As a consequence, and in addition to the price impacts on consumers who continue to purchase saws, consumers who decide not to purchase table saws because of the higher prices will experience a loss in consumer surplus. For purposes of this analysis, we assume that cost increases as well as royalties are pushed forward to consumers. Table 12 provides baseline sales and median retail price estimates,[93] along with the total per product compliance cost estimates, including both the costs associated with manufacturing the redesigned table saws and the expected costs of replacement parts over the expected product life

[93] Retail price information was collected for all of the table saw models available. However, we were unable to calculate a weighted average retail price for each category of saw because we do not have sales information for the various models. Consequently, we apply the median price advertised for each category as baseline pre-regulatory retail prices.

of a table saw. Table 12 also provides an estimate of the expected royalty fee, under the assumption, based on Dr. Gass's statements, that the fee would amount to 8 percent of a saw's wholesale price.[94] The per unit cost and royalty fee estimates are provided for both the low-end and high-end cost estimates.

Table 12. Baseline Annual Table Saw Shipments, Retail Prices, and Per Unit Compliance Cost Estimates and Royalty Fees

Table Saw Type	Pre-Regulatory Baseline Estimates		Per Unit Cost Estimates*		Per Unit Royalty Fees	
	Shipments**	Median Price (Per Unit)	Low-End Estimates (% of Baseline)	High-End Estimates (% of Baseline)	Low-End Cost Estimates	High-End Cost Estimates
Bench	499,000	$400	$236 (59.0%)	$536 (134%)	$37	$57
Contractor	133,000	$1,225	$382 (31.2%)	$926 (75.6%)	$99	$135
Cabinet	33,000	$2,550	$412 (16.2%)	$956 (37.5%)	$187	$223

* Includes direct manufacturing and replacement part costs.
** Excludes 10,000 units assumed to contain the AIM technology

Table 13 shows the expected reduction in annual sales as well as the expected lost consumer surplus. Reduced sales could range from 93,400 table saws under the low-end cost estimates (column a) to about 251,700 under the high-end cost estimates (column d), a sales reduction of about 14.0 percent to 37.8 percent, respectively. The annual loss in consumer surplus ranges from about $10.0 million under the low cost estimates (column c), to about $72.3 million, under the high cost estimates (column f).

94 IEc, 2016b at 14. Staff also spoke with Dr. Gass on November 26, 2015, who indicated that SawStop would accept royalty payments of 8 percent of a saw's wholesale value if a rule is mandated requiring AIM technology on all table saws.

Table 13. Aggregate Expected Post-Regulatory Annual Table Saw Sales, Sales Reduction, and Lost Consumer Surplus, by Cost Level and Table Saw Type

Table Saw Type	Low-End Cost Estimate			High-End Cost Estimate		
	(a) Expected Sales Reduction	(b) Expected Post-Regulatory Sales	(c) Aggregate Lost Consumer Surplus (millions $)	(d) Expected Sales Reduction	(e) Expected Post-Regulatory Sales	(f) Aggregate Lost Consumer Surplus (Millions $)
Bench	78,500	420,500	$7.3	213,000	286,000	$54.0
Contractor	13,000	120,000	$2.3	34,200	98,800	$16.0
Cabinet	1,900	31,100	$0.4	4,500	28,500	$2.3
Total	93,400	571,600	$10.0	251,700	413,300	$72.3

Table 14 presents the total costs per table saw, including both the direct manufacturing costs, replacement part costs, and the lost consumer surplus. The lost consumer surplus, per table saw, is calculated as the aggregate lost consumer surplus (from Table 13, columns c and f) divided by the post-regulatory estimate of sales (Table 13, columns b and e). Total per unit costs range from roughly $253 to $725 per bench saw to roughly $400 to $1,000 per unit for contractor and cabinet saws.

Table 14. Total Costs of the Proposed Rule, per Table Saw, by Cost Level and Table Saw Type

Table Saw Type	Low-End Cost Estimates, per Table Saw			High-End Cost Estimates, per Table Saw		
	(a) Direct + Replacement Costs	(b) Lost Consumer Surplus	(c) Total (a) + (b)	(d) Direct + Replacement Costs	(e) Lost Consumer Surplus	(f) Total (d) + (e)
Bench	$236	$17	$253	$536	$189	$725
Contractor	$382	$19	$401	$926	$162	$1,088
Cabinet	$412	$13	$425	$956	$81	$1,037

The annual aggregate costs of the rule are estimated in columns (c) and (f) of Table 15, and range from about $170 million based on our low-end cost estimates, to about $345 million based on our high-end cost estimates. Bench table saws account for about 63 percent of the total under the low-end annual cost estimates and about 60 percent of the costs under the high-end estimates.

Table 15. Annual Post-Regulatory Sales, Per Unit Cost Estimates, and Aggregate Annual Costs of the Proposed Rule, by Cost Level and Table Saw Type

Table Saw Type	Low-End Cost Estimates			High-End Cost Estimates		
	(a) Annual Post-Regulatory Table Saw Sales	(b) Per Unit Costs (Direct Costs + Replacement Costs + Lost Consumer Surplus)	(c) Aggregate Costs (millions $) (a) × (b)	(d) Annual Post-Regulatory Table Saw Sales	(e) Per Unit Costs (Direct Costs + Replacement Costs + Lost Consumer Surplus)	(f) Aggregate Costs (millions $) (d) × (e)
Bench	420,500	$253	$106.4	286,000	$725	$207.4
Contractor	120,000	$401	$48.1	98,800	$1,088	$107.5
Cabinet	31,100	$425	$13.2	28,500	$1,037	$29.6
Total	571,600		$167.7	413,300		$344.5

Over time, we would expect the costs of the AIM technology to decrease. If, for example, we assume that the annual aggregate costs remain constant for years 1 through 5, but decline by about one-third in years 6 through 10, the present value of the aggregate costs over 10 years (using a 3 percent discount rate) would range from about $1,200 million to $2,500 million; on an annualized basis, this would amount to about $140 million to $290 million annually. Alternatively, if annual aggregate costs remain constant for years 1 through 5, but decline by about two-thirds in years 6 through 10, the present value of the aggregate costs over 10 years (using a 3 percent discount rate) would range from about $990 million to $2,000 million; on an annualized basis, this would amount to about $120 million to $240 million.

F. Benefit-Cost Findings

The expected benefits and costs of the proposed rule, are presented and compared in Table 16. The estimated benefits per table saw are provided in rows (a) and (b). The estimated costs per table saw are shown in rows (c) and (d). Cost estimates were developed from Table 15; they represent the average lower and upper bound cost estimates, weighted by projected sales. Net benefits per table saw are estimated in rows (e) and (f), and range from about $2,500 to $4,000 with a 3 percent discount rate and about $1,500 to $2,700 at 7 percent.

Table 16. Estimates of Benefits, Costs and Net Benefits, by Table Saw (2014 dollars)

Categories			Discount Rate		Row
			3 Percent	7 Percent	
Estimates per Table Saw, Over Its Expected Product Life	Expected Benefits per Table Saw	70% Effective	\$3,335	\$2,345	(a)
		90% Effective	\$4,288	\$3,015	(b)
	Expected Costs per Table Saw	Lower Bound Cost Estimates	\$293	\$293	(c)
		Higher Bound Cost Estimates	\$833	\$833	(d)
	Range of Expected Net Benefits per Table Saw	(a) – (d) (b) – (c)	\$2,502 to \$3,995	\$1,512 to \$2,722	(e) (f)
Expected Annual Sales	Low Cost Estimate		571,600	571,600	(g)
	High Cost Estimate		413,300	413,300	(h)
Aggregate Annual Estimates, Based on One Year of Sales	Range of Expected Benefits (Millions \$)	(a) × (h) (b) × (g)	\$1,378 to \$2,450	\$969 to \$1,723	(i) (j)
	Range of Expected Costs (Millions\$)	(c) × (g) (d) × (h)	\$168 to \$344	\$168 to \$344	(k) (l)
	Range of Expected Net Benefits (Millions \$)	(i) − (l) (j) − (k)	\$1,034 to \$2,282	\$625 to \$1,555	(m) (n)

Given table saw sales estimates, shown in rows (g) and (h) of Table 16, we can provide aggregate annual estimates of the benefits and costs of the proposed rule. As shown in rows (i) and (j), estimates of aggregate annual benefits range from about \$970 million to \$2,450 million, and aggregate costs, shown in rows (m) and (n), range from about \$170 million to about \$345 million. Aggregate net benefits, from rows (m) and (n), range from about \$1,030 million to \$2,280 million with a 3 percent discount rate, and from about \$630 million to \$1,560 million at 7 percent.

G. Sensitivity Analysis

The benefit-cost analysis described our methodology and the results of our reference case analysis. This section presents an analysis to help evaluate the sensitivity of the results to variations in some of the key parameters and assumptions of the analysis. Such an analysis is needed to account for uncertainty in the values of the input variables. The variables CPSC staff examines include: (1) the expected product life of table saws, (2) the number of table saws in use, (3) the national estimate of medically treated injuries involving table saws, and (4) our estimates of injury costs.

Relative to the reference case analysis, the sensitivity analysis allows: the expected product life of table saws to vary by about 20 percent; the number of table saws in use to vary by 25 percent; and the national estimate of medically treated injuries by the upper and lower bounds of an approximate 95 percent confidence interval. Finally, we evaluate the results of the analysis when benefits are limited to the economic costs of injury (*i.e.*, medical costs and work loss), and the intangible costs associated with pain and suffering are excluded. This exclusion of pain and suffering is not intended to suggest that the intangible costs are not important; rather it simply shows the impact of limiting the costs to the economic losses associated with medical costs and work losses.

Table 17 describes the results of the sensitivity analysis. Only changes in *net benefits* per table saw are shown in the table. Aside from changing the input variables, the methodology used to estimate net benefits in the sensitivity analysis was identical to that presented in the reference case analysis shown in Table 16.

Variations in the expected product life of the table saws had a relatively small impact on net benefits (See Table 17, Part B, rows b and c). A longer expected product life reduces societal costs per table saw on an annual basis (because there would be more saws in use), but increases the number years over which benefits are accumulated in the present value calculation. Conversely, a shorter expected product life increases the annual societal costs per table saw (because there would be fewer saws in use), but decreases the number of years over which the benefits are accumulated. In all cases, net benefits remained positive and significant, and roughly equal to estimates from the reference case.

Variations in the number of saws in use, which might result if sales were systematically under- or over-estimated, had a somewhat greater impact on net benefits (Table 17, Part B, rows d and e). Net benefits rose when fewer saws were assumed to be in use, because injury costs were apportioned over a smaller population of saws; conversely, net benefits decreased when more saws were assumed to be in use. Nevertheless, net benefits remained positive.

Table 17. Sensitivity Analysis: Expected Net Benefits Associated with Variations in Input Values

Part A: Reference Case Results.*			
Row	Input Value	Range of Expected Net Benefits per Table Saw, by Discount Rate	
		3 Percent	7 Percent
a	Reference Case Analysis* (Rows (i) and (j) from Table 16)	$2,502 to $3,995	$1,512 to $2,722
* Reference Case Inputs: 3% discount rate; expected product life, 13.3 years; saws in use, 8.2 million; medically treated blade-contact injuries, 54,843 per year; including100% of pain and suffering estimates in injury cost calculation;			
Part B: Alternative Inputs for Sensitivity Analysis			
Row	Input Variable and Value(s) Used in Sensitivity Analysis	Range of Expected Net Benefits by Discount Rate	
		3 Percent	7 Percent
Expected Product Life (years)			
b	Lower expected product life: 10.8 years	$2,817 to $4,400	$1,834 to $3,136
c	Higher expected product life: 16.2 years	$2,502 to $3,995	$1,414 to $2,596
Saws in Use			
d	25% fewer saws in use: 6.1 million	$3,651 to $5,472	$2,319 to $3,760
e	25% more saws in use: 10.3 million	$1,822 to $3,121	$1,034 to $2,107
Medically Treated Injuries (per year)			
f	Approximate lower 95% CI: 45,150	$1,914 to $3,239	$1,098 to $2,190
g	Approximate upper 95% CI: 64,500	$3,088 to $4,749	$1,924 to $3,252
Exclusion of Pain and Suffering Estimates from Injury Costs			
h	Medical costs and work losses only, excluding imputed costs of pain and suffering.	$279 to $1,136	−$52 to $711

Variations in the national estimate of medically treated injuries (rows f and g), were based on the lower and upper bounds of an approximate 95 percent confidence interval, based on estimates the coefficient of variation (CV) from the NEISS injury estimates. The upper bound estimates increased net benefits substantially, as would be expected, while the lower bound estimates lowered them.

Finally, net benefits were significantly reduced when benefits were limited to the reduction in economic losses associated with medical costs and work losses, excluding the intangible costs associated with pain and suffering (Table 17, Part B, row h). Reductions in pain and suffering accounted for about 70 percent of the societal costs associated with blade-contact injuries. Nevertheless, although net benefits appear to have remained positive using a 3 percent discount rate, benefits were generally comparable to costs when a 7 percent discount rate was applied.

H. Breakeven Analysis

The preceding analysis evaluated the expected benefits and costs of the proposed rule over the table saw market as a whole, combining all of the saw types into a single category. However, because we had no information on the distribution of injuries by saw type, we were unable to evaluate the relationship between benefits and costs for each of the three major saw categories: bench saws, contractor saws, and cabinet saws.

Such a detailed analysis of benefits and costs, by saw type, is useful because the saw types have different physical characteristics and different patterns of usage. Contractor saws, in general, are heavier, less mobile, and more expensive than bench saws; similarly, cabinet saws are heavier, less mobile, and more expensive than contractor saws. Some types of table saws may be used more frequently or more intensively than others. Contractor and cabinet saws may be more likely to be used by hobbyists or occupational users who may, relative to bench saw users, have more expertise or experience in the safe use of table saws.

On the other hand, many consumers use table saws only occasionally. These types of consumers may be less likely to fully understand table saw risks (*e.g.*, how quickly and unexpectedly kickback injuries can occur) or to remember safety procedures; they are also probably more likely to purchase the inexpensive bench saw models. Consequently, because of the different characteristics and potentially varying use patterns associated with the various saw types, it is possible that the costs of the proposed rule might exceed the benefits for one or more table saw types, even though, in aggregate (as shown above), benefits exceed aggregate costs for the market as a whole.

Although we cannot conduct a benefit-cost analysis of the individual saw types, we can evaluate the relationship between benefits and costs of the proposed rule by saw type. To do this, we will, for each saw type, estimate the number of injuries that would have to be prevented in order for benefits to equal or exceed the costs. This is called a breakeven analysis, and the number of injuries that would have to be prevented before benefits would equal costs can be called the breakeven estimate. We will then develop several hypothetical distributions of injuries across saw types, and compare the expected injury reduction for each to the breakeven estimates. Table 18 shows the breakeven injury estimates, including hypothetical injury distributions and the expected injury reduction associated with one year of table saw sales, by table saw type.

CPSC staff applied the breakeven analysis to table saw sales from a single year to allow staff to calculate the breakeven injury estimate from information that we have already presented in this regulatory analysis. Staff also followed the single years' worth of table saw sales through their useful product lives to determine the expected number of injuries that would likely be prevented by the proposed rule.

Table 18. Breakeven injury estimates and the expected injury reduction associated with one year of table saw sales, by table saw type

		Type of Saw		
Row		Bench	Contractor	Cabinet
a	Breakeven Injury Estimates	1,437 – 3,116	650 – 1,615	178 – 445
Hypothetical Injury Distributions				
b	1. Every Saw Has the Same Annual Risk of Injury	Bench	Contractor	Cabinet
c	Annual Risk per Saw	0.00669	0.00669	0.00669
d	Estimated Annual Injuries	1,913 – 2,812	661 -- 803	191 – 208
e	Present Value of Annual Injury Estimate	13,435 – 23,990	6,451 – 10,567	2,186 – 3,323
f	Present Value of Expected Injury Reduction*	8,330 – 19,192	4,000 – 8,454	1,355 – 2,818
g	2. Equivalent risks for the saw types, over expected product life	Bench	Contractor	Cabinet
h	Annual Risk per Saw	0.00808	0.00475	0.00337
i	Estimated Annual Injuries	2,312 – 3,399	470– 571	96 – 105
j	Present Value of Annual Injury Estimate	16,237 – 28,993	4,586 – 7,512	1,101 – 1,774
k	Present Value of Expected Injury Reduction*	10,067 – 23,194	2,843 – 6,010	682 – 1,419
l	3. Injury Risks Proportional to the Median Saw Price	Bench	Contractor	Cabinet
m	Annual Risk per Saw	0.00318	0.00974	0.02027
n	Estimated Annual Injuries	910 – 1,337	962 – 1,169	578 – 631
o	Present Value of Annual Injury Estimate	6,389 – 11,408	9,396 – 15,389	6,628 – 10,679
p	Present Value of Expected Injury Reduction*	3,961 – 9,126	5,825 – 12,311	4,109 – 8,543
q	4. Injuries are Proportional to Median Saw Price	Bench	Contractor	Cabinet
r	Annual Risk per Saw	0.00103	0.00700	0.04187
s	Estimated Annual Injuries	295 -- 433	691 -- 840	1,193 – 1,302
t	Present Value of Annual Injury Estimate	2,070 – 3,696	6,749 – 11,054	13,687 – 22,053
u	Present Value of Expected Injury Reduction*	1,283 – 2,957	4,184 – 8,843	8,486 – 17,642

* Assumes 70 percent to 90 percent of the blade-contact injuries are prevented or mitigated by the proposed rule.

1. Calculation of the Breakeven Injury Estimates

Breakeven injury estimates are derived from: (1) the expected post-regulatory sales, and (2) the aggregate cost estimates, by saw type, presented in Table 15. For example, to calculate the breakeven injury estimate for bench saws, we begin with the aggregate cost estimates of

$106.4 million to $207.4 million. The $106.4 million was based on our lower bound cost estimate for bench saws (annual sales of 420,500 bench saws × $253 cost per bench saw) and $207.4 million was based on our upper bound cost estimate (annual sales of 286,000 bench saws × $725 cost per bench saw).

If we divide these aggregate cost estimates by the average cost per injury (*i.e.*, $74,050 with a 3 percent discount rate and $66,550 at 7 percent), we can estimate a range of injuries that would have to be prevented for benefits to equal or exceed costs. For bench saws, using a 3 percent discount rate, the breakeven estimates range from 1,437 injuries ($106.4 million ÷ $74,050) to 2,801 injuries ($207.4 million ÷ $74,050). Using a 7 percent discount rate, the breakeven estimates range from about 1,599 injuries ($106.4 million ÷ $66,550) to about 3,116 ($207.4 million ÷ $66,550). If, for simplicity, we combine these ranges, we have an overall breakeven range from about 1,437 (based on the lower bound cost estimate injury costs discounted at 3 percent) to 3,116 injuries (based on the upper bound cost estimate and injury costs discounted at 7 percent).

This breakeven estimate means that if the proposed rule could prevent at least 1,437 to 3,116 bench saw injuries over the expected product life of one years' production and sale of bench saws, then the benefits of the proposed rule would equal or exceed the costs for that saw type. Using the same methodology, the breakeven injury estimate for contractor saws ranges from 650 to 1,615, and the breakeven estimate for cabinet saws ranges from 178 to 445. CPSC staff notes that throughout this breakeven analysis, we are implicitly assuming that the types of injuries experienced, and hence the societal costs, are the same across the three types of table saws. However, in reality, the distribution of injuries and the resulting societal costs, by saw type, are likely to vary.

2. Hypothetical Blade-contact injury Distributions

Because we have no information on the actual distribution of blade-contact injuries across saw types, CPSC staff considered four hypothetical distributions. The first assumes that injuries are proportional to saws in use, and that every table saw has an equal likelihood of injury on an annual basis. Thus, the risk for a bench saw, over the course of a year, is equal to the risk for contractor and cabinet saws. Because the present value of the expected injury reduction for bench saws (8,330 to 19,192; row f) exceeds the breakeven range (1,437 to 3,116; row a), we can say that the benefits are very likely to exceed the costs for bench saws for this hypothetical injury distribution. Additionally, the present value of prevented injuries ranges from 4,000 to 8,454 injuries for contractor saws and 1,355 to 2,818 injuries for cabinet saws. Because the present value of each of these ranges exceeds the breakeven range (650 – 1,615 for contractor saws and 178 – 445 for cabinet saws), we can say that, for this distribution of injuries, the estimated benefits of the proposed rule are likely to exceed the costs for all three table saw types.

The second hypothetical injury distribution assumes that the risks for the saw types are equal to one another over their expected product lives. Consequently, given the expected product life of about 10 years for bench saws, 17 years for contractor saws, and 24 years for cabinet saws, the annual risk for contractor saws would, on an annual basis, be about 59 percent (10 years ÷ 17 years) of the risk for bench saws, and the risk for cabinet saws would be about 42 percent (10 years ÷ 24 years) of the risk for bench saws. Given the distribution of an estimated 8.2 million table saws currently in use by saw type, this hypothetical injury distribution would suggest that about 75.2 percent of the 54,843 blade-contact injuries in 2015 involved bench saws, 19.9 percent involved contractor saws, and 4.9 percent involved cabinet saws. This injury distribution suggests increased injury risk for bench saws but lower risks for contractor and cabinet saws (row h). Nevertheless, the present value of injuries prevented (row k) would continue to exceed the breakeven levels (row a).

Our third hypothetical injury distribution assumes that the blade contact risk for the three table saw types is proportional to their median retail prices. Given the median retail prices (*i.e.*, \$400 per bench saw, \$1,225 per contractor saw, and \$2,550 per cabinet saw), the annual risk on a contractor saw would be about 3.06 times the risk for a bench saw (*i.e.*, \$1,225 ÷ \$400) and the annual risk on a cabinet saw would be about 6.37 times the risk for a bench saw (*i.e.*, \$2,550 ÷ \$400). Given the distribution of the estimated 8.2 million table saws currently in use by saw type, this hypothetical injury distribution would suggest that about 29.6 percent of the 54,843 blade-contact injuries in 2015 involved bench saws, 40.8 percent involved contractor saws, and 29.6 percent involved cabinet saws. Relative to the first two hypothetical injury distributions, this injury distribution would suggest that injury risks are lower on bench saws, but higher on contractor and cabinet saws (row m). The results suggest that the present value of injuries prevented (row p) would exceed the breakeven levels.

Whereas the third hypothetical injury distribution suggested that *injury risks* were proportional to median prices, our fourth hypothetical injury distribution assumes that estimated *blade-contact injuries*, by table saw type, are proportional to the median retail prices. Consequently, the annual number of blade-contact injuries on contractor saws would be about 3.06 times the number on bench saw injuries, and the number of injuries on cabinet saws would be about 6.37 times the number on bench saws. Given the distribution of the estimated 8.2 million table saws currently in use by saw type, this hypothetical injury distribution would suggest that about 9.6 percent of the 54,843 blade-contact injuries in 2015 involved bench saws, 29.3 percent involved contractor saws, and 61.1 percent involved cabinet saws. Comparing the present value of the expected injury reduction (row u) with the breakeven injury estimates (row a) suggests that the expected injury reduction would exceed the breakeven level. However, for bench saws, the present value of injury reduction (1,283 to 2,957) appears to be generally comparable to, or slightly lower than, the breakeven level (1,437 to 3,116).

3. Sensitivity Analysis of Breakeven Results

The breakeven analysis evaluated four hypothetical injury distributions, and found (for the most part) that the expected injury reduction for each of the saw types substantially exceeded the breakeven estimates, regardless of the hypothesized injury distribution. The CPSC staff also conducted a sensitivity analysis of the breakeven results by allowing variation in some key parameters and assumptions underlying the analysis, including variations in the number of table saws in use, the national estimate of medically treated injuries, and estimates of injury costs. Results are presented in Table 19, which shows the *present value of the expected injury reduction* for the four injury distributions presented in Table 18, when estimates of the number of Tables saws (by type) were either 25 percent lower or 25 percent higher than in the base analysis and when estimates of medically treated injury estimates were set equal to the lower and higher bounds of an approximate 95 percent confidence interval, based on the coefficient of variation from the NEISS blade-contact injury estimates.

As suggested by rows (b) through (p) of Table 19, the present value of the expected injury reductions from the first three hypothetical injury distributions remain uniformly higher than the breakeven estimates (row a), as do the projected injury reductions for contractor and cabinet saws from the fourth hypothesized injury distribution (rows q through u). However, considering bench saws from the fourth injury distribution, the present value injury estimates appear to be generally comparable, or marginally lower, than the breakeven injury estimates when: (1) the estimate of bench saws in use was assumed to be 25 percent higher than the reference case (row s); and (2) when bench saw injuries were estimated at the lower bound of an approximate 95 percent confidence interval for medically treated injuries (row t).

Table 19. Sensitivity Analysis for Breakeven Results

		Type of Saw		
Row		Bench	Contractor	Cabinet
a	Breakeven Injury Estimates	1,437 – 3,116	650 – 1,615	178 – 445
Hypothetical Injury Distributions and Present Values for Expected Injury Reductions, Conditional on the Described Input Variation				
b	1. Every Saw Has the Same Annual Risk of Injury	Bench	Contractor	Cabinet
c	25% fewer Table Saws in Use	11,106 – 25,590	5,333 – 11,271	1,807 – 3,758
d	25% more Table Saws in Use	6,664 – 15,354	3,200 – 6,762	1,084 – 2,254
e	Lower bound Estimate of Medically Treated Injuries	6,860 – 15,806	3,294 – 6,962	1,117 – 2,320
f	Upper bound Estimate of Medically Treated Injuries	9,799 – 22,578	4,705– 9,945	1,595 – 3,315
g	2. Equivalent risks for the saw types, over expected product life	Bench	Contractor	Cabinet
h	25% fewer Table Saws in Use	13,420 – 30,920	3,791 – 8,011	910 – 1,892
i	25% more Table Saws in Use	8,052 – 18,552	2,274 – 4,807	595– 1,135
j	Lower bound Estimate of Medically Treated Injuries	8,291 – 19,104	2,342 – 4,950	562 – 1,169
k	Upper bound Estimate of Medically Treated Injuries	11,843 – 27,287	3,346 – 7,070	803 – 1,670
l	3. Injury Risks Proportional to the Median Saw Price	Bench	Contractor	Cabinet
m	25% fewer Table Saws in Use	5,281 – 12,169	7,767 – 16,414	5,479 – 11,391
n	25% more Table Saws in Use	3,168 – 7,310	4,660 – 10,089	3,287 – 6,834
o	Lower bound Estimate of Medically Treated Injuries	3,262 – 7,517	4,798 – 10,139	3,384 – 7,036
p	Upper bound Estimate of Medically Treated Injuries	4,660 – 10,736	6,853 – 14,482	4,834 – 10,050
q	4. Injuries are Proportional to the Median Saw Price	Bench	Contractor	Cabinet
r	25% fewer Table Saws in Use	1,710 – 3,942	5,579 – 11,790	11,314 – 23,523
s	25% more Table Saws in Use	1,027 –2,364	3,347 – 7,074	6,788 – 14,114
t	Lower bound Estimate of Medically Treated Injuries	1,057 – 2,435	3,446 – 7,283	6,989 – 14,530
u	Upper bound Estimate of Medically Treated Injuries	1509 – 3,477	4,922 – 10,402	9,982 – 20,754

The CPSC staff also considered the sensitivity of the results to the exclusion of the intangible costs associated with the pain and suffering. The staff is not suggesting that the intangible costs are unimportant; rather the analysis simply shows the impact of limiting the costs to the economic losses associated with medical costs and work losses. By implicitly reducing injury costs, we are in effect changing the breakeven estimates which, were estimated as the quotient of aggregate injury costs for each type of saw divided by the average injury cost. Using a 3 percent discount rate, and excluding the pain and suffering component, the average injury cost would be reduced from about $74,050 to $21,900; using a 7 percent discount rate, the average injury cost would be reduced from about $66,550 to $17,300. Consequently, following the bench saw example discussed earlier, the breakeven estimate, excluding the intangible costs associated with pain and suffering, would range from 4,854 injuries (106.4 million ÷ $21,900) to 9,461 injuries ($207.4 million ÷ $21,900) when discounted at 3 percent. When discounted at 7 percent, the breakeven estimate would range from 6,150 injuries ($106.4 million ÷ $17,300) to 11,994 injuries ($207.4 million ÷ $17,300). Thus, for bench saws, the overall range for the breakeven injury estimate is 4,854 to 11,994 injuries. Using the same methodology, the breakeven injury estimate for contractor and cabinet saws would range from 2,194 to 6,217 and 602 to 1,711, injuries respectively.

The breakeven injury estimates for the three types of saws, excluding pain and suffering, are presented in Table 20 and compared to the present value of the expected injury reductions developed in Table 18.

Table 20. Breakeven Injury Estimates (Excluding Pain and Suffering) and the Present Value of Expected Injury Reductions Associated with One Year of Table Saw Saws, by Table Saw Type

		Type of Saw		
Row		Bench	Contractor	Cabinet
a	Breakeven Injury Estimates	4,854 – 11,988	2,194 – 6,214	602 – 1,711
Hypothetical Injury Distributions				
b	1. Equivalent risks for the saw types, on an annual basis			
c	Present Value of Expected Injury Reduction	8,330 – 19,192	4,000 – 8,454	1,255 – 2,818
d	2. Equivalent risks for the saw types, over expected product life			
e	Present Value of Expected Injury Reduction	10,067 – 23,194	2,843 – 6,010	682 – 1,419
f	3. Injury Risks Proportional to the Median Saw Price			
g	Present Value of Expected Injury Reduction	3,961 – 9,126	5,825 – 12,311	4,109 – 8,543
h	4. Injuries are Proportional to Median Saw Price			
i	Present Value of Expected Injury Reduction	1,283 – 2,957	4,184 – 8,843	8,486 – 17,642

The results suggest that, even without the pain and suffering component, the expected injury reduction would exceed the breakeven estimates for most of the saw types and injury distributions. However, there were several exceptions. First, the present value of the expected injury reduction was generally comparable to the breakeven injury estimates for contractor and cabinet saws under the second hypothetical injury distribution (row e). Second, the present value estimates were generally comparable to, or slightly less than, the breakeven estimates for bench saws under the third hypothetical injury distribution (row g). And third, the present value estimates were lower than the breakeven estimates for bench saws under the fourth hypothetical injury distribution (row i).

Staff's analysis shows, that, for the most part, the sensitivity analysis of the breakeven estimates indicated that estimates of the present value of the expected injury reduction were either comparable to or substantially exceeded the breakeven injury estimates for the various saw types and across all of the hypothetical injury distributions. The primary exception involved bench saws under the fourth hypothetical injury distribution, in which the relative risk on cabinet saws was roughly 40 times the risk on a bench saw.

I. Summary of the Preliminary Regulatory Analysis

Based on CPSC staff's analysis, the proposed rule would address approximately 54,800 medically treated table saw blade-contact injuries that occur annually. The societal cost of these injuries, on the order of about $3.65 billion to $4.06 billion annually, represents the pool from which the benefits would be derived. Medical costs and work losses, the economic losses associated with these injuries, account for about 30 percent of the total; the intangible, or non-economic, costs associated with pain and suffering account for the remaining 70 percent of the total. We expect the proposed rule would prevent or substantially mitigate 70 percent to 90 percent of the medically treated blade-contact injuries.

CPSC staff's review also shows substantial net benefits (*i.e.*, benefits − costs) for the proposed rule. Estimates of net benefits, across all saw types, averaged about $1,500 to $4,000 per saw over its expected product life. Aggregate net benefits over approximately one year's production and sale of table saws could amount to about $625 million to about $2,300 million. Net benefits varied but generally remained positive in our sensitivity analysis.

Because we had no information on the distribution of injuries across saw types (*i.e.*, bench, contractor, and cabinet saws), CPSC staff was unable to compare directly the benefits and costs for each saw type. However, based on several assumptions discussed above and in TAB C of the staff briefing package, staff was able to conduct a breakeven analysis by estimating the approximate number of injuries that would have to be substantially mitigated for each type of saw for the benefits to equal or exceed the costs. This analysis suggested that, under most plausible injury distributions, the benefits likely would exceed the costs for each saw type.

Notwithstanding the high level of expected net benefits, the proposed rule also would be costly and would result in disruption of the table saw market. Under the rule, table saw manufacturers would need to develop their own AIM technology, without impinging on existing patents or license the patented AIM technology that already exists. Most, if not all, table saw models not already incorporating the AIM technology would require major design changes and the retooling of production facilities, a process that likely would take two or more years to accomplish. The cost impact of the proposed rule on market sales might also be substantial, potentially reducing aggregate sales by about 14 percent to 38 percent annually. In discussions between staff and manufacturers, several firms indicated that the cost of redesigning their saws to incorporate the AIM technology may be too great, relative to their sales volume, to support such a redesign. These firms indicated that they might respond by reducing or eliminating their offerings of table saws to the U.S. market.

Although the proposed rule would substantially reduce blade-contact injuries and the societal costs associated with those injuries, the impact of increasing table saw production costs on consumers also would be considerable. Staff expects that the prices for the least expensive bench saws now available could more than double, to $300 or more. In general, the retail prices of bench saws could increase by as much as $200 to $500 per unit, and the retail prices of contractor and cabinet saws could rise by as much as $350 to $1,000 per unit.[95] These higher

[95] The current retail prices of the SawStop models and the Bosch REAXX™ model currently marketed are consistent with the upper end of these possible price increases.

prices may be mitigated in the longer run, but the extent of any future price reductions is unknown.

Additionally, because of the likely decline in sales following the promulgation of a rule, consumers who choose not to purchase a new saw due to the higher price will experience a loss in utility by forgoing the use of table saws, or because they continue to use older saws which they would have preferred to replace. There may also be some other utility impacts. The inclusion of the AIM technology will, for example, increase the weight and (potentially) the size of table saws to accommodate the new technology, to allow access to change the brake cartridge, and to mitigate the effects of the force associated with the activation of the brake cartridge. While this factor may have a relatively small impact on the heavier and larger contractor and cabinet saws, the impact on some of the smaller and lighter bench saws could markedly reduce their portability.

As discussed further below, the Commission also considered several alternatives to the proposed rule. These alternatives would mitigate the proposed rule's costs and potential disruptions in the marketplace. In particular, they could, individually or in combination, reduce the adverse impacts of the proposed rule on manufacturers (including small manufacturers), allow for greater choice in the types and safety characteristics of the table saws that consumers can purchase, reduce the impact of the proposed rule on table saws intended for commercial or professional use, and address the market failures resulting in the need for a product safety rule in the first place. However, these alternatives would reduce the expected benefits of the proposed rule. These alternatives are the same alternatives as those considered in the initial regulatory flexibility analysis in section XII of the preamble, and TAB D of the staff briefing package.

Accordingly, any potential impacts of alternatives on small manufacturers are also addressed here in section XI.J.

J. Regulatory Alternatives

1. No Action Alternative

Under this alternative, the Commission would take no regulatory action and the status quo would be maintained, at least in the short term. This option acknowledges that passive safety devices, such as blade guards, riving knives, and pawls, are already provided to purchasers of new table saws and can be used by consumers to prevent many types of blade-contact injury. Additionally, the option recognizes that table saws with the AIM technology are already available for consumers who want and can afford them.

Over the longer term, changes in the voluntary standard may increase the level of safety with table saws. Sales of table saws with the AIM technology may also gradually increase as consumers become more familiar with the improved safety characteristics of these table saws. Table saws with AIM systems are now available for purchase by consumers in all table saw categories, including the introductions of the SawStop bench saw model in March 2015 and the introduction of the Bosch REAXX™ jobsite saw in June 2016. Moreover, sales of saws with the AIM technology could expand further if prices decline. However, for now, the price differentials between a table saw with AIM and a comparable saw without AIM are substantial, particularly for bench saws.

We cannot estimate the benefits and costs that would be associated with this alternative because the estimates would be affected by factors such as the extent to which manufacturers introduce new table saws with AIM technology, the price of the table saws, and the rate at which consumers would choose to purchase table saws with AIM technology in the absence of a rule.

However, because the rate at which AIM technology would be adopted in the absence of a mandatory rule probably would be substantially lower than the rate under a mandatory rule, both the benefits and costs of this alternative would be much lower than estimated for the proposed rule. Most significantly, although taking no mandatory regulatory action would minimize the impact on small table saw manufacturers, it would not mitigate the large number of blade-contact injuries that are associated with table saws.

2. Defer to the Voluntary Standard for Table Saws

Another alternative would be for the CPSC staff to continue participating and encouraging safety improvements to the voluntary standard for table saws, UL 987. While this option would be similar to the 'no action alternative,' the Commission could direct the staff to continue to pursue safety improvements in the voluntary standard, including the adoption of the AIM safety technology over time, as a conditional alternative to a mandatory standard. The Commission could consider proposing a mandatory standard if the voluntary standard development activities remain unsatisfactory.

CPSC staff has had an ongoing, active role in the voluntary standards body and the development of UL 987. Staff has supported recent changes in the voluntary standard, including requirements for improved blade guards and riving knives, and considers the newer blade guard systems to be a significant improvement over earlier systems. However, as discussed in section VI of the preamble, there is little evidence that improvements in these passive safety devices has effectively reduced the number or severity of blade-contact injuries on table saws. Additionally, voluntary standards committees have twice rejected initiatives by UL to adopt voluntary standards that include AIM systems for table saws. Although relying on the voluntary standard process would minimize the impact on small table saw manufacturers, that approach would be unlikely to mitigate the blade-contact injuries that are associated with table saws.

3. Later Effective Dates

The proposed rule includes an effective date that is 3 years after the final rule is published in the *Federal Register*. Given the complexities and costs that would be associated with developing (or licensing) the AIM technology, redesigning virtually all table saw models, and retooling production facilities, an effective date later than 3 years could further reduce the impact of the rule on small manufacturers. A longer effective date would allow manufacturers additional time to spread the costs of developing or negotiating for the rights to use an AIM technology, to modify the design of their table saws to incorporate the AIM technology, and to retool their factories for production. For manufacturers that might choose to exit the table saw market, perhaps because their volume of table saw sales does not justify the cost of redesigning the table saws, the additional delay might also provide them with more time to consider alternative business opportunities. A later effective date might especially benefit manufacturers of bench saws because of the added technical difficulties in engineering small bench saws to incorporate an AIM technology.

While later effective dates would mitigate somewhat the impact of the proposed rule on some manufacturers, including small manufacturers, that approach also could delay the introduction of table saws with AIM technology into the market and possibly discourage manufacturers from introducing table saws with AIM technology earlier than the effective date. Moreover, a delayed effective date would delay the mitigation of blade-contact injuries associated with table saws, and reduce the net benefits associated with the proposed rule. The

Commission seeks comment on the duration of the effective date and whether a longer or shorter effective date is appropriate.

4. Exempt Contractor and Cabinet Saws from a Product Safety Rule

Another alternative considered by the Commission would exempt cabinet and/or contractor saws that are used by and are intended for professional, commercial, or industrial users. Or the Commission could exempt an even smaller subset of cabinet or industrial saws based on a certain size, weight, power, and electrical specifications. These alternatives would reduce the impact on small table saw manufacturers because cabinet and contractor saw manufacturers tend to be small. (Manufacturers of bench saws, on the other hand, tend to be large.) However, there is no clear dividing line between consumer and professional saws, except at the very highest levels of price and performance. Additionally, we have little information on the proportion of occupational purchasers for contractor saws and cabinet saws.

Moreover, as discussed above in section VI.C. of the preamble, although most cabinet and contractor saws are used by professionals or in commercial settings, they are available for sale to consumers, and many serious consumer woodworkers and hobbyists also use these saws. Cabinet and contractor saws are also frequently used in schools and other educational settings. CPSC staff's breakeven analysis found that mandating AIM technology on cabinet and contractor saws likely would result in substantial net benefits under the various scenarios modelled. However, the Commission seeks comment regarding whether the scope of the rule should be modified to exclude certain types of table saws that are primarily used for commercial or industrial use or that have certain specifications.

5. Limit the Applicability of the Performance Requirements to Some, but Not All, Table Saws

Rather than requiring all table saws to meet the requirements of the proposed rule, the Commission could consider an alternative that requires only a subset of table saws to meet the requirements. For example, if a firm produces only bench saws, the Commission might require the firm to produce at least one bench saw model that meets the requirements of the standard. Similarly, if a firm produces bench saws and contractor saws, the Commission might require the firm to produce at least one bench saw model and one contractor saw model that meet the requirements of the standard. Or, as a variation, the Commission might allow each manufacturer to produce at least one bench saw model that does not meet the requirements of the standard as long as their other bench models conform to the requirements of the rule.

Limiting the requirement for the AIM technology to a subset of table saws could have several advantages. Saws with the AIM technology would be available in substantially greater numbers than they have been in recent years. It would also address the potential market failure associated with one firm's market power over the AIM technology through patents, effectively eliminating competition, while at the same time allowing consumers to choose table saws without AIM technology if they prefer. Consequently, consumers who place a great value on safety or who face greater than average risks will find the safer table saws more desirable and will be more likely to buy them. Consumers who do not want the safer but more expensive saws can decide to purchase saws without the AIM technology. In this way, consumer preferences might be better matched with the products they wish to purchase.

If licensing agreements satisfactory to all parties could be arranged, this alternative would also alleviate (though not eliminate) the burden of the proposed rule on some manufacturers, including small manufacturers, because it would not require that all of their saws contain the AIM technology. However if licensing arrangements could not be agreed upon, then small manufacturers might be faced with an even greater burden and potentially face even higher prices. If patent holders are not willing to license their technology under reasonable terms, the impact on small manufacturers could be greater because they would need either to incur greater costs to develop their own technology or exit the table saw market.

Moreover, this alternative would address only a portion of blade-contact injuries. If, for example, the requirement led to about 50 percent of table saws being equipped with the AIM technology, the expected benefits would be on the order of about 50 percent of the benefits described in the reference case analysis (or somewhat higher if consumers with the greater risks were more likely to purchase the safer table saws).[96] Accordingly, this alternative would not mitigate the large number of blade-contact injuries associated with table saws, and would reduce the net benefits associated with the proposed rule. The Commission seeks comment on what impact limiting the requirement for the AIM technology to a subset of table saws would have on manufacturers, including small businesses.

6. Information and Education Campaign

The Commission could conduct an information and education campaign informing consumers about blade contact hazards and blade-contact injuries, and the benefits of the AIM technology. This alternative could be implemented on its own, in the absence of other regulatory options, or it could be implemented in combination with any of the alternative options.

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[96] We cannot predict what proportion of table saw sales would ultimately contain the AIM technology under this alternative. If consumers place a high value on safety, and prices are reduced or moderated over time, the proportion might be high. If, however, consumers would generally prefer saws without the AIM technology because of the lower prices or for other reasons, the proportion would be lower. Product liability concerns on the part of manufacturers would probably increase the proportion of table saws with the AIM technology. Once the table saws with AIM technology become more commonplace, table saws without the technology would be more likely to be challenged in product liability suits.

As discussed in section IX of the preamble and in TAB E of the staff briefing package, the effectiveness of warnings and instructions is limited. Although educational programs offer more opportunities to present hazard information in varied ways, and in greater detail than warning labels, the effectiveness of such programs is also limited because they depend on consumers not only receiving and understanding the message, but also being persuaded to heed the message. Although the Commission believes that such a campaign could help inform consumers, based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on table saws.

XII. Initial Regulatory Flexibility Analysis

This section provides an analysis of the impact the proposed rule would have on small businesses. Whenever an agency is required to publish a proposed rule, section 603 of the Regulatory Flexibility Act (RFA) requires that the agency prepare an initial regulatory flexibility analysis (IRFA) that describes the impact that the rule would have on small businesses and other entities. 5 U.S.C. 603. An IRFA is not required if the head of an agency certifies that the proposed rule will not have a significant economic impact on a substantial number of small entities. 5 U.S.C. 605. The IRFA must contain:

(1) a description of why action by the agency is being considered;

(2) a succinct statement of the objectives of, and legal basis for, the proposed rule;

(3) a description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;

(4) a description of the projected reporting, recordkeeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and

(5) identification to the extent practicable, of all relevant Federal rules which may duplicate, overlap or conflict with the proposed rule.

An IRFA must also contain a description of any significant alternatives that would accomplish the stated objectives of the applicable statutes and that would minimize any significant economic impact of the proposed rule on small entities. According to the IRFA, alternatives could include: (1) differing compliance or reporting requirements that take into account the resources available to small businesses; (2) clarification, consolidation, or simplification of compliance and reporting requirements for small entities; (3) use of performance rather than design standards; and (4) an exemption from coverage of the rule, or any part of the rule thereof, for small entities. The alternatives the Commission considered are discussed in section XI(J) of the preamble and TAB D of the staff briefing package.

A. Reason for Agency Action

The proposed rule for table saws would reduce an unreasonable risk of injury associated with blade-contact injuries on table saws. CPSC staff estimates that there are approximately 54,800 medically treated blade-contact injuries annually based on 2015 injury data and estimates from the ICM. Almost 23 percent of the injuries involved fractures, amputations accounted for 14 percent of the injuries, and lacerations accounted for about 57 percent. AIM technology has been shown to effectively mitigate the severity of injuries caused by a victim’s hand or other body part contacting the blade while the table saw is in operation. Accordingly, the proposed rule would establish a performance requirement to address the risk of injuries associated with blade-contact injuries on table saws.

B. Objectives of and Legal Basis for the Proposed Rule

The objective of the proposed rule is to mitigate operator injuries resulting from blade contact on table saws. The Commission published an ANPR in October 2011, which initiated this proceeding to evaluate regulatory options and potentially develop a mandatory standard to address the risks of blade-contact injuries associated with the use of table saws. The proposed rule is being promulgated under the authority of the CPSA.

C. Small Entities to Which the Proposed Rule Will Apply

The proposed rule would apply to manufacturers, importers, and private labelers of table saws that are sold in the United States. As of February 2016, CPSC is aware of 22 firms that supply table saws to the U.S. market. Of these 22 firms, at least 8, and possibly 10, are small according to criteria established by the Small Business Administration (SBA).[97] According to the SBA criteria, a table saw manufacturer is considered small if it has fewer than 500 employees, and a table saw importer is considered small if it has fewer than 100 employees. Private labelers of table saws are considered “small” if their annual revenue exceeds $38.5 million in the case of home centers, $32.5 million in the case of department stores, and $7.5 million in the case of hardware stores.[98]

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[97] IEc, 2016a at 9.

[98] Under the North American Industrial Classification System (NAICS) manufacturers of table saws are classified in category 333243 (Sawmill, Woodworking, and Paper Machinery Manufacturing). Importers or private labelers of table saws include some department stores (NAICS category 4452111, home centers (NAICS category 444110), and some hardware stores (NAICS category 444130).

Small table saw manufacturers supply mostly contractor and cabinet saws, which are typically more expensive and heavier than bench saws. Contractor saws generally retail for between $529 to $2,049 and weigh between about 198 and 414 pounds. Cabinet saws typically retail for $1,199 to $5,349 and weigh between about 321 and 1,040 pounds. One small company sells a multipurpose machine that includes a table saw, lathe, drill press, sander, and router, among other tools. The cost of this multipurpose machine starts at about $3,379. As of March 2016, only three bench saw models were being offered by small manufacturers. One of these was a bench saw that was much heavier (233 pounds) and more expensive ($1,499) than most other bench saws. Another bench saw, offered by SawStop, already incorporates an AIM technology and retails for around $1,300. The size and weight of the third bench is more typical of the bench table saws offered by the larger manufacturers.[99]

D. Compliance, Reporting, and Record Keeping Requirements of Proposed Rule

The proposed rule would establish a performance requirement limiting the depth of cut to 3.5 mm when a test probe contacts the spinning saw blade at a radial approach rate of 1.0 m/s. Section 14 of the CPSA requires manufacturers, importers, or private labelers of a consumer product subject to a consumer product safety rule to certify, based on a test of each product or a reasonable testing program, that the product complies with all rules, bans or standards applicable to the product. The proposed rule does not specify a test procedure that the Commission would use to determine compliance with the standard. Any test procedure that will accurately determine compliance with the proposed performance requirements may be used. However, if a final rule is issued, manufacturers must certify that the product conforms to the standard, based on either a

[99] IEc, 2016a, Table Saw Models, February 29, 2016.

test of each product, or any reasonable method to demonstrate compliance with the requirements of the standard. For products that manufacturers certify, manufacturers would issue a general certificate of conformity (GCC).

Section 14 of the CPSA sets forth the requirements for GCCs. Among other requirements, each certificate must identify the manufacturer or private labeler issuing the certificate and any third party conformity assessment body, on whose testing the certificate depends, the place of manufacture, the date and place where the product was tested, each party's name, full mailing address, telephone number, and contact information for the individual responsible for maintaining records of test results. The certificates must be in English. The certificates must be furnished to each distributor or retailer of the product and to the CPSC, if requested.

1. Costs of Proposed Rule that Would Be Incurred by Small Manufacturers

To comply with the proposed rule, table saw manufacturers would need to license or develop an AIM technology. To license a technology, manufacturers will have to pay a royalty to the owner of the patents on the technology. The royalty cost for licensing an AIM technology is uncertain. Dr. Gass of SawStop has indicated that SawStop would be willing to license the SawStop AIM technology for a royalty payment of 8 percent of the wholesale price of the saw, but only if the Commission establishes a mandatory standard requiring AIM technology. There is no certainty that SawStop actually would license its technology under terms that would be acceptable to other manufacturers even if a mandatory standard were established. Several companies have asserted that they had attempted to license the SawStop technology without success. Bosch uses an AIM technology on its REAXX™ bench saw that was developed, in part, through a joint venture of several members of the PTI. The terms under which this technology may be available for license are not known and may be affected by ongoing patent infringement litigation.

To avoid royalty or licensing fees, the manufacturer would have the challenge of developing its own AIM technology that did not infringe on an existing patent. At a minimum, developing an AIM system would likely cost at least several hundred thousand dollars, and perhaps several million dollars, based on the estimated costs of developing the existing technologies. However, the extent and scope of the SawStop patents that could impact future AIM technological developments is unknown. It is possible that new AIM technologies that are developed could also infringe on existing SawStop patents that have been filed or are pending.

After acquiring an AIM technology, manufacturers will need to redesign their table saws and retool their manufacturing facilities to incorporate the technology. According to several manufacturers, incorporating an AIM technology would require a redesign of each table saw including possibly, the trunnion, the cabinet, and interior of the saw. In addition, the support structure of the table saw, including the stand, might have to be strengthened to bear the added weight of the system and to absorb the force that could result from the system being triggered.

Estimates of the redesign and retooling costs ranged from a low of about $100,000 per model to $700,000. The redesign and retool process would be expected to take 1 to 3 years depending upon the problems encountered in the process. The redesign and retooling costs for subsequent models might be somewhat less than the costs associated with the first model.

There is some uncertainty as to how the redesign and retooling costs would affect manufacturers. One manufacturer noted that the redesign and retooling costs have to be paid upfront and manufacturers generally desire to amortize these costs over three years. However, most table saw brand owners contract with Chinese or Taiwanese manufacturers to actually manufacture the table saws. In some cases, these manufacturers may produce table saws for more than one firm and may be willing to absorb some of the costs in order to remain in the market.

In addition to the redesign and retooling costs, there will be added costs due to the additional components required on saws that incorporate an AIM technology. Depending upon the specific system used, the additional parts may include a brake cartridge, cables, additional parts or brackets to secure the brake cartridge, electrodes and assemblies and a power supply or motor control. These additional components are expected to add between $58 and $74 to the manufacturing cost of a table saw.

2. Impacts on Small Businesses

To comply with the proposed rule, most small manufacturers are expected to license an AIM technology instead of developing their own technology. The costs of attempting to develop their own AIM technology would probably be too high for most small manufacturers. However, there is no certainty that small manufacturers would be able to negotiate acceptable licensing agreements with SawStop or another patent holder. If small manufacturers are unable to negotiate acceptable licensing agreements for AIM technology, it is likely that all small table saw manufacturers, with the exception of SawStop, will exit the U.S. table saw market.

If small table saw manufacturers are able to license AIM technology, they would be expected to evaluate the sales volume of each table saw model and the likely cost of redesigning and retooling the model and decide whether to continue offering the model in the United States. If the manufacturer does not believe that the sales volume would be sufficient to recoup these costs in a reasonable amount of time, it is likely that the manufacturer would discontinue the sale of the model (at least in the United States).[100] The fact that some small table saw manufacturers might license the AIM technology from SawStop would mean that these manufacturers would be paying royalties to a competitor. This would be expected to reduce their competitiveness in the table saw market. Four firms indicated to CPSC staff that they would likely reduce or eliminate the table saws that they currently offer in the United States if AIM technology is mandated.

With the exception of SawStop and one other firm, most small table saw manufacturers also supply other types of woodworking or metal working equipment. Anecdotal information suggests that U.S. sales of table saws account for a small percentage of the total revenue of most small firms. Information supplied by one manufacturer suggests that U.S. table saw sales accounted for about 1 percent of the firm's total revenue. Two other firms estimated that U.S. table saw sales accounted for between 5 and 8 percent of their total revenue. Actions that impact a firm's revenue by more than 1 percent are potentially significant. Therefore, given that it is likely that small table saw manufacturers would drop one or more table saws from the U.S. market if the proposed rule were adopted, and may leave the market entirely if they are unable to license an AIM technology, the proposed rule could have a significant impact on small manufacturers. However, the proposed rule is not likely to cause most small manufacturers to fail completely. One small manufacturer, SawStop, would significantly benefit from the promulgation of the proposed rule because it already manufactures table saws with AIM technology and owns multiple patents that cover AIM technology.

[100] One small manufacturer indicated to staff in a telephone call on November 30, 2015, that they would want to be able to amortize the redesign and retooling costs over a 3-year period.

E. Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rule

OSHA has established standards that cover woodworking equipment used in workplace settings. These standards are codified at 29 CFR 1910.213. Generally, these requirements cover workplace safety and the use of safety devices such as blade guards and hoods. Currently, OSHA standards do not mandate performance requirements that would use AIM technology on table saws that are used by consumers. Accordingly, the Commission has not identified any federal rules that duplicate or conflict with the proposed rule.

F. Alternatives Considered to Reduce the Burden on Small Entities

Under section 603(c) of the Regulatory Flexibility Act, an initial regulatory flexibility analysis should "contain a description of any significant alternatives to the proposed rule which accomplish the stated objectives of the applicable statutes and which minimize any significant impact of the proposed rule on small entities." CPSC examined several alternatives to the proposed rule that could reduce the impact on small entities. These include: (1) no regulatory action; (2) defer to voluntary standard activities for table saws; (3) establish alternative effective dates; (4) exempt or limit certain categories of table saws from the rule. These alternatives are discussed in more detail in section XI.J. of the preamble. The Commission invites comments on this IRFA and the potential impact of the proposed rule on small entities, especially small businesses. Small businesses that believe they will be affected by the proposed rule are especially encouraged to submit comments. The comments should be specific and describe the potential impact, magnitude, and alternatives that could reduce the impact of the proposed rule on small businesses.

XIII. Environmental Considerations

The Commission's regulations address whether CPSC is required to prepare an environmental assessment (EA) or an environmental impact statement (EIS). 16 CFR 1021.5. Those regulations state CPSC's actions that ordinarily have "little or no potential for affecting the human environment," and therefore, are categorically excluded from the need to prepare and EA or EIS. Among those actions are rules, such as the proposed rule addressing blade-contact injuries on table saws, which provide performance standards for products. *Id*. 1021.5(c)(1).

XIV. Executive Order 12988 (Preemption)

In accordance with Executive Order 12988 (February 5, 1996), the CPSC states the preemptive effect of the proposed rule, as follows:

The regulation for addressing blade-contact injuries on table saws is proposed under authority of the CPSA. 15 U.S.C. 2051–2089. Section 26 of the CPSA provides that "whenever a consumer product safety standard under this Act is in effect and applies to a risk of injury associated with a consumer product, no State or political subdivision of a State shall have any authority either to establish or to continue in effect any provision of a safety standard or regulation which prescribes any requirements as to the performance, composition, contents, design, finish, construction, packaging or labeling of such product which are designed to deal with the same risk of injury associated with such consumer product, unless such requirements are identical to the requirements of the Federal Standard." 15 U.S.C. 2075(a). Upon application to the Commission, a state or local standard may be excepted from this preemptive effect if the state or local standard: (1) provides a higher degree of protection from the risk of injury or illness than the CPSA standard, and (2) does not unduly burden interstate commerce. In addition, the federal government, or a state or local government, may establish or continue in effect a non-identical requirement for its own use that is designed to protect against the same risk of injury as the CPSC standard if the federal, state, or local requirement provides a higher degree of protection than the CPSA requirement. 15 U.S.C. 2075(b).

Thus, the table saw requirements proposed in today's *Federal Register* would (if finalized) preempt non-identical state or local requirements for table saws designed to protect against the same risk of injury.

XV. Certification

Section 14(a) of the CPSA requires that products subject to a consumer product safety rule under the CPSA, or to a similar rule, ban, standard or regulation under any other act enforced by the Commission, must be certified as complying with all applicable CPSC-enforced requirements. 15 U.S.C. 2063(a). A final rule addressing blade-contact injuries on table saws would subject table saws to this certification requirement.

XVI. Paperwork Reduction Act

The proposed rule does not require manufacturers (including importers) to maintain records beyond those necessary to comply with 16 C.F.R. part 1110. Accordingly, the rule does not contain collection of information requirements as defined under the Paperwork Reduction Act, 44 U.S.C. 3501–3520.

XVII. Effective Date

The CPSA requires that consumer product safety rules take effect not later than 180 days from their promulgation unless the Commission finds there is good cause for a later date. 15 U.S.C. 2058(g)(1). The Commission proposes that the rule would take effect 3 years from the date of publication of the final rule for table saws.

Given the complexities and costs that would be associated with developing or licensing the AIM technology, redesigning virtually all table saw models, and retooling production facilities, the Commission believes that this later effective date could reduce the impact of the rule on manufacturers, including small manufacturers. This later date would allow manufacturers to spread the costs of developing or negotiating for the rights to use an AIM technology, modify the design of their table saws to incorporate the AIM technology, and retool their factories for the production of table saws with the new technology. For manufacturers who might choose to exit the table saw market, perhaps because their volume of table saw sales does not justify the cost of redesigning the table saws, the additional delay might also provide them with more time to consider alternative business opportunities.

XVIII. Proposed Findings

The CPSA requires the Commission to make certain findings when issuing a consumer product safety standard. Specifically, the CPSA requires that the Commission consider and make findings about:

- the degree and nature of the risk of injury;
- the number of consumer products subject to the rule;
- the need of the public for the product and the probable effect on utility, cost, and availability of the product; and
- other means to achieve the objective of the rule, while minimizing the impact on competition, manufacturing, and commercial practices.

15 U.S.C. 2058(f)(1).

The CPSA also requires that the Commission find that the rule is reasonably necessary to eliminate or reduce an unreasonable risk of injury associated with the product and that issuing the rule is in the public interest. 15 U.S.C. 2058(f)(3).

In addition, the Commission must find that:

- if an applicable voluntary standard has been adopted and implemented, that compliance with the voluntary standard is not likely to reduce adequately the risk of injury, or compliance with the voluntary standard is not likely to be substantial;
- that benefits expected from the regulation bear a reasonable relationship to its costs; and
- that the regulation imposes the least burdensome requirement that would prevent or adequately reduce the risk of injury. *Id*.

These findings are discussed below.

A. Degree and Nature of the Risk of Injury

In 2015, there were an estimated 33,400 table saw, emergency department-treated injuries. Of these, CPSC staff estimates that 30,800 (92 percent) are likely related to the victim making contact with the saw blade. Of the 30,800 emergency department-treated, blade-contact injuries, an estimated 28,900 injuries (93.8 percent) involved the finger. The most common diagnosis in blade-contact injuries is an estimated 18,100 laceration injuries (58.8 percent), followed by an estimated 5,900 fractures (19.0 percent), an estimated 4,700 amputations (15.2 percent), and an estimated 2,000 avulsions (6.5 percent). An estimated 3,800 (12.3 percent) of the blade-contact injury victims were hospitalized.

An estimated 4,700 amputation injuries on table saws occurred in 2015, alone. Compared to all other types of consumer products, CPSC estimates that table saw-related amputations account for 18.6 percent of all amputations in the NEISS in 2015. When compared to all other workshop products, table saws account for an estimated 52.4 percent of all amputations related to workshop products in 2015. Based on NEISS estimates, the trend analysis for yearly blade-contact injuries associated with table saws showed no discernible change in the number of injuries or types of injuries related to table saw blade contact from 2004 to 2015. In addition, the trend analysis for the risk of blade-contact injury per 10,000 table saws in use yearly showed no discernible change in the risk of injury associated with table saw blade contact from 2004 to 2015.

B. Number of Consumer Products Subject to the Proposed Rule

The annual shipments of all table saws to the U.S. market from 2002 to 2014 have ranged from 429,000 to 850,000. Estimates of sales value are not readily available industry-wide. However, staff estimates that:

- bench saws account for about 75 percent of the units sold and have an average product life estimated at 10 years;
- contractor saws (including hybrids) account for 20 percent of the units sold and have an average product life of 17 years;
- cabinet saws account for 5 percent of the units sold and have an average product life of 24 years;
- the annual number of table saws in use in the United States is 8.2 million table saws, including about 5.1 million bench saws, 2.3 million contractor saws, and 0.8 million cabinet saws.

Thus, bench, contractor, and cabinet saws account for about 62 percent, 28 percent, and 10 percent of the table saw population, respectively.

C. The Need of the Public for Table Saws and the Effects of the Proposed Rule on their Utility, Cost, and Availability

Consumers commonly purchase table saws for the straight sawing of wood and other materials, and more specifically, to perform rip cuts, cross cuts, and non-through cuts. Because operator finger/hand contact with the table saw blade is a dominant hazard pattern, the Commission proposes a performance requirement that would limit the depth of cut and significantly reduce the frequency and severity of blade-contact injuries on table saws.

The proposed rule would increase table saw production costs. CPSC expects that the prices for the least expensive bench saws now available would more than double, to $300 or more. In general, the retail prices of bench saws could increase by as much as $200 to $500 per unit, and the retail prices of contractor and cabinet saws could rise by as much as $350 to $1,000 per unit. These higher prices may be mitigated in the longer run, but the extent of any future price reductions is unknown.

Because of the likely decline in sales following the promulgation of a rule, consumers who choose not to purchase a new saw, due to the higher price, will experience a loss in utility by forgoing the use of table saws, or because they continue to use older saws that they would have preferred to replace. There may also be some other impacts on utility, such as an increase in the weight and (potentially) size of table saws. This factor may have a relatively small impact on the heavier and larger contractor and cabinet saws, but could markedly reduce the portability of some of the smaller and lighter bench saws.

D. Other Means to Achieve the Objective of the Proposed Rule, While Minimizing Adverse Effects on Competition and Manufacturing

The Commission considered alternatives to the proposed rule. For example, the Commission considered not taking regulatory action, deferring to the voluntary standard development process, exempting or limiting certain table saws from regulation, and information and education campaigns. However, as explained further in these proposed findings (section XVIII.I. of the preamble), the Commission finds that these alternatives would not adequately mitigate the unreasonable risk of injuries that is associated with table saw blade contact.

E. Unreasonable Risk

CPSC estimates that 30,800 table saw-related injuries involving blade contact were treated in hospital emergency departments (ED) in 2015. An estimated 93.8 percent of these injuries involved the finger. The most common diagnoses in blade-contact injuries are laceration injuries, fractures, amputations, and avulsion. Thousands of amputations (an estimated 4,700 amputation injuries in 2015 alone) occur each year on table saws. When compared to all other workshop products, table saws account for an estimated 52.4 percent of all amputations related to workshop products in 2015.

Existing safety devices, such as the blade guard and riving knife, do not adequately reduce the number or severity of blade-contact injuries on table saws. Table saws have been equipped with these passive safety devices since 2009 and there is no evidence of the effectiveness of these safety devices in reducing or mitigating blade-contact injuries. In CPSC's 2015 modular blade guard survey, a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed, and a majority of respondents reported they did not use the blade guard "sometimes" (28%), "often" (17%) or "always" (14%). Any situation where the blade guard is not used eliminates the effectiveness of the blade guard in preventing blade-contact injuries. In addition, a review of CPSRMS database found 11 incidents involving table saws that meet the current voluntary standard requirements for riving knives and modular blade guards. These incidents show that blade-contact injuries continue to occur on table saws equipped with riving knives and modular blade guards.

CPSC's trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws covered the timespan before the voluntary standard implemented the requirement for riving knives and modular blade guards on table saws (2004 to 2009) and the timespan after the requirements were implemented (2010 to 2015). The data showed that there is no discernible change in the number of injuries or types of injuries related to table saw blade contact from 2004 to 2015. A trend analysis to assess the risk of injury per 10,000 table saws in use showed there is no discernible change in the risk of injury associated with table saw blade contact from 2004 to 2015.

CPSC staff's review shows substantial net benefits for the proposed rule. Estimates of net benefits, across all table saw types, averaged about $1,500 to $4,000 per saw over its expected product life. Aggregate net benefits over approximately 1 year's production and sale of table saws could amount to about $625 million to about $2,300 million. The Commission concludes preliminarily that there is an unreasonable risk of injury associated with blade-contact injuries on table saws and finds that the proposed rule is reasonably necessary to reduce that unreasonable risk of injury.

F. Public Interest

This proposed rule is intended to address an unreasonable risk of blade-contact injuries on table saws. As explained in this preamble, adherence to the requirements of the proposed rule would reduce and mitigate severe blade-contact injuries on table saws in the future; thus, the rule is in the public interest.

G. Voluntary Standards

The current voluntary standard for table saws is Underwriters Laboratories Inc. (UL) 987, *Stationary and Fixed Electric Tools.* In August 2016, UL published the first edition of UL 62841-3-1, *Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery Part 3-1: Particular Requirements for Transportable Table Saws*. UL 62841-3-1. The effective date for UL 62841-3-1 is August 29, 2019. Until that date, UL 987 remains in effect, and table saw manufacturers can list their products to either UL 987 or UL 62841-3-1. Both standards specify that table saws shall be provided with a modular blade guard and riving knife.

The Commission does not believe that the voluntary standards adequately address blade-contact injuries on table saws. Existing safety devices, such as the blade guard and riving knife, which have been provided on table saws since 2009, do not adequately reduce the number or severity of blade-contact injuries on table saws. In CPSC's 2015 modular blade guard survey, 80 percent of respondents indicated that there are circumstances that require the blade guard to be removed. Clearly, removal of the blade guard eliminates its ability to prevent or reduce injuries. CPSC's review of incidents from the CPSRMS database identified 11 incidents involving table saws that were equipped with riving knives and modular blade guard systems. These incidents show that blade-contact injuries continue to occur on table saws equipped with riving knives and modular blade guards. Finally, CPSC's trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws from 2004 to 2015 shows that there is no discernible change in the number of injuries or types of injuries related to table saw blade contact from 2004 (when table saws did not have riving knives and modular blade guards) to 2015 (when table saws did have these features).

For these reasons, the Commission believes that the voluntary standard will not adequately address an unreasonable risk of blade-contact injuries on table saws.

H. Relationship of Benefits to Costs

Based on estimates from NEISS and the ICM, the Commission finds that the proposed rule would address an estimated 54,800 medically treated blade-contact injuries annually. The societal costs of these injuries (in 2014 dollars and using a 3 percent discount rate) amounted to about $4.06 billion in 2015. Amputations accounted for about 14 percent of the medically treated blade-contact injuries and almost two-thirds of the injury costs. Overall, medical costs and work losses account for about 30 percent of these costs, or about $1.2 billion. The intangible costs associated with pain and suffering account for the remaining 70 percent of injury costs.

Because of the substantial societal costs attributable to Blade-contact injuries (about $4 billion annually), and the expected high rate of effectiveness of the proposed requirements in preventing blade-contact injuries, the estimated *gross* benefits of the proposed rule (*i.e.*, the expected reduction in societal costs) could amount to an average of about $2,300 to $4,300 per saw. Based on 1 year's production and sale of table saws, aggregate gross benefits could range from about $970 million to $2,450 million annually.

Staff estimates showed that increased manufacturing cost, as well as the expected costs of replacement parts for the AIM system, would range from about $230 to $540 per bench saw, to about $375 to $925 per contractor saw, and to about $400 to $950 per cabinet saw. These costs likely would be mitigated somewhat over time, but the extent of any future cost reduction is unknown. Based on 1 year's production and sale of table saws, aggregate gross costs could range from about $170 million to $340 million annually. In addition to the direct manufacturing and replacement parts costs, firms may need to pay approximately $30 million to $35 million annually in royalty fees to patent holders for the AIM technology.

Additionally, some consumers who would have purchased table saws at the lower pre-regulatory prices will choose not to purchase new table saws. The cost impact of the proposed rule on market sales may reduce aggregate sales by as much as 14 percent to 38 percent annually. The decline in sales will result in lost utility to consumers who choose not to purchase table saws because of the higher prices. Further, more reductions in consumer utility may result from the added weight, and hence, reduced portability associated with adding the AIM technology to the table saws.

Based on our benefit and cost estimates, the Commission estimates that net benefits (*i.e.*, benefits minus costs) for the market as a whole (*i.e.*, combining the three types of table saws together) amount to an average of about $1,500 to $4,000 per saw. Aggregate net benefits on an annual basis could amount to about $625 million to about $2,300 million.

I. Least Burdensome Requirement that would Adequately Reduce the Risk of Injury

The Commission considered less burdensome alternatives to the proposed rule addressing blade-contact injuries on table saws and concluded preliminarily that none of these alternatives would adequately reduce the risk of injury.

No Action Alternative. The Commission considered not taking any regulatory action. Under this alternative table saws would continue to use existing passive safety devices, such as blade guards, riving knives, and anti-kickback pawls. Additionally, table saws with the AIM technology are already available for consumers who want and can afford them. However, not taking any action would leave the unreasonable risk of blade-contact injuries on table saws unaddressed. Based on the severity of injuries and recurring hazard patterns of Blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on all table saws.

Defer to the Voluntary Standard for Table Saws. The Commission considered deferring action to allow the voluntary standard for table saws, UL 987, to develop AIM technology. Although the CPSC has supported recent changes in the voluntary standard with requirements for newer blade guard systems and riving knives and considers these to be a significant improvement over earlier systems, there is little evidence that improvements in these passive safety devices have effectively reduced injuries. Additionally, voluntary standards committees have twice rejected initiatives by UL to adopt provisions that would require AIM systems. Consequently, it does not appear that the voluntary standards process is likely to lead to a requirement for the AIM technology in the near future.

Later Effective Dates. The proposed rule would require an effective date that is 3 years after the final rule is published in the *Federal Register*. The Commission considered a later effective date. An effective date later than 3 years could further reduce the impact of the rule on small manufacturers because it would allow them additional time to spread the costs of developing or negotiating for the rights to use an AIM technology, modify the design of their table saws to incorporate the AIM technology, and retool their factories for the production. For manufacturers that might choose to exit the table saw market, the additional delay might provide them with more time to consider alternative business opportunities.

However, later effective dates could also delay the introduction of table saws with AIM technology into the market and discourage manufacturers from introducing table saws with AIM technology earlier than the effective date, and possibly, put those manufacturers at a competitive disadvantage. Accordingly, the Commission believes that a 3-year effective date from the issuance of a final rule is an appropriate length of time.

Exempt Contractor and Cabinet Saws from a Product Safety Rule. The Commission considered whether to exempt cabinet and/or contractor saws used by professional, commercial, or industrial users, or based on certain size, weight, power, and electrical specifications of the table saw. However, based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on all table saws. Moreover, there is no clear dividing line between consumer and professional saws, except at the very highest levels of price and performances.

Limit the Applicability of the Performance Requirements to Some, but Not All, Table Saws. The Commission also considered limiting the scope of the rule to a subset of table saws to allow manufacturers to produce both table saw models with AIM technology, and models without AIM technology. However, based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on all table saws.

Information and Education Campaign

The Commission also considered whether to conduct an information and education campaign informing consumers about the dangers of blade-contact hazards, and the benefits of the AIM technology. Although such a campaign could help inform consumers, without a performance requirement, that approach would not be sufficient to address the unreasonable risk of blade-contact injuries on table saws.

XIX. Request for Comments

We invite all interested persons to submit comments on any aspect of the proposed rule. Specifically, the Commission seeks comments on the following:

Scope

- Information on whether certain types of table saws should be excluded from the scope of the rule, such as mini or micro tables saws, or table saws that are used primarily for commercial or industrial use.
- Information on whether the scope of the rule should be expanded to include types of saws other than table saws (*e.g.*, tile saws).
- Information on whether the definition of table saws should be revised, or whether other definitions are necessary.
- Information on home-made table saws or other dangerous alternatives consumers may pursue if they are not willing or are unable to purchase a table saw (with AIM capabilities).

Market Information

- Information on table saw sales, by table saw type (bench, contractor, cabinet), and information on the expected product lives of each type of table saw.

Patents

- Information on the effects of the pending expiration of certain SawStop patents in 2020 and 2022.
- Information on barriers to licensing technology that is patented.

- Information on the role of patents in standard business practice, and how this does or does not relate to table saw safety.

Utility

- Information on what impacts AIM technology may have on the utility of table saw use by consumers.

Effectiveness

- Information on effectiveness of AIM technologies. The CPSC staff's regulatory analysis estimated that the requirements of the proposed rule would reduce the risk of blade-contact injury by 70 percent to 90 percent. The Commission seeks comments from the public that either support these effectiveness estimates or that help the Commission adjust them appropriately.
- Information concerning the extent to which table saws are used for cutting wet wood and conductive materials, such as non-ferrous metals, and the extent to which the AIM technology may be deactivated during use.
- Information on whether consumers will use more unsafe methods to cut wood as an alternative to table saws that are equipped with AIM technology.

Manufacturing Costs

- Information on manufacturing costs. Based on the available information, there is considerable uncertainty concerning the per unit manufacturing cost impact on a table saw that would meet the requirements of the proposed rule. The Commission seeks any comments that would allow us to make more precise estimates or narrow the range we present regarding the unit manufacturing cost impact of a rule requiring the use of AIM technology on table saws.

- Information on the feasibility of incorporating AIM technology on small bench top table saws.

Test Requirements

- Information on how different detection methods may be applied as part of an AIM system and appropriate test methods to properly evaluate the triggering of AIM systems employing these detection methods.
- Studies or tests that have been conducted to evaluate AIM technology in table saws.
- Studies, research, or tests on the radial velocity of the human hand/finger in wordworking and, in particular, during actual blade contact incidents.

Regulatory Alternatives

- Information on whether a 36-month effective date is reasonable, and whether a longer or shorter effective date is warranted.
- Information on the feasibility of limiting or exempting a subset of table saws or certain types of table saws from the performance requirements.
- Information on the potential impact of the proposed rule on small entities, especially small businesses.

Anti-stockpiling

- Information on the proposed product manufacture or import limits and the base period with respect to the anti-stockpiling provision.

Comments should be submitted in accordance with the instructions in the **ADDRESSES** section at the beginning of this document.

XX. Conclusion

For the reasons stated in this preamble, the Commission proposes requirements to address an unreasonable risk of injury associated with table saws.

List of Subjects

16 CFR Part 1245

Consumer protection, Imports, Information, Safety.

For the reasons discussed in the preamble, the Commission proposes to amend Title 16 of the Code of Federal Regulations as follows:

1. Add part 1245 to read as follows:

PART 1245-SAFETY STANDARD FOR BLADE-CONTACT INJURIES ON TABLE SAWS

Sec.

1245.1 Scope, purpose and effective date.

1245.2 Definitions.

1245.3 Requirements.

1245.4 Test procedures.

1245.5 Prohibited stockpiling.

1245.6 Findings.

Authority: 15 U.S.C. 2056, 2058 and 2076.

§ 1245.1 Scope, purpose and effective date.

(a) This part 1245, a consumer product safety standard, establishes requirements for table saws, as defined in § 1245.2(a). These requirements are intended to reduce an unreasonable risk of injury associated with blade-contact injuries on table saws.

(b) Any table saw manufactured or imported on or after [date that 36 months after publication of a final rule] shall comply with the requirements stated in § 1245.3

§ 1245.2 Definitions.

In addition to the definitions in section 3 of the Consumer Product Safety Act (15 U.S.C. 2051), the following definition applies for purposes of this part 1245.

(a) *Table Saw* means a woodworking tool that has a motor-driven circular saw blade, which protrudes through the surface of table. Table saws include bench saws, contractor saws, and cabinet saws.

(b) [Reserved]

§ 1245.3 Requirements.

(a) *General.* All table saws covered by this standard shall meet the requirements stated in paragraph (b) of this section.

(b) *Test.* All table saws, when powered on, shall limit the depth of cut to 3.5 mm when a test probe contacts the spinning saw blade at a radial approach rate of 1.0 m/s.

(c) *Test Probe.* The test probe shall act as the surrogate for a human body/finger and allow for the accurate measurement of the depth of cut to assess compliance with paragraph (b) of this section.

§ 1245.4 Test procedures.

Any test procedure that will accurately determine compliance with the standard may be used.

§ 1241.5 Prohibited stockpiling.

(a) *Base period.* The base period for table saws is any period of 365 consecutive days, chosen by the manufacturer or importer, in the 5-year period immediately preceding the promulgation of the final rule.

(b) *Prohibited acts.* Manufacturers and importers of table saws shall not manufacture or import table saws that do not comply with the requirements of this part in any 12-month period between (date of promulgation of the rule) and (effective date of the rule) at a rate that is greater than 120 percent of the rate at which they manufactured or imported table saws during the base period.

§ 1241.6 Findings.

(a) *General.* To issue a consumer product safety standard under the Consumer Product Safety Act, the Commission must make certain findings and include them in the rule. 15 U.S.C. 2058(f)(3). These findings are presented in this section.

(b) *Degree and nature of the risk of injury.* In 2015, there were an estimated 33,400 table saw, emergency department-treated injuries. Of these, CPSC staff estimates that 30,800 (92 percent) likely are related to the victim making contact with the saw blade. Of the 30,800 emergency department-treated, blade-contact injuries, an estimated 28,900 injuries (93.8 percent) involved the finger. The most common diagnosis in blade-contact injuries is an estimated 18,100 laceration injuries (58.8 percent), followed by an estimated 5,900 fractures (19.0 percent), an estimated 4,700 amputations (15.2 percent), and an estimated 2,000 avulsions (6.5 percent). An estimated 3,800 (12.3 percent) of the blade-contact injury victims were hospitalized.

An estimated 4,700 amputation injuries on table saws occurred in 2015, alone. Compared to all other types of consumer products, CPSC staff estimates that table saw-related amputations account for 18.6 percent of all amputations in the NEISS in 2015. When compared to all other workshop products, table saws account for an estimated 52.4 percent of all amputations related to workshop products in 2015. Based on NEISS estimates, the trend analysis for yearly blade-contact injuries associated with table saws showed no discernible change in the number of injuries or types of injuries related to table saw blade contact from 2004 to 2015. In addition, the trend analysis for the risk of blade-contact injury per 10,000 table saws in use yearly showed no discernible change in the risk of injury associated with table saw blade contact from 2004 to 2015.

(c) *Number of consumer products subject to the rule.* The annual shipments of all table saws to the U.S. market from 2002 to 2014 have ranged from 429,000 to 850,000. Estimates of sales value are not readily available industry-wide. However, staff estimates that:

- bench saws account for about 75 percent of the units sold and have an average product life estimated at 10 years;
- contractor saws (including hybrids) account for 20 percent of the units sold and have an average product life of 17 years;
- cabinet saws account for 5 percent of the units sold and have an average product life of 24 years;
- the annual number of table saws in use in the United States is 8.2 million , including about 5.1 million bench saws, 2.3 million contractor saws, and 0.8 million cabinet saws.

Thus, bench, contractor, and cabinet saws account for about 62 percent, 28 percent, and 10 percent of the table saw population, respectively.

(d) *The need of the public for table saws and the effects of the rule on their utility, cost, and availability.* Consumers commonly purchase table saws for the straight sawing of wood and other materials, and more specifically, to perform rip cuts, cross cuts, and non-through cuts.

Because operator finger/hand contact with the table saw blade is a dominant hazard pattern, the Commission proposes a performance requirement that would limit the depth of cut and significantly reduce the frequency and severity of blade-contact injuries on table saws.

The proposed rule would increase table saw production costs. CPSC expects that the prices for the least expensive bench saws now available would more than double, to $300 or more. In general, the retail prices of bench saws could increase by as much as $200 to $500 per unit, and the retail prices of contractor and cabinet saws could rise by as much as $350 to $1,000 per unit. These higher prices may be mitigated in the longer run, but the extent of any future price reductions is unknown.

Because of the likely decline in sales following the promulgation of a rule, consumers who choose not to purchase a new table saw, due to the higher price, will experience a loss in utility by forgoing the use of table saws, or because they continue to use older saws that they would have preferred to replace. There may also be some other impacts on utility, such as an increase in the weight and (potentially) size of table saws. This factor may have a relatively small impact on the heavier and larger contractor and cabinet saws, but could markedly reduce the portability of some of the smaller and lighter bench saws.

(e) *Other means to achieve the objective of the rule, while minimizing the impact on competition and manufacturing.* The Commission considered alternatives to the proposed rule. For example, the Commission considered not taking regulatory action, deferring to the voluntary standard development process, exempting or limiting certain table saws from regulation, and information and education campaigns. However, as explained further in these proposed findings (section XVIII.I. of the preamble), the Commission finds that these alternatives would not adequately mitigate the unreasonable risk of blade-contact injuries on table saws.

(f) *Unreasonable risk.* CPSC estimates that 30,800 table saw-related injuries involving blade contact were treated in hospital emergency departments (ED) in 2015. An estimated 93.8 percent of these injuries involved the finger. The most common diagnoses in blade-contact injuries are laceration injuries, fractures, amputations, and avulsion. Thousands of amputations, (an estimated 4,700 amputation injuries in 2015 alone), occur each year on table saws. When compared to all other workshop products, table saws account for an estimated 52.4 percent of all amputations related to workshop products in 2015.

Existing safety devices, such as the blade guard and riving knife, do not adequately reduce the number or severity of blade-contact injuries on table saws. Table saws have been equipped with these passive safety devices since 2009, and there is no evidence of the effectiveness of these safety devices in reducing or mitigating blade-contact injuries. In CPSC's 2015 modular blade guard survey, a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed, and a majority of respondents reported they did not use the blade guard "sometimes" (28%), "often" (17%) or "always" (14%). Any situation where the blade guard is not used, eliminates the effectiveness of the blade guard in preventing blade-contact injuries. In addition, a review of CPSRMS database found 11 incidents involving table saws that meet the current voluntary standard requirements for riving knives and modular blade guards. These incidents show that blade-contact injuries continue to occur on table saws equipped with riving knives and modular blade guards.

CPSC's trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws covered the timespan before the voluntary standard implemented the requirement for riving knives and modular blade guards on table saws (2004 to 2009) and the timespan after the requirements were implemented (2010 to 2015). The data showed that there is no discernible change in the number of injuries or types of injuries related to table saw blade contact from 2004 to 2015. A trend analysis to assess the risk of injury per 10,000 table saws in use showed there is no discernible change in the risk of injury associated with table saw blade contact from 2004 to 2015.

CPSC staff's review shows substantial net benefits for the proposed rule. Estimates of net benefits, across all table saw types, averaged about $1,500 to $4,000 per saw over its expected product life. Aggregate net benefits over approximately 1year's production and sale of table saws could amount to about $625 million to about $2,300 million. The Commission concludes preliminarily that there is an unreasonable risk of injury associated with blade-contact injuries on table saws and finds that the proposed rule is reasonably necessary to reduce that unreasonable risk of injury.

(g) *Public interest.* This proposed rule is intended to address an unreasonable risk of blade-contact injuries on table saws. As explained in this preamble, adherence to the requirements of the proposed rule would reduce and mitigate the severity of blade-contact injuries on table saws in the future; thus, the rule is in the public interest.

(h) *Voluntary standards.* The current voluntary standard for table saws is Underwriters Laboratories Inc. (UL) 987, *Stationary and Fixed Electric Tools.* In August 2016, UL published the first edition of UL 62841-3-1, *Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery Part 3-1: Particular Requirements for Transportable Table Saws*. UL 62841-3-1. The effective date for UL 62841-3-1 is August 29, 2019. Until that date, UL 987 remains in effect, and table saw manufacturers can list their products to either UL 987 or UL 62841-3-1. Both standards specify that table saws shall be provided with a modular blade guard and riving knife.

The Commission does not believe that the voluntary standards adequately address blade-contact injuries on table saws. Existing safety devices, such as the modular blade guard and riving knife, which have been provided on table saws since 2009, do not adequately reduce the number or severity of blade-contact injuries on table saws. In CPSC's 2015 modular blade guard survey, 80 percent of respondents indicated that there are circumstances that require the blade guard to be removed. Clearly, removal of the blade guard eliminates its ability to prevent or reduce injuries. CPSC's review of incidents from the CPSRMS database identified 11 incidents involving table saws that were equipped with riving knives and modular blade guard systems. These incidents show that blade-contact injuries continue to occur on table saws equipped with riving knives and modular blade guards. Finally, CPSC's trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws from 2004 to 2015 shows that there is no discernible change in the number of injuries, types of injuries, or risk of injuries related to table saw blade contact from 2004 (when table saws did not have riving knives and modular blade guards) to 2015 (when table saws did have these features).

For these reasons, the Commission believes that the voluntary standard will not adequately address an unreasonable risk of injury associated with blade-contact injuries on table saws.

(i) *Relationship of benefits to costs.* Based on estimates from NEISS and the ICM, the Commission finds that the proposed rule would address an estimated 54,800 medically treated blade-contact injuries annually. The societal costs of these injuries (in 2014 dollars and using a 3 percent discount rate) amounted to about $4.06 billion in 2015. Amputations accounted for about 14 percent of the medically treated blade-contact injuries but almost two-thirds of the injury costs. Overall, medical costs and work losses account for about 30 percent of these costs, or about $1.2 billion. The intangible costs associated with pain and suffering account for the remaining 70 percent of injury costs.

Because of the substantial societal costs attributable to blade-contact injuries (about $4 billion annually), and the expected high rate of effectiveness of the proposed requirements in preventing blade-contact injuries, the estimated *gross* benefits of the proposed rule (*i.e.*, the expected reduction in societal costs) could amount to an average of about $2,300 to $4,300 per saw. Based on 1 year's production and sale of table saws, aggregate gross benefits could range from about $970 million to $2,450 million annually.

Staff estimates showed that increased manufacturing cost, as well as the expected costs of replacement parts for the AIM system, would range from about $230 to $540 per bench saw, about $375 to $925 per contractor saw, and about $400 to $950 per cabinet saw. These costs likely would be mitigated somewhat over time, but the extent of any future cost reduction is unknown. Based on 1 year's production and sale of table saws, aggregate gross costs could range from about $170 million to $340 million annually. In addition to the direct manufacturing and replacement parts costs, firms may need to pay approximately $30 million to $35 million annually in royalty fees to patent holders for the AIM technology.

Additionally, some consumers who would have purchased table saws at the lower pre-regulatory prices will choose not to purchase new table saws. The cost impact of the proposed rule on market sales may reduce aggregate sales by as much as 14 percent to 38 percent annually. The decline in sales will result in lost utility to consumers who choose not to purchase table saws because of the higher prices. Further, more reductions in consumer utility may result from the added weight, and hence, reduced portability associated with addition the AIM technology on table saws.

Based on our benefit and cost estimates, the Commission estimates that net benefits (*i.e.*, benefits minus costs) for the market as a whole (*i.e.*, combining the three types of table saws together) amount to an average of about $1,500 to $4,000 per saw. Aggregate net benefits on an annual basis could amount to about $625 million to about $2,300 million.

(j) *Least burdensome requirement that would adequately reduce the risk of injury.* The Commission considered less burdensome alternatives to the proposed rule addressing blade-contact injuries on table saws and concluded preliminarily that none of these alternatives would adequately reduce the risk of injury.

No Action Alternative. The Commission considered not taking any regulatory action. Under this alternative, table saws would continue to use existing passive safety devices, such as blade guards, riving knives, and anti-kickback pawls. Additionally, table saws with the AIM technology are already available for consumers who want and can afford them. However, not taking any action would leave the unreasonable risk of blade-contact injuries on table saws unaddressed. Based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on all table saws.

Defer to the Voluntary Standard for Table Saws. The Commission considered deferring action to allow the voluntary standard for table saws, UL 987, to develop AIM technology. Although the CPSC has supported recent changes in the voluntary standard with requirements for newer blade guard systems and riving knives and considers these to be a significant improvement over earlier systems, there is little evidence that improvements in these passive safety devices have effectively reduced injuries. Additionally, voluntary standards committees have twice rejected initiatives by UL to adopt provisions that would require AIM systems. Consequently, it does not appear that the voluntary standards process is likely to lead to a requirement for the AIM technology in the near future.

Later Effective Dates. The proposed rule would require an effective date that is 3 years after the final rule is published in the *Federal Register*. The Commission considered a later effective date. An effective date later than 3 years could further reduce the impact of the rule on small manufacturers because it would allow them additional time to spread the costs of developing or negotiating for the rights to use an AIM technology, modify the design of their table saws to incorporate the AIM technology, and retool their factories for the production. For manufacturers that might choose to exit the table saw market, the additional delay might provide them with more time to consider alternative business opportunities.

However, later effective dates could also delay the introduction of table saws with AIM technology into the market and discourage manufacturers from introducing table saws with AIM technology earlier than the effective date, and possibly, put those manufacturers at a competitive disadvantage. Accordingly, the Commission believes that a 3-year effective date from the issuance of a final rule is an appropriate length of time.

Exempt Contractor and Cabinet Saws from a Product Safety Rule. The Commission considered whether to exempt cabinet and/or contractor saws used by professional, commercial, or industrial users, or based on certain size, weight, power, and electrical specifications of the table saw. However, based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on all table saws. Moreover, there is no clear dividing line between consumer and professional saws, except at the very highest levels of price and performances.

Limit the Applicability of the Performance Requirements to Some, but Not All, Table Saws. The Commission also considered limiting the scope of the rule to a subset of table saws to allow manufacturers to produce both table saw models with AIM technology, and models without AIM technology. However, based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, the Commission believes that a performance requirement is necessary to reduce the unreasonable risk of blade-contact injuries on all table saws.

Information and Education Campaign

The Commission also considered whether to conduct an information and education campaign informing consumers about the dangers of blade-contact hazards, and the benefits of the AIM technology. Although such a campaign could help inform consumers, without a performance requirement, that approach would not be sufficient to address the unreasonable risk of blade-contact injuries on table saws.

Dated: ________________

____

Todd A. Stevenson,
Secretary, Consumer Product Safety Commission

BRIEFING PACKAGE

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

January 2017

For Further Information Contact:

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EXECUTIVE SUMMARY

Background: 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. CPSC staff prepared a briefing package in response to the petition, and on July 11, 2006, the Commission voted to grant Petition CP 03-2. The Commission directed staff to draft an advance notice of proposed rulemaking (ANPR). In 2011, staff prepared a briefing package, and on October 11, 2011, the Commission published an ANPR to consider whether a new performance safety standard is needed to address an unreasonable risk of injury associated with table saws. Staff received approximately 1,600 public comments. This package presents information for the Commission to use in considering whether to publish the staff's draft notice of proposed rulemaking (NPR) for performance requirements to address table saw blade contact injuries.

Product: Table saws are stationary power tools used for the straight sawing of wood and other materials.[1] The basic design of a table saw consists of a motor-driven saw blade that protrudes through a flat table surface. To make a cut, the operator places the workpiece on the table and, using a rip fence or miter gauge as guides, pushes the workpiece into the blade.

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 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.

Incident Data:

CPSC staff reviewed all National Electronic Injury Surveillance System (NEISS) cases related to table saw product code 0841 that were treated in 2015. Staff reviewed and categorized the data to remove cases that were not related to an operational table saw and to classify cases that were due to contact with the blade. In 2015, there were an estimated 33,400 table saw, emergency department-treated injuries. Of these, staff estimates that 30,800 (92 percent) are likely related to the victim making contact with the saw blade.

Of the 30,800 emergency department-treated blade-contact injuries in 2015, an estimated 28,900 injuries (93.8 percent) involved the finger. The most common diagnoses in blade contact injuries follows: an estimated 18,100 laceration injuries (58.8 percent); followed by an estimated 5,900 fractures (19.0 percent); an estimated 4,700 amputations (15.2 percent); and an estimated 2,000 avulsions (6.5 percent). An estimated 3,800 (12.3 percent) of the blade contact injury victims in 2015 were hospitalized.

[1] "Stationary" refers to the table saw being stationary relative to the moving workpiece, unlike a portable tool that is moved relative to the workpiece.

Thousands of amputations, an estimated 4,700 amputation injuries in 2015 alone, occur each year on table saws. Compared to all other types of consumer products, table saw-related amputations are estimated to account for 18.6 percent of all amputations in the NEISS in 2015. When compared to all other workshop products, table saws account for an estimated 52.4 percent of all amputations related to workshop products in 2015. The estimated mean age for table saw blade contact injury victims is 55.6; whereas, all other workshop product-related injury victims have an estimated mean age of 42.7. This approximate 13-year difference in the mean age of victims is a statistically significant difference (p-value < 0.0001), indicating that table saw blade contact injuries involve older victims in comparison to injuries related to all other workshop products.

CPSC staff estimated the yearly blade contact injuries associated with table saws from 2004 to 2015 by using estimates from NEISS. Staff then estimated the risk of blade contact injury per 10,000 table saws, using the estimated number of table saws in use for each year.[2] Staff's trend analysis of the data indicates the following:

- There is no discernable change in the number of injuries or type of injuries related to table saw blade contact from 2004 to 2015.
- There is no discernible change in the risk of injury associated with table saw blade contact.

CPSC staff also reviewed table saw-related reported incidents collected by CPSC and stored in the Consumer Product Safety Risk Management System (CPSRMS) database. Staff identified 53 incidents in the CPSRMS database that involve blade contact injury on a table saw that occurred between January 1, 2004 and December 31, 2015, and were reported to CPSC by March 1, 2016. Of the 53 reported incidents related to table saw blade contact, 36 incidents involved table saws that came equipped with a traditional blade guard, and 11 incidents involved table saws that came equipped with a modular blade guard. Laceration and amputation injuries occurred on table saws equipped with traditional guards and on table saws equipped with modular blade guards. In addition, staff's review of the reports indicates that the incident scenarios for table saws with modular blade guards are similar to table saws with traditional blade guards in terms of incidents occurring with and without the use of blade guards and incidents occurring with and without unexpected workpiece movement from kickback of the material.

Based on the statistical analysis of table saw injuries, CPSC staff believes that operator finger/hand contact with the table saw blade is a dominant hazard pattern for which a remedy can readily be achieved. Improving the injury mitigation performance of a table saw is a strategy for reducing the frequency and severity of blade contact injuries on table saws.

Recommendation for Proposed Rule: CPSC staff conducted a range of tests on sample table saws with active injury mitigation (AIM) technology. Based on the test results, data analysis, and technical feasibility, CPSC staff recommends the following performance requirements to reduce the severity of operator blade contact injuries on table saws:

[2] CPSC's Directorate for Economic Analysis (TAB C) provided the estimated numbers of table saws in use for this analysis.

- Table saws shall demonstrate a minimum level of injury mitigation, defined as a depth of cut, that is 3.5 mm or less when a test probe, representing a human finger, contacts the spinning blade at a radial approach rate of 1 meter per second (m/s). The depth of cut represents the quantitative threshold between a simple and complex laceration to the most vulnerable surface of the finger; this translates to the difference between a minor injury which will heal by itself, or require only minor medical attention, and a severe injury, such as the laceration of arteries, nerves, and tendons, which would require extensive medical treatment to repair, including microsurgery.

Staff believes that a performance requirement that limits to 3.5 mm the depth of cut to a test probe that contacts a saw blade will significantly reduce the severe lacerations, fractures, amputations, and avulsions associated with operator blade-contact incidents on table saws. This is because the probe will have the appropriate properties to indicate human body/finger contact with the saw blade and the equivalent injury mitigation on a real human finger will avoid most microsurgery. Most microsurgery will be avoided because the neurovascular bundle in a human little finger, which contains nerves and arteries, is at a depth of approximately 3.5 mm below the 0.5 mm thick epidermal layer of the skin.[3,4] In this manner, a 3.5 mm depth of cut into a conductive test probe is a surrogate for a 4mm depth of cut into a finger with insulating epidermis over conductive tissue. For probes that are based on detection of other human body properties, the 3.5 mm depth of cut limitation still translates to an injury that will avoid most microsurgery for the reasons stated before regarding location of the neurovascular bundle in a human little finger.

Economic Evaluation: The draft proposed rule would address roughly 54,800 medically treated blade contact injuries annually. The societal costs of these injuries amount to about $4 billion in 2015. These high costs are attributable to the large number of amputations, which account for about 14 percent of medically treated blade contact injuries but almost two-thirds of the injury costs. Because of the high estimates of societal costs associated with blade contact injuries, and the expected high rate of effectiveness of the draft proposed rule in mitigating or preventing blade contact injuries, the estimated *gross* benefits of the proposed rule (*i.e*., the expected reduction in societal costs) may range from $2,300 to $4,300 per table saw.

The proposed rule would also be costly and would result in some disruption of the table saw market. Under the rule, table saw manufacturers would need to develop their own AIM technology, without impinging on existing patents, or chose to license a patented and available AIM technology. Based on current table saw designs, most, if not all, table saw models not already incorporating the AIM technology would require major design changes and the retooling of production facilities, a process that likely would take 2 years or longer to accomplish.

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[3] Research by Underwriters Laboratories (UL) that determined the maximum depth for a cut to a finger before serious injury is sustained is 4 mm from the surface of the skin. UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014. Retrieved from http://library.ul.com/wp-content/uploads/sites/40/2015/02/UL_WhitePapers_Tablesaw_V11.pdf.

[4] Research that indicates the thickness of the epidermis, the top layer of the skin, is approximately 0.369 +/-0.112 mm, or rounded to a maximum thickness of approximately 0.5 mm). Judi Whitton and J.D. Everall, "The Thickness of the Epidermis," *British Journal of Dermatology*, Vol. 89, Issue 5 (November 1973), pgs. 467-476.

Additionally, higher manufacturing costs may lead to retail prices rising sharply, reduced sales, and the exit of some firms from the U.S. market.

Estimates of the increased manufacturing cost, as well as the expected costs of replacement parts for the AIM system, amount to about $230 to $540 per bench saw, to about $375 to $925 per contractor saw, to about $400 to $950 per cabinet saw. These higher costs may be mitigated somewhat over time, but the extent of any future cost reduction is unknown. Based on 1-year's production and sale of table saws, aggregate gross costs could range from about $170 million to $345 million annually.

Based on staff's benefit and cost estimates, estimated net benefits (*i.e.*, benefits minus costs) for the market as a whole (*i.e.,* addressing all table saw types) amounted to an average of about $1,500 to $4,000 per saw. Staff also performed a sensitivity analysis that explored plausible changes in the assumptions regarding expected product life, number of table saws in use, national estimate of medically treated injuries, discount rate, and injury cost estimates. Net benefits varied, but they generally remained positive in the sensitivity analysis.

Voluntary Standards: The current U.S. voluntary consensus standards for table saws are the eighth edition of UL 987 *Stationary and Fixed Electric Tools* and the first edition of UL 62841-3-1 *Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery Part 3-1: Particular Requirements for Transportable Table Saws*. Underwriters Laboratories Inc. (UL) published the first edition of UL 987 *Stationary and Fixed Electric Tools* in 1971. UL 987 included requirements for table saws that specified the following safety devices: a single-piece blade guard, a spreader, and anti-kickback pawls. In 2005, UL published the sixth edition of UL 987, which added requirements for a riving knife to the general requirements for table saws. The effective date for the riving knife requirements was January 2014. In 2007, UL published the seventh edition of UL 987, which expanded the table saw guarding requirements to include a new modular blade guard design developed by a joint venture of the leading table saw manufacturers. The effective date for the modular blade guard requirements was January 2010. In 2011, UL published the eighth edition of UL 987, which clarified existing requirements for table saws and remains the current edition of UL 987.

In February 2016, UL balloted a proposal to adopt the first edition of International Electrotechnical Commission (IEC) 62841-3-1, *Standard for Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery – Safety – Part 3-1: Particular Requirements for Transportable Table Saws* as the first edition of UL 62841-3-1. The proposal passed, and in August 2016, UL published the first edition of UL 62841-3-1 *Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery Part 3-1: Particular Requirements for Transportable Table Saws*. UL 62841-3-1 is recognized as an American National Standards Institute (ANSI) standard and includes requirements for a modular blade guard, riving knife, and anti-kickback pawls. The effective date for UL 62841-3-1 is August 29, 2019. Until that date, UL 987 remains in effect, and table saw manufacturers can list their products to either UL 987 or UL 62841-3-1.

In February 2015 and again in February 2016, UL balloted a proposal to include AIM system requirements for table saws. The proposal included a performance requirement that limited the depth of cut to a test probe, upon triggering the AIM system at an approach rate of 1 m/s, to 4 mm. Both of UL's ballots to introduce AIM requirements to table saws failed to achieve consensus due to objections from the table saw industry that AIM requirements should not be mandatory and that the proposed requirements were not sufficiently developed.

Conclusion/Recommendation: From January to December 2015, CPSC staff estimates 30,800 emergency department-treated table saw blade contact injuries resulted in an estimated 18,100 (58.8 percent) laceration injuries, an estimated 5,900 (19.0 percent) fractures, an estimated 4,700 (15.2 percent) amputations, and an estimated 2,000 avulsions (6.5 percent). Trend analyses of injury and risk indicate that there is no discernable change in the number of injuries or type of injuries and no discernible change in the risk of injury associated with table saw blade contact from 2004 to 2015.

CPSC staff believes that the baseline level of protection on table saws is provided by the use of a blade guard and riving knife to prevent blade contact injuries. However, in cases where blade contact does occur, technical analysis shows that CPSC staff's recommended requirements for a secondary level of protection will reduce the severity of blade contact injuries caused by operator contact with the table saw blade, thereby reducing the frequency of lacerations, fractures, amputations, and avulsions. Staff believes that the recommended requirements are technologically feasible and that the benefits of the draft proposed rule substantially exceed the rule's costs for all table saw categories.

Moreover, staff believes that the current voluntary standards for table saws will not reduce the severity of table saw operator blade contact injuries. Incident data hazards and risk have not changed in the years since the voluntary standard was revised to address blade contact injuries. The voluntary standards do not have requirements to mitigate injury when contact is made with the blade. In addition, staff is aware of blade contact injury incidents that have occurred on table saws meeting the current voluntary standards. For these reasons, CPSC staff recommends that the Commission publish the draft NPR for table saws submitted with this briefing package.

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B	Table Saw Blade Contact Injury Analysis
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E	Human Factors Assessment of Blade-Contact Scenarios and Responses to ANPR Public Comments
F	2014-2015 Table Saw Special Study Cautionary Statement

United States
Consumer Product Safety Commission
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Bethesda, MD 20814

This document has been electronically approved and signed.

Memorandum

January 13, 2017

TO: The Commission
Todd Stevenson, Secretary

THROUGH: Mary T. Boyle, General Counsel
Patricia H. Adkins, Executive Director

FROM: George A. Borlase, Assistant Executive Director
Office of Hazard Identification and Reduction
Caroleene Paul, Project Manager
Directorate for Engineering Sciences

SUBJECT: Proposed Rule 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 notice of proposed rulemaking (NPR) 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 to grant Petition CP 03-2 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 a better understanding of hazard patterns related to table saw injuries. In 2011, staff prepared a briefing package with a recommendation to commence rulemaking, and the Commission voted to publish an ANPR. On October 11, 2011, the Commission published an ANPR to consider whether a new performance safety standard is needed to address an unreasonable risk of injury associated with table saws.[6] The Commission received approximately 1,600 comments in response to the ANPR.

This package presents CPSC staff's recommendation for a proposed rule, followed by a preliminary regulatory analysis that discusses the potential benefits and costs of the draft

[5] Petition CP 03-2 is available on CPSC's website at: http://www.cpsc.gov/library/foia/foia03/petition/Bladesawpt1.pdf.
[6] 76 FR 62678 Table Saw Blade Contact Injuries; Advance Notice of Proposed Rulemaking

proposed rule requirements, along with an initial regulatory flexibility analysis (IRFA) that discusses the potential impact of the draft proposed rule on small businesses.

Staff is recommending that the Commission publish an NPR to address blade contact injury hazards associated with the use of table saws.

II. DISCUSSION

A. Product Review (see Tab A)

1. Description

Table saws are stationary power tools used for the straight sawing of wood and other materials. The basic design of a table saw consists of a motor-driven saw blade that protrudes through a flat table surface. To make a cut, the operator places the workpiece on the table and, using a rip fence or miter gauge as a guide, pushes the workpiece into the blade (see Figure 1).

Standard safety devices on table saws are designed to reduce contact between the saw blade and the operator and to reduce kickback, a phenomenon in which the saw blade imparts its kinetic energy to the workpiece and ejects the workpiece back towards the operator. 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.

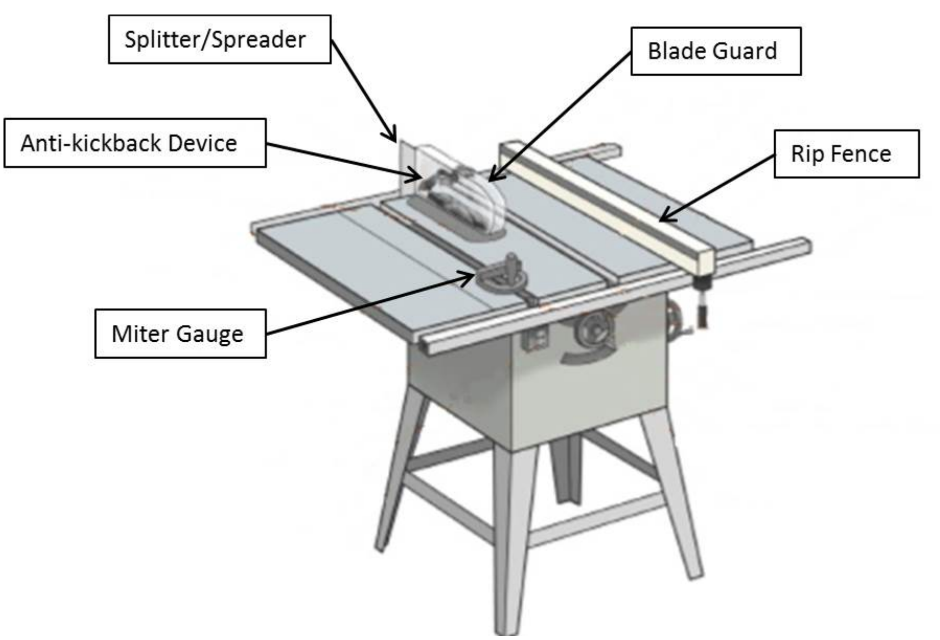

Figure 1. Typical table saw components.

Blade Guards

Blade guards surround the exposed blade and function as a physical barrier between the blade and the operator. Blade guards are designed either as a single-piece unit that covers the saw blade, as shown in Figure 1, or as a modular system with a fixed top barrier and independent side barriers, as shown in Figure 2.

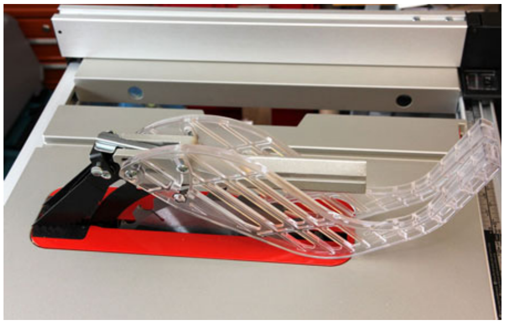

Figure 2. Typical modular blade guard.

Kickback-Prevention Devices

Kickback-prevention devices include splitters, riving knives, and anti-kickback pawls. A splitter (see Figure 1), 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 already fed through the blade. This prevents the workpiece from closing up on itself after it passes the blade, and pinching the blade, which can cause the workpiece to be thrown upwards and back toward the operator. Before 2009, most table saws were designed with a splitter located behind the blade that was attached to the blade guard. If a cut required removal of the splitter or guard, they were removed together.

Riving knives (see Figure 3) are curved metal plates that are similar to, and perform the same function as, splitters, but are often located closer to the blade, rise no higher than the top of the blade, and attach to the arbor assembly so that they are raised and lowered with the blade.[7] Like splitters, riving knives physically prevent the two halves of the cut workpiece from moving back towards each other and pinching the spinning blade. However, unlike splitters, the riving knife can be left in place for non-through cuts (see II.A.2 for examples of non-through cuts).

Anti-kickback pawls (see Figure 4) are another device designed to help reduce kickback. The pawls are mounted on both sides of the splitter and consist of a pair of spring-loaded pieces of metal with barbed teeth on the bottom edge that allow passage of the workpiece but will dig into it if it begins to move back toward the operator.

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

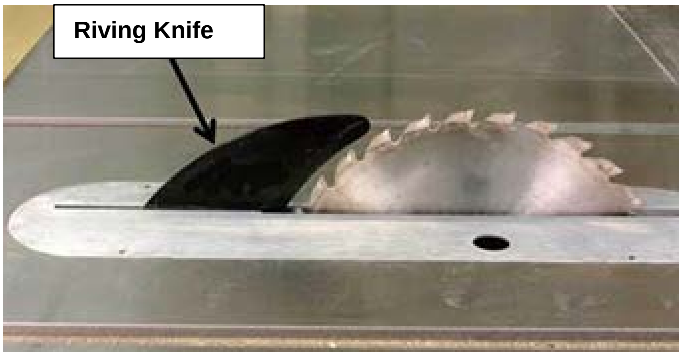

Figure 3. Typical riving knife.

Figure 4. Typical anti-kickback pawls.

The riving knife and modular blade guard represent the latest progression in table saw safety design that have been incorporated into the voluntary standards for table saws. Table saws equipped with the riving knife and modular blade guard became available on the U.S. market beginning in 2008, and by 2012, table saw manufacturers introduced more than 900,000 table saws with the latest safety devices.[8]

2. 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 5). 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.

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 to keep the workpiece secure and at a specific angle to the blade. The miter gauge can be angled relative to the blade to perform "miter" cuts. The miter gauge slides in a recessed track and is slowly pushed forward, feeding the workpiece through the blade.

Although less common than ripping and crosscutting, other 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. Dado and rabbet cuts are the most common forms of these cuts. A dado produces a simple channel or trough in the workpiece; dadoes that run along the length of the workpiece, rather than across its width, are sometimes referred to as grooves. A rabbet is a similar non-through cut, which is located at the edge or end of a workpiece. Non-through cuts that run the length or width of the workpiece require removal

[8] Although the voluntary standard effective date for riving knives and modular blade guard was January 31, 2014, and January 31, 2010, respectively; the industry accelerated compliance with the voluntary standard and the new guarding system with modular blade guard and riving knife became available on table saws the fourth calendar quarter of 2007. Therefore, staff assumes the widespread availability of the modular blade guard and riving knife began in 2008. Comment from PTI to table saw ANPR. Page 17. Retrieved from https://www.regulations.gov/document?D=CPSC-2011-0074-1081.

of the blade guard to allow the workpiece to be run over the saw blade (rather than through) for the entire length or width of the workpiece; during such cuts, the riving knife can still be used.

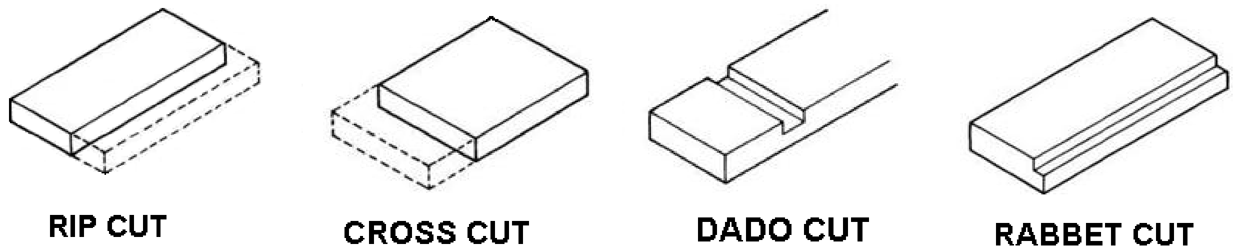

Figure 5. Sample cutting operations.

3. Table Saw Categories/Types

Table saws generally fall into three different categories of saws: (1) bench saws, (2) contractor saws, and (3) cabinet saws. Bench saws comprise a range of table saws that are portable due to their small size and low weight, or their attachment to a folding stand with wheels. Contractor and cabinet saws are larger and heavier and are not intended to be portable. Generally, the range of quality and accuracy of a table saw is commensurate with its size, motor horsepower, weight, and indirectly, price.

Bench Saws

Bench saws are intended to be transportable so they tend to be small, lightweight, and relatively inexpensive (see Figure 6). In recent years, bench saw designs have evolved to include saws with larger and heavier-duty table surfaces, with some attached to a folding stand with wheels to maintain mobility (see Figure 7). These larger portable saws on wheeled stands are called jobsite saws because they are capable of heavier-duty work, but they are still portable enough to move to a work site.

Bench saws generally run on standard house voltage (110-120 volts), use universal motors[9], drive the saw blade through gears, and range in weight from 34 pounds to 133 pounds. The universal motor and gear drive produce the high-decibel noise and vibration that are distinctive characteristics of bench saws. Prices for bench saws without active injury mitigation technology range from $129 per model to as much as $1,490 for a high-end model.[10] Recent introductions of jobsite saws with active injury mitigation technology range in price from $1,299 to $1,499.

[9] A universal motor runs on AC or DC power, has high starting torque, can run at high speed, and is lightweight and compact. For these reasons, universal motors are commonly used in portable power tools and equipment.
[10] Prices for table saws are from Tab C, Preliminary Regulatory Analysis of the Draft Proposed Rule for Table Saws. August, 2016.

Figure 6. Typical bench saw.

Figure 7. Typical jobsite saw.

Contractor Saws

Contractor saws used to be considered portable table saws, but designs have progressed with larger motors and heavier table tops to the point that most contractor saws are considered non-portable (see Figure 8). Although a mobile base can be added to the frame to make contractor saws mobile, they are often found in home workshops as non-portable saws that are a less-expensive alternative to cabinet saws.

Contractor saws generally run on standard house voltage, use induction motors, are belt driven, and range in weight from around 200 pounds to 400 pounds. The induction motor and belt drive result in a table saw that produces less vibration, is quieter, more accurate, able to cut thicker pieces of wood, and more durable than a bench saw. Prices for contractor saws range from around $500 to $2,000.

Cabinet Saws

Cabinet saws are heavier than contractor saws because the higher-powered motor is enclosed in a solid base (see Figure 9). These saws are typically the highest grade saw found in the home woodworking shop.

Cabinet saws generally run on 220-240 volts, use a 1.75-5 hp or stronger motor, are belt driven, and weigh from around 300 pounds to 1,000 pounds. Components in cabinet saws are designed for heavy use and durability, and the greater weight further reduces vibration so that cuts are smoother and more accurate. Cabinet saws are expected to last a lifetime (with an average product life of 24 years) and prices range from around $1,200 to $5,000.

Figure 8. Typical contractor saw.

Figure 9. Typical cabinet saw.

4. Table Saw Market (see Tab C)

Suppliers

CPSC staff identified at least 22 firms that supply table saws to the U.S. market. This listing may not be all inclusive because there are a number of Asian table saw manufacturers not included who may have achieved some U.S. distribution.

The Power Tool Institute (PTI) estimates that its member companies account for 80 percent of all table saws sold in the United States. Most are large, diversified international corporations with billions of dollars in sales, such as Stanley Black and Decker, Robert Bosch (Bosch), Makita, and Techtronic Industries Co., Ltd. These four large, diversified firms are currently supplying table saws to the U.S. market, but table saws comprise a relatively small part of their revenues, probably less than 1 percent. PTI tends to represent the mass market bench table saw manufacturers, while many of the smaller suppliers are primarily in the cabinet and contractor saw market segments.

Table Saw Sales

Although the design and engineering of table saws may occur in the United States, interviews and public comments indicate that most table saws are currently manufactured overseas; several firms interviewed indicated that their saws are manufactured in Taiwan. As an example, Grizzly Industrial, Inc., indicated that it operates quality control offices in Taiwan and China and imports saws from Asia. This pattern is supported by data from the U.S. International Trade Commission, which indicates that in 2014, approximately 99 percent of imported table saw units were built in Taiwan and China.

According to PTI, total annual shipments of table saws to the U.S. market from 2002 to 2014 have ranged from 429,000 to 850,000 units. The average over the 13-year period amounted to about 675,000 units annually. Estimates of sales value are not readily available. Based on available information, bench saws may account for approximately 75 percent of the table saw market by unit volume; contractor and cabinet saws may account for 20 percent and 5 percent, respectively.

Population of Table Saws in Use

The annual number of table saws in use, a measure of risk exposure, was estimated with the CPSC's Product Population Model (PPM), a computer model that projects the number of products in use given estimates of annual product sales and product failure rates (for more detailed information on the PPM see Tab C). Based on shipment and product life estimates provided from PTI, staff estimates that there were about 8.2 million table saws in use in the United States during 2015, including about 5.1 million bench saws, 2.3 million contractor saws, and 0.8 million cabinet saws. Thus, bench, contractor, and cabinet saws may account for about 62 percent, 28 percent, and 10 percent, respectively, of the table saw population.

B. Incident Data (see Tab B)

1. National Electronic Injury Surveillance System (NEISS)

The National Electronic Injury Surveillance System (NEISS) is a national stratified probability sample of emergency departments in the United States and its territories that provides the data to generate national estimates of emergency department-treated injuries related to consumer products. There are five strata in the NEISS: children's hospitals, small hospitals, medium hospitals, large hospitals, and very large hospitals. Within each stratum is a sample of hospitals that make up the primary sampling units (PSUs) of the NEISS. For each hospital in the sample, every first-time emergency department visit for an injury associated with a consumer product is recorded.[11] To facilitate injury estimates associated with a product or product group, each injury has a product code that identifies the type of product involved. Other product-specific information, such as the product manufacturer or events leading to the hazard, is not recorded in the NEISS. However, information that is recorded for each injury includes sex, age, diagnosis, disposition, and body part. Additional information about the NEISS can be found online at: http://www.cpsc.gov/en/Research--Statistics/NEISS-Injury-Data.

In 2001, CPSC performed a NEISS special study for stationary power saw-related injuries.[12] The results were published in a memorandum, "Injuries Associated with Stationary Power Saws, 2001" (2001 NEISS special study).[13] In 2007, CPSC staff launched another stationary power saw special study, running through 2008. The report, "Survey of Injuries Involving Stationary Saws: Table and Bench Saws, 2007-2008" (2007-2008 NEISS special study), presented estimates of the numbers and types of emergency department-treated injuries related to table saws in this two-year study, which was published in March 2011.[14] In late 2011, CPSC's ANPR for table saws was published in the *Federal Register*.[15] The ANPR used the 2007-2008 NEISS special study estimates as the analytical support for the discussion of table saw-related injuries. However, public comments submitted to the CPSC in response to the ANPR called attention to a contradiction between the estimated numbers for each type of table saw and the estimated injuries of direct-drive and indirect-drive table saws in the 2007-2008 special study.[16] CPSC staff conducted a reanalysis of the saw type and drive type responses provided by the injury victims in the 2007-2008 special study. The results of the reanalysis were published in June 2014. CPSC staff found that the estimated number of injuries based on the type of saw were inconsistent with the estimated injuries associated with respondent-declared drive type which indicated that bench

[11] NEISS does not record return visits to the emergency department or other follow-up medical visits for the same injury.
[12] Stationary refers to power saws that are not hand-held.
[13] https://www.cpsc.gov/s3fs-public/pdfs/powersaw.pdf.
[14] http://www.cpsc.gov//PageFiles/118311/statsaws.pdf.
[15] ANPR Briefing Package: https://www.cpsc.gov/s3fs-public/pdfs/foia_tablesaw_0.pdf.
[16] It should be noted that the EC analysis (TAB C) in the ANPR package noted that there was an apparent inconsistency between some study participants' responses to the type of saw used and their responses to the question about the type of drive system used in the saw.

saws may be associated with a much larger proportion of the estimated injuries than initially reported.[17]

Because the results from the June 2014 reanalysis indicated that the type of table saw reported in the 2007-2008 special study had inconsistencies that raised questions about the distribution of type of table saw in table saw-related injuries, CPSC staff implemented a 2014-2015 NEISS special study. This study, conducted by contractors, collected computer-aided telephone interview (CATI) responses from individuals treated for injuries related to stationary saws (this category includes table saws) and to unidentified types of saw in emergency departments of NEISS member hospitals between July 2014 and December 2015. For injuries determined to be table saw-related, interviewers read definitions to the participants regarding each table saw type, and interviewers asked additional questions when the participant identified a saw and drive type that were not compatible.

After contractors completed the 2014-2015 NEISS special study CATI interviews and CPSC staff compiled the data, CPSC subject matter experts and statisticians discovered unexpected patterns in participant response data across the 275 completed table saw survey responses. Further analysis revealed evidence that the interviewer affected the participants' responses, a phenomenon known as "interviewer effect." Ninety-four percent (259) of the completed surveys were conducted by two interviewers from one company. Statistically significant differences between responses collected by the two interviewers existed for critical questions, such as the type of table saw involved in the injury, use of safety features, and activities preceding the injury. The presence of this effect implies that the responses may not be reliable or reproducible.[18] CPSC senior statisticians recommended that the CATI interviewer-collected participant responses to the 2014-2015 NEISS special study results not be used for regulatory development. Therefore, estimates presented in this memorandum use only the data abstracted from NEISS hospital records for injuries related to product code 0841 (table or bench saws).

Contractor interviewer information from the 2007-2008 special study is not available, so CPSC staff was unable to prove or disprove interview effect in that study's responses. However, given the indeterminable integrity of the responses, and the fact that the 2007-2008 special study is almost a decade old, CPSC staff is not using the data from the 2007-2008 special study to inform recommendations for CPSC's NPR for performance requirements to address table saw blade contact injuries.

2. Emergency Department-Treated, Table Saw Blade-Contact Injury Analysis for 2015

Starting with all of the NEISS cases associated with product code 0841 (that is, all injuries recorded in the NEISS as associated with a table or bench saw), CPSC staff reviewed and categorized the data, removing any cases that were not related to an operational table saw, and also classifying whether the injury could have been due to blade contact.

[17] Results of reanalysis retrieved from: http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Home%20Maintenance%20and%20Construction/CoverpageandMemoofStaffAnalysisofTableSawTypeinNEISSSpecialStudy.pdf.

[18] Stralka, K. (2016). 2014-2015 Table Saw Special Study Cautionary Statement. (See Tab F.)

Because NEISS is a probability sample, each case collected represents a weight of the total estimate of injuries in the United States, and thus, annual injuries can be estimated from those cases. Based on NEISS product code 0841, there were an estimated 33,400 table saw-related, emergency department-treated injuries in 2015. Of these, staff estimates that 30,800 (92 percent) likely involved the victim making contact with the blade.

Table 1 provides the emergency department-treated, blade contact injury estimates for the NEISS variables for age (provided in age groups in the table), sex, body part injured, diagnosis, disposition, and locale.

Males represent the majority of victims with blade contact injuries (96.4 percent), and an estimated 45 percent of injuries occurred to victims over age 61.

Of the 30,800 estimated blade-contact injuries, an estimated 28,900 injuries (93.8 percent) involved the finger. The most common diagnosis in blade contact injuries in 2015, is as follows: an estimated 18,100 laceration injuries (58.8 percent); followed by an estimated 5,900 fractures (19.0 percent); an estimated 4,700 amputations (15.2 percent); and an estimated 2,000 avulsions[19] (6.5 percent). An estimated 3,800 (12.3 percent) of the blade-contact injury victims were hospitalized.

[19] Merriam-Webster Dictionary defines avulsion as “a tearing away of a body part accidentally or surgically.” https://www.merriam-webster.com/dictionary/avulsion

Table 1. Victim and Injury Characteristics of Table Saw Blade Contact Injuries, 2015.`

	n	Injury Estimate: Estimate	Injury Estimate: CV†	Injury Estimate: 95% Confidence Interval	Percent of Total Estimate
Total	**642**	**30,800**	**0.09**	**25,400—36,200**	**100%**
Age Group					
≤20	16	*	*	*	*
21-30	51	2,200	0.16	1,500—2,800	7.0
31-40	76	3,800	0.18	2,500—5,200	12.5
41-50	96	4,100	0.15	2,900—5,300	13.2
51-60	133	6,400	0.14	4,600—8,100	20.7
61-70	153	8,200	0.14	5,900—10,400	26.6
71-80	88	4,300	0.16	3,000—5,600	14.0
81+	29	1,300	0.20	800—1,800	4.1
Sex					
Male	622	29,700	0.09	24,400—34,900	96.4
Female	20	*	*	*	*
Body Part					
Finger	592	28,900	0.10	23,200—34,500	93.8
Hand	46	1,600	0.18	1,100—2,200	5.3
Other	4	*	*	*	*
Diagnosis					
Laceration	372	18,100	0.11	14,200—22,000	58.8
Fracture	112	5,900	0.17	3,900—7,800	19.0
Amputation	119	4,700	0.18	3,000—6,300	15.2
Avulsion	37	2,000	0.24	1,100—2,900	6.5
Other	2	*	*	*	*
Disposition					
Treated and Released	537	26,800	0.10	21,600—32,100	87.1
*Hospitalized***	98	3,800	0.20	2,300—5,300	12.3
Other	7	*	*	*	*
Locale Where Injury Occurred					
Home	416	20,600	0.11	16,200—25,100	67.0
Unknown	223	10,100	0.19	6,400—13,900	32.9
Other	3	*	*	*	*

Cells marked by "" indicate an estimate that does not meet CPSC reporting limits.
**Hospitalization refers to the combination of two dispositions: treated and transferred, treated and admitted.
†Coefficient of variation (CV) is a measure of the dispersion of the data as a ratio of the standard deviation to the estimate. The higher the CV, the larger the dispersion; for estimates derived from the NEISS, a CV over 0.33 is high.

3. Comparison to Other Consumer Product-Related Injuries (2015)

CPSC staff compared the distributions of table saw injury characteristics against all other consumer product-related injury characteristics. Table saw blade-contact injuries have a much larger proportion of injuries to fingers (compared to all other types of consumer products) and have significantly larger proportions of diagnoses for lacerations and amputations. An estimated 18.6 percent of all amputations in the NEISS are related to table saws.

Table saws, in particular table saw blade-contact injuries, also represent a larger proportion of injuries to fingers than all other workshop products (which include tools such as radial arm saws, miter saws, circular saws, band saws, and routers, along with other power and manual woodworking tools). In addition, table saw blade contact injuries have significantly larger proportions of diagnoses for lacerations, fractures, and amputations, than injuries associated with all other workshop products. Table saws account for an estimated 52.4 percent of all amputations related to workshop products.

When comparing table saw blade-contact injuries to all other workshop product-related injuries, differences in the distributions of age groups exist. Older age groups represent larger proportions of table saw blade-contact injuries than for other workshop products. Approximately 45 percent of the estimated table saw blade-contact injuries are within the age range of 61 through 80. In comparison, the proportion of all other workshop product-related injuries for the 61 through 80 age groups is approximately 18 percent. Staff analysis indicates that the mean age for table saw blade contact injuries is 55.6 years, compared to 42.7 years for all other workshop product-related injuries. This approximate 13-year difference in the mean age of injuries is a statistically significant difference (p-value < 0.0001), indicating that table saw blade-contact injuries involve older victims in comparison to injuries related to all other workshop products.

4. Blade Contact Injury Trend Analysis

CPSC staff estimated the yearly injuries associated with table saw blade contact from 2004 to 2015, using estimates from NEISS. The date range for the trend analysis includes a timespan before the voluntary standard required table saws to be equipped with a riving knife and modular blade guard (2004 to 2009) and a timespan after the voluntary standard requirements became effective on most table saws (2010 to 2015). Table saws manufactured before the current voluntary standard remain in use throughout this entire period. However, in more recent years, after the current voluntary standard became effective, an increasing proportion of table saws in use conform to the current voluntary standard. Thus, if the voluntary standard was impacting the number or severity of injuries, there would be a steady decrease in the number of injuries or severity of injuries as the proportion of compliant table saws increased.

Table 2 provides the estimated number of table saw blade-contact, emergency department-treated injuries from 2004 through 2015. CPSC staff performed trend analyses for blade contact injuries, as well as blade contact amputations, hospitalizations, and finger/hand injuries. CPSC staff concludes that there is no discernible change in the number of blade contact injuries or type of injuries related to table saw blade contact from 2004 to 2015.

Table 2. NEISS Estimates for Table Saw Blade Contact Injuries, 2004-2015.

Year	Table Saw Blade Contact Injury Estimates			
	n	Estimate	CV	95% Confidence Interval
2015	642	30,800	0.09	25,100—36,500
2014	631	30,300	0.08	25,300—35,300
2013	662	29,500	0.09	24,500—34,500
2012	648	29,500	0.09	24,100—34,900
2011	632	29,600	0.09	24,300—35,000
2010	657	30,100	0.10	24,000—36,200
2009	714	33,000	0.10	26,500—39,500
2008	723	34,600	0.09	28,700—40,500
2007	694	31,100	0.09	25,400—36,700
2006	766	34,200	0.09	27,900—40,400
2005	812	34,500	0.09	28,300—40,700
2004	773	36,300	0.09	29,600—43,100

CPSC staff analyzed the risk of blade contact injury using the estimated number of table saws in use for each year because that is the only information available to staff. Table 3 provides the risk of blade contact injury per 10,000 table saws in use for each year in the analysis.

Table 3. Risk of Table Saw Blade Contact Injury per 10,000 Table Saws in Use, 2004-2015.

Year	Table Saw Blade Contact Injury Estimates		Estimated Number of Table Saws in Use (in 10,000's)*	Risk Estimates** of Table Saw Blade Contact Injury per 10,000 Table Saws in Use	
	Blade Contact Injury Estimate	95% Confidence Interval	Table Saws in Use Estimate[20]	Risk Estimate[21]	95% Confidence Interval
2015	30,800	25,100—36,500	813.8	37.8	30.9—44.8
2014	30,300	25,300—35,300	818.6	37.0	30.8—43.2
2013	29,500	24,500—34,500	824.0	35.8	29.8—41.8
2012	29,500	24,100—34,900	832.5	35.4	28.9—41.9
2011	29,600	24,300—35,000	838.9	35.3	29.0—41.7
2010	30,100	24,000—36,200	847.7	35.5	28.3—42.7
2009	33,000	26,500—39,500	873.1	37.8	30.3—45.3
2008	34,600	28,700—40,500	881.5	39.3	32.6—45.9
2007	31,100	25,400—36,700	882.5	35.2	28.8—41.5
2006	34,200	27,900—40,400	865.0	39.5	32.2—46.7
2005	34,500	28,300—40,700	846.3	40.8	33.5—48.0
2004	36,300	29,600—43,100	829.4	43.8	35.7—51.9

*CPSC's Directorate for Economics provided the estimated numbers of table saws in use for this analysis.
**Risk estimates are calculated from the exact point estimate, not the rounded estimate.

[20] No estimates of variance or covariance associated with the number of table saws in use were calculated. CPSC staff determined that the ability to detect trend for risk of injury is increased by omission of the variance-covariance associated with the denominator variable (thus, creating a more conservative approach). Variance for risk will increase if using both numerator and denominator variance and covariance structures; this makes it harder mathematically to detect trend. However, CPSC staff determined that there is minimal impact on the analyses performed for risk, and conclusions are unlikely to change if another method was chosen.

[21] CVs for risk estimates are equivalent to the CVs for injury estimates, due to no variance estimates being used for the risk denominator estimates.

CPSC staff performed a trend analysis for the risk of blade contact injury per 10,000 table saws and concludes that there is no discernible change in the risk of injury associated with table saw blade contact from 2004 to 2015.

5. Reported Table Saw Blade-Contact Incidents

Table saw-related incidents are not commonly reported to CPSC through means other than the NEISS. However, CPSC staff received a small number of reports of table saw-related injuries through other means, such as news articles, consumer-submitted reports, attorney-submitted reports, and manufacturer and retailer reports. Reported incidents through means other than the NEISS are entered into the CPSC's Consumer Product Safety Risk Management System (CPSRMS) database.

Staff identified 53 incidents in the CPSRMS database that involved blade-contact injury on a table saw that occurred between January 1, 2004 and December 31, 2015, and was reported to CPSC by March 1, 2016. These are anecdotal reports of blade-contact injuries, thus, one cannot use these reports to understand trend or magnitude of the number of blade-contact injuries. This analysis is used to further understand scenarios and the injuries associated with table saw blade-contact injuries, information not typically captured within a NEISS report. Because this is not a representative sample of all blade-contact injuries, only injury estimates from the NEISS are used for nationally representative estimates of table saw and/or blade-contact injuries.

Table 4 provides the distribution of the type of table saw in reported incidents.

Table 4: Table Saw Type for Reported Blade-Contact Injuries, 2004-2015

Saw Type	Frequency	Percent
Bench saw[22]	26	49.1
Contractor saw	22	41.5
Cabinet saw	2	3.8
Unknown	3	5.7
Total	**53**	**100.0**

* Due to rounding errors, totals may not exactly equal 100.

Staff also recorded unexpected workpiece movement in the review of incidents, and Table 5 summarizes incidents by unexpected workpiece movement (such as kickback of the workpiece). For the majority of incidents, it is unknown whether unexpected workpiece movement was involved in the blade contact, thus making conclusions difficult. However, of the incidents where information about the contribution of workpiece movement was known, most blade-contact injuries involved some type of unexpected workpiece movement.

[22] One incident involved a 4-inch table saw, also known as a "mini" or "micro" table saw.

Table 5: Unexpected Workpiece Movement for Reported Table Saw Blade-Contact Injuries, 2004-2015

Unexpected Workpiece Movement	Frequency	Percent
Yes	20	37.7
No	4	7.5
N/A[23]	1	1.9
Unknown	28	52.8
Total	**53**	**100.0***

* Due to rounding errors, totals may not exactly equal 100.

For each table saw in the 53 reported incidents, staff recorded the type of blade guard that came with the saw, as well as information on whether the blade guard was in use at the time of the incident. Table 6 provides the frequency of the type of blade guard, by the use of the blade guard. There are large proportions of unknowns for the blade guard use, making conclusions difficult.

Table 6: Type of Blade Guard by Blade Guard Use for Reported Table Saw Blade-Contact Injuries, 2004-2015

Frequency (Row Percent)	**Blade Guard in Use**				
Type of Blade Guard	*Yes*	*No*	*Unknown*	*N/A*[24]	**Total**
Modular	1 9.1%	1 9.1%	9 81.8%	0 0.0%	**11**
Traditional	7 19.4%	7 19.4%	19 52.8%	3 8.3%	**36**
Other/Unknown[25]	1 16.7%	2 33.3%	3 50.0%	0 0.0%	**6**
Total	**9**	**10**	**31**	**3**	**53**

[23] Stock movement is "N/A" in one incident, where the victim was not performing a cut at the time of blade contact. Reportedly, the victim started the saw accidentally, and a nearby object pulled the victim's hand into the blade.
[24] Blade guard use is recorded as "N/A" in three incidents, when blade guard use was either impossible (Dado cut, molding attachment on a saw from the 1950s), or the victim started the saw accidentally, and his hand was pulled into the blade by a nearby object.
[25] For the six incidents in the blade guard type of "Other/Unknown," one incident is in the "other" category, where the blade guard description did not fully meet the traditional description, but the saw was manufactured in the time span of traditional blade guards; the remaining five incidents in this category were classified as "unknown" blade guard type, due to the limited information provided.

To gain additional understanding of the type of blade guard and the reported injuries, Table 7 shows the frequency for the type of blade guard by injury type.

Table 7: Injury Description for Reported Table Saw Blade-Contact Injuries, 2004-2015

Injury	Type of Blade Guard*			
	Modular	*Traditional*	*Other/Unknown/NA*	**Total**
Amputation	4	21	4	**29**
Amputation and Laceration	0	3	1	**4**
Fatal Laceration	0	1	0	**1**
Laceration	2	4	1	**7**
Laceration and Fracture	1	0	0	**1**
No Details Provided	4	7	0	**11**
Total	**11**	**36**	**6**	**53**

* Table 6 shows that it is often unknown whether a blade guard was in use at the time of the incident. This table does not break down the type of injury and type of guard according to whether the blade guard was in use or not.

Of the 53 incidents identified in the CPSRMS database, 36 involved table saws with a traditional blade guard, and 11 involved table saws with a modular blade guard. However, staff's review of the reports indicates that the incident scenarios for table saws with modular blade guards are similar to the scenarios for table saws with traditional blade guards, in terms of incidents occurring with and without the use of blade guards, and incidents occurring with and without unexpected stock movement from kickback of the material.

There were three victims recorded as a death in CPSRMS for table saws. Two of the victims had amputation injuries from the table saw and underwent reattachment or transplant surgery. It was reported that one died from "complications to reattachment surgery" with other medical conditions contributing, and the other died from "pulmonary thromboembolizations." CPSC's Directorate for Health Sciences staff determined that the exact cause of death is unclear or the cause of death is related to the medical treatment received in both these incidents. Therefore, these two deaths are not attributable directly to the table saw, and are counted as injuries, not fatalities, in relation to the table saw blade contact. This leaves one fatality related directly to a table saw, where a 56-year-old male lacerated his right wrist due to blade contact. Subsequently, the victim died due to blood loss from the laceration.

C. Hazard Characteristics

1. Blade Contact

CPSC staff believes that blade contact is the primary hazard on table saws that can be addressed. Of the 33,400 table saw-related injuries treated in hospital emergency departments in 2015, an estimated 30,800 injuries (92 percent) involved blade-contact injuries.

Of the 30,800 blade contact injuries, an estimated 28,900 injuries (93.8 percent) involved the finger. The most common diagnosis in blade contact injuries in 2015 is an estimated 18,100 laceration injuries (58.8 percent); followed by an estimated 5,900 fractures (19.0 percent); an estimated 4,700 amputations (15.2 percent); and an estimated 2,000 avulsion (6.5 percent). An estimated 3,800 (12.3 percent) blade-contact injury victims were hospitalized.

Thousands of amputations, including an estimated 4,700 amputation injuries in 2015 alone, occur each year on table saws. CPSC staff compared table saw blade contact emergency department-treated injuries from the 2015 NEISS to all other consumer product-related, emergency department-treated injuries in the same timeframe (January 1, 2015 through December 31, 2015). An estimated 18.6 percent of all amputations reported in the NEISS in 2015 are related to table saws. When compared to all other workshop products, table saws account for an estimated 52.4 percent of all amputations related to workshop products in 2015.

2. Blade Guard Type and Use

Of the 53 reported incidents related to table saw blade-contact injury that CPSC staff identified in the CPSRMS, 36 incidents involved table saws that came equipped with a traditional blade guard, but 11 incidents involved table saws that came equipped with a modular blade guard. Laceration and amputation injuries occurred on table saws equipped with traditional guards and on table saws equipped with modular blade guards. In addition, staff's review of the reports indicates that the incident scenarios for table saws with modular blade guards are similar to the scenarios for table saws with traditional blade guards, in terms of incidents occurring with and without the use of blade guards, and incidents occurring with and without unexpected stock movement from kickback of the material.

D. Injury Analysis

CPSC staff reviewed analyses of finger injuries on table saws conducted by researchers at the University of Michigan in a study titled, "Table saw injuries: epidemiology and a proposal for preventive measures," and by UL in a report titled, "Table Saw Hazard Study on Finger Injuries Due to Blade Contact." [26,27]

Lacerations of varying severity to the finger or hand are the most common injury associated with table saw operator blade contact. The severity of injury ranges from minor cuts to severe cuts and cuts resulting in amputation. Finger lacerations can be classified into two categories by the extent of damage to the structures of the finger:

1) simple lacerations involving damage only from the skin surface to a depth of approximately 2 mm[26] to 4 mm,[27] and
2) complex lacerations involving cuts deeper than 4 mm that cause damage to tendons, nerves, and vessels.[27]

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[26] Chung, K. and Shauver, M. 2014. Table saw injuries: epidemiology and a proposal for preventive measures.
[27] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014. Retrieved from http://library.ul.com/wp-content/uploads/sites/40/2015/02/UL_WhitePapers_Tablesaw_V11.pdf.

Simple lacerations can be managed at emergency departments with little expertise, or by simple at-home care because these cuts generally heal without complications.[26] Conversely, complex lacerations require skilled microsurgery to repair damaged tendons, nerves, and vessels, and such care often requires hospital stays, transfer to a hospital with the required expertise, and extensive occupational therapy.

UL's report reviewed magnetic resonance imaging (MRI) scans that show critical tissues are deepest at the proximal phalanx of the long finger (base of the middle finger) and most shallow at the distal phalanx of the little finger. The neurovascular bundle, which contains the nerves and arteries, is the structure closest to the skin's surface. The mean distance from the surface of the skin to the neurovascular bundle on the tip of the little finger is 4.3 mm.[28] Therefore, UL determined that, based on measurements from the study, a depth of 4 mm is the maximum depth of cut to a finger before serious injury is sustained.[29]

E. Analysis of Operator Behavior in Blade-Contact Injuries (see Tab E)

The most basic and common cutting operations performed on a table saw are ripping, which involves narrowing the width of a piece of wood or other "workpiece" by sawing along its length; and crosscutting, which involves shortening the length of a workpiece by sawing across its width. Anecdotally, ripping appears to be the more common of these two operations in the context of table saw use.

Ripping

The standard ripping procedure after selecting the blade, setting the blade height, setting the rip fence parallel to, and the desired distance from, the blade, and installing the blade guard system, if applicable, involves the following steps or tasks:

1. Place the workpiece flat on the table, with one long side against the rip fence.
2. Switch on the table saw, and let the saw blade get up to speed.
3. Slowly push or "feed" the workpiece through and past the blade, while keeping the workpiece flat against the fence.

The workpiece should be pushed entirely through and past the blade, generally with the hands, before switching off the saw. Once the saw has been switched off, the consumer should wait until the saw blade has come to a complete stop before moving or reaching for the workpiece or cutoff, or before otherwise moving the hands toward the blade.

Consumers might use a push stick or similar object while ripping narrow pieces to help keep their hands away from the blade. Owner's manuals and table saw literature commonly recommend the use of push sticks, particularly when the space between the blade and fence is narrow—for example, about 2 to 6 inches.

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[28] Staff's analysis of cadaverous tissue data indicates that the measurements presented in UL's research report are relative to the volar (palmar) surface of the skin.
[29] UL Research Report, *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.

Blade contact may be more likely to occur while the consumer is ripping a workpiece, rather than crosscutting, because consumers often use just their hands to feed the workpiece into the blade while ripping. Additionally, ripping has greater potential to result in kickback, compared to crosscutting. "Kickback" can be defined as the binding of a workpiece in the blade and the consequent thrusting of that workpiece back toward the consumer. As staff described, ripping involves the cut workpiece passing between the spinning blade and a rip fence, which forms a fixed boundary that constrains the movement of the workpiece. Thus, any lateral movements or rotation of the workpiece (or misalignment of the fence) may cause the workpiece to bind and be thrown or propelled at the consumer.

The sudden movement of the workpiece from kickback can cause the consumer to lose control of the workpiece and lead to blade contact in a number of ways. For example:

- The consumer's hand or push stick can slip off the workpiece, causing the hand to move into the blade.
- The workpiece can strike the consumer's arm or hand, sending the hand into the blade.
- The consumer can reflexively reach for the workpiece to regain control and inadvertently move the hand into the blade.
- The consumer's hand, if positioned behind the blade to hold, support, or remove the workpiece or cutoff, can be "pulled" into the blade with the workpiece.

Many of these examples are consistent with known blade-contact incidents involving ripping with table saws, including some cases in which a blade guard was in use.[30]

Blade guard systems generally are designed to allow free passage of the workpiece; and therefore, other objects, such as hands and fingers, can also move into the blade from the front. Thus, although blade guard systems can reduce the likelihood of blade contact from certain angles and certain approaches, the potential for contact remains.

In addition, hand or finger contact with the blade can also occur even without kickback. Possible blade-contact scenarios during ripping, and unrelated to kickback, include:

- The consumer's hand gets too close to the blade while feeding the workpiece, particularly small workpieces, and the fingers contact the blade. In some cases, the consumer may be wearing gloves for protection, or because of cool temperatures, and the blade catches the glove and pulls the hand into the blade.[31]

[30] For example, IDI nos.040225HCC3185, 050805CCC3441, and 141120CNE0001.
[31] For example, IDI nos. 121018CNE1304.

- The consumer reaches near or past the blade to regain control of a workpiece that is slipping, lifting up, falling off the table, or otherwise moving in an unexpected way, and the hand contacts the blade.[32]

- The consumer reaches for a cutoff or brushes debris from the table while the blade is still spinning and the hand contacts the blade.[33] Saw blades can continue spinning for some time after a table saw has been switched off; so some consumers might contact the blade after having already switched off the table saw, but before the blade has come to a complete stop. Furthermore, consumers who are aware of the potential for kickback might be motivated to remove a cutoff immediately to prevent a cut piece from kicking back or being thrown in some other way.

- The consumer gets distracted and turns or looks away, causing his or her hand to move into the blade. Such a distraction may not be merely daydreaming but can include cases in which someone enters the room and the operator diverts attention to make sure the other person is not placing themselves in a hazardous situation. This may be especially likely if the other person is someone for whom the consumer is responsible, such as a child.

- The consumer slips, stumbles, or otherwise loses balance and inadvertently moves a hand into the blade, possibly as a natural motor response to regain balance. Similarly, if a consumer is startled by something or someone, the consumer may move reflexively or jerk a hand toward the blade.

- The consumer's hand or push stick slips off the workpiece, causing the hand to move into the blade. This scenario is similar to the one cited earlier in the context of kickback, but it is not necessarily preceded by a sudden movement of the workpiece.

Many of the scenarios described may be more likely to occur if the consumer is tired, or if the view of the blade or cut is impaired somehow. Working with a table saw for long periods would likely contribute to fatigue, which in turn, can degrade a consumer's decision-making abilities, judgment, reaction time, and vigilance.[34] Blade guard systems might contribute to difficulties in seeing where a cut is being made, and consumers sometimes report this as a reason for removing blade guard systems.[35] Staff also notes that consumers typically are instructed to wear eye

[32] For example, IDI nos. 080415CCC2550.
[33] For example, IDI nos. 050328HWE3010.
[34] Staff also notes that, when ripping, consumers must make sure the workpiece maintains contact with the rip fence for the entire cut. Thus, a consumer's attention is likely to be where the workpiece meets the fence, rather than the blade, for at least part of the cut. This necessarily means that adequate attention cannot be given to the position of the hands relative to the blade. If attention is focused, instead, on the fingers relative to the blade, the workpiece may move off the rip fence and lead to kickback, which also can cause the fingers to contact the blade.
[35] Smith, T. P. (2011). *Human Factors Evaluation of Technology Intended to Address Blade-Contact Injuries with Table Saws*. Staff report, U.S. Consumer Product Safety Commission, Bethesda, MD. Available: http://www.cpsc.gov//PageFiles/93907/hftablesaw072011.pdf.

protection when operating a table saw.[36] Although proper eye gear can provide important protection from projectiles striking the eye, the eye protection may affect one's ability to see a cut clearly, particularly if the eyewear is scratched or partially covered in debris, such as sawdust.

Crosscutting

The standard crosscutting procedure after selecting the blade, setting the blade height, setting the miter gauge to the desired angle, moving or removing the rip fence, and installing the blade guard system, if applicable, involves these steps or tasks:

1. Place the workpiece flat on the table, with one long side against the miter gauge, crosscut sled, or similar jig that slides in a track in the table and runs parallel to the blade.
2. Switch on the table saw, and let the saw blade get up to speed.
3. Slowly feed the workpiece through and past the blade, using the miter gauge, while firmly holding the workpiece against the miter gauge.

As in the case of ripping, the workpiece should be pushed entirely through and past the blade before switching off the saw; and once the saw has been switched off, consumers should wait until the saw blade has come to a complete stop before moving the workpiece or cutoff, or otherwise moving the hands toward the blade.

Blade-contact scenarios involving crosscutting are similar to those involving ripping because many of the same potential issues can arise, such as the consumer feeding the workpiece with the consumer's hand too close to the blade, reaching past the blade for a cutoff, or becoming distracted. Although the potential for some forms of kickback seems less likely for crosscutting than for ripping, kickback still occurs, and the consequent loss of workpiece control can result in the hand contacting the blade.

In addition, during a crosscut, the workpiece may become "jammed" in the blade guard or anti-kickback device. This may be more likely if the workpiece shifts position or rotates from against the miter gauge. In such a scenario, the consumer may reach toward the blade to adjust the workpiece position or attempt to move the offending portion of the guard system, and inadvertently contact the blade with the fingers.

F. Relevant Adult-Aging Issues (see Tab E)

As noted in Section II.B, approximately 45 percent of all estimated table saw-related, emergency department-treated injuries that likely related to the victim making contact with the blade involved consumers older than 60 years of age, and the mean age for table saw blade-contact victims (55.6 years old) is approximately 13 years older than the mean age for victims involved in injuries from all other workshop products (42.7 years old).

[36] For example, general safety instructions for all power tools, published by the Power Tool Institute (PTI), state that one should: "[a]lways wear eye protection"; and the section of the document that is specific to table saws states, in part: "Always wear safety goggles or safety glasses with side shields." See http://www.powertoolinstitute.com/pti-includes/pdfs/Tool-Specific-Files/Table-Saws.pdf.

Although staff does not know if these findings are due to older consumers having greater exposure to these products, adult aging is associated with declines in many perceptual, cognitive, and physical abilities.[37]

Some age-related deficits that may contribute to table saw blade-contact incidents include:

- *Vision*: Increased lighting requirements (needing more light to see clearly) and difficulty focusing on objects, especially in the periphery, may impact an older consumer's ability to detect and effectively avoid a peripheral spinning blade while focusing on maintaining workpiece contact with the rip fence.
- *Attention and Inhibitory Control*: Older adults may be more susceptible to distractions and irrelevant information.
- *Balance*: Age-related declines in sensory, cognitive, and motor control systems may affect an older consumer's ability to maintain balance.
- *Muscle strength and power*: Declines in muscular strength and power may limit the extent to which an older consumer can maintain control over a workpiece or recover from an unexpected loss of balance.
- *Motor control and coordination*: Declines in motor control and coordination may limit the extent to which an older consumer can effectively stop a movement once it has begun.

The degree of age-related deficits among these and other abilities can be highly variable among individuals, and not all older adults will exhibit the changes described here. Nevertheless, these examples illustrate why older adults might be particularly susceptible to blade-contact injuries with table saws, despite the tendency for people to become more cautious with advancing age.[38]

G. Voluntary Standards

1. Background

Underwriters Laboratories Inc. (UL) published the first edition of UL 987 *Stationary and Fixed Electric Tools* in 1971. UL 987 included requirements for table saws that specified the following safety devices: a single-piece blade guard, a spreader, and anti-kickback pawls. In 2005, UL published the sixth edition of UL 987, which added requirements for a riving knife to the general requirements for table saws. The effective date for the riving knife requirements was January 2014. In 2007, UL published the seventh edition of UL 987, which expanded the table saw guarding requirements to include a new modular blade guard design developed by a joint venture

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[37] Smith, T. P. (2005). *Older consumer safety: Phase I: A review and summary of the literature on age-related differences in the adult consumer population, and product-related interventions to compensate for those differences*. CPSC staff project report, U.S. Consumer Product Safety Commission, Bethesda, MD. Retrieved from: https://www.cpsc.gov/PageFiles/103904/older.pdf.

[38] The literature is somewhat mixed, but research generally indicates that people become more cautious or risk-averse with increasing age (Botwinick, 1984, as cited in Sternberg & Lubart, 2001; National Research Council, 2000; Panek, 1997; Sanfey & Hastie, 2000; Shaie & Willis, 2002; Vercruyssen, 1997). However, older adults also rely increasingly on accumulated knowledge and experience, rather than seek new information that might contradict their previously held beliefs or expectations (Davis & Loftus, 2005; National Research Council, 2000; Park & Gutchess, 2000; Peters, Finucane, MacGregor, & Slovic, 2000; Sanfey & Hastie, 2000; Schaie, 2004).

of the leading table saw manufacturers. The effective date for the modular blade guard requirements was January 2010. The revised standard specified that the blade guard shall not consist of a hood, but comprise 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, offering easier methods to remove and install the guard, and incorporating a permanent riving knife design.[39] In 2011, UL published the eighth edition of UL 987, which clarified requirements for table saws, and the eighth edition remains the current edition of UL 987.

In February 2016, UL balloted a proposal to adopt the first edition of International Electrotechnical Commission (IEC) 62841-3-1, *Standard For Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery – Safety – Part 3-1: Particular Requirements for Transportable Table Saws*, as the first edition of UL 62841-3-1. This effort was part of UL's international harmonization goal to adopt international standards, such as one published by the IEC (International Electrotechnical Commission) or ISO (International Organization for Standardization), into one UL standard, based on the IEC/ISO standard, with appropriate national differences.[40] The proposal passed, and in August 2016, UL published the first edition of UL 62841-3-1 *Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery Part 3-1: Particular Requirements for Transportable Table Saws*. UL 62841-3-1 is recognized as an American National Standards Institute (ANSI) standard and includes requirements for a modular blade guard, riving knife, and anti-kickback pawls.

The effective date for UL 62841-3-1 is August 29, 2019. Until that date, UL 987 remains in effect, and table saw manufacturers can list their products to UL 987 or UL 62841-3-1.

2. Modular Blade Guard and Riving Knife

<u>Voluntary Standard Requirement</u>

UL 987, Section 43.2.2 and UL 62841-3-1, Section 19.101 specify that table saws shall be provided with a modular blade guard. UL 987, Section 43.2.3 and UL 62841-3-1, Section 19.103 specify that table saws shall be equipped with a riving knife. Both voluntary standards include: (1) similar performance requirements to ensure that the modular blade guard prevents incidental contact from the top and from both sides of the saw blade, and (2) similar specifications for the location and rigidity of the riving knife.

<u>CPSC Staff's Evaluation:</u>

CPSC staff does not believe requirements for a riving knife and modular blade guard will adequately reduce the number or severity of table saw blade-contact injuries because table saws have been equipped with these safety devices since 2009, and staff has not seen evidence of the effectiveness of these safety devices in reducing or mitigating blade contact injuries. In 2011,

[39] Power Tool Institute presentation to Chairman Tenenbaum and Commissioner Adler, November 2, 2009.
[40] UL's harmonization efforts are described at: http://ulstandards.ul.com/about/harmonizing-standards/.

staff evaluated the modular blade guard system and concluded that it is an improvement over the single-hood guard design, but its effectiveness is still limited by users' willingness to use the guard.[41] CPSC staff has since conducted a survey of table saw blade-guard use among owners of table saws with modular blade guards, reviewed incidents from the Consumer Product Safety Risk Management System (CPSRMS) database to identify incidents involving table saws equipped with modular blade guard systems, and performed a trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws from 2004 to 2015.[42]

In 2015, staff conducted a survey of table saw users who own, or are familiar with, a table saw with the modular guard system.[43] Results of the survey indicate that a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed, and a majority of respondents did not use the blade guard "sometimes" (28%), "often" (17%), or "always" (14%). The results of the user survey demonstrate that removal of the blade guard is a necessary and proper action when making certain cuts on table saws. In addition, many users choose not to use the modular blade guard at all or only some of the time. Any situation in which the blade guard is not used eliminates the effectiveness of the blade guard in preventing blade-contact injuries. Accordingly, use of the blade guard for injury prevention cannot be relied upon.

Case in point, staff is aware of at least 11 incidents from the CPSRMS database that involve table saws that meet the current voluntary standard requirements for riving knives and modular blade guards. Of those 11 incidents, four involved amputations, two involved lacerations, and one involved laceration and fracture. These incidents show that blade-contact injuries continue to occur on table saws equipped with riving knives and modular blade guards.

CPSC staff performed a trend analysis of the annual estimated number of emergency department-treated injuries associated with table saws from 2004 to 2015.[44] This trend analysis includes the timespan before the voluntary standard implemented the requirement for riving knives and modular blade guards on table saws (2004 to 2009) and the timespan after the requirements were implemented (2010 to 2015). Staff concludes that there is no discernable change in the number of injuries or type of injuries related to table saw blade contact from 2004 to 2015. CPSC staff then analyzed risk of injury per 10,000 table saws in use for each year in the analysis. CPSC staff performed a trend analysis and concluded that there is no discernible change in the risk of injury associated with table saw blade contact.

Based on the trend analysis of injuries and risk of injuries from 2004 to 2015, and incidents from the CPSRMS database showing that blade contact injuries occur on table saws equipped with riving knives and modular blade guard systems, staff does not see evidence that the voluntary

[41] 76 FR 62678 Table Saw Blade Contact Injuries; Advance Notice of Proposed Rulemaking.
[42] Estimated from NEISS produce codes 0841, 0842, 0843, and 0895).
[43] Sherehiy, B. and Nooraddini, I. (2016). Table Saw Blade Guard Survey. Retrieved from: http://www.cpsc.gov/Global/Regulations-Laws-and-Standards/Voluntary-Standards/Voluntary-Standards-Reports/EurekaFactsTableSawBladeGuardSurveyReport(Final6bcleared)updatedcoverpage.pdf.
[44] Estimated from NEISS produce codes 0841, 0842, 0843, and 0895).

standard requirements for riving knives or modular blade guards adequately reduce blade-contact injuries on table saws.

3. Active Injury Mitigation (AIM) Requirement

In June 2011, UL announced its intention to create a standard that addresses the performance characteristics needed to reduce blade-contact injuries associated with table saws. UL invited CPSC staff to participate actively in developing blade-to-skin performance requirements for UL 987. UL formed a working group that met regularly during 2011 to 2015 to develop performance requirements for table saws to address flesh-to-blade contact injuries. The UL working group developed the term "active injury mitigation" (AIM) to describe any type of safety system that detects an imminent or actual human contact to the table saw blade and then performs an action that mitigates the severity of the injury.

In January 2014, UL published a report titled, *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*.[27] The report provides an in-depth study with hazard analyses, injury classification, approach speed experiments, and more. The intent of the research was to understand the circumstances that lead to hand/finger contact injuries for table saw operators and to help identify critical parameters to define the hazard level. The report identified the quantitative threshold between a simple and complex laceration of a finger at about 4 mm from the surface of the skin.

In February 2015, UL balloted a proposal to add AIM requirements for table saws to the *Standard for Stationary and Fixed Electric Tools*, UL 987. The performance requirements consist of a defined relationship between approach velocity of a finger to a rotating table saw blade and the depth of cut to the finger once contact has been made. The ballot proposed a performance requirement that introduced a surrogate test finger that demonstrates the proper triggering characteristics particular to the AIM technology to the table saw blade at an approach rate of 1 m/s, and that limits the depth of cut to 4 mm or less upon contact with the blade.

CPSC staff sent a letter to UL, dated March 24, 2015, expressing staff's support of AIM requirements in the voluntary standard.[45] Staff also provided in-depth investigations (IDIs) of five incidents that occurred on table saws that met the UL standard for table saws at the time (had riving knife and modular blade guard). In April 2015, the ballot failed to reach consensus; the ballot received 14 votes against (versus 7 votes for) the proposal.

In March 2015, UL published a report titled, *General Characteristics of a Surrogate Finger for Table Saw Safety Testing*.[46] The report discusses the attributes of a human finger that could be used as the basis for triggering an AIM system and identified three primary methods to detect a human finger: visual, electrical, and thermal.

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[45] Letter from Caroleene Paul, CPSC, to John Stimitz, UL, dated March 24, 2015. Retrieved from: https://www.cpsc.gov/s3fs-public/CPSClettertoULcommenttoAIMSproposalwenclosures.pdf.

[46] UL Research Report *General Characteristics of Surrogate Finger for Table Saw Safety Testing*, March 2015. Retrieved from http://library.ul.com/wp-content/uploads/sites/40/2015/12/UL-Research-Report-on-Finger-Surrogate-Characteristics-for-Table-Saw-Testing-2015.pdf.

In February 2016, UL balloted two proposals:

1) To adopt the first edition of International Electrotechnical Commission (IEC) 62841-3-1, *Standard for Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery – Safety – Part 3-1: Particular Requirements for Transportable Table Saws*, as the first edition of UL 62841-3-1.
2) To add AIM system requirements for table saws as part of the adoption of IEC, or as part of UL 987, which can be merged later when UL 987 is merged with IEC 62841-3-1.

The UL proposal stated that the performance requirements for AIM in the ballot were intended to be technology-neutral, so that manufacturers had the maximum latitude to design table saws that meet the intent of the requirements. The ballot proposed a performance requirement that introduced a conductive test probe, connected to a circuit that mimicked the electrical properties of a human body, to the table saw blade at an approach rate of 1 m/s. The performance requirement limited the depth of cut to the test probe upon contact with the blade to 4 mm or less. The performance requirement also permitted other test probes to be used for AIM technology that depend on visual or thermal detection of finger contact to the blade.

CPSC staff sent a letter of comment to UL dated, March 11, 2016, expressing staff's support of AIM requirements in the voluntary standard for table saws. [47] In April 2016, the UL proposal for adoption of IEC 62841-3-1 reached consensus when the ballot received 15 votes in favor (versus 2 votes against) of the proposal. However, the proposal to add an AIM requirement did not reach consensus; the ballot received 12 votes against (versus 5 votes for) the proposal. Both of UL's ballots to introduce AIM requirements to table saws failed to achieve consensus due to objections from the table saw industry that AIM requirements should not be mandatory and that the proposed requirements were not sufficiently developed.

CPSC Staff's Evaluation:

Currently, there are no AIM requirements in the voluntary standards for table saws for staff to evaluate.

4. Conclusion

CPSC staff does not believe the current voluntary standards for table saws adequately address the risk of blade-contact injuries from table saws, which in 2015, were an estimated 30,800 emergency-department treated blade-contact injuries. Of the 30,800 injuries, there were an estimated 18,100 laceration injuries (58.8 percent), followed by an estimated 5,900 fractures (19.0 percent), an estimated 4,700 amputations (15.2 percent), and an estimated 2,000 avulsions (6.5 percent).

[47] Letter from Caroleene Paul ,CPSC, to John Stimitz ,UL, dated March 11, 2016. Retrieved from: https://www.cpsc.gov/s3fs-public/CPSClettertoULcommenttoAIMS.pdf.

The voluntary standards attempted to address the blade-contact hazard with a substantial change in safety equipment design from a single-piece blade guard attached to a stationary splitter to a modular blade guard attached to a riving knife. Table saws sold in the United States since 2008 are equipped with a modular blade guard and riving knife. However, CPSC staff analysis of NEISS data related to table saw injuries from 2004 to 2015 found no discernable change in the number of injuries or types of injuries related to table saw blade contact from the period before the voluntary standard change in safety devices was enacted (2004 to 2009), to the period after the requirements for modular blade guards and riving knives became effective (2010 to 2015). CPSC staff also concludes that there is no trend in the risk of injury per 10,000 table saws in use related to table saw blade contact from 2004 to 2015; therefore, there is no evidence that the risk of blade contact injury has decreased. In addition, staff's review of table saw blade-contact injury reports stored in CPSC's CPSRMS shows anecdotal evidence that blade contact injuries continue to occur on table saws that meet the current voluntary standards requirements intended to address blade contact injury.

Based on the NEISS and other incident data, the lack of evidence of the effectiveness of riving knives and modular blade guards in reducing blade contact injuries and the absence of AIM requirements to address blade contact injuries, staff does not believe that the current voluntary standards adequately address the risk of blade-contact injury associated with table saw use.

III. STAFF RECOMMENDATIONS FOR PROPOSED RULE

A. Staff's Engineering Analysis (see Tab A)

Active Injury Mitigation (AIM)

Since 2004, table saws have been introduced to the U.S. market with active injury mitigation (AIM) capabilities that mitigate injuries once a hand/finger makes contact with a rotating saw blade.[48] In February 2015, UL, the standard development organization for the voluntary standards for table saws, defined an "AIM" system as an active system that serves to mitigate or prevent injury from exposure to a rotating saw blade.

CPSC staff considers AIM to be a viable approach to address blade contact injury in conjunction with to existing passive safety strategies (blade guard and riving knife) to prevent blade contact on table saws. Active injury mitigation is defined by a performance standard that limits depth of cut after detection of blade contact and provides a layer of safety that can mitigate a blade contact injury if the blade guard or riving knife are removed or fail to function properly. AIM can also protect against blade contact injuries that can occur when a blade guard and riving knife are in place and functioning properly, but blade contact occurs nonetheless.

At a basic level, any AIM system must perform two functions: (1) *detects* contact between the rotating table saw blade and a human body part, and (2) *reacts* to mitigate injury. UL's literature research indicates that detection can be achieved by: (1) sensing electrical properties of the

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[48] In 2004, the first SawStop table saw with AIM technology was sold. Retrieved from: http://www.sawstop.com/company/about.

human body/finger, (2) sensing thermal properties of the human body/finger, or (3) visual sensing and tracking of the human body/finger. [49] Current AIM technologies on the market rely on the first type detection: electrical sensing of the human body; thus, this discussion focuses heavily on those technologies, although the principles for other technologies are similar.

Reaction systems must perform some type of action to limit the severity of injury upon human body/finger contact with the table saw blade. Removing either the spinning blade or the human body/finger from the point of contact is the most logical method to achieve this goal. Current AIM technologies on the market remove the spinning blade from the point of contact quickly enough, within milliseconds, to reduce significantly the severity of injury.

<u>Electrical Detection of Human Body</u>

Current AIM technologies available on table saws in the U.S. market rely on electrical detection of contact between a table saw operator and the rotating saw blade to activate the AIM system. The electrical detection involves circuitry that generates a detection signal with defined electrical characteristics (see Figure 10). The signal can then be coupled onto the saw blade through various means, such as conductive, magnetic, or capacitive coupling devices. Additional circuitry continuously monitors the characteristics of the detection signal. The detection signal changes when a human body part comes into contact with the saw blade and the monitoring circuit senses the change in the signal. If the change is beyond a certain limit, the monitoring circuit then activates a reaction mechanism.

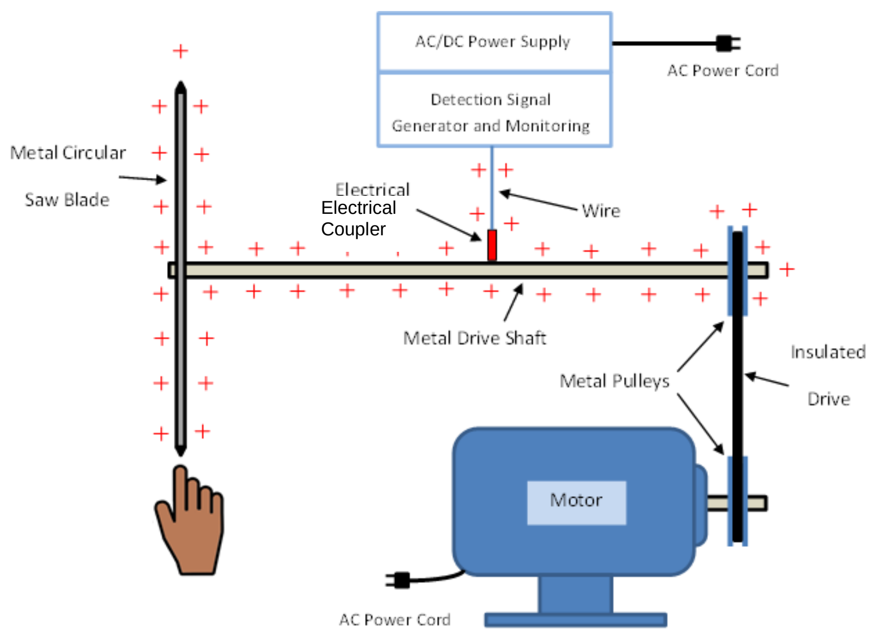

Figure 10. Example of electrical detection of human body

[49] Jiang, H., Tabaddor, M., and He, F. (2015). General Characteristics of a Surrogate Finger for Table Saw Safety Testing. *UL Research Report*. Retrieved from: http://library.ul.com/wp-content/uploads/sites/40/2015/12/UL-Research-Report-on-Finger-Surrogate-Characteristics-for-Table-Saw-Testing-2015.pdf.

Products/Technology on the Market

In 2004, SawStop, LLC (SawStop) released an industrial table saw featuring AIM technology based on electrical detection of the human body, and a mechanical brake reaction that stops the blade from spinning and moves the saw blade assembly beneath the table top surface. Typically, the reaction occurs in less than 5 milliseconds after contact is detected. SawStop has also introduced to the market a professional cabinet saw, a contractor saw, and a jobsite with the same AIM technology. The SawStop AIM system works in three steps:

1. Monitor and Detect
    - The blade carries a small electrical signal.
    - When a person contacts the blade, the signal changes because the human body is conductive.
    - The change to the signal activates the safety system.
2. Brake Activation
    - An aluminum brake block is forced into the spinning blade by a spring released by an electric signal.
    - The blade's angular momentum drives the blade assembly beneath the table top, removing the risk of further contact.
    - Power to the motor is shut off.
3. The AIM system must then be reset by:
    - Shutting off the saw.
    - Removing the brake cartridge and embedded blade.
    - Installing a new blade (if necessary) and brake cartridge.

In 2016, Robert Bosch, LLC (Bosch) released a jobsite table saw featuring AIM technology based on electrical detection of the human body and a combustion-based mechanical reaction that forces the saw blade assembly beneath the table top surface. The Bosch REAXX™ saw Active Response Technology™ system also works in three steps:

1. Monitor and Detect
    - The blade carries a small, low-voltage signal.
    - When a person contacts the blade, the signal changes because the human body is conductive.
    - The change to the signal activates the safety system.
2. Blade Retraction
    - A combustion reaction is triggered in a cylindrical cartridge, which fires a piston at a high rate of speed (this action is similar to the deployment of an air bag in an automobile).
    - The piston pushes against a linkage to rapidly rotate the saw blade assembly below the table surface away from the operator.
    - The blade assembly remains locked under the table after activation, while the blade coasts to a stop after power to the motor is cut off automatically.
3. The AIM system must then be reset by:
    - Shutting off the saw.

- Inserting a fresh/new activation cartridge (two cartridges are paired together, so the un-activated side of the same dual-action cartridge may be used).
- Unlocking the blade assembly and raising it back into place.

Neither the SawStop, nor Bosch AIM technologies can be used when cutting conductive materials (that allow the flow of an electrical current) because both systems rely on electrical detection of the human body. A person touching the conductive material being cut would allow the detection signal to pass through the conductive material and into the person, activating the system as soon as the material touches the saw blade. For this reason, each product has a bypass mode to allow the user to cut conductive materials. In addition, cutting wet wood that is moist enough to conduct enough electricity to activate the AIM system can cause tripping of the safety system. Accordingly, the AIM system generally must be deactivated while cutting wet wood. The table saw automatically exits the bypass mode and resets to normal mode after the saw is turned off and the blade comes to a complete stop.

Testing Done by Engineering Sciences (ES) Staff

CPSC staff purchased samples of table saws with AIM technology and developed test protocols to evaluate the performance of the technology. UL report, "Table Saw Hazard Study on Finger Injuries Due to Blade Contact," identified critical parameters that would define the hazard associated with a human finger/hand coming into contact with a spinning table saw blade.[50] The two critical parameters identified are:

1) Approach velocity of the hand/finger when making contact with the table saw blade.
2) Maximum depth of cut to the hand/finger that would distinguish between simple and complex lacerations.

Ethical considerations prohibit the use of human subjects to test the AIM capability of a table saw to mitigate blade contact injury. In lieu of a human body, a performance test can be developed using a suitable test probe, and in the case of an AIM system that relies on electrical detection, an electric circuit mimicking human contact to trigger the AIM system. Effective injury mitigation can be defined by a maximum depth of cut to the test probe when it is introduced to the table saw blade at a prescribed approach rate. The allowable depth of cut in the probe represents the quantitative threshold between a simple and complex laceration, which is the difference between a minor injury and a severe injury to arteries, nerves, and tendons that requires microsurgery. This threshold is 4 mm from the surface of the skin.[51]

CPSC staff focused on test protocols that introduced a probe, as a substitute for a human finger, into the rotating saw blade and measured the resulting depth of cut on the probe after activation of the table saw's AIM system. Staff determined that an AIM system based on electrical detection can be triggered by a conductive test probe that is coupled to an electric circuit that mimics the human body, referred to here as the human body network (HBN).

[50] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.
[51] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.

The test probe requires two properties: (1) electrical conductivity, and (2) volumetric and mechanical properties that allow depth of cut to be measured. The probe is coupled electrically to the HBN, which is a network of resistors and capacitors that approximate how the body would respond to an electrical signal. The body's response is the result of two physical properties of the human body: (1) body resistance, which is a physical property of the human body that limits the flow of electrical current into the body when a voltage source is contacted; and (2) body capacitance, which is a physical property of the human body that allows the body to store electrical charge from a voltage source. A detailed description of staff's development of the HBN for these tests is found in Tab A, Section II.E.

CPSC staff used a cuboid-shaped test probe made of conductive silicone rubber because the probe had already been developed by UL in its own testing of AIM technology and the probe was readily available. The test probe, shown in Figure 11, is made of low-resistance, conductive silicone rubber measuring 12.5 mm x 12.5 mm x 60 mm. Staff determined that a layer of less conductive material to represent the epidermis (outer layer of skin) of a human finger is not necessary for AIM testing because the system is definitively triggered by contact with conductive "flesh" once the epidermal layer has been broken. Therefore, for test triggering purposes, staff used a test probe that represents the conductive layer of human flesh once the epidermis has been cut by a table saw blade.

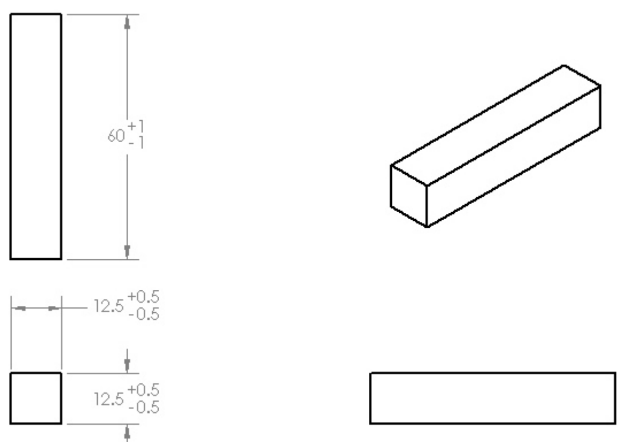

Figure 11. Test Probe (Dimensions in mm).

The quantitative threshold between a simple and complex laceration of a human finger is a 4.0 mm cut from the surface of the skin, and the mean epidermal thickness for a fingertip is 0.369 mm ± 0.112 mm, or a maximum thickness of approximately 0.5 mm.[52,53] Because the test probe represents human flesh beneath the epidermis, staff subtracted the 0.5 mm thickness of the epidermal layer of skin from the 4.0 mm threshold value to arrive at a 3.5 mm value for the maximum allowable depth of cut to the test probe. This 3.5 mm value represents the quantitative threshold between a simple and complex laceration of a human finger, as measured by the test probe.

[52] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.
[53] Judi Whitton and J.D. Everall, "The Thickness of the Epidermis," *British Journal of Dermatology*, Vol. 89, Issue 5 (November 1973), pgs. 467-476.

Staff coupled the test probe to the HBN with a wire lead, fixed the probe in a holder attached to a computer-controlled linear actuator, and fastened the actuator to the table saw surface. This test protocol allowed staff to control the approach of the test probe to a rotating saw blade, and to measure the depth of cut to the test probe after activation of the table saw's AIM system. A detailed description of staff's test methodology is found in Tab A, Section II.E.1.a.

The approach rate of the test probe to the saw blade represents the rate of speed at which a human finger moves toward the saw blade during a blade-contact incident on a table saw. However, there is no standard body of data that quantifies finger/hand approach rate to the saw blade in a table saw incident, and CPSC staff analysis of blade-contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade. Sudden movement of the workpiece from kickback can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. Hand/finger contact is also possible without kickback, in situations where the operator's hand gets too close to the blade while feeding the workpiece, or the operator is distracted and inadvertently contacts the saw blade.[54] In comments to the table saw ANPR, published on October 11, 2011, SawStop presented analysis of their incident data (over 1,316 table saw incidents), which indicates approach rates to the blade occurred between 3.6 in/s (91 mm/s) and 14.5 in/s (368 mm/s), and 14 percent of the incidents involved kickback of the workpiece.[55] In 2014, UL conducted their own analysis of approach rates and noted the difficulty of taking laboratory measurements of human subjects and translating that information to estimate the approach velocity of an operator's hand or finger toward the center of the saw blade, or radial component of the approach velocity, in an actual blade-contact incident (see Figure 12).[56] UL considered their own analysis of SawStop's incident data, literature searches, and human subject experiments, and determined that 39.4 in/s (1000 mm/s or 1 m/s) is a reasonable first-order estimate of a typical case in which a table saw operator accidentally contacts the saw blade.

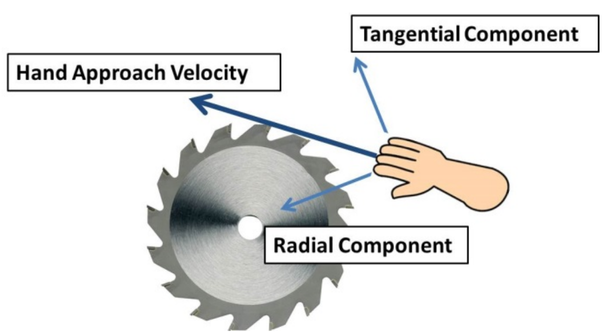

Figure 12. Components of Approach Velocity.

Staff's analysis of operator behavior in table saw blade-contact injuries indicates that blade-contact injuries occur at approach rates that range from slow feeding of the workpiece when the

[54] Smith, T. (2016). Memorandum. Human Factors Assessment of Blade-Contact Scenarios and Responses to ANPR Public Comments. Rockville, MD. (see Tab E).
[55] Gass, S. (2012). Comments and Information Responsive to the ANPR for Table Saw Blade Contact Injuries By SawStop, LLC. Retrieved from: https://www.regulations.gov/document?D=CPSC-2011-0074-1106.
[56] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.

operator's hand is close to the blade and inadvertent contact is made, to faster approach rates that occur when kickback of the workpiece causes the operator's hand to make contact with the blade. Staff believes that a radial approach rate of 1 m/s is appropriate for a performance test because this is a high rate of speed for the radial component of the hand's approach rate to the saw blade. In addition, this radial approach rate is more than twice as fast as the highest radial approach rate calculated by SawStop in more than a thousand blade-contact injuries that activated their AIM system. Therefore, staff conducted all tests at an approach rate of 1 m/s.

Test results

Staff developed a test method to evaluate various AIM systems to compare them to the performance standard limiting the depth of cut after triggering, using a test probe that can be used to evaluate the depth of cut when the probe makes contact with the rotating saw blade while approaching the blade at 1 m/s. This test method is known to work with AIM systems that use electrical sensing to detect finger contact and injury mitigation after contact. The test method may work if a system were designed using visual tracking, or other means of detection, to mitigate injury after detection. However, the test probe used to test AIM systems based on other methods of detection should have the appropriate properties to trigger the system. Staff tested a SawStop JSS-MCA jobsite table saw and a Bosch REAXX™ jobsite table saw for AIM technology performance in accordance with the above test protocol. Both saws have 10-inch diameter blades, and the manufacturer's blades were used in all test runs. Tests were run with the probe connected to the HBN, which was connected to the table saw's ground wire.

Staff tested 11 HBN settings/configurations to represent the effect of mutual capacitance between the human body and its surroundings, which increases the capacitance of the human body beyond its minimum self-capacitance of 50 pF in 50 pF steps up to 500 pF plus an additional short circuit test.[57] The HBN settings reflect a stepped increase in increments of 50 pF to cover a reasonable range of body capacitance. CPSC staff tested both table saws with 11 test-probe activations at an approach rate of 1 m/s and determined the probe depth of cut for each test run. The results are shown in Table 8. For all capacitance values, both the SawStop and Bosch table saws produced cuts that were under the 3.5 mm threshold for allowable depth of cut into the probe. The depth of cut for the SawStop table saw tests ranged from 1.5 mm to 2.8 mm, and the depth of cut for the Bosch table saw tests ranged from 1.9 mm to 2.5 mm.

[57] The units for electrical capacitance is the farad (F). For most applications, the capacitance value is very small, so the picofarad (pF) is used to denote one trillionth (10^{-12}) of a farad.

Table 8. Depth of Cut Values for SawStop and Bosch Table Saws

Test Run	HBN Capacitance	Depth of Cut (mm)	
		SawStop	Bosch
1	50	2.3	2.2
2	100	2.8	2.1
3	150	2.5	1.9
4	200	2.5	2.2
5	250	2.7	2.1
6	300	2.1	1.8
7	350	1.5	2.4
8	400	2.1	2.5
9	450	2.7	2.5
10	500	2.6	2.5
11	Short circuit	2.6	2.5

B. Recommendation for probe test with minimum depth of cut

Requirement

CPSC staff recommends a performance requirement for table saws that limits the depth of cut to a test probe upon making contact with the saw blade at a radial approach rate of 1.0 m/s, to 3.5 mm. The test probe shall have the appropriate properties (*e.g.*, electrical, optical, thermal, electromagnetic, ultrasound, etc.) to indicate human body/finger contact with the saw blade, and the test probe shall have the appropriate physical properties to measure depth of cut. The test probe and test method described in Tab A are considered appropriate for the evaluation of AIM systems using an electrical detection system. This test method should be used for such systems and will be used by CPSC staff in evaluating such systems. For AIM systems using a different detection approach, the method should be modified, based on sound material science and engineering knowledge, to ensure that triggering the AIM system would function properly as a surrogate for human blade contact and maintain the physical properties of the probe described in Tab A to ensure that the depth of cut can be measured properly. Staff seeks comments on how different detection methods may be applied as part of an AIM system, and what appropriate changes to the test method are necessary to evaluate properly the triggering of AIM systems employing these detection methods.

Rationale

CPSC staff believes a safety requirement to limit the severity of a table saw blade-contact injury should be used along with existing table saw voluntary standard requirements for a blade guard and riving knife that are intended to prevent blade contact. AIM systems provide a layer of safety that can mitigate a blade contact injury if the blade guard or riving knife are removed or fail to function properly, as well as blade contact injuries that can occur when a blade guard or riving knife are in place and functioning properly, but where blade contact occurs nonetheless.

CPSC staff test results indicate that table saws with AIM systems that rely on electrical detection are able to mitigate injury to a test probe that approaches the center of the rotating saw blade at a rate of 1 m/s, upon contact with the blade, by limiting the depth of cut to 1.5 mm to 2.8 mm. The performance of these table saws in terms of limiting depth of cut were well below the 3.5 mm threshold between a simple and complex laceration in a human finger, as measured by the test probe.

Staff believes that a performance requirement that limits the depth of cut to a test probe that contacts a saw blade to 3.5 mm will significantly reduce the severe lacerations, fractures, amputations, and avulsions associated with operator blade-contact incidents on table saws. This is because the probe will have the appropriate properties to indicate human body/finger contact with the saw blade and the equivalent injury-mitigation on a human finger will avoid most microsurgery. Most microsurgery will be avoided because the neurovascular bundle in a human little finger, which contains nerves and arteries, is at a depth of approximately 3.5 mm below the 0.5 mm thick epidermal layer of the skin. In this manner, a 3.5 mm depth of cut into a conductive test probe is a surrogate for a 4mm depth of cut into a finger with insulating epidermis over conductive tissue. For probes that are based on detection of other human body properties, the 3.5 mm depth-of-cut limitation still translates to an injury that will avoid most microsurgery for the reasons stated before, insofar as location of the neurovascular bundle in a human little finger. Additionally, incidents that occur under conditions that increase AIM performance (such as slower approach rate of the hand/finger to the saw blade and/or circumstances that increase detection) may result in injury severity that may not require medical attention beyond a bandage.

Staff recognizes there may be some scenarios, such as kickback, which can cause the operator's hand to be "pulled" into the blade at a high rate of speed or lead the operator to reaches as fast as possible for a falling workpiece, and other scenarios where the radial velocity of the hand/finger exceeds 1 m/s when it contacts the saw blade. At approach speeds greater than 1 m/s, AIM system performance may result in injury severity that requires extensive medical attention, including the microsurgical repair of nerves, blood vessels, and tendons for an incident that might otherwise have resulted in an amputation or the involvement of several digits or a wider area. The only available data on radial approach rates during kickback and non-kickback-related table saw blade-contact incidents indicate the approach rate does not exceed 0.368 m/s[58]; however, staff recognizes that there may be some incidents that occur under conditions so demanding that AIM performance is unable to prevent a severe injury from occurring. Nevertheless, staff believes that the majority of operator blade-contact injuries from table saws can be mitigated by the proposed performance requirements.

IV. ECONOMIC ANALYSIS

A. Preliminary Regulatory Analysis (see Tab C)

CPSC staff conducted a preliminary regulatory analysis of the draft proposed rule. The full analysis is attached as Tab C, and the main findings are summarized below.

[58] Gass, S. (2012). Retrieved from: https://www.regulations.gov/document?D=CPSC-2011-0074-1106.

The benefits of the proposed rule are measured by the reduction in the societal costs of injuries resulting from the use of the safer saws. Thus, the benefits assessment requires an annual estimate of medically attended table saw injuries, the costs of those injuries, and the expected effectiveness of the proposed rule in reducing those injuries.

Medically Treated Blade-Contact Injuries

According to CPSC staff's analysis of NEISS data, there were about 30,800 blade-contact injuries treated in hospital EDs during 2015. In addition to injuries initially treated in hospital EDs, many product-related injuries are treated in other medical settings, such as physicians' offices, clinics, and ambulatory surgery centers. Some injuries also result in direct hospital admissions, and bypass the hospital ED entirely. The number of table saw injuries initially treated *outside* of hospital EDs are estimated with the CPSC's Injury Cost Model (ICM), which bases its estimates on empirical relationships between the characteristics of injuries (diagnosis and body part) and victims (age and sex) initially treated in hospital EDs and the characteristics of those initially treated in other settings. (See Tab C for discussion.) Based on the ICM projections, there were an additional 24,050 blade-contact injuries treated annually in other treatment settings. Combined with the ED-treated injuries, there were an estimated annual total of about 54,850 medically treated blade-contact injuries in 2015.

Societal Costs of Blade-Contact Injuries

The societal costs of the medically treated table saw blade-contact injuries are quantified with the ICM. The ICM is fully integrated with NEISS, and in addition to providing estimates of the societal costs of injuries reported through NEISS, the ICM also estimates the costs of medically treated injuries that are initially treated outside of hospital emergency departments. The major aggregated societal cost components provided by the ICM include: medical costs, work losses, and the intangible costs associated with lost quality of life or pain and suffering.

According to the ICM, the estimated injury costs of the approximately 54,850 medically treated table saw blade-contact injuries in 2015 amounted to about $4 billion (in 2014 dollars and using a 3 percent discount rate).[59] Although amputations accounted for about 14 percent of the projected medically treated blade contact injuries, amputations accounted for almost two-thirds of the societal costs of blade contact injuries. Overall, medical costs and work losses accounted for 30 percent of the total societal costs, while the non-economic losses associated with pain and suffering accounted for 70 percent. Injury cost estimates for non-hospitalized injuries ranged from about $28,000 for blade-contact injuries treated outside of hospitals and EDs, to about $42,000 for injuries initially treated in hospital EDs (but not admitted). Injury costs for hospitalized injuries (of which about 40% were amputations), in contrast, averaged about $450,000 per injury.

[59] The 3 percent rate is intended to represent what is sometimes called the "social rate of time preference," and this value is more appropriate when evaluating health-related interventions. (See Tab C for discussion.)

Benefits and Costs of the Draft Proposed Rule

For purposes of the regulatory analysis, CPSC staff estimated that the proposed rule would prevent or substantially mitigate 70 percent to 90 percent of blade-contact injuries. Therefore, the estimated benefits, realized by a reduction in injury costs from blade-contact injuries that were prevented or mitigated, ranged from about $2,300 to $4,300 per table saw, over a table saw's expected product life. (See Tab C for discussion.)

While the benefits of the proposed rule are substantial, the expected costs are also large. As described at Tab C, the increased costs of the draft proposed rule, including direct manufacturing costs, and the expected costs of AIM system replacement parts over the life of a saw, may range from about $230 to $540 per bench saw, to about $375 to $925 per contractor, and to about $400 to $950 per cabinet saw. These costs likely would decrease over time, but the extent of the reduction in costs is uncertain.

The expected retail price increases resulting from the rule could reduce table saw sales industry wide by about 14 percent to 38 percent per year. In addition to the potential detrimental impact on manufacturers, consumers who would decide not to purchase saws because of the higher prices will suffer a loss in utility in the form of lost consumer surplus, amounting to about $10 million to $72 million annually.

The draft proposed rule may also create other utility impacts. The inclusion of the AIM technology may, for example, increase the weight and (potentially) the size of table saws in order to accommodate the new technology and to mitigate the effects of the forces associated with the activation of the technology. Although this factor may have a relatively small impact on the heavier and larger contractor and cabinet saws, the impact on the smaller and lighter bench saws will vary, depending upon engineering design decisions by the manufacturer.

In addition to the direct manufacturing costs, the cost of replacement parts and lost consumer surplus, the draft proposed rule is likely to generate approximately $30 million to $35 million annually in royalty fees for the AIM technology, which will accrue to patent holders. This is based on the assumption that royalties will amount to about 8 percent on the wholesale costs of table saws when a rule becomes effective. These royalties represent transfers from manufacturers to the patent holder(s), and, according to OMB's Circular A-4, these costs should not be included as costs, for purposes of a benefit-cost analysis. This is because, from a societal standpoint, the royalty fees represent a transfer from one market segment to another (*i.e.*, from table saw manufacturers to patent holders) and the remain available (by a different party) for productive use. Nevertheless, the royalty transfers effectively represent a "cost" to the manufacturers, who will have to pay them, and are likely to be figured into increases in retail prices of table saws. The table saw manufacturers who would be paying royalties to a competitor would, in effect, be reducing their own competitiveness, relative to the patent holder receiving the royalties.

If, however, table saw manufacturers choose not to license already-patented AIM technology, they will be required to develop technology to meet the draft proposed rule's requirements. Most, if not all, table saw models not already incorporating the AIM technology would require major design changes and the retooling of production facilities, a process that would likely take two years or longer to accomplish. Developing such a technology would require investment of several million dollars.

Based on staff's benefit and cost estimates, net benefits (*i.e.*, benefits minus costs) for the market as a whole (*i.e.*, combining the three types of table saws together) amounted to an average of about $1,500 to $4,000 per saw. Aggregate annual net benefits could amount to about $625 million to about $2,300 million. Net benefits varied but generally remained positive in our sensitivity analysis.

<u>Breakeven Analysis</u>

Because staff had no information on the distribution of injuries across saw types (*i.e*., bench, contractor, and cabinet saws), staff was unable to evaluate directly the benefits and costs for each type of saw. Such an analysis is important because the costs of the draft proposed rule could exceed the benefits for one or more saw types, even though, in aggregate, benefits exceed the costs for the market as a whole. However, based on several assumptions, staff was able to conduct a breakeven analysis by estimating the approximate number of injuries that would have to be prevented, for each type of saw, for the benefits to equal or exceed the costs. The breakeven estimates suggest that *if* the draft proposed rule could prevent at least 1,437 to 3,116 bench saw injuries over the expected product life of 1 year's production and sale of bench saws, then the benefits of the draft proposed rule would equal or exceed the costs for that saw type. Using the same methodology, the breakeven injury estimate for contractor saws ranges from 650 to 1,615 injuries, and the breakeven estimate for cabinet saws ranges from 178 to 445 injuries. (See Tab C for more detailed discussion.)

To test different allocations of injuries by table saw type, staff evaluated four hypothetical blade-contact injury distributions and estimated the number of injuries under each injury distribution that would likely be prevented, for each saw type, by the draft proposed rule. This value was then be compared to the breakeven estimates to determine if benefits were likely to exceed the costs. In general, the breakeven analysis found that the expected injury reduction for each of the saw types exceeded the breakeven estimates, suggesting that, under most plausible injury distributions, the benefit of the rule exceeded the costs for each type of saw. (See Tab C for more detailed discussion.)

<u>Stockpiling for Table Saws</u>

The proposed rule would prohibit the manufacture or importation of noncomplying table saws in any period of 12 consecutive months between the date of promulgation of the final rule and the effective date, at a rate that is greater than 120% of the rate at which they manufactured or imported table saws during the base period for the manufacturer. The base period is any period of 365 consecutive days, chosen by the manufacturer or importer, in the 5-year period immediately preceding promulgation of the rule. The stockpiling limit would allow the industry to meet any foreseeable increase in the demand for table saws without allowing large quantities of table saws to be stockpiled.

B. Initial Regulatory Flexibility Analysis (see Tab D)

In accordance with the Regulatory Flexibility Act, CPSC staff conducted an initial regulatory flexibility analysis to examine the impact of the draft proposed rule on small entities. (See Tab D for discussion.)

CPSC staff is aware of 22 firms that supply table saws to the U.S. market. At least 8, and possibly 10, would be considered "small," according to criteria established by the U.S. Small Business Administration (SBA).

Small table saw manufacturers supply mostly contractor and cabinet saws, which are typically more expensive and heavier than bench saws. One small company sells a multipurpose machine that includes a table saw, lathe, drill press, sander, and router, among other tools. As of March 2016, only three bench saw models were being offered by small manufacturers.

To comply with the draft proposed rule, table saw manufacturers lacking an AIM technology would be required to license or develop an AIM technology or develop their own technology. Most small manufacturers are expected to attempt to license an AIM technology and the royalty cost for licensing an AIM technology is uncertain. Dr. Stephen Gass of SawStop has stated that SawStop would be willing to license the SawStop AIM technology for a royalty payment of 8 percent of the wholesale price of the saw, if the Commission establishes a mandatory standard requiring AIM technology on all table saws (see Tab C for discussion). However, there is no certainty that small manufacturers would be able to negotiate acceptable licensing agreements with SawStop or another patent holder. If a small manufacturer is unable to negotiate an acceptable licensing agreement (and is unwilling or unable to develop their own), it would likely exit the U.S. table saw market.

If small table saw manufacturers are able to license AIM technology, they would be expected to evaluate the sales volume of each table saw model and the likely cost of redesigning and retooling the model (which may amount to about $100,000 to $700,000 per model), and thereafter, decide whether to continue offering the model in the United States. If the manufacturer does not believe that the sales volume would be sufficient to recoup these costs in a reasonable amount of time, it is likely that the manufacturer would discontinue the sale of the model (at least in the United States). The fact that some small table saw manufacturers might license the AIM technology from SawStop (or other patent holders, if any), would mean that these manufacturers would be paying royalties to a competitor. This would be expected to reduce their competitiveness in the table saw market. Four firms indicated to CPSC staff that they would likely reduce or eliminate the table saws that they currently offer in the United States if AIM technology is mandated. We would expect that other firms, especially those with only a small market share of sales, would also consider such actions.

Except for SawStop and one other firm, most small table saw manufacturers supply other types of woodworking or metal working equipment. Anecdotal information suggests that U.S. sales of table saws account for a small percentage of the total revenue of most small firms. Information supplied by one manufacturer suggests that U.S. table saw sales accounted for about 1 percent of the firm's total revenue. Two other firms estimated that U.S. table saw sales accounted for between 5 percent and 8 percent of their total revenue. Actions that impact a firm's revenue by more than 1 percent are potentially significant. Therefore, given that it is likely that small table saw manufacturers would drop one or more table saws from the U.S. market if AIM technology were mandated, and may leave the market entirely if they are unable to license or develop an AIM technology, the draft proposed rule could have a significant impact on small manufacturers. However, the draft proposed rule is not likely to cause most small manufacturers to fail completely because they also produce other products. One small manufacturer, SawStop, would significantly benefit from promulgation of the draft proposed rule because SawStop already manufactures table saws with AIM technology and owns multiple patents that cover the technology. SawStop would also benefit from licensing agreements.

V. COMMENTS TO ANPR

In this section, staff describes and responds to comments to the table saw ANPR. Included is a summary of comments by topic, followed by CPSC staff's response. We received approximately 1,600 comments, which are posted on: www.regulations.gov, by searching under the docket number for the table saw ANPR, CPSC-2011-0074.

Approximately 134 commenters supported developing regulatory standards for table saws. The other commenters opposed rulemaking action. The latter commenters raised issues in the following areas:

- Nature of Requirements and Monopoly
- Voluntary Standards Process
- Personal Responsibility and Free Market/Choice
- Table Saw Incident Data and Analysis
- Economic Issues
- Unintended Consequences
- Training and Warnings
- Actions Outside the Authority of the CPSC

The comment topics are separated by category.

Nature of Requirements and Monopoly

1. **Comment:** Numerous commenters stated that table saw performance requirements that mitigate or reduce blade-contact injuries would force all manufacturers to use the SawStop patented technology. Many commenters stated that mandating the use of the SawStop technology will result in a monopoly and stifle innovation, granting an unfair advantage to one company. Commenters stated that table saw performance requirements would be "a design standard" because SawStop's parent company (SD3, LLC) owns a number of U.S. patents for sensing technology and blade braking and blade retracting technology.[60]

[60] Dr. Stephen Gass, David A. Fanning, and James David Fulmer are members of a limited liability company called SD3, LLC that owns patent rights related to the SawStop technology. Retrieved from https://www.cpsc.gov/PageFiles/82887/Bladesawpt1.pdf.

Response: CPSC staff recommends performance requirements for table saw safety that provide a layer of safety that can mitigate a blade-contact injury if the blade guard or riving knife are removed or fail to function properly; the performance requirements would also address blade-contact injuries that can occur when a blade guard and riving knife are in place and functioning properly, yet blade contact occurs nonetheless. The proposed performance requirement for table saws limits the depth of cut to a test probe, upon making contact with the saw blade at a radial approach rate of 1.0 m/s, to 3.5 mm. The test probe shall have the appropriate properties to indicate human body/finger contact with the saw blade and shall have the appropriate physical properties to measure depth of cut. There are many methods to detect human contact with a table saw blade that range from electrical, optical, thermal, electromagnetic, to ultrasound and more. Likewise, there are many methods to limit the depth of cut to a probe.

Although the staff is not recommending a particular AIM technology, staff is aware that currently, there are only two AIM systems, SawStop and Bosch REAXX™, currently capable of mitigating a blade-contract injury. These systems operate by sensing electrical properties of the human body/finger. However, there are other systems that can be developed that use other properties of the human body such as thermal sensing of the human body/finger, or visual sensing and tracking of the human body/finger. Although these systems do not exist yet, staff believes that such systems can be developed that would not require electrical sensing technology, but rather, would use other sensing of the human body.

Staff is aware of ongoing patent litigation between SawStop and other table saw manufacturers, including Bosch. For example, on July 16, 2013, SawStop filed a complaint against Bosch at the U.S. International Trade Commission (ITC), requesting an investigation under section 337 of the Tariff Act of 1930 to limit entry into the United States of the Bosch REAXX™ table saws that allegedly infringed on several SawStop patents. *In the Matter of Certain Table Saws Incorporating Active Injury Mitigation Technology and Components Thereof*, Investigation No. 337-TA-965. The status of litigation between Bosch and SawStop has not been resolved. In addition, we do not know what other SawStop patents may be impacted by companies that attempt alternative AIM technologies, and we note that SawStop has filed at least 100 patents with the U.S. Patent and Trademark Office related to SawStop's woodworking safety systems. Therefore, it is possible that any injury mitigation system on a table saw that relies on sensing electrical properties of the human body and finger and engages a reaction that retracts the blade will implicate a SawStop patent.

The outcome of ongoing lawsuits involving the SawStop technology will determine some of the impacts that may result from a mandatory rule requiring AIM technology for table saws. If the courts determine that the patents covering the SawStop technology allow for companies to manufacture their own saws with alternative AIM technologies (such as the Bosch REAXX saw), then some manufacturers may choose to try to develop their own proprietary technology or license the Bosch technology (if available) as an alternative to the SawStop technology.

Alternatively, if the courts decide that other technologies do, in fact, infringe upon SawStop patents, then SawStop may effectively have a monopoly on the technology needed to comply with a mandatory rule, until SawStop's patents expire. However, even if the patents expire, if new technology is not developed, other manufacturers likely would be required to work with SawStop and/or Bosch to license the SawStop or Bosch technology for use in their saws. Even if all of the relevant patents become public, many manufacturers may not be able to develop their own AIM systems, and will either have to license the technology, or exit the table saw market. As discussed in TAB C of the staff briefing package, the level at which the royalty payments are set will play a significant role in determining the economic impacts that CPSC's rule would have on table saw manufacturers.

Voluntary Standard Process

1. **Comment:** Numerous commenters stated that CPSC staff should work with the table saw industry to offer solutions. The commenters stated that the voluntary standards process is working and has resulted in the addition of a permanent riving knife on all table saws. In addition, other commenters stated that the industry has also required the modular blade guard on all table saws, which has improved the safety of table saws.

   Numerous commenters also stated that current table saws (some referring to older table saws with traditional blade guards, and some referring to newer table saws with riving knives and modular blade guards) are safe if used properly. Many commenters cited their own personal experiences with table saw use and claimed that because they have not had an injury this proves that current table saws are safe.

   Response: CPSC staff performed a trend analysis of the annual estimated number of emergency department-treated table saw blade-contact injuries from 2004 to 2015. This trend analysis includes the timespan before the voluntary standard require driving knives and modular blade guards on table saws (2004 to 2009) and the timespan after the requirements were implemented (2010 to 2015). Staff concludes that there is no discernable change in the number of injuries or types of injuries related to table saws from 2004 to 2015. CPSC staff then analyzed risk of blade contact injury per 10,000 table saws in use for each year in the analysis. CPSC staff performed a trend analysis and concludes there is no discernible change in the risk of blade-contact injury associated with table saws. Based on the trend analysis of blade-contact injuries and the risk of blade-contact injuries from 2004 to 2015, staff does not see evidence that the voluntary standard requirements for riving knives or modular blade guards have reduced or changed blade contact injuries on table saws.

   In addition, staff is aware of at least 11 incidents from the CPSRMS data base (2004-2015) that involve table saws that meet the current voluntary standard requirements for a riving knife and modular blade guard. A riving knife may reduce the occurrence of kickback (that can lead to unexpected stock movement and finger/hand contact with the blade) on a table saw, but kickback can still occur on table saws equipped with a riving knife. Furthermore, reducing kickback will not eliminate blade-contact injuries because blade-contact injuries can occur without kickback of the stock.

CPSC staff believes that 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. Results of a user survey of table saw owners with modular blade guards indicate that a majority of respondents (80%) reported that there are circumstances that require the blade guard to be removed, and a majority of respondents said that they removed the blade guard "sometimes" (28%), "often" (17%) or "always" (14%).[61] The results of the user survey demonstrate that removal of the blade guard is a necessary and proper action when making certain cuts on table saws. In addition, many users choose not to use the modular blade guard at all or only some of the time. Any situation where the blade guard is not used eliminates the effectiveness of the blade guard in preventing blade-contact injuries. Accordingly, this analysis indicates that use of the blade guard for injury prevention is insufficient.

Based on the trend analysis of blade-contact injuries and risk of blade-contact injuries from 2004 to 2015, the CPSRMS incidents, plus staff's analysis of the efficacy of riving knives and modular blade guards, staff does not see evidence that the voluntary standard requirements have reduced or changed table saw blade-contact injuries.

CPSC staff has participated with the table saw industry and other stakeholders in UL working groups since September 2011 to develop safety standards for table saws. UL proposed active injury mitigation (AIM) system performance requirements for table saws in February 2015 and February 2016, which indicates that the voluntary standards governing body believes that table saws r should exhibit active injury mitigation performance. However, despite these efforts, the AIM requirements have not been adopted in the UL standard. Therefore, CPSC staff recommends that the Commission propose performance requirements to address the unreasonable risk of injuries associated with table saws.

2. **Comment:** Numerous commenters stated that table saw users should be responsible for their actions, should use common sense when operating the table saw, and should accept the risk of using a table saw. Many commenters stated that SawStop table saws are already available and the free-market system should determine whether consumers will purchase a table saw with enhanced safety features. Many of these same commenters opposed any mandate from the federal government to make table saws safer. These commenters contended that the federal government should not regulate consumer choice or behavior. Many commenters stated that other products can also cause injury, such as knives or band saws, and the commenters asked whether the CPSC will regulate those products as well. Other commenters argued that lawsuits against table saw manufacturers reward users who are irresponsible and use table saws improperly.

    Response: CPSC staff's analysis of blade-contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade, and there are

[61] Sherehiy, B. and Nooraddini, I. (2016). Table Saw Blade Guard Survey. Retrieved from: http://www.cpsc.gov/Global/Regulations-Laws-and-Standards/Voluntary-Standards/Voluntary-Standards-Reports/EurekaFactsTableSawBladeGuardSurveyReport(Final6bcleared)updatedcoverpage.pdf.

certain cuts on table saws that require removal of the blade guard. Therefore, an operator's decision to use a table saw without all safety devices does not necessarily indicate intentional neglect or ignorance on the part of the operator. Sudden movement of the workpiece from kickback can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. Hand/finger contact is also possible without kickback, in situations where the operator's hand gets too close to the blade while feeding the workpiece or the operator is distracted and inadvertently contacts the saw blade. In addition, many of the scenarios leading to blade contact may be more likely if the consumer is tired or if the view of the blade, or cut, is impaired in some way.

There are an estimated 3,800 amputations that occur each year on table saws. And when compared to all other types of consumer products, an estimated 18.6 percent of all amputations in the NEISS in 2015 are related to table saws. When compared to all other workshop products, table saws accounted for an estimated 52.4 percent of all amputations related to workshop products in 2015.

Based on the severity of injuries and recurring hazard patterns of blade-contact injuries, coupled with the high societal costs of these injuries, CPSC staff recommends performance requirements to reduce these addressable risks of injury, taking into consideration the rule's potential effect on utility, cost, and product availability to consumers.

3. **Comment:** Many commenters supported preserving consumer choice in the table saw market by not mandating AIM technology. Most wanted table saws equipped with AIM technology to be available, and some even stated that they owned a SawStop saw; however, they wanted to preserve the option to purchase less expensive table saws not equipped with an AIM technology. Many commenters stated that the consumer should decide whether table saws equipped with AIM technology are worth the increased cost. Some commenters stated that because there are already safety devices, such as splitters, blade guards, and push sticks, which if used properly will reduce injuries, consumers who properly use these devices should not be forced to pay more for saws with AIM technology. Some commenters requested that manufacturers be required to offer at least one table saw with AIM technology, instead of requiring all table saws to be equipped with the technology. Other commenters noted that saws equipped with AIM technology are already available in the marketplace, and if consumers wanted these saws, they could purchase them.

Response: CPSC staff acknowledges that although some consumers would prefer table saws with the AIM technology, other consumers would prefer to have the option to purchase a table saw without the AIM technology. Some consumers would also prefer the use of passive table saw safety devices, as opposed to the AIM technology.

The draft proposed rule would prevent consumers from purchasing table saws without the AIM technology, but would also substantially reduce the serious blade contact injuries involving table saws every year. In addressing the blade-contact risk, the CPSC must weigh the costs of blade-contact injury against the cost of limiting consumer choice. However, in addition to the draft proposed rule, the Commission could consider various alternatives that would not require all table saws to be produced with the AIM technology. These alternatives are discussed in the staff's regulatory analysis of the draft proposed rule.

4. **Comment:** Some commenters stated that if the CPSC did not mandate a particular technology, other companies could introduce their own safety technologies, some that may prove to be better than SawStop's technology. Some commenters predicted that if CPSC did not mandate the SawStop AIM technology, other injury-mitigation technologies would be developed, and the competition among the technologies would eventually bring down the prices associated with these new technologies.

   Response: Although the draft proposed rule would require that saws contain AIM technology, the rule would not mandate a specific technology, but instead would establish a performance standard that must be met by any technology. Manufacturers would be free to develop other AIM technologies and incorporate them into table saws, or license the AIM technology from existing patent holders, as long as the AIM technologies meet the performance criteria.

   The proposed performance requirement for table saws limits the depth of cut to a test probe, upon making contact with the saw blade at a radial approach rate of 1.0 m/s, to 3.5 mm. The test probe shall have the appropriate properties to indicate human body/finger contact with the saw blade and shall have the appropriate physical properties to measure depth of cut. There are many methods to detect human contact with a saw blade that range from electrical, optical, thermal, electromagnetic, ultrasound and more. Likewise, there are many methods to limit the depth of cut to a probe. Such methods could include retracting the blade through pneumatic (high pressure air), or hydraulic (high pressure oil) systems. Another method could involve projecting the blade away from the hand or projecting the table upwards, rather than retracting the blade.

Table Saw Incident Data Analysis

1. **Comment:** Numerous commenters stated that CPSC staff injury data analysis was faulty because it did not include the effects of the modular blade guard system. Specifically, "a meaningful analysis cannot be completed based on upon the 2007-2008 Injury Report since it includes data only related to old guard designs rather than the new modular blade guarding system." The Power Tool Industry (PTI) estimated that, in 2012, more than 900,000 table saws had been sold since 2007 that use the modular blade guard. Some commenters stated that CPSC staff failed to estimate the risk of injury associated with table saw use, and that this data is needed to evaluate the effectiveness of the voluntary standard requirements for a riving knife and modular guard on table saws.

   Response: CPSC staff estimated the yearly table saw blade-contact injuries from 2004 to 2015, by using estimates from NEISS. The date range for the trend analysis includes a timespan before the voluntary standard required table saws to be equipped with a riving knife and modular blade guard (2004 to 2009) and a timespan after the voluntary standard requirements became effective on most table saws (2010 to 2015). A proportion of table saws manufactured before the current voluntary standard are expected to remain in use throughout this whole period. However, in more recent years, after the current voluntary standard became effective, an increasing proportion of table saws in use conform to the current voluntary standard. Thus, if the voluntary standard was positively impacting the number or severity of injuries, there would be a steady decrease in the number of injuries or severity of injuries as the proportion of compliant table saws increased.

   CPSC staff performed trend analyses for blade-contact injuries, as well as blade-contact amputations, hospitalizations, and finger/hand injuries. CPSC staff concludes that there is no discernible decrease in the number of blade contact injuries or type of injuries related to table saw blade contact from 2004 to 2015. CPSC staff also performed a trend analysis for the risk of blade contact injury per 10,000 table saws, and likewise, concludes that there is no discernible decrease in the risk of injury associated with table saws from 2004 to 2015.

   CPSC staff has also received reported incidents through means other than the NEISS, which are entered in the CPSC's Consumer Product Safety Risk Management System (CPSRMS) database. Of the 53 incidents identified in the CPSRMS database that were reported in the period from 2004 to 2015, 36 incidents involved table saws with a traditional blade guard, and 11 involved table saws with a modular blade guard. However, a review of the reports indicates that the incident scenarios for table saws with modular blade guards are similar to incidents involving table saws with traditional blade guards in terms of their use with and without blade guards and accidents occurring with and without unexpected stock movement from kickback of the material. In addition, the modular blade guard survey conducted by the CPSC in 2015 indicates that consumers frequently remove the modular blade guard to perform certain cuts, or do not use the modular blade guard at all or only some of the time.

   Based on the trend analysis of blade-contact injuries and risk of blade contact injuries dating from 2004 to 2015, plus anecdotal evidence that blade-contact injuries continue to occur on table saws that meet the current voluntary standards requirements intended to address blade contact injury, staff does not see evidence that the voluntary standard requirements for riving knives or modular blade guards have reduced or changed blade-contact injuries on table saws.

2. **Comment:** One commenter questioned the results of the 2007-2008 NEISS special study, which indicated that 68.7 percent of saws involved in incidents were fixed cabinet saws, 18.3 percent were semi-portable contractor saws, and 10.5 percent were portable bench saws. The commenter stated the results were inconsistent with other data in the survey regarding the table saws' characteristics.

   Response: CPSC staff reanalyzed the saw type and drive type responses provided by the injury victims in the 2007-2008 special study. The results of the reanalysis were published in June 2014, and the results led staff to recommend that anyone who intended to reference the report in terms of injuries by saw type should consider staff's finding that the distribution of injuries for different types of saws cannot be based on how respondents answered questions about the type of saw.[62]

   CPSC staff is not relying on the data used in the 2007-2008 special study for the draft proposed rule. Staff reviewed all the NEISS cases related to table saw product code 0841 that were treated in 2015 to estimate: the number of emergency department-treated table saw blade-contact injuries in 2015, injury diagnosis, and characteristics of the victims. In addition, staff looked at annual injury estimates for table saws from 2004 to 2015 to perform trend analyses on number of injuries, types of injury, and risk of injury over the 10-year period. Lastly, staff reviewed table saw-related reported incident reports stored in the CPSRMS database.

   Based on the statistical analysis and review of anecdotal reports of table saw injuries, CPSC staff believes that operator finger/hand contact with the table saw blade is a dominant hazard pattern that can be addressed by a performance requirement.

3. **Comment:** Several commenters stated that most table saw injuries are caused by kickback of the workpiece and the SawStop system does not prevent kickback. Others stated that riving knives will eliminate kickback, and therefore, reduce most injuries.

   Response: CPSC staff analysis of blade-contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade, and there are certain cuts on table saws that require removal of the blade guard. Sudden movement of the workpiece from kickback can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. However, hand/finger contact is also possible without kickback when the operator's hand gets too close to the blade while feeding

[62] Results of reanalysis retrieved from: http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Home%20Maintenance%20and%20Construction/CoverpageandMemoofStaffAnalysisofTableSawTypeinNEISSSpecialStudy.pdf.

the workpiece, or when the operator is distracted and inadvertently contacts the saw blade. Possible blade-contact scenarios that are unrelated to kickback include the following:

- The consumer's hand gets too close to the blade while feeding the workpiece, particularly small workpieces when making rip cuts and the fingers contact the blade. In some cases, the consumer may be wearing gloves for protection, or because of cool temperatures, and the blade catches the glove and pulls the hand into the blade.[63]

- The consumer reaches near or past the blade to regain control of a workpiece that is slipping, lifting up, falling off the table, or otherwise moving in an unexpected way, and the hand contacts the blade.[64]

- The consumer reaches for a cutoff or brushes debris from the table while the blade is still spinning and the hand contacts the blade.[65] Saw blades can continue spinning for some time after a table saw has been switched off, so some consumers might contact the blade after having already switched off the table saw, but before the blade has come to a complete stop. Furthermore, consumers who are aware of the potential for kickback might be motivated to remove a cutoff immediately to prevent a cut piece from kicking back or otherwise being thrown.

Staff identified 53 incidents in the CPSRMS database that involve blade-contact injury on a table saw that occurred between January 1, 2004 and December 31, 2015, and were reported to CPSC by March 1, 2016. For the majority of incidents, it is unknown whether unexpected workpiece movement was involved in the blade contact, thus making conclusions difficult. Of the incidents where information about the contribution of workpiece movement was known, most blade-contact injuries involved some type of unexpected workpiece movement; however, a few did not involve stock movement. In addition, 11 of the 53 incidents involved table saws that meet the current voluntary standard requirements for a riving knife and modular blade guard. This indicates that blade contact injuries continue to occur on table saws equipped with a riving knife. Staff also notes that while the draft proposed rule would not eliminate kickback, the AIM systems would reduce injuries that occur when kickback results in blade contact by the user.

4. **Comment:** Based on estimates from the National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP), which is a statistical subsample of NEISS hospitals, one commenter claimed that the full NEISS sample overestimated the number of table saw blade contact injuries in 2007-2008. More specifically, the commenter argued that because the proportion of NEISS-AIP amputations treated in hospital EDs was statistically less than the proportion of ED amputations from the full NEISS estimate, NEISS-AIP is the appropriate and preferable sample to use when making national estimates of table saw ED injuries.

[63] For example, IDI nos. 121018CNE1304.
[64] For example, IDI nos. 080415CCC2550.
[65] For example, IDI nos. 050328HWE3010.

Response: The CPSC staff estimate of emergency department (ED)-treated blade-contact injuries for table saws, including the estimate of ED-treated amputations, was based on the weighted national estimate of actual blade-contact injuries reported through the full NEISS sample of hospitals during 2007-2008. NEISS is a stratified national probability sample of approximately 100 U.S. hospital EDs that allows the CPSC to make statistically valid national estimates of product-related injuries treated in U.S. hospital EDs. The NEISS-AIP is a statistical subsample of the full NEISS sample that is administered by the CDC, and consists of approximately two-thirds of the NEISS hospitals in each stratum. This subsample collects information on injuries outside CPSC's jurisdiction, including occupational, motor vehicle, boating, and other injuries. For table saw injuries (product code = 0841) in 2007-2008, approximately 62 percent of the weighted national estimate comes from the hospitals in the NEISS-AIP subsample. However, the commenter estimated that amputations from the NEISS-AIP subsample accounted for only about 52 percent of amputations from the total NEISS sample and reported that the difference (*i.e.*, the difference between the percentage of amputations and the percentage of overall table saw injuries reported through NEISS-AIP) was statistically significant. Based on this statistical finding, the commenter concluded that the amputation estimate from NEISS-AIP was preferable to the amputation estimate from the full NEISS sample. It appears that the commenter lowered the amputation estimate from the full NEISS sample to make it consistent with NEISS-AIP. No explanation was provided for the conclusion that the NEISS-AIP subsample was preferable to the full NEISS sample, other than the reported concern by the commenter that CPSC's estimate of "the share of amputation injuries that do not require hospitalization may [have been] unrealistically large."

Based on an evaluation by the Directorate for Epidemiology's Data Systems Division, the lower proportion of amputations coming from NEISS-AIP (about 52 percent) was not, in fact, statistically different than the overall national estimate of table saw injuries that came from the full NEISS sample as the commenter claimed.

Finally, as noted, the NEISS-AIP is a statistical sub-sample of the full NEISS sample, and consists of approximately two-thirds of the NEISS hospitals in each stratum. Similarly, according to the Directorate for Epidemiology, non-NEISS-AIP (*i.e.*, the sample NEISS hospitals not contained in NEISS-AIP) also represents a statistical subsample of the full NEISS sample, consisting of approximately one-third of the hospitals in each stratum. All three samples (NEISS, NEISS-AIP, and non-NEISS-AIP) constitute valid statistical samples of U.S. hospital EDs, and with the proper reweighting of the NEISS-AIP and the non-NEISS-AIP subsamples, all would produce statistically valid national estimates of consumer product-related injuries treated in U.S. hospital EDs, which are not statistically different from one another.

Economic Analysis

Several comments questioned the methodology that CPSC staff used to estimate injury costs in the ANPR package. In particular, comments focused on staff's estimates of emergency department (ED) visits, calculation of intangible costs, and staff's conclusion that the regulation is justified.

1. **Comment:** One comment stated that CPSC staff gives no basis for projecting injury estimates derived from NEISS onto other medically treated injuries to obtain a national injury rate for table saws. The commenter noted that other estimates of table saw-related injuries differ from CPSC's. For example, the commenter states that using the NIOSH hospital sample, the average total number of work-related injuries treated in hospital emergency rooms due to table saws was below the CPSC estimate. The commenter asserted that, to the extent that more serious injuries are likely to be treated in emergency rooms, the mix of injury severity based on the NEISS data overstates the severity mix once the injury total is multiplied by a set factor.

   Response: The CPSC staff uses the CPSC's Injury Cost Model (ICM) to project the number of medically attended injuries treated outside of hospital emergency departments (*e.g*., non-ED office visits, including medical treatment in doctor's offices, emergency clinics, ambulatory care centers).[66] As described more fully at Tab C, estimates were derived from empirical relationships between ED-treated injuries and injuries treated in other settings, based on National Health Interview Survey records (which provided detailed information on where the injuries were treated) stretching over 10 years. The methodology for this calculation is described in Miller et al. (2000), and was cited in the technical memorandum from the Directorate for Economic Analysis. Since the ANPR was published, the methodology for projecting the number of non-ED treated injuries has been updated. It is described in: *Revised Incidence Estimates for Non-Fatal, Non-Hospitalized Consumer Product Injuries Treated Outside Emergency Departments*, Bruce Lawrence, Pacific Institute for Research and Evaluation, Calverton, MD, April 2013.

   The estimate of occupational table saw injuries treated in hospital EDs is not relevant for the table saw analysis. The CPSC excludes occupational injuries from the CPSC estimate of consumer injuries whenever possible. Moreover, the NIOSH estimates mentioned by the commenter were not based on a "NIOSH hospital sample." Rather, they were based on the NEISS All Injury Program (AIP), a subsample of NEISS hospitals administered by the CDC. As discussed, the AIP subsample covers a much broader range of injuries, *i.e.* occupational, motor vehicle, boating, and other injuries. Thus, the results for CPSC estimate of consumer injuries and the NIOSH estimate of occupational injuries are not inconsistent.

   Finally, the mix of injury severities from the NEISS ED injury sample was not simply projected onto the estimate of injuries treated outside of hospital EDs. Rather, the estimates were based on the characteristics of injuries treated outside of hospital EDs. For example, based on information from the National Health Interview Survey, a 40-year-old woman with a fractured clavicle is almost twice as likely to be treated in a doctor's office (or some other non-ED settings) than a 10-year-old boy (Miller et al., 2000, Table 6). Consequently, for this example, the ICM would estimate more injuries treated outside the emergency room for 40-year-old women and fewer injuries treated outside of hospital EDs for 10-year-old boys. The

[66] Miller, et al. (2000). The Consumer Product Safety Commission's Revised Injury Cost Model. Retrieved from: https://www.cpsc.gov/PageFiles/100269/costmodept1.PDF.

more serious and life-threatening injuries are more likely to be treated in hospital emergency rooms, and this is reflected in the CPSC injury estimates.

2. **Comment:** Two comments focused on several aspects of the economic value of injury risks used by the CPSC in its 2011 analysis. One commenter suggested that the CPSC did not provide any supporting data for any of the four cost components of the Injury Cost Model (ICM): medical treatment, lost time from work, product liability costs, and pain and suffering. With regard to two of the ICM components, the commenter suggested that counting product liability costs as well as pain and suffering may lead to double counting. Furthermore, the appropriate method for assessing the benefits from public programs is society's willingness to pay to avert small risks, an *ex ante* amount, as opposed to a retrospective piecemeal approach adopted by the CPSC. Finally, this commenter noted that even if jury awards for pain and suffering corresponded to willingness to pay values, there is no justification for applying these rates to all table saw injuries. Another commenter stated that the pain and suffering portion of the ICM injury cost estimates are overstated and inappropriate.

   Response: The methodology and data supporting the various components in the injury cost model are described more fully at Tab C. However, in recent years CPSC staff has excluded the product liability costs from ICM cost estimates. Although this component was intended to represent the costs of administering the product liability system in the United States, there was the possibility of some double-counting, as suggested by the commenter. Accordingly, product liability costs administration costs are not included in the proposed rule.

   The commenter promotes the concept of willingness-to-pay over the method used by CPSC staff to estimate the likely benefits of regulation. CPSC does use willingness-to-pay estimates in valuing fatal injuries. However, such estimates do not generally exist for nonfatal injuries.

3. **Comment:** One commenter asserted that the injury data used by CPSC's staff to estimate societal costs in its 2011 analysis were based on extrapolations that were imprecise and resulted in greatly overstated societal costs. The commenter based this statement on two factors. First, the commenter said that injury costs should be limited to blade contact injuries reported through hospital emergency rooms. Second, because only about 11 percent of ED treated injuries resulted in hospitalization, the commenter suggested that inclusion of the ED treated and released injuries greatly exaggerated the CPSC estimate of societal costs.

   Response: CPSC staff uses the CPSC's ICM to project the number of medically treated injuries treated outside of hospital emergency departments (*e.g*., non-ED office visits, including medical treatment in doctor's offices, emergency clinics, ambulatory care centers), and the costs of those injuries. Estimates were derived from empirical relationships between ED-treated injuries and injuries treated in other settings, and based on National Health Interview Survey records (which provided detailed information on where the injuries were treated) stretching over 10 years. The methodology for this calculation was described in Miller et al. (2000). Cost estimates for the injuries treated outside of hospital emergency departments are generally less than the costs of injuries initially treated in emergency rooms.

To exclude injuries treated outside of hospital emergency departments would severely underestimate the types and costs of injuries associated with table saw use.

Second, although it is true that costs associated with injuries that were treated and released from emergency departments are substantially less than hospitalized injuries, the costs associated with treated-and-released injuries can still be substantial. To exclude the treated-and-released injuries, which typically account for about 90 percent to 95 percent of table saw injuries presenting at hospital emergency departments, would substantially underestimate the cost of table saw injuries.

4. **Comment:** One commenter asserted that the "methodology CPSC uses to extrapolate from ED-treated injuries to all medically attended injuries does not take into account the fact that table saw injuries are likely to be more serious, and thus more likely to require treatment in a hospital ED, than injuries involving fingers, wrists, hands, and lower arms that are associated with other consumer products." Based on this supposition, the commenter contended that the ICM overstates the annual number of blade-contact injuries treated during non-ED office visits. The commenter suggested that this purported error could be corrected by reducing CPSC's estimate of non-ED office visits (based on ratios involving rates of hospitalization), and the commenter concluded that there were about 42,800 medically attended blade-contact injuries involving table saws annually during 2007-2008, about 36 percent fewer than CPSC's estimate of 67,300.

   Response: As described at Tab C, the CPSC's ICM uses empirically derived relationships between ED-treated injuries and injuries treated in other settings (non-ED office visits, including medical treatment in doctor's offices, emergency clinics, ambulatory care centers, etc.) to estimate the number of injuries treated outside of hospital EDs. It does not use a single 1-to-1 extrapolation factor, as suggested by the commenter. Nor does it estimate non-ED table saw blade-contact injuries by assuming "that the average injury severity (and thus the likelihood of seeking ED treatment) is comparable to that for other types of products," as suggested by the commenter. Rather, based on national survey data from the National Health Interview Survey, the ICM uses information on the age, sex, diagnosis (*e.g.*, fracture, amputation, etc.), body part, and injury disposition to estimate injuries treated in non-ED settings. For example, according to national survey data (from the National Health Interview Survey), a 40-year-old woman with a fractured clavicle is almost twice as likely to go to a doctor office, an emergency clinic (or some other non-ED office setting) as a 10-year-old boy. Consequently, as suggested by this example, the ICM estimates more injuries treated outside the emergency room for certain combinations of injury and victim characteristics. For other types of injuries, a greater proportion would be treated in hospital emergency rooms.

   The ICM uses a classification tree that takes into account age, gender, body part, and injury diagnosis in determining the ratios of non-ED office visits to ED treated injuries. Thus, for example, estimates of non-ED doctor-treated finger amputations involving table saws are not product specific, but rather, are based on general ratios of finger amputations involving all consumer products in each of the medical treatment settings (*i.e.*, the ratio of finger amputations treated in the EDs to amputations treated in non-ED office visits), with adjustments for the other factors noted above. At the time of the ANPR, these estimates were based on an analysis of 10 years of data from the National Health Interview Survey (NHIS, 1987 to 1996), which provided information on the proportion of finger amputations initially treated in the ED relative to the proportion of finger amputations initially treated outside of the ED during non-ED office visits. The current version of the ICM uses data from the 1996-2007 Medical Expenditure Panel Survey (MEPS) and uses the same classification tree methodology to estimate the proportion of injuries treated outside the ED. The data and methodology are described in the Task 2 report, *Revised Incidence Estimates for Non-Fatal, Non-Hospitalized Consumer Product Injuries Treated Outside Emergency Departments*, Bruce Lawrence, Pacific Institute for Research and Evaluation, Calverton, MD, April 2013.

The hospital-admitted injuries that the commenter discussed are used by the ICM only to estimate the injuries that bypass the emergency room and are admitted directly to the hospital. Injuries that bypass the ED, but result in hospitalization, would, for example, include cases in which an injury is initially treated in a doctor's office, but the doctor decides that the victim should be hospitalized immediately. One medical facility, the Maryland Institute for Emergency Medical Services Systems (MIEMSS), also directly admits trauma victims. The ratio used for estimating these direct admissions was computed with data from the National Ambulatory Medical Care Survey and the National Hospital Discharge Survey. Since the ANPR was published, the methodology for projecting the number of admitted injuries bypassing the emergency room has been updated and is described in the Task 8 report, *Ratios for Computing Medically Treated Injury Incidence and Its Standard Error from NEISS Data*. Bhattacharya, Lawrence, & a., Pacific Institute for Research and Evaluation, Calverton, MD, Aug 2012.

The commenter points out that, when compared to injuries involving other products, a higher proportion of table saw blade-contact injuries that are treated initially in hospital EDs results in hospital admission. Based on NEISS estimates, this statement is correct. It may also suggest that, relative to other product-related hazards, a higher proportion of blade-contact injuries are likely to be treated initially in hospital EDs as opposed to non-ED settings (a conclusion that is fully consistent with the staff's ICM estimates of table saw blade contact injuries). However, this conclusion is not sufficient to allow us to quantify directly the proportion of blade contact injuries treated outside the ED, as suggested by the commenter. Nor does it imply, by itself, that the ICM has overestimated the number of table saw injuries initially treated in non-ED office visits or that the number of injuries treated outside of hospital EDs should be lowered (as claimed by the commenter). The commenter provides no data to support this assertion. In contrast, the ICM bases estimates of non-ED office visits on 10 years of NHIS data showing the relationship between injuries treated in the ED and injuries treated elsewhere.

To estimate the number of injuries treated in non-ED settings, the commenter applied diagnosis-specific ratios of the hospitalization rate for table saw injuries to the hospitalization rate for other products. However, this appears to be an *ad hoc* procedure for reducing non-ED office visits (which the commenter had already concluded, without supporting data, to be too high): the commenter presents no empirical basis for estimating (or reducing) the number of injuries treated in non-ED office visits based solely on information from ratios of hospitalized injuries. While the severity of an injury may affect where an injury is treated, the number of table saw injuries treated in doctors' offices cannot be determined directly and solely from estimates of injuries that are hospital admitted.

5. **Comment:** One commenter stated: "the approach CPSC uses to value the intangible costs of injuries is based on estimates from an unrepresentative sample of jury awards and settlements involving unrelated products, motor vehicles, and premises liability. Moreover, the inflators used to "roll-forward" older ICM model values to estimate 2008 dollar costs produce much higher unit cost estimates than if reasonable alternative methods were used to adjust for changes in prices and wages over time."

   Response: The intangible cost estimates contained in the ICM are based on a regression analysis of a sample of jury awards for pain and suffering. Using regression analysis allowed CPSC staff to adjust the pain and suffering awards by a number of relevant factors, including the injury diagnosis and body part affected, the sex of the victim, and the medical costs and work losses resulting from the injury. This process allowed staff to provide specialized estimates of the intangible costs, based on the characteristics of the injury. Additionally, because some of the awards involved motor vehicles and premises liability, the regression analysis also adjusted for these factors to isolate and exclude their impacts from the pain and suffering estimates attributable to consumer products.

   The commenter also criticized the jury verdict methodology for estimating lost quality of life, and presented alternative valuations, based on reductions in quality-adjusted life years. However, if these estimates are adjusted using indices that reflect actual changes in price levels, rather than changes in the "real wage cost" used by the commenter, then the estimates of costs associated with the lost quality of life would result in costs per table saw injury that are comparable to, or higher than, CPSC's estimates.

   The commenter's initial cost estimates were based on year 2000 data, and consequently (like the CPSC analysis), needed to be inflated to reflect 2008 dollar values. Whereas, CPSC staff used an index derived from per capita medical expenditures (total U.S. medical expenditures divided by the U.S. population) to inflate medical costs from 2000 to 2008, the commenter uses the medical component from the Consumer Price Index (CPI) to adjust the medical costs to 2008 levels. The CPI medical care index is based on a market basket of products and services from 1982 to 1984. The CPI medical index was not used in the ICM because of possible distortions caused by changes in treatment methods and outcomes, as described in Schmidt (1995).[67] However, because medical costs make up a small proportion of total costs in the CPSC ICM framework, the difference between the 40 percent inflator (CPI-U medical) used by the commenter and the 56 percent inflator used by CPSC (per capita medical costs) does not make a substantial difference in injury cost estimates.

   Additionally, where the CPSC used the Employment Cost Index for Total Compensation, all workers, to inflate work losses and the intangible costs of injury, the commenter used the

[67] Mary Lynn Schmidt, "Comparing market basket changes and the CPI, " Bureau of Labor Statistics, 1995.

real wage cost (RWC) index, which is substantially lower (the RWC index increased the cost estimate by about 5 percent, as compared to the CPSC's adjustment of about 30 percent). The commenter's approach for inflating non-medical costs for changes in the nominal price level is not appropriate; it provides estimates of changes in real wages, but does not adjust for changes in the price level, the main purpose of the exercise. (The change in the RWC index is computed by dividing the changes in wages by the CPI-All Items index, and measures changes over and above inflation.) As a consequence, the commenter's approach, using the RWC to inflate non-medical costs, substantially underestimates the actual change in the nominal price level.

6. **Comment:** One commenter suggested that the tangible and intangible societal costs associated with table saw blade-contact injuries amounted to about $1.39 billion, less than 60 percent of the CPSC societal cost estimate of $2.36 billion that CPSC staff used in its 2011 analysis.

   Response: The commenter's two adjustments to the table saw blade-contact injury estimates are the principal reason for the difference between their estimates of injury costs and the ANPR estimates. Using the NEISS-AIP subsample proportions, as the commenter does, to adjust the estimate for non-admitted injuries has no statistical justification. Second, the commenter's assertions that the CPSC underestimated the proportion of table saw injuries that were treated in a hospital setting (and hence, the CPSC's estimate of other medically attended injuries is overestimated) is not supported by any empirical data, such as the 10 years of National Health Interview Survey used by CPSC to calculate the ratios between injuries treated and released from the emergency department and those treated in doctors' offices and clinics. Correcting for these two injury adjustments would raise the commenter's cost estimate by 31.7 percent to about $1.83 billion. Additionally, correcting both injury and inflator estimates would raise the injury cost estimate to approximately $2.2 billion, roughly comparable to the $2.36 billion estimate in the ANPR. The regulatory analysis provided in Tab C of the NPR briefing package provides substantially higher estimates of societal costs, approximately $4.0 billion in 2014 dollars, based on more recent data and analyses.

7. **Comment:** One commenter asserted that an economic justification for product safety regulation requires some kind of fundamental market failure. The commenter noted that in the absence of such a failure, the usual assumption is that consumers will purchase products that offer the mix of characteristics and product price that best match their preferences. The major types of market failure mentioned by the commenter include: (1) inadequate or asymmetric information about risks, (2) externalities that impose costs on non-table saw users, and (3) market power that would allow firms some control over market prices. Based on an evaluation of the available information, this commenter concluded that there was no economic justification for a possible table saw rule; in other words, none of the market failures was present, or was not present to such a degree as to require a regulatory fix.

Response: According to the Office of Management and Budget's (OMB's) Circular A-4 (OMB, 1993), which provides OMB's guidance on regulatory analyses, a key element of a good regulatory analysis is a statement of the need for such a rule, and a description of the problem that the rule is intended to address. By a "statement of need," Circular A-4 is referring to an explanation of why private markets failed to provide sufficient safety.[68] In other words, if improved safety is needed, why have private markets been unable to efficiently provide it? Such a market failure provides an economic justification for regulatory intervention. The major types of market failure, as described in *Circular A-4*, concern: (1) inadequate or asymmetric information, (2) externalities, or (3) market power. Inadequate or asymmetric information would exist when consumers underestimate or are generally unaware of the risks posed by risky products, or are unable to interpret or adequately process the risk information. Externalities would exist in the market place when one party's actions impose uncompensated benefits or costs on another party. Market power would exist when firms can exercise market power to reduce output below what would be offered in a competitive industry to obtain higher prices. We address each of these factors:

Inadequate or asymmetric information. Many of the risks associated with the use of table saws, as well as the potential severity of injuries when users come into contact with a moving blade, are obvious. However, some risks associated with the use of table saws may be poorly understood by consumers, such as the fact that sudden movement of the workpiece from kickback can cause the operator to lose control of the work piece and cause his/her hand to fall into or be "pulled" into the blade. Saw blades are jagged and rotate rapidly. Because the blades are used to cut wood, their impact on fingers or hands is readily imaginable. Table saws also come with extensive warnings and safety devices (such as blade guards, riving knives, and anti-kickback pawls) that are intended to reduce the risk of blade contact. Hence, it would be difficult to argue that the risks of table saw use are unknown or somehow hidden from the consumer.

On the other hand, it is possible that some of those injured have not been trained in proper table saw use, or have not paid close attention to product warnings. Non-occupational users, who would be the focus of a potential rule, may use table saws only sporadically and forget or simply neglect safety procedures. Fatigue also is known to have played a role in some incidents, and the risk of fatigue due to extended periods of cutting may not be obvious to all consumers. Some of those injured may be children and adolescents who are still undergoing cognitive development and may not fully appreciate the dangers posed by table saws. This is not to suggest that users are unaware of the obvious risks. However, casual users may be unaware of how quickly and how violently an injury can occur, if, for example, a cut results in kickback. Consequently, some consumers could underestimate the actual risks they face. It also may be difficult for occasional users to interpret or process the risk information in a way that allows them to take the appropriate level of safety precautions.

[68] Executive Order 12866 of 1993, says that "Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American People."

Externalities. Externalities exist when one party's actions impose uncompensated benefits or costs on another party. In the case of table saws, the externalities would generally be financial in nature. If, for example, medical treatment costs are not borne by the injured party, but rather shifted to the public at large, there is a financial externality that the purchaser may not take into account when buying or using a table saw. Based on the injury cost information reviewed by staff for the draft proposed rule, medical costs and lost wages amounted to roughly $160 million and $1,040 million, respectively. Some proportion of these medical costs and work losses are shifted to the public at large by means of insurance premiums and unemployment compensation.

Market Power. Market power exists when one or more firms can exert some control over the price of the product (by limiting production), or create barriers that prevent other firms from entering the market. For table saws, patents acquired by one firm regarding their active injury mitigation (AIM) technology, combined with efforts to prevent patent infringement, appear to have provided that firm with sufficient market power to exert some control over the price of the technology (by means of licensing agreements) and to limit the ability of other firms to develop and market similar technology. The emergence of a second firm that began producing and selling a table saw model with the AIM technology in 2016 does not preclude or negate the existence of market power for one or both of these firms. Moreover, litigation over the patent infringement of the second firm is ongoing.

In summary, there could be several market impediments to a more widespread adoption of the AIM technology by table saw purchasers. These impediments are discussed in the regulatory analysis at Tab C.

8. Comment: Based on an evaluation of information provided in the ANPR and the methodology used in Dr. John Graham's economic analysis of AIM safety technology, one commenter concluded that mandating the SawStop technology for the bench top category of table saws is not economically justifiable. Numerous other commenters also stated that the costs of regulation to increase table saw safety are not justified.

Response: The economic impact of the proposed rule is addressed in the regulatory analysis, which evaluates the possible benefits and costs of the draft proposed rule. This analysis is contained at Tab C of the NPR briefing package.

The draft proposed rule would address roughly 54,850 medically treated blade-contact injuries annually. The societal costs of these injuries amount to about $4 billion annually. Based CPSC staff's benefit and cost estimates, net benefits (*i.e*., benefits minus costs) for the market as a whole amounted to an average of $1,500 to $4,000 per saw.

9. Comment: Some commenters asserted that a standard mandating the AIM technology will increase the price of table saws and will make table saws unaffordable for many individuals and small businesses. Similarly, some said that mandating the AIM technology would increase the price of table saws to the point that it prohibits people from purchasing a table saw for home hobby use or for starting a small business. One commenter equated the increased cost of buying a table saw with having to pay for someone else's stupidity. Another commenter asserted: "requiring automatic detection and blade retraction in the case of body-contact will eliminate the sub-$1,000 saw segment." For this reason, the commenter opposed mandating the AIM technology.

Response: CPSC staff estimates that the draft mandatory standard could increase the retail prices of bench saws by about $200 to $500 per bench saw and about $350 to $1,000 per contractor and cabinet saw. The price increase could cause a contraction in market for new table saws, reducing annual sales by as much as 14 percent to 38 percent, as some users are either priced out of the market or continue to use older table saws. These higher costs may be mitigated somewhat over time, but the extent of any future cost reduction is unknown. However, given that the least expensive bench saws currently cost about $129, and the least expensive contractor saws are priced at about $529, CPSC staff expects that some bench and contractor saws will retail for under $1,000. Additionally, there is no evidence to suggest that the draft proposed will eliminate table saws from home hobby use or for starting small businesses.

10. **Comment:** Some commenters expressed concern about the effects of the draft proposed rule on small businesses, such as construction contractors, small woodworking shops, cabinet makers, and wood furniture shops. The concerns centered on small businesses being unable to afford new table saws and going out of business. Two commenters suggested that unemployment would increase due to these small businesses closing.

    Response: CPSC staff estimates that the draft proposed rule could increase the price of table saws significantly. However, even if the increased cost of a new table saw was $800, and a firm purchased a new table saw each year, the impact on the firm would unlikely be significant, unless the firm had annual receipts of less than $80,000. Nevertheless, it is possible that a small number of small businesses might lay off a small number of employees.

11. **Comment:** Some commenters stated that the SawStop technology is expensive, given the cost of the cartridges and blades that would have to be replaced when the technology is triggered. One commenter noted that his blades cost about $100 each, and his dado set costs about $300. The commenter expressed concern that the need to replace the cartridge when changing between saw blade and dado set would also increase the set-up time when making such transitions. Some commenters were concerned with false-positive detection with the SawStop systems, especially when cutting pressure-treated wood or metal, increasing their costs. One commenter claimed to have "managed medium size shops where the technology probably saved a finger," but also where "accidental tripping of the mechanism cost thousands of dollars annually." Another commenter expressed some concerns about the availability of replacement cartridges and whether they would be interchangeable among different brands or models of table saws. If replacement cartridges were specific to the brand or model of table saw, this could limit the availability and add to the cost of activation.

    Response: CPSC staff is aware of two table saw AIM technologies that have been developed; the first requires replacement of an activation cartridge and almost always the repair or replacement of the blade once the system has been activated. The second only requires replacement of the activation cartridge after two activations. The future availability of the second system is questionable, due to ongoing patent litigation. Replacement costs would generally be incurred only if the user's hand or arm came into contact with an operating table saw blade. On average, the replacement cost for the average blade and/or cartridge is expected to amount to roughly $11 to $14 annually over the life of the saw, which would be far below the cost of a blade-contact injury that could amount to tens of thousands of dollars. CPSC staff acknowledges that if a different cartridge is required for use with a dado set, then switching between a regular blade and a dado set may require more time and expense than required in the absence of an AIM system. This may affect productivity in some shops that do a large volume of dado cuts. If there are frequent false-activations of the technology, the costs of replacement blades, dado brake cartridges, and cartridges would be higher.

12. **Comment:** One commenter stated that the increased cost of table saws that incorporate an AIM technology will not increase the likelihood that people will purchase table saws, but it will likely reduce the demand for table saws and harm table saw manufacturers.

    Response: A mandatory standard will increase the manufacturing cost of table saws, and manufacturers will attempt to pass on the increased costs to consumers in the form of higher prices. Although some consumers might be more likely to purchase the safer table saws with the AIM technology, the expected price increase likely will result in a significant decrease in the quantity of table saws demanded. CPSC staff estimates that the number of table saws sold annually could decrease by about 90,000 to 250,000 units, at least initially. Because of the expected higher costs and reduced sales, some table saw manufacturers are likely to be adversely affected by a mandatory standard.

13. **Comment:** One commenter compared a potential regulation requiring an AIM technology in table saws to regulations requiring the use of seat belts. The commenter stated that a person who injures a finger with a table saw is unlikely to become a burden to society at large, which the commenter states is often the case with victims of automobile accidents. Therefore, the commenter stated that the decision of whether to purchase a table saw equipped with AIM technology versus one without it should be left up to the consumer. Another commenter implied, however, that taxpayers will either pay for table saw injuries on what the commenter called the front end, due to the additional cost of a table saw equipped with AIM technology, or the tail end, due to the disability of consumers injured in accidents involving table saws. The commenter stated that he preferred paying the additional cost on the front end.

    Response: These commenters appear to be discussing the issue of externalities that might be associated with table saw injuries. Externalities would be the costs of injuries that are borne by third parties, people other than users or suppliers of table saws. The existence of externalities may provide a justification for regulation, if the purpose of the regulation is to reduce the costs that fall on third parties not engaged in the activity (*i.e.*, supplying or using table saws). For table saws, the externalities are largely financial and would exist when the costs of medical treatment and work losses resulting from blade contact are shifted to the public through medical insurance premiums and unemployment compensation. However, these externalities constitute a relatively small proportion of the societal costs associated with table saw blade-contact injuries. As described in the regulatory analysis, the primary cost of injury is associated with the intangible costs of injury, or pain and suffering. These costs are largely borne by the injury victims, rather than third party bystanders. Therefore, although some of the medical costs and some of lost productivity costs associated with table saw injuries could be considered externalities, most of the societal costs associated with table saw injuries are borne by the injured person and do not, therefore, constitute externalities.

Unintended Consequences

1. **Comment:** Numerous commenters stated that adding AIM technology to table saws will give users a false sense of security and will increase unsafe behavior in users that will translate to injuries on other power tools. Many commenters felt that users will not learn to respect the dangers of table saws and power tools, in general. Some asserted that "excessive reliance on safety devices can lead to complacent behavior, which inevitably results in an accident."

   Response: A table saw with active injury mitigation would likely advertise the AIM system; thus, consumers clearly would be aware of the presence of an AIM system. This awareness creates the opportunity for behavioral adaptations of the type described in the comments. However, the extent and type of behaviors altered in response to this awareness likely depends on the awareness level, type of information available to consumers about the system, and, perhaps most importantly, how consumers naturally are inclined to use the product based on their goals.[69] If consumers currently use the product differently than they would like *because* of the potential hazard associated with blade contact, then a reduction in perceived risk associated with blade contact might lead consumers to use the product differently.

   For example, consumers choose to use, and are encouraged to use, blade guards despite the challenges blade guards can present in making certain cuts difficult and some non-through cuts impossible. Thus, if consumers believe that the AIM system is likely to be effective at reducing severe injuries from blade contact, then some of those consumers might be less likely to use the blade guard systems that they prefer not to use in the first place. However, people also tend to fear "dread risks," which can be defined as "low-probability, high-consequence events," and such risks have a substantial influence on risk perception.[70] Arguably, severe injuries from blade contact on a table saw that employs an AIM system would fall under the category of a "dread risk" because the consequences of such a system

[69] This is consistent with research, reported by Williams and Noyes (2011), which found most user actions with products are guided by the afforded "ease of use" and the goals of the task. Williams, D. J., & Noyes, J. M. (2011). Reducing the Risk to Consumers: Implications for Designing Safe Consumer Products. In W. Karwowski, M. M. Soares, & N. A. Stanton (Eds.), *Human Factors and Ergonomics in Consumer Product Design: Uses and Applications* (pp. 3–21). Boca Raton, FL: CRC.
[70] Gigerenzer, G. (2004). Dread Risk, September 11, and Fatal Traffic Accidents. *Psychological Science, 15*(4). 286–287.

failing could be quite severe—involving possible amputation, which would likely evoke visceral feelings of dread or horror—even if the probability of such a failure is low. In addition, consumers likely would be motivated to avoid blade contact even if the consequences of such contact are not severe because consumers are unlikely to be ambivalent about being injured by a spinning blade with sharp teeth, even if the resulting injury is minor.

Staff finds it difficult to predict whether consumers will take less care when using a table saw with an AIM system relative to current table saws. However, even if true, a key factor in assessing the ultimate effect of an AIM system is whether such a system likely will result in a decrease in serious injuries. If the system is effective and works as intended, the severity of an injury resulting from blade contact will be lessened, which likely would reduce the overall number of severe injuries associated with table saws. (See Tab E for more detailed discussion.)

2. **Comment:** Several commenters suggested that some users might modify the saws to bypass the safety mechanism; especially in the case of false activations, which users will perceive as a nuisance.

   Response: Some consumers might attempt to bypass the AIM safety technology. As discussed in the regulatory analysis, this would tend to reduce the benefits of the proposed rule. However, because the AIM technology is not generally expected to interfere with the normal use of the table saw, most consumers would have little reason to bypass the AIM system once it is already on the saw.

3. **Comment:** Numerous commenters also stated that to avoid paying for a table saw with additional safety features, consumers will pursue more dangerous methods to cut wood by using other tools, such as circular saws, buying used products, or continuing to use an older table saw past its safety life.

   Response: CPSC staff agrees that the draft proposed rule will increase the price of table saws, and that these price increases are likely to reduce sales. We do not know how consumers who would have purchased a new table had the price not increased will respond. Some may hire professionals, instead of doing some projects themselves. Others might borrow or rent table saws, or use an older table saw that they would have preferred to replace. Some might also attempt to use other tools in the place of table saws, as the commenters suggests. If the "other" substitute tools are risky, then the estimated benefits attributed to the draft proposed rule would be reduced. Staff is seeking comment on the likelihood that consumers will pursue more dangerous methods to cut wood, and what those methods would be, if table saws are equipped with active injury mitigation technology.

4. **Comment:** One commenter suggested that mandating the AIM technology on all saws would result in additional non-blade-contact and kickback injuries because consumers would be less likely to use other safety technology, such as blade guards and riving knife/splitter combinations. Moreover, the current state of the AIM technology only has the potential to mitigate blade contact injury; it does not necessarily prevent blade contact.

Response: Staff agrees that reliance on the AIM safety technology could lead some consumers to reduce their use of other safety technology, such as blade guards or riving knife/splitter combinations, thereby increasing exposure and risk of operator blade contact. However, such impacts cannot be quantified with available data and would have to be determined empirically. AIM technology does not prevent blade contact, but it does limit the severity of injury to the operator when contact occurs. Empirical data would have to show that any increase in blade contact due to user change in behavior with current safety devices occurs under circumstances that decrease AIM performance and results in injury severity that requires extensive medical attention.

5. **Comment:** A couple of commenters expressed concern over the impact of the draft proposed rule on the ShopSmith multitool system. The commenters stated that the ShopSmith equipment could not be redesigned to allow for the installation of a SawStop system. One commenter expressed concern that the draft proposed rule could force the company out of business.

   Response: Incorporating an AIM technology on some table saws may present some especially difficult challenges on some manufacturers that are not faced by other table saw manufacturers. Although the engineering challenges can be resolved, the upfront costs for incorporating the AIM system on some table saws may be substantial for a small business. As discussed in the regulatory flexibility analysis, it is possible that some small manufacturers would reduce their table saw offerings or even exit the table saw market if the draft proposed rule is promulgated.

<u>Training and Warnings</u>

1. **Comment:** Several commenters stated that table saw injuries are best reduced by training and educating users on safe practices and operation of table saws. Many believed mandatory training in the form of certification is needed, while others believed that instructional videos should be provided with every table saw purchase. Other commenters stated that only warnings or instruction labels are required to reduce injuries.

   Response: CPSC staff agrees that warnings, instructions, and other methods of educating consumers about the proper use of table saws are important. However, the effectiveness of such approaches is known to be limited. For example, safety and warnings literature consistently identify a classic hierarchy of approaches that should be followed to control hazards. The use of warnings is viewed universally as less effective at eliminating or reducing exposure to hazards than designing the hazard out of a product or guarding the consumer from the hazard. Warnings are less effective because they do not prevent consumer exposure to the hazard, and instead rely on educating consumers about the hazard, and then persuading consumers to alter their behavior in some way to avoid the hazard. In addition, to be effective, warnings rely on consumers behaving consistently, regardless of situational or contextual factors that influence precautionary behavior, including fatigue, stress, or social influences. Thus, warnings should be viewed as "last resort" measures that supplement, rather than replace, redesign or guarding, unless these higher-level, hazard-control efforts are not feasible.

Educational programs may offer more opportunities to present hazard information in varied ways and in greater detail than is possible on a warning label. However, educational programs suffer from limitations similar to those that undercut warnings because, like all hazard communications, the effectiveness of such programs depends on affected consumers not only receiving and understanding the message, but also being persuaded to heed the message. Mere knowledge or awareness of a hazard is not necessarily enough.

This is not meant to suggest that warnings and similar educational efforts are totally ineffective. Staff agrees that warnings, instructions, and other methods of educating consumers about the proper use of table saws is important and supports the use of these methods to help reduce the incidence of injuries. However, the effectiveness of such approaches is known to be limited. Human error is inevitable, even among expert woodworkers, so even consumers who are fully aware of the hazards and how to avoid them may suffer from slips or lapses that could lead to blade contact and injury despite the consumer's best intentions to use a product safely. Performance requirements that can detect and react to blade contact in a way that lessens the consequences makes the table saw system more forgiving of such errors and expected behaviors, so that the results are not catastrophic. (see Tab E for more detailed discussion).

<u>Other comments</u>

1. **Comment:** Several commenters stated that CPSC should:
   - Mandate AIM technology on table saws, but only in industrial or workshop settings;
   - Provide an open license for AIM technology;
   - Provide a retrofit option for existing table saws; and
   - Encourage AIM technology through tax policy.

   Response: The CPSA does not give the Commission authority to regulate table saws in industrial settings, to license patents, modify current products on the market, or to offer tax incentives.

VI. STAFF RECOMMENDATION

Staff believes table saw safety performance requirements are needed to address an unreasonable risk of injury associated with blade contact on table saws. Staff identified the following factors for the Commission to consider (16 C.F.R. § 1009.8):

- *Frequency and severity of injuries*. For 2015, CPSC staff is aware of 30,800 emergency department-treated, table saw blade-contact injuries resulting in an estimated 18,100 laceration injuries (58.8 percent), followed by an estimated 5,900 fractures (19.0 percent), an estimated 4,700 amputations (15.2 percent), and an estimated 2,000 avulsions (6.5 percent). An estimated 3,800 (12.3 percent) of the blade contact injury victims were hospitalized.

  Thousands of amputations, including an estimated 4,700 emergency department-treated amputation injuries in 2015 alone, occur each year on table saws. CPSC staff compared table saw blade-contact emergency department-treated injuries from the 2015 NEISS to all other consumer product-related, emergency department-treated injuries in the same timeframe (January 1, 2015 through December 31, 2015). An estimated 18.6 percent of all amputations reported in the NEISS in 2015 are related to table saws. When compared to all other workshop products, table saws account for an estimated 52.4 percent of all amputations related to workshop products in 2015.

- *Unforeseen nature of the risk*. Many of the risks associated with the use of table saws, as well as the potential severity of injuries when users come into contact with a moving blade, are obvious. However, some risks associated with the use of table saws may be poorly understood by consumers. CPSC staff analysis of blade-contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade, and there are certain cuts on table saws that require removal of the blade guard. Sudden movement of the workpiece from kickback can cause the operator to lose control of the work piece and cause his/her hand to fall into or be "pulled" into the blade. Hand/finger contact is also possible without kickback, in situations where the operator's hand gets too close to the blade while feeding the workpiece, or the operator is distracted and inadvertently contacts the saw blade. In addition, many of the scenarios leading to blade contact may be more likely if the consumer is tired, or if the view of the blade or cut is impaired somehow. The risk of fatigue and poor visibility, along with the sudden consequences of blade contact, may not be obvious to all consumers; however, we cannot quantify the extent of the impact of this.

  Casual users may be unaware of how quickly and how violently an injury can occur if, for example, a cut results in kickback. Consequently, some consumers could underestimate the actual risks they face. It may also be difficult for occasional users to interpret or process the risk information in a way that allows them to take the appropriate level of safety precautions.

- *Amenability of hazard to injury reduction*. CPSC staff believes that the base level of safety on table saws is the use of a blade guard and riving knife to prevent blade contact injuries.

However, in cases where blade contact does occur, technical analysis shows that CPSC staff's recommended performance requirements will reduce the severity of injuries caused by operator contact with the table saw blade, thereby reducing the frequency of severe lacerations, fractures, amputations, and avulsions. CPSC staff test results indicate that currently available table saws with AIM systems that rely on electrical detection were able meet the recommended performance standard, limiting the depth of cut to a test probe approaching toward the center of the rotating saw blade at a rate of 1 m/s. These currently available saws using electrical detection and various mitigation systems were able to move and/or stop the blade upon contact of the probe with the blade, successfully limiting the depth of cut to 1.5 mm to 2.8 mm. The performance of these table saws, in terms of limiting depth of cut, were well below the 3.5 mm recommended performance standard, which mimics the threshold between a simple and complex laceration in a human finger, as measured by the test probe.

Staff believes that a performance requirement that limits the depth of cut to a test probe that contacts a saw blade to 3.5 mm will significantly reduce the severe lacerations, fractures, amputations, and avulsions associated with operator blade-contact incidents on table saws because the probe will have the appropriate properties to indicate human body/finger contact with the saw blade, and the equivalent injury mitigation on a real human finger will avoid most microsurgery. Furthermore, staff believes that these requirements are technically feasible, as demonstrated by two different saws using two different AIM systems, which shows that the hazard is amenable to injury reduction.

- *Cost and benefit of CPSC action*. Staff believes that the recommended requirements are technologically feasible and that the benefits of the draft proposed rule substantially exceed the rule's costs for all table saw categories. The draft proposed rule would address roughly 54,800 medically treated blade-contact injuries annually. The societal costs of these injuries amounted to about $4 billion in 2015. Because of the high estimates of societal costs associated with blade-contact injuries, and the expected high rate of effectiveness of the draft proposed rule in mitigating or preventing blade contact injuries, the estimated *gross* benefits of the proposed rule (*i.e*., the expected reduction in societal costs) may range from $2,300 to $4,300 per table saw. Estimates of the increased manufacturing cost, as well as the expected costs of replacement parts for the AIM system, amount to about $230 to $540 per bench saw, to about $375 to $925 per contractor saw, and to about $400 to $950 per cabinet saw.

  Based on staff's benefit and cost estimates, estimated net benefits (*i.e*., benefits minus costs) for the market as a whole (*i.e.* addressing all table saw types) amounted to an average of about $1,500 to $4,000 per saw. Staff also performed a sensitivity analysis that explored plausible changes in the assumptions regarding expected product life, number of table saws in use, national estimates of medically treated injuries, discount rates, and injury cost estimates. Net benefits varied, but they generally remained positive in the sensitivity analysis.

  Preventing product-related injury to senior citizens. Senior citizens have been identified as a segment of the population that factors into the Commission's consideration of priorities in regulatory actions (16 C.F.R. § 1009.8(6)). Approximately 45 percent of all estimated table saw-related, emergency department-treated injuries that likely related to the victim making contact with the blade involved consumers older than 60 years of age. Staff cannot say if these findings are due solely to older consumers having greater exposure to these products, but adult aging is associated with declines in many perceptual, cognitive, and physical abilities. Some of these age-related deficits likely contribute to blade-contact incidents with table saws. Staff identified differences in the distribution of age groups when comparing table saw blade-contact injuries to all other workshop, product-related injuries. Staff analysis of injuries in 2015 indicates that the mean age for table saw blade contact injuries is 55.6 years, compared with 42.7 years for all other workshop, product-related injuries. This approximately 13-year difference in the mean age of injuries is a statistically significant difference and indicates that table saw blade-contact injuries involve older victims, compared to victims of injuries related to all other workshop products.

Moreover, staff believes that the current voluntary standards for table saws will not reduce the severity of table saw operator blade-contact injuries because incident data hazards and risk of injury per 10,000 table saw units have not changed in the years since the voluntary standard was revised to address blade-contact injuries. In addition, staff is aware of blade-contact injury incidents that have occurred on table saws that meet the current voluntary standards. For these reasons, CPSC staff recommends that the Commission publish the draft NPR for table saws submitted with this briefing package.

CPSC staff recommends that the Commission propose an effective date of 36 months following publication of the final rule. Staff recognizes that some manufacturers will be required to redesign and test new prototype products. Interviews with several companies suggest that the redesign and retooling of table saws would, at least on the initial models, be expected to take 1 to 3 years. However, redesigning and retooling subsequent models would require a shorter period and cost less.[71] This design and test process is similar to the process that manufacturers use when introducing new model table saws with upgraded technology. Therefore, staff believes that 36 months is a reasonable period for manufacturers to comply with new mandatory requirements.

[71] IEc, 2016b. *Final table saws cost impact analysis*. Prepared by Jane Isreal, Jennifer Baxter, and Saritha Ramakrishna, June 9, 2016, Cambridge, MA: Industrial Economics, Incorporated.

TAB A

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

Memorandum

Date: November 19, 2016

TO: Caroleene Paul, Project Manager
Directorate for Engineering Sciences

THROUGH: Joel Recht, Assistant Executive Director
Office of Hazard Identification and Reduction

Mark Kumagai, Division Director
Division of Mechanical and Combustion Engineering

FROM: Vincent Amodeo, ESMC
Mark Gill, ESEF
Directorate for Engineering Sciences

SUBJECT: Proposed Performance Requirements to Address Blade-contact Injuries on Table Saws

I. INTRODUCTION

A. Product

Table saws are stationary power tools used for the straight sawing of wood and other materials. The basic design of a table saw consists of a motor-driven saw blade that protrudes through a flat table surface. To make a cut, the operator places the workpiece on the table and, using a rip fence or miter gauge as guides, pushes the workpiece into the blade (see Figure 1).

Safety devices on table saws are designed to minimize contact between the saw blade and the operator and to minimize kickback of the workpiece. Kickback occurs when the energy of the spinning blade is transferred to the workpiece and can occur under several scenarios. One common scenario occurs when the blade becomes pinched by the two sections of the board being cut, causing the board to propel back towards the operator at great force.

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.

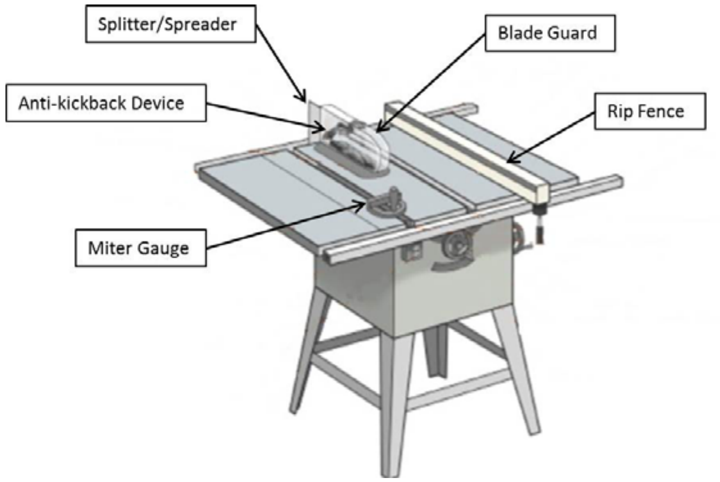

Figure 1. Typical table saw components.

Blade Guards

Blade guards surround the exposed blade and function as a physical barrier between the blade and the operator. Blade guards are designed either as a single-piece unit that covers the saw blade, as shown in Figure 1, or as a modular system with a fixed top barrier and independent side barriers, as shown in Figure 2.

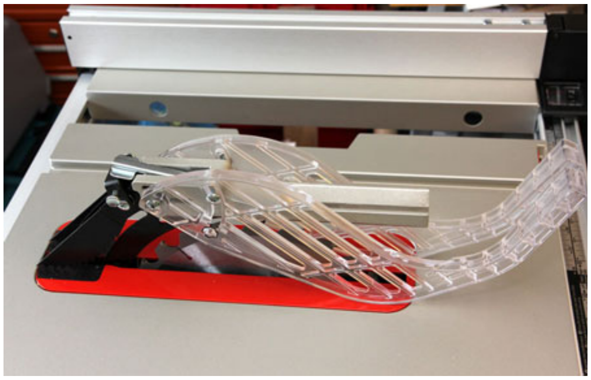

Figure 2.Typical modular blade guard.

Kickback Prevention Devices

Kickback prevention devices include splitters, riving knives, and anti-kickback pawls. A splitter (see Figure 1), 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 after it passes the blade and pinching the blade, which can cause the workpiece to be thrown upwards and back toward the operator. Before 2009, most table saws were designed with a splitter located behind the blade that was attached to the blade guard. If a cut required removal of the splitter or guard, they were removed together.

Riving knives (see Figure 3) are curved metal plates that are similar to, and perform the same function as, splitters, but are often located closer to the blade, rise no higher than the top of the blade, and attach to the arbor assembly so that they raise and lower with the blade.[1] Like splitters, riving knives physically prevent the two halves of the cut workpiece from moving back towards each other and pinching the spinning blade. However, unlike splitters, the riving knife can be left on for non-through cuts (see Section B for examples of non-through cuts).

Anti-kickback pawls (see Figure 4) are another device designed to help reduce kickback. The pawls are mounted on the splitter or riving knife behind both sides of blade and consist of a pair of spring-loaded pieces of metal with barbed teeth on the bottom edge that allows passage of the work piece but will dig into the work piece if it begins to move back toward the operator.

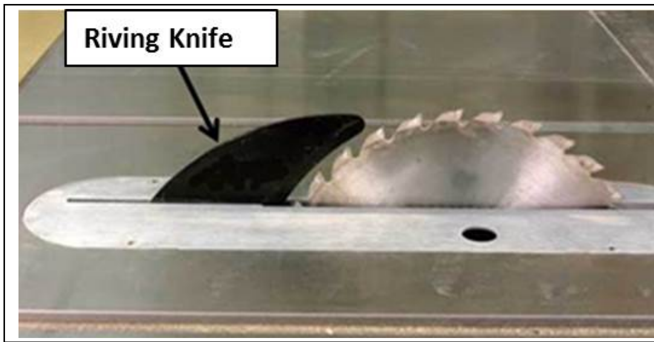

Figure 3. Typical riving knife.

Figure 4. Anti-kickback pawls.

The riving knife and modular blade guard represent the latest progression in table saw safety design that have been incorporated into the voluntary standards for table saws. Table saws equipped with the riving knife and modular blade guard became available on the U.S. market beginning in 2008, and by 2012, table saw manufacturers introduced more than 900,000 table saws with the latest safety devices.[2]

B. 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 5). When ripping, the workpiece is placed flat on the table with one long side against a rip fence (see **Error! Reference source not found.**), which is set parallel to the saw blade. The operator then slowly pushes the workpiece against the fence and through the saw blade.

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 to keep the workpiece secure and at a specific angle to the blade. The miter gauge can be angled relative to

[1] The arbor assembly includes the arbor, which is the metal shaft that holds the saw blade.
[2] Although the voluntary standard effective date for riving knives and modular blade guard was January 31, 2014, and January 31, 2010, respectively; the industry accelerated compliance with the voluntary standard and the new guarding system with modular blade guard and riving knife became available on table saws the fourth calendar quarter of 2007. Therefore, staff assumes the widespread availability of the modular blade guard and riving knife began in 2008. Comment from PTI to table saw ANPR. Page 17. Retrieved from: https://www.regulations.gov/document?D=CPSC-2011-0074-1081.

the blade to perform “miter” cuts. The miter gauge slides in a recessed track and is slowly pushed forward, feeding the workpiece through the blade.

Although less common than ripping and crosscutting, other 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. Dado and rabbet cuts 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. A rabbet is a similar non-through cut that is located at the edge or end of a workpiece. Non-through cuts that run the length or width of the workpiece require removal of the blade guard to allow the work piece to be run across the top of the saw blade for the entire length or width of the work piece; during such cuts, the riving knife can still be used.

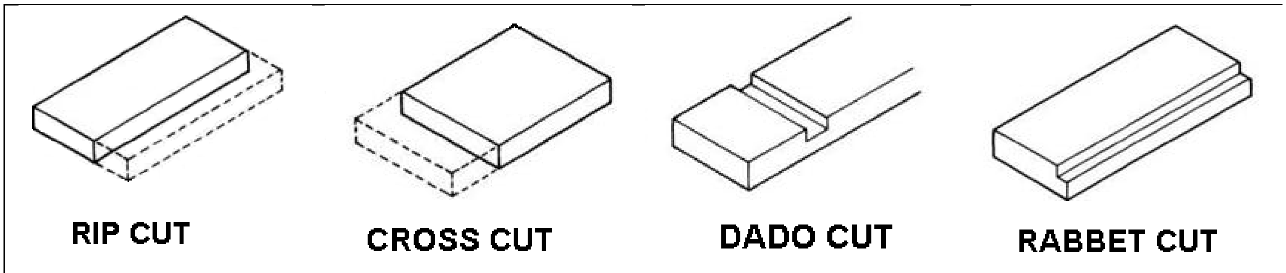

Figure 5. Sample cutting operations.

C. Table Saw Categories/Types

Table saws generally fall into three different categories of saws: (1) bench saws, (2) contractor saws, and (3) cabinet saws. Bench saws comprise a range of table saws that are portable, due to small size and low weight, or their attachment to a folding stand with wheels. Contractor and cabinet saws are larger and heavier, and they are intended to be stationary. Generally, the range of quality and accuracy of a table saw is commensurate with its size, motor horsepower, weight, and indirectly, price.

<u>Bench Saws</u>

Bench saws are intended to be transportable so they tend to be small, lightweight, and relatively inexpensive (see Figure 6). In recent years, bench saw designs have evolved to include saws with larger and heavier-duty table surfaces, with some bench saws mounted on a folding stand with wheels to maintain mobility (see Figure 7). These larger portable saws on wheeled stands are called jobsite saws because they are capable of heavier-duty work, but they are still portable enough to move to a work site.

Bench saws generally run on standard house voltage (110-120 volts), use universal motors,[3] drive the saw blade through gears, and range in weight from 34 to 133 pounds. The universal motor and gear drive produce the high-decibel noise and vibration that are distinctive characteristics of bench saws. Prices for bench saws without active injury mitigation (AIM)

[3] A universal motor runs on AC or DC power, has high starting torque, can run at high speed, and is lightweight and compact. For these reasons, universal motors are commonly used in portable power tools and equipment.

technology range from $129, to as much as $1,490 for a high-end model.[4] Recent introductions of jobsite saws with AIM technology range in price from $1,299 to $1,499.

	
Figure 6. Typical bench saw.	**Figure 7. Typical jobsite saw.**

Contractor Saws

Contractor saws used to be considered portable table saws, but designs have progressed towards larger motors and heavier table tops to the point that most contractor saws are considered stationary saws (see Figure 8). Although a mobile base can be added to the frame to make a contractor saw more mobile, contractor saws are often found in home workshops as a stationary saw that is a less expensive alternative to a cabinet saw.

Contractor saws generally run on standard house voltage, use induction motors, are belt driven, and range in weigh from around 200 to 400 pounds. The induction motor and belt drive result in a table saw that produces less vibration, is quieter, more accurate, and able to cut thicker pieces of wood, and they are more durable than a bench saw. Prices for contractor saws range from around $500 to $2,000.

Cabinet Saw

Cabinet saws are heavier than contractor saws because the higher-powered motor is enclosed in a solid base (see Figure 9). These saws are typically the highest-grade saw found in the home woodworking shop.

Cabinet saws generally run on 220-230 volts, use a 1.75-5 hp or stronger motor, are belt driven, and weigh from 300 to 1,000 pounds. Components in cabinet saws are designed for heavy use and durability, and the greater weight reduces vibration so that cuts are smoother and more accurate. Cabinet saws are expected to last a lifetime (with an average product life of 24 years) and prices range from around $1,200 to $5,000.

[4] Prices for table saws are from Tab C, Preliminary Regulatory Analysis of the Draft Proposed Rule for Table Saws. August, 2016.

Figure 8. Typical contractor saw.

Figure 9. Typical cabinet saw.

II. DISCUSSION

A. Active Injury Mitigation (AIM)

Since 2004, table saws have been introduced to the U.S. market with active injury mitigation (AIM) capabilities that mitigate injuries once a hand/finger makes contact with a rotating saw blade.[5] In February 2015, Underwriters Laboratories, Inc. (UL), the standard development organization for the voluntary standards for table saws, defined an "active injury mitigation" system as an active system that serves to mitigate or prevent injury from exposure to a rotating saw blade.

CPSC staff considers AIM technology to be an approach to address blade-contact injury adjunct to existing safety strategies (blade guard and riving knife) which prevent blade contact on table saws. Active injury mitigation is defined by a performance standard limiting depth of cut after detection of blade contact, and it provides a layer of safety that can mitigate a blade-contact injury if the blade guard or riving knife are removed or fail to function properly. AIM can also mitigate blade-contact injuries that can occur when a blade guard and riving knife are in place and functioning properly, but blade contact occurs anyway.

At a basic level, any AIM system must perform two functions: (1) *detect* contact between the rotating table saw blade and a human body part, and (2) *react* to mitigate injury. UL's literature research indicates detection can be achieved by: (1) sensing electrical properties of the human body/finger, (2) sensing thermal properties of the human body/finger, or (3) visual sensing and tracking of the human body/finger.[6] Current AIM technologies rely on the first type: electrical sensing of the human body. Thus, this discussion focuses heavily on those technologies, although the principles for other technologies are similar.

Reaction systems must perform some type of action to limit the severity of injury upon human body/finger contact with the table saw blade. Removing either the spinning blade or the human

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[5] In 2004, the first SawStop table saw with AIM technology was sold. Retrieved from: http://www.sawstop.com/company/about.

[6] Jiang, H., Tabaddor, M., and He, F. (2015). General Characteristics of a Surrogate Finger for Table Saw Safety Testing. *UL Research Report*. Retrieved from: http://library.ul.com/wp-content/uploads/sites/40/2015/12/UL-Research-Report-on-Finger-Surrogate-Characteristics-for-Table-Saw-Testing-2015.pdf.

body/finger from the point of contact is the most logical method to achieve this goal. Current AIM technologies remove the spinning blade from the point of contact quickly enough, within milliseconds, to reduce significantly the severity of injury.

B. Electrical Detection of Human Body

As noted, available AIM technology relies on electrical detection of contact between a table saw operator and the rotating saw blade to activate the AIM system. The electrical detection involves circuitry that generates a detection signal with defined electrical characteristics (see Figure 10). The signal can then be coupled onto the saw blade through various means, such as conductive, magnetic, or capacitive coupling devices. Additional circuitry continuously monitors the characteristics of the detection signal. The detection signal changes when a human body part comes into contact with the saw blade and the monitoring circuit senses the change in the signal. If the change is beyond a certain limit, the monitoring circuit then activates a reaction mechanism.

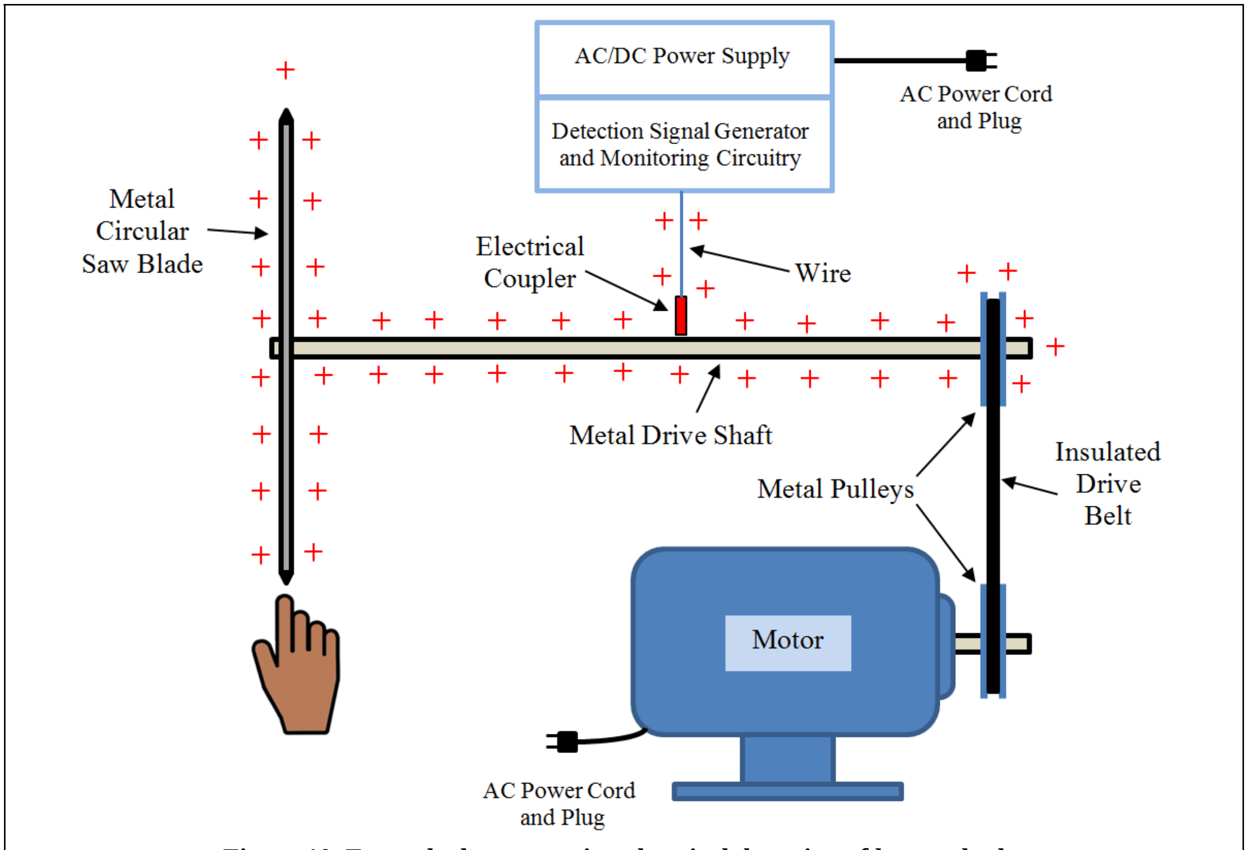

Figure 10. Example demonstrating electrical detection of human body.

C. Products/Technology on the Market

1. SawStop, LLC (SawStop)

In 2004, SawStop, LLC (SawStop), released an industrial cabinet table saw featuring AIM technology that is based on electrical detection of the human body and a mechanical brake reaction that stops the blade from spinning and moves the saw blade assembly beneath the table top surface. Typically, the reaction occurs in less than 5 milliseconds once contact is detected.

SawStop has also introduced a professional cabinet saw, a contractor saw, and a jobsite saw with the same AIM technology. The SawStop AIM system works in three steps:

1. Monitor and Detect
   - The blade carries a small electrical signal.
   - When a person contacts the blade, the signal changes because the human body is conductive.
   - The change to the signal activates the reaction system.
2. Brake Activation
   - An aluminum brake block is forced into the spinning blade by a spring released by an electric signal.
   - The blade’s angular momentum drives the blade assembly beneath the table top, removing the risk of further contact.
3. The AIM system must then be reset by:
   - Shutting off the saw.
   - Removing the brake cartridge and embedded blade.
   - Installing a new blade (if necessary) and brake cartridge.

The SawStop AIM technology cannot be used when cutting conductive materials (that allow the flow of an electrical current) because the system relies on electrical detection of the human body. A person touching the conductive material being cut would allow the detection signal to pass through the conductive material and into the person, activating the system as soon as the material touches the saw blade. For this reason, the SawStop table saws have a bypass mode that temporarily deactivates the AIM system to allow the user to cut conductive materials. In addition, cutting wet wood that is moist enough to conduct enough electricity to activate the AIM system can cause tripping of the safety system. Therefore, the AIM system is generally deactivated while cutting wet wood. The table saw automatically exits the bypass mode and resets to normal mode after the saw is turned off and the blade comes to a complete stop.

2. Robert Bosch, LLC (Bosch)

In 2016, Robert Bosch, LLC (Bosch), released a jobsite table saw featuring AIM technology based on electrical detection of the human body and a combustion-based mechanical reaction that forces the saw blade assembly beneath the table top surface. The Bosch REAXX™ saw Active Response Technology™ system also works in three steps:

1. Monitor and Detect
   - The blade carries a small electrical signal.
   - When a person contacts the blade, the signal changes because the human body is conductive.
   - The change to the signal activates the reaction system.
2. Blade Retraction
   - A combustion reaction is triggered in a cylindrical cartridge, which fires a piston at a high rate of speed (this action is similar to the deployment of an air bag in an automobile).
   - The piston pushes against a linkage to rapidly rotate the saw blade assembly below the table surface away from the operator.

- The blade assembly remains locked under the table after activation, while the blade coasts to a stop when power to the motor is automatically cut off.

3. The AIM system must then be reset by:
   - Shutting off the saw.
   - Inserting a fresh/new activation cartridge (two cartridges are paired together, so the un-activated side of the same dual-action cartridge may be used).
   - Unlocking the blade assembly and raising it back in place.

The Bosch AIM technology cannot be used when cutting conductive materials (that allow the flow of an electrical current) because the system relies on electrical detection of the human body. A person touching the conductive material being cut would allow the detection signal to pass through the conductive material and into the person, activating the system as soon as the material touches the saw blade. For this reason, the Bosch REAAX™ table saw has a bypass mode that temporarily deactivates the AIM system to allow the user to cut conductive materials. In addition, cutting wet wood that is wet enough to conduct enough electricity to activate the AIM system can cause tripping of the safety system, so the AIM system is generally deactivated while cutting wet wood. The table saw automatically exits the bypass mode and resets to normal mode after the saw is turned off.

D. Voluntary Standard for Table Saws

Background

Underwriters Laboratories Inc. (UL) published the first edition of UL 987 *Stationary and Fixed Electric Tools* in 1971. UL 987 included requirements for table saws that specified the following safety devices: a single-piece blade guard, a spreader, and anti-kickback pawls. In 2005, UL published the sixth edition of UL 987, which added requirements for a riving knife to the general requirements for table saws. The effective date for the riving knife requirements was January 2014. In 2007, UL published the seventh edition of UL 987, which expanded the table saw guarding requirements to include a new modular blade guard design developed by a joint venture of the leading table saw manufacturers. The effective date for the modular blade guard requirements was January 2010. The revised standard specified that the blade guard shall not consist of a hood, but comprise 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, offering easier methods to remove and install the guard, and incorporating a permanent riving knife design.[7] In 2011, UL published the eighth edition of UL 987, which clarified existing requirements for table saws and remains the current edition of UL 987.

In February 2016, UL balloted a proposal to adopt the first edition of International Electrotechnical Commission (IEC) 62841-3-1, *Standard For Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 3-1: Particular Requirements For Transportable Table Saws,* as the first edition of UL 62841-3-1. This effort was part of UL's international harmonization goal to adopt international standards, such as one published by the IEC (International Electrotechnical Commission) or ISO (International Organization for Standardization), into one UL standard based on the IEC/ISO

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

standard with appropriate national differences.[8] The proposal passed, and in August 2016, UL published the first edition of UL 62841-3-1, *Electric Motor-Operated Hand-Held Tools, Transportable Tools and Lawn and Garden Machinery Part 3-1: Particular Requirements for Transportable Table Saws*. UL 62841-3-1 is recognized as an American National Standards Institute (ANSI) standard and includes requirements for a modular blade guard, riving knife, and anti-kickback pawls.

The effective date for UL 62841-3-1 is August 29, 2019. Until that date, UL 987 remains in effect and table saw manufacturers can list their products to UL 987 or UL 62841-3-1.

Modular Blade Guard and Riving Knife

UL 987, Section 43.2.2 and UL 62841-3-1, Section 19.101 specify that table saws shall be provided with a modular blade guard. UL 987, Section 43.2.3 and UL 62841-3-1, Section 19.103 specify that table saws shall be equipped with a riving knife. Both voluntary standards include: 1) similar performance requirements to ensure that the modular blade guard prevents incidental contact from the top and from both sides of the saw blade, and 2) similar specifications for the location and rigidity of the riving knife.

AIM Requirement

In June 2011, UL announced its intention to create a standard that addresses the performance characteristics needed to reduce blade-contact injuries associated with table saws, and UL invited CPSC staff to participate in developing blade-to-skin performance requirements for UL 987. UL formed a working group that met on a regular basis from 2011 to 2015, to develop performance requirements for table saws to address flesh-to-blade contact injuries. The UL working group developed the term “active injury mitigation” (AIM) to describe any type of safety system that detects an imminent or actual human contact to the table saw blade and then performs an action that mitigates the severity of the injury.

In January 2014, UL published a report titled, *Table Saw Hazard Study On Finger Injuries Due To Blade Contact*.[9] The report provides an in-depth study regarding hazard analyses, injury classification, approach speed experiments, and more. The intent of the research was to understand the circumstances that lead to hand/finger contact injuries to operators of table saws and to help identify critical parameters that would define the hazard level. The report identified the quantitative threshold between a simple and complex laceration of a finger at about 4 mm from the surface of the skin.

In February 2015, UL balloted a proposal to add AIM system requirements for table saws to UL 987. The performance requirements consist of a defined relationship between approach velocity of a finger to a rotating table saw blade and the depth of cut to the finger once contact has been made. The ballot proposed a performance requirement that introduces a surrogate test finger, which demonstrates the proper triggering characteristics particular to the AIM technology, to the table saw blade at an approach rate of 1 m/s and limits the allowable depth of cut in the surrogate upon contact with the blade to 4 mm or less.

[8] UL’s harmonization efforts are described at http://ulstandards.ul.com/about/harmonizing-standards/.
[9] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014. Retrieved from: http://library.ul.com/wp-content/uploads/sites/40/2015/02/UL_WhitePapers_Tablesaw_V11.pdf.

CPSC staff sent a letter to UL dated March 24, 2015, expressing staff's support of AIM requirements in the voluntary standard.[10] Staff also provided in-depth investigations (IDIs) of five incidents involving table saws that meet the current UL standards (*i.e*., had riving knife and modular blade guard). In April 2015, the ballot failed to reach consensus; the ballot received 14 votes against (compared to 7 votes in favor of) the proposal.

In March 2015, UL published a report titled, *General Characteristics of a Surrogate Finger for Table Saw Safety Testing*.[11] The report discusses the characteristics of a human finger that could be used as the basis for triggering an AIM system, and it identified three primary methods to detect a human finger: visual, electrical, and thermal.

In February 2016, UL balloted two proposals:

1) To adopt the first edition of International Electrotechnical Commission (IEC) 62841-3-1, *Standard For Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery – Safety – Part 3-1: Particular Requirements For Transportable Table Saws,* as the first edition of UL 62841-3-1.
2) To add AIM requirements for table saws as part of the adoption of IEC 62841-3-1 or as part of UL 987 that can be merged later when UL 987 is merged with IEC 62841-3-1.

The UL proposal stated that the performance requirements for AIM in the ballot were intended to be technology neutral so that manufacturers had the maximum latitude to design table saws that meet the intent of the requirements. The ballot proposed a performance requirement that introduces a conductive test probe, connected to a circuit that mimics the electrical properties of a human body to the table saw blade at an approach rate of 1 m/s, and limits the depth of cut upon contact with the blade to 4 mm or less. The performance requirement also allowed for other test probes to be used for AIM technology that depends on visual or thermal detection of finger contact to the blade.

CPSC staff sent a letter of comment to UL dated March 11, 2016, expressing staff's support of AIM requirements in the voluntary standard for table saws.[12] In April 2016, the UL proposal for adoption of IEC 62841-3-1 reached consensus when the ballot received 15 votes in favor (compared to 2 votes against) of the proposal. However, the proposal to add an AIM requirement did not reach consensus; the ballot received 12 votes against (compared to 5 votes in favor of) the proposal.

E. Technical Work Performed by CPSC Engineering Sciences (ES) Staff

CPSC staff purchased samples of table saws with AIM technology and developed test protocols to evaluate the performance of the technology. UL's report titled, "Table Saw Hazard Study on

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[10] Letter from Caroleene Paul, CPSC, to John Stimitz, UL, dated March 24, 2015. Retrieved from: https://www.cpsc.gov/s3fs-public/CPSClettertoULcommenttoAIMSproposalwenclosures.pdf.
[11] UL Research Report *General Characteristics of Surrogate Finger for Table Saw Safety Testing*, March 2015. Retrieved from http://library.ul.com/wp-content/uploads/sites/40/2015/12/UL-Research-Report-on-Finger-Surrogate-Characteristics-for-Table-Saw-Testing-2015.pdf.
[12] Letter from Caroleene Paul, CPSC, to John Stimitz ,UL, dated March 11, 2016. Retrieved from: https://www.cpsc.gov/s3fs-public/CPSClettertoULcommenttoAIMS.pdf.

Finger Injuries Due to Blade Contact," identified critical parameters that would define the hazard associated with a human finger/hand coming into contact with a spinning table saw blade.[13] The two critical parameters identified are:

1) Approach velocity of the hand/finger when making contact with the table saw blade.
2) Maximum depth of cut to the hand/finger that would distinguish between simple and complex lacerations.

Ethical considerations prohibit the use of human subjects to test the AIM capability of table saws to mitigate blade-contact injury. In lieu of a human body, a performance test can be developed using a suitable test probe and an electric circuit mimicking human contact to trigger the AIM system. Effective injury mitigation can be defined by a maximum depth of cut to the test probe when it is introduced to the table saw blade at a representative approach rate. The allowable depth of cut in the probe represents the quantitative threshold between a simple and complex laceration, which is the difference between a minor injury and a severe injury to arteries, nerves, or tendons that requires microsurgery. This threshold is 4 mm from the surface of the skin, based on the UL research cited earlier.[13]

CPSC staff based initial test protocols on research conducted by UL during development of UL's proposed AIM test requirements. Modifications were made to the protocol during early trials to ensure that the test results were quantifiable.

To activate the AIM system, CPSC staff used a test probe made of conductive silicone rubber material coupled to an electric circuit representing a range of human bodies. Staff fixed the probe in a holder attached to a computer controlled linear actuator, and fixed the actuator to the table saw. This test set-up allowed staff to control the approach rate of the probe to a spinning saw blade, and to measure the depth of cut in the probe after the table saw's AIM system activation.

CPSC staff conducted tests on two table saws models currently available for sale in the U.S. market that are equipped with AIM technology.

1. Development of AIM System Test Requirements

a. Test Method.

ES staff determined that an AIM system based on electrical detection can be triggered by a conductive test probe that is coupled to an electric circuit that mimics the human body. The test probe material requires two properties for AIM testing: (1) electrical conductivity, and (2) volumetric and mechanical properties that allow depth of cut to be measured. The electric circuit that mimics the human body is described in the next section; 1.b. Human Body Network (HBN).

Staff used a cuboid-shaped test probe made of conductive silicone rubber because the probe had already been developed by UL in its own testing of AIM technology and the probe was readily available for purchase. The test probe, shown in Figure 11, is made of low-resistance, conductive silicone rubber, measuring 12.5 mm x 12.5 mm x 60 mm. ES staff testing showed that a 0.5 mm layer of less-conductive material representing the epidermal outer layer (skin)

[13] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.

of a human finger is not necessary for AIM testing because the system is definitively triggered by contact with conductive "flesh" once the epidermal layer has been broken. Elimination of the skin layer allows for a simpler, less costly, homogeneous probe in which the cut can be made cleanly and measured accurately. Therefore, for test-triggering purposes, staff used a test probe that represents the conductive layer of flesh only.

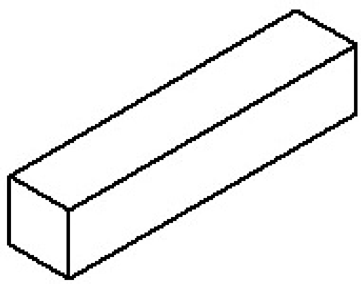

Figure 11. Test Probe.

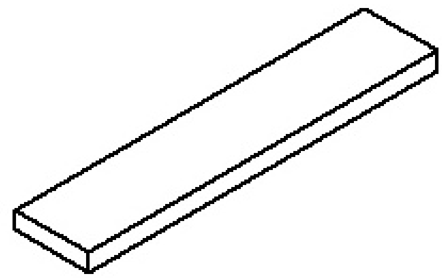

Figure 12. Probe Stabilizer.

Staff determined during test development that placing a non-conductive plastic stabilizer strip underneath the probe provided enough rigidity for a precise cut to be made and measured. Staff used an impact-resistant UHMW polyethylene strip measuring 12.5 mm x 3 mm x 0.25 mm x 60 mm to stabilize the test probe, as shown in Figure 12. The test probe, placed on top of the stabilizer strip, was then mounted in a rigid "J"-shaped holder made from non-conductive plastic, as shown in Figure 13Figure 13. Probe Assembly..

ES staff set the table saw blade to its maximum height at 0 degree bevel and used a programmable belt-driven linear actuator, capable of approach rates of 2 m/sec with a minimum travel distance of 0.5 m to conduct the tests. The probe assembly was attached to this linear actuator, which was mounted to the table saw surface, such that the distance between the center of the probe and the table surface is 15 mm. A 26-gauge wire was embedded into the center of the end of the probe and connected to the grounded HBN, which represented the presence of the operator (Figure 14 and **Error! Reference source not found.**).

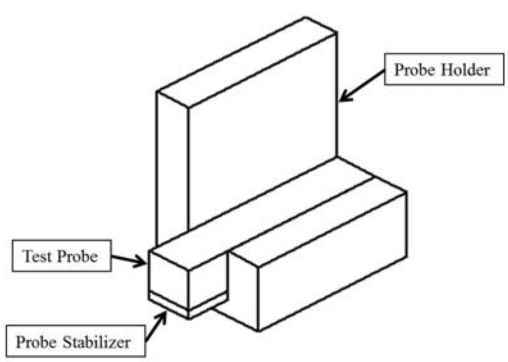

Figure 13. Probe Assembly.

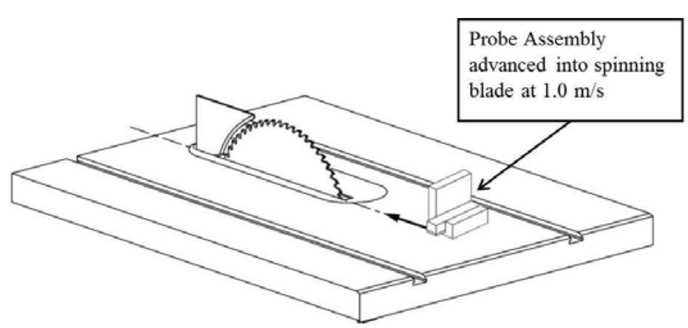

Figure 14. Probe Assembly on Table Saw.

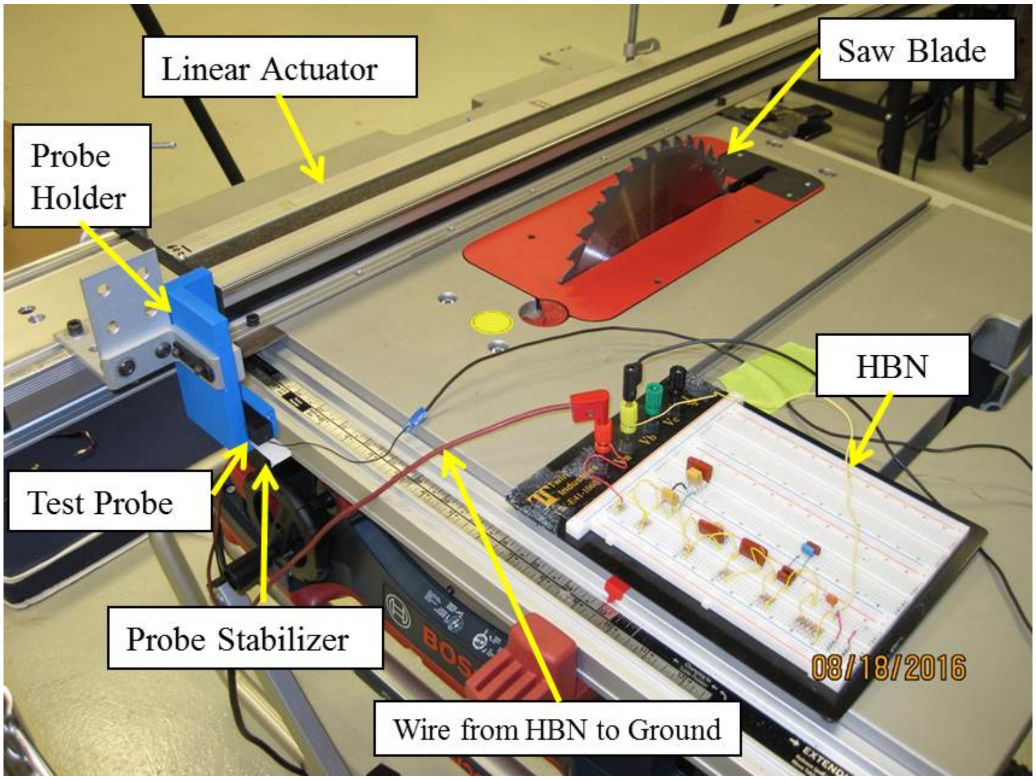

Figure 15. Test Set Up.

The approach rate of the test probe to the saw blade represents the rate of speed at which a human finger moves toward the saw blade during a blade-contact incident on a table saw. However, there is no standard body of data that quantify finger/hand approach rate to the saw blade in a table saw incident; and CPSC staff analysis of blade-contact incidents indicates that there are many scenarios in which an operator's finger/hand can contact a table saw blade. Sudden movement of the workpiece from kickback can cause the operator to lose control of the workpiece and cause his/her hand to fall into or be "pulled" into the blade. Hand/finger contact is also possible without kickback, in situations where the operator's hand gets too close to the blade while feeding the workpiece, or the operator is distracted and inadvertently contacts the saw blade.[14] In comments to the table saw ANPR published on October 11, 2011, SawStop presented analysis of their incident data (more than 1,316 table saw incidents), which indicates approach rates to the blade occurred between 3.6 in/s (91 mm/s) and 14.5 in/s (368 mm/s); and 14 percent of the incidents involved kickback of the workpiece.[15] In 2014, UL conducted their own analysis of approach rates and noted the difficulty of taking laboratory measurements of human subjects and translating that information to estimate the approach velocity of an operator's hand or finger toward the center of the saw blade, or radial component of the approach velocity, in an actual blade-contact incident (see Figure 16).[16] UL considered their own analysis of SawStop's incident data, literature searches, and human subjects experiments, and determined that 39.4 in/s

[14] Smith, T. (2016). Memorandum. Human Factors Assessment of Blade contact Scenarios and Responses to ANPR Public Comments. Rockville, MD. (see Tab D)
[15] Gass, S. (2012). Comments and Information Responsive to the ANPR for Table Saw Blade Contact Injuries By SawStop, LLC. Retrieved from: https://www.regulations.gov/document?D=CPSC-2011-0074-1106.
[16] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.

(1000 mm/s or 1 m/s) is a reasonable first-order estimate of a typical case where a table saw operator accidentally contacts the saw blade.

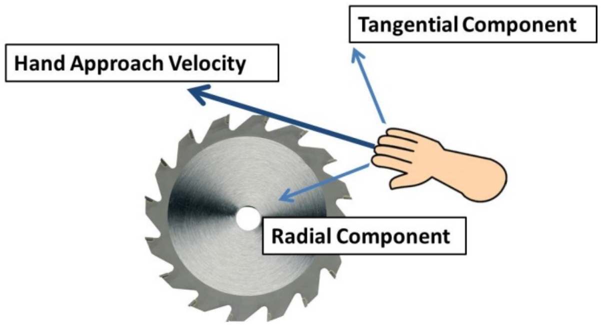

Figure 16. Components of Approach Velocity.

Staff's analysis of operator behavior in blade-contact injuries indicates that blade-contact injuries occur at approach rates that range from slow feeding of the workpiece when the operator's hand is close to the blade and inadvertent contact is made, to faster approach rates that occur when kickback of the workpiece causes the operator's hand to make contact with the blade. Staff believes a radial approach rate of 1 m/s is appropriate for a performance test because this is a high rate of speed for the radial component of the hand's approach rate to the saw blade. In addition, this radial approach rate is more than twice as fast as the highest radial approach rate calculated by SawStop in more than a thousand blade-contact injuries that activated their AIM system. Therefore, staff conducted all tests at an approach rate of 1 m/s.

After AIM system activation, the probe was removed from the holder, and the external X and Y cut dimensions (see Figure 17 and Figure 18) were measured to the nearest tenth of a millimeter using a 20x microscope. The depth of cut was then calculated using the following equation:

$$\text{(1)} \quad \text{Depth of Cut} = X \cdot Y/(X^2 + Y^2)^{1/2}$$

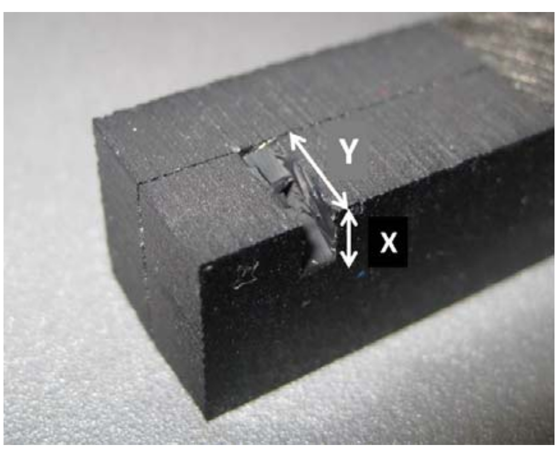

Figure 17. View of Test Probe Cut.

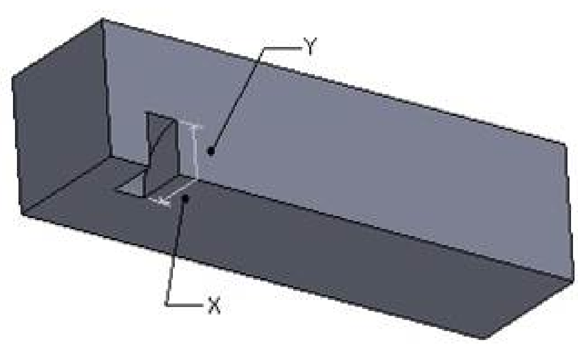

Figure 18. Test Probe Cut Dimensions.

While the blade actually makes an arc-shaped cut in the probe because the radius of the blade is large (relative to the cut size in the probe) at approximately 127 mm (5 inches), the arc's length can be approximated very closely, by using the depth of cut equation cited above. This equation calculates the height of the right triangle formed by X and Y, which is approximately equal to the actual depth of cut in the probe (see cross-section view of test probe, blade, and cut in Figure 19).

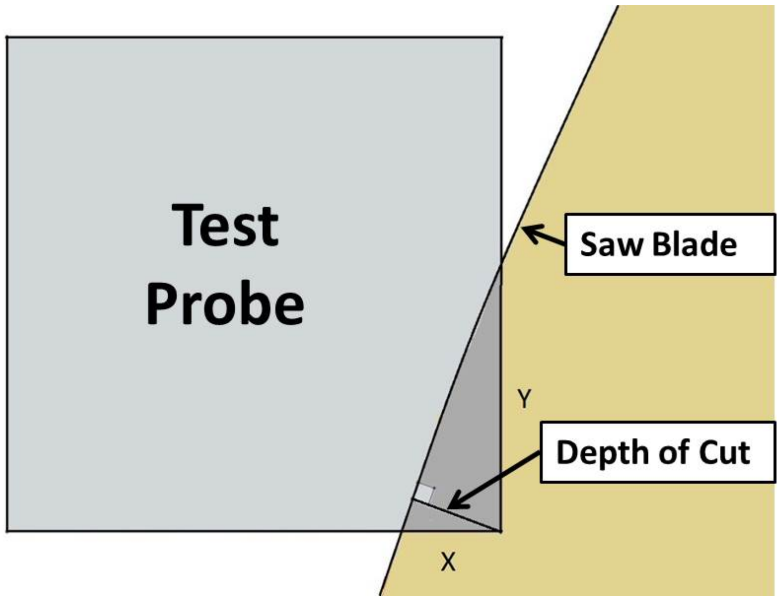

Figure 19. Depth of Cut Calculated from X and Y Cut Dimensions.

The UL report titled, "Table Saw Hazard Study on Finger Injuries Due to Blade Contact," identified the quantitative threshold between a simple and complex laceration in a human finger as a 4.0 mm cut from the surface of the skin.[17] Simple lacerations can be managed at emergency departments with little expertise or by simple home care because these cuts generally heal without complications.[18] Conversely, complex lacerations require skilled microsurgery to repair damaged tendons, nerves, and vessels, and such care often requires hospital stays, transfer to a hospital with the required expertise, and extensive occupational therapy. Although the thickness of the epidermis can vary, one study of 214 skin samples from 188 volunteers found the mean epidermal thickness for the fingertip to be 0.369 mm, with a standard deviation of 0.112 mm.[19] Assuming a normal statistical distribution for the thickness of human skin, the mean epidermal thickness for a fingertip is 0.369 mm ± 0.112 mm, or a maximum thickness of approximately 0.5 mm. Because the test probe represents human flesh beneath the epidermis, staff subtracted the 0.5 mm thickness of the epidermal layer of skin from the 4.0 mm threshold value to arrive at a 3.5 mm value for the maximum allowable depth of cut to the test probe. This 3.5 mm value represents the quantitative threshold between a simple and complex laceration in a human finger, as measured by the test probe.

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[17] UL Research Report *Table Saw Hazard Study on Finger Injuries Due to Blade Contact*, January 2014.
[18] Chung, K. and Shauver, M. 2014. Table saw injuries: epidemiology and a proposal for preventive measures.
[19] Judi Whitton and J.D. Everall, "The Thickness of the Epidermis," *British Journal of Dermatology*, Vol. 89, Issue 5 (November 1973), pgs. 467-476.

b. Human Body Network.

Existing research into the electrical nature of the human body makes it possible to replicate the human body electrical properties with an electric circuit,[20] earlier referred to as a human body network (HBN). An HBN roughly approximates how the body responds to an electrical signal due to an electrical property known as bioelectrical impedance, which is composed of two other electrical properties – the body's electrical resistance, $R_{s,}$ and capacitance, C_s (Figure 20). Body resistance is a physical property of the human body that limits the flow of electrical current into the body when a voltage source is contacted. Body capacitance is a physical property of the human body that allows the body to store electrical charge from a voltage source. HBNs are constructed with electrical components known as resistors, capacitors, and inductors, the presence and size of which depend upon the body characteristics to be simulated.

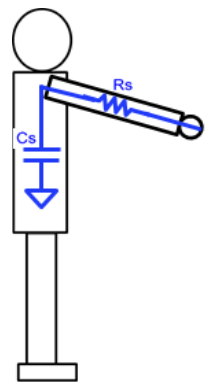


Figure 20. Graphical depiction of the human body's electrical resistance, Rs, and capacitance, Cs.

In developing an HBN for the evaluation of AIM, ES staff noted the presence of user clothing, footwear, work gloves, and painted or coated metal parts of a table saw. These are insulators that limit reliable electrical contact between a user and the saw to just a single point, the saw's metal blade. When a detection signal is present on the saw blade and the saw blade is contacted, the detection signal interacts with the body's electrical resistance and capacitance. The AIM system activates in response to the change in the detection signal caused by interaction with the body's impedance.

In the case of a detection signal coming into contact with the body, the signal produces an electrical current that flows into the body through its electrical resistance, charging the body's electrical capacitance. R_s varies according to the characteristics of human skin and the current path through the body, as well as "signal frequency," which reflects how quickly the signal changes over time. In the case of evaluating an AIM system, this relates to the frequency of the detection signal. For $C_{s,}$ the body has a minimal, intrinsic value of

[20] For example the American National Standards Institute (ANSI) and the Electrical Overstress/Electrostatic discharge Association (EOS/ESD) use an HBN model for electrostatic discharge tests and the HBN is described in Joint Standard for Electrostatic Discharge Sensitivity Testing – Human Body Model (HBM) – Component Level, ANSI/ESDA/JEDEC JS-001-2014. In addition, the International Electrotechnical Commission also uses an HBN model for electrostatic discharge tests and the HBN is described in Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test, IEC 61000-4-2:2008.

capacitance referred to as “self-capacitance,” which is augmented by the body’s proximity to nearby conductive objects, such as walls, flooring, support structures, and electrical equipment, including the table saw itself (see Figure 21).

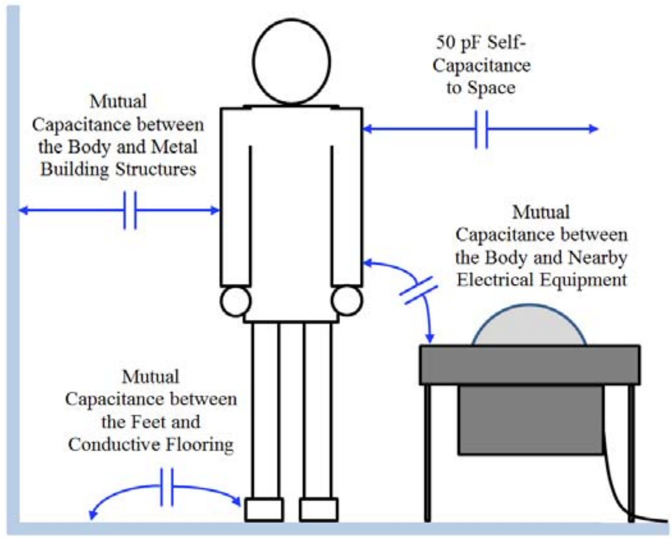


Figure 21. Depiction of the self-capacitance of the human body, and various mutual capacitances that augment the capacitance of the human body.

To gain insight into the variations in the body’s resistance and capacitance, ES staff studied various HBNs used in the areas of electrostatic discharge (ESD) and electric shock. ESD involves the unintentional generation and storage of electric charge on the human body, with its rapid discharge, typically through a fingertip, to nearby metal objects, including sensitive electronic devices. Electric shock involves the passage of a hazardous electric current through the body, due to contact with certain types of electrical circuits.

<u>ESD HBNs</u>

The two most common HBNs used for ESD consist of a fixed-value resistor, R_s, representing the body’s electrical resistance, in series with a fixed-value capacitor, C_s, representing the body’s electrical capacitance (see Figure 22).

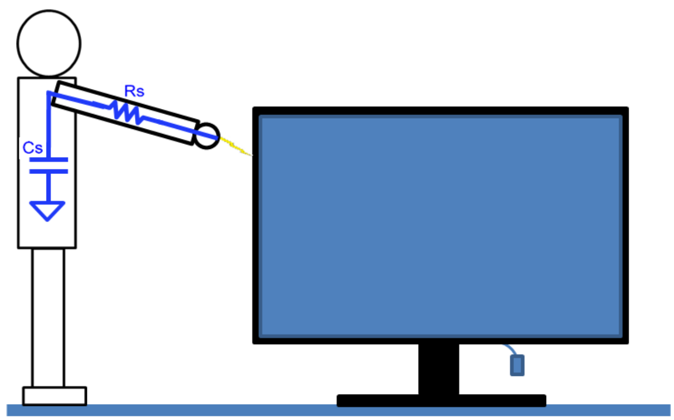


Figure 22. An electrostatic discharge event from charge stored in the human body’s capacitance, Cs, and discharged through the body’s resistance, Rs, onto an electronic device.

The American National Standards Institute (ANSI) and the Electrical Overstress/Electrostatic discharge Association (EOS/ESD) use an HBN model for testing with C_s = 100 picofarads and R_s = 1500 ohms,[21] while the International Electrotechnical Commission uses C_s = 150 picofarads and R_s = 330 ohms.[22] While both models are widely accepted and provide consistency for conducting ESD tests, the value of C_s can vary considerably, as explained before, due to mutual capacitance between the body and its surroundings. Although C_s typically ranges from 50 to several hundred picofarads,[23,24,25,26] measurements in the thousands of picofarads have been observed.[27]

Electric Shock HBNs

ESD HBNs use specific values of body resistance, R_s, which work well for reproducing short-duration electrostatic discharges. When considering an electric shock event, in which electric current enters one body part and exits another, and the time-varying (frequency-dependent) nature of voltages in electric circuits, C_s does not affect the level of electric current that flows through the body. Rather, R_s determines the amount of electric current that flows and is represented better by a network consisting of resistors and capacitors. One such HBN for assessing electric shock potential in information technology equipment is shown below in Figure 23 and described in the voluntary standard UL 60950-1, *Information Technology Equipment – Safety – General Requirements*.[28]

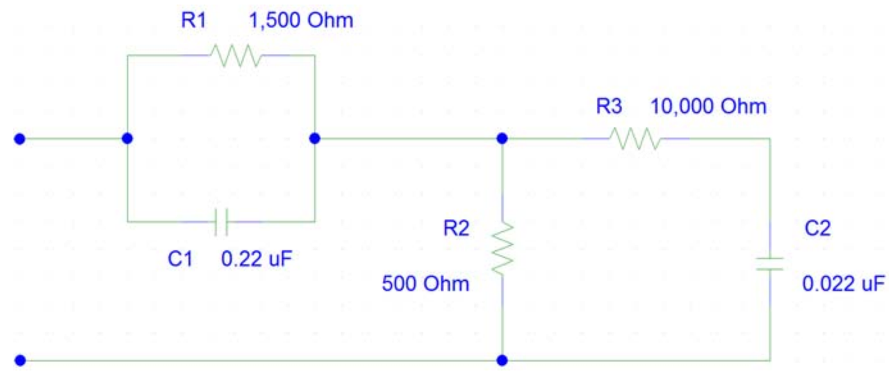


Figure 23. Example ESD HBN from Figure D.1 of Annex D, UL 60950-1-1.

[21] Joint Standard for Electrostatic Discharge Sensitivity Testing – Human Body Model (HBM) – Component Level, ANSI/ESDA/JEDEC JS-001-2014.
[22] Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test, IEC 61000-4-2:2008 (International Electrotechnical Commission, 2008).
[23] Microelectronic Circuits: Analysis & Design, Muhammad H. Rashid, (Cengage Learning, 2011), p 1025.
[24] Fluidization, Solids Handling, and Processing: Industrial Applications (Particle Technology Series), Wen-Ching Yang (William Andrew Publishing Co., 1999), p. 843.
[25] ESD Program Management, A Realistic Approach to Continuous Measurable Improvement in Static Control, G. Theodore Dangelmayer (Springer, 1990), p. 43.
[26] Electrical Hazards and Accidents: Their Cause and Prevention, E.K. Greenwald (Editor), (John Wiley and Sons, 1991), p. 164.
[27] Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) MIL-HDBK-263B, Appendix D (U.S. Department of Defense, 1994), p. 52.
[28] UL 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements (Underwriters Laboratories, Inc., 2003), p. 233.

UL 60950-1-1 indicates the frequency range for the HBN to be 15 Hz to 1 MHz, which has proven sufficient for evaluating electric shock hazards, but is slightly limited when considering the range of detection signals that might be present in AIM system circuitry. Research by other experts, recognized by UL,[29] has led to the development of an electric shock HBN having a wider frequency range of 40 Hz to 110 MHz[30] (see Figure 24).

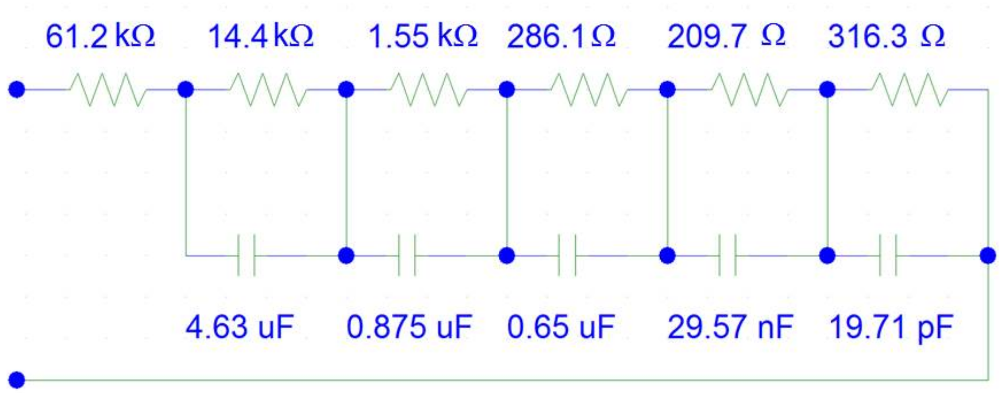


Figure 24. HBN for electric shock covering a frequency range of 40 Hz to 110 MHz.

HBNs for electric shock are designed considering extremely low body impedance for worst-case shock conditions, due to the presence of body perspiration and salts, as well as firm contact with live parts presenting a shock hazard. However, human body impedance can vary extensively, principally depending upon the resistance of the epidermis, ranging up to hundreds of kilo ohms due to dry skin. In other words, dry skin has high resistance and poor conductivity, compared to the low resistance of the salty flesh/blood underneath the skin.

The National Institute of Occupational Safety and Health has found that broken skin may drop the body's resistance down to a low resistance of 1,000 Ohms.[31] As stated in Section II.E.1.a., the maximum thickness of the epidermis layer is approximately 0.5 mm. Therefore, if the 0.5 mm layer of epidermis is accounted for in depth of cut analysis, the highly resistive nature of the epidermis can be removed from consideration for an HBN for AIM evaluation.

<u>Hybrid HBN model for AIM Testing</u>

A hybrid HBN model for AIM system testing must be designed considering the following:

- the various electrical signals that could be used to detect contact between a saw blade and the human body,
- the presence of human body capacitance that can vary, depending upon the proximity of grounded building structures and electrical equipment, and
- the frequency-dependent nature of body resistance.

[29] Hai Jiang, Mahmood Tabaddor, Fan He, "General Characteristics of a Surrogate Finger for Table Saw Safety Testing," (Underwriters Laboratories, March 2015), p. 15.

[30] V. De Santis, Pierre A. Beeckman, Domenico A. Lampasi, Mauro Feliziani, "Assessment of Human Body Impedance for Safety Requirements Against Contact Currents for Frequencies up to 110 Mhz," Biomedical Engineering, IEEE Transactions on Biomedical Engineering, Vol. 58, Issue 2, pgs. 390-396.

[31] "Worker Deaths by Electrocution, a Summary of NIOSH Surveillance and Investigative Findings," (National Institute of Occupational Safety and Health, May 1998), p. 7.

Such a model is conceived by placing a capacitor, representing the body's capacitance, C_s, in series with the previously mentioned 40 Hz – 110 MHz frequency-dependent HBN for electric shock (see Figure 25).

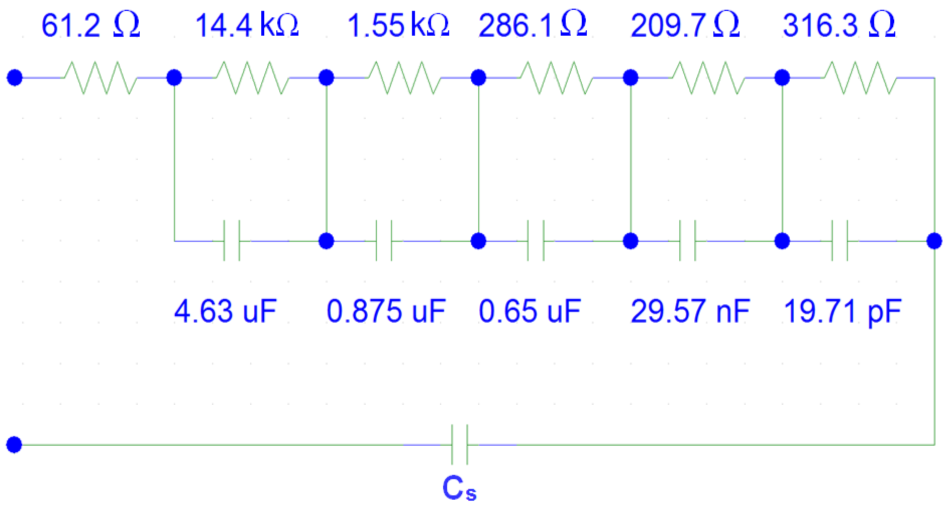


Figure 25. Recommended hybrid body model for testing table saw AIM system, showing the frequency-dependent resistive network in series with the human body capacitance, Cs.

The presence of conductive flooring, walls, and nearby electrical equipment have the effect of increasing the capacitance of the human body beyond its minimum self-capacitance of 50 pF. Tests conducted by staff with table saws from two manufacturers, starting with an initial value of 50 pF for the human body capacitance, incrementing the capacitance by 50 pF steps in consecutive tests to a final capacitance of 500 pF, and finally shorting out the capacitance completely, demonstrate the AIM circuity is responsive over a continuous range of capacitances, starting at 50 pF. This approach allowed staff to systematically evaluate the effect of incremental 50 pF changes for the expected range of human body capacitance, where the resultant capacitive impedance (Z) corresponds to the inverse of the capacitance (C) in accordance with the following formula:

$$Z = \frac{1}{2\,\pi\,f\,C}$$

where: Z = impedance
f = frequency
C = capacitance

Figure 26 plots the capacitive impedance values for the ten incremental 50 pF steps in capacitance from 50 pF to 500 pF. It can be seen in the top half of the graph that the selected values introduced a large gap in the capacitive impedance between the first two values of 50 pF and 100 pF, and beyond the 4th value (200 pF) there is very little change in the corresponding capacitive impedance.

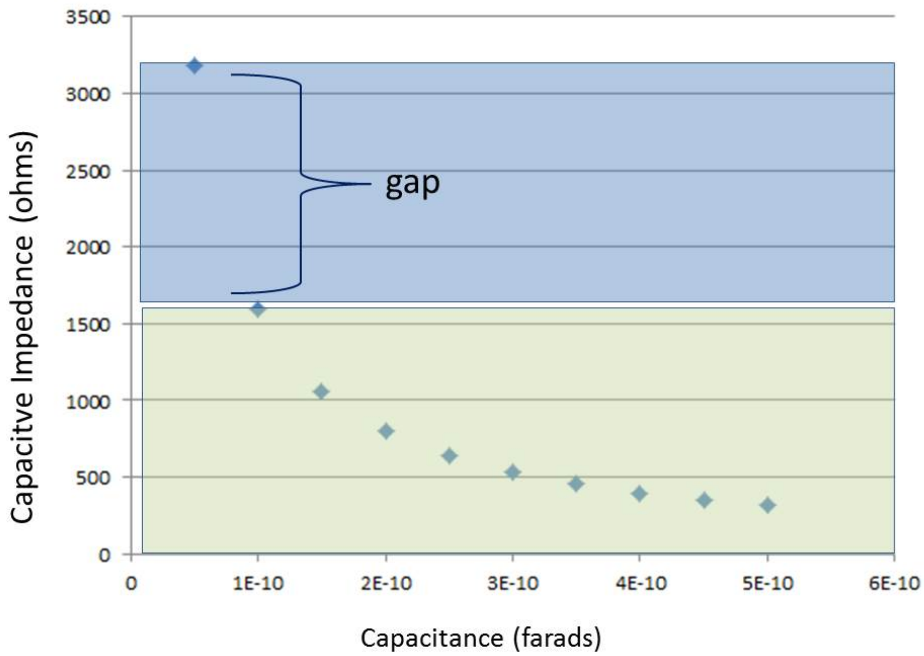


Figure 26. Graph showing unequal human body impedance with 50 pF intervals.

Therefore, to cover the range of expected human body capacitances more equally, and in an attempt to reduce the number of tests to demonstrate compliance, staff specifies a C_s of 50 pF for the first test, followed by tests with C_s set to 66 pF, 100 pF, and 200 pF. These values of capacitance have the effect of starting with a maximum impedance contribution from the human body capacitance (50 pF), and then stepping downward from this maximum value in four equal steps, as shown in Figure 27.

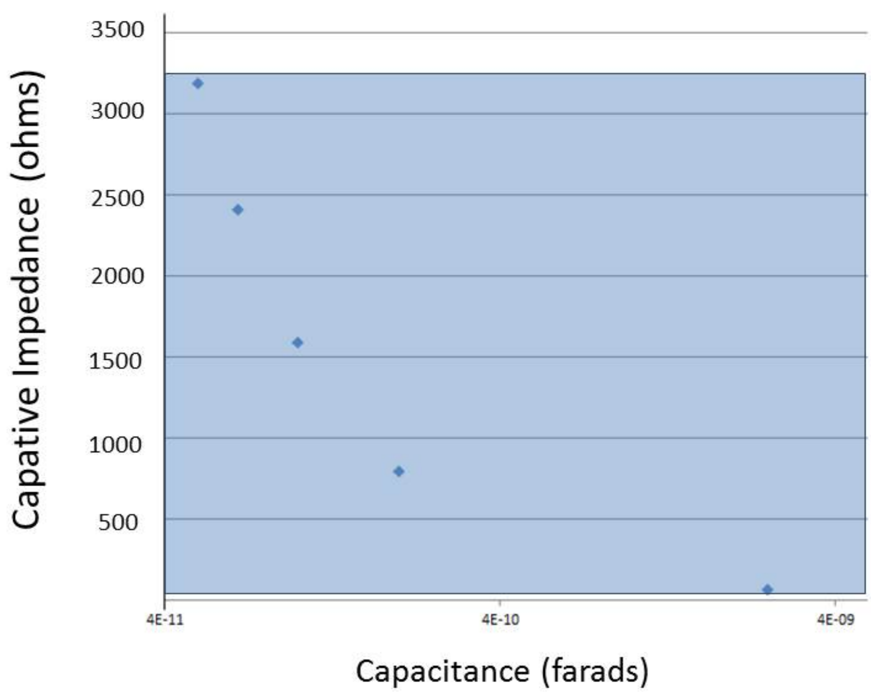


Figure 27. Graph showing equally-sized human body capacitive impedance, with five tests.

It is important to note that since C_s may extend into the nanofarad range, its contribution to the overall impedance of the hybrid network decreases due to an inverse relationship between capacitance and impedance. Therefore, to represent the decreased effect of human body capacitances beyond 200 pF, the capacitor is replaced by a short circuit for one additional test represented by the point in the lower right of Figure 27.

Electrical Properties of Surrogate Finger

To safely evaluate the AIM system detection capabilities with the hybrid HBN while the saw blade is rotating and measure the depth of cut that occurs after a table saw's AIM system activates, staff used a conductive polymer that is molded into the shape of a rectangular prism to act as a surrogate finger. The surrogate used by staff has the dimensions 12.5 mm by 12.5 mm by 60 mm, and a mean electrical resistance of 50 to 100 Ohms, as measured from one end of the surrogate to the opposite end. The surrogate finger's mechanical properties are described by ES staff elsewhere in this memorandum.

Electrical Test Setup

The HBN was verified with a test signal having a fundamental frequency equal to that of the detection signal to be within 0% to +5% of its calculated impedance. For electrical connections, staff made a 5 mm deep pin hole into the geometric center of one end of the surrogate finger, inserted one end of a 0.5 cm-length of No. 26 AWG insulated solid copper conductor into the 5 mm deep pin hole on the surrogate finger, and connected the other end of the wire to one side of the hybrid HBN. Staff then connected the other side of the hybrid HBN to the table saw's grounded metal frame or to the green grounding conductor in the power supply cord. Staff used insulated wiring, minimum No. 18 AWG, to make the electrical connection to ground. The complete assembly is shown in Figure 28.

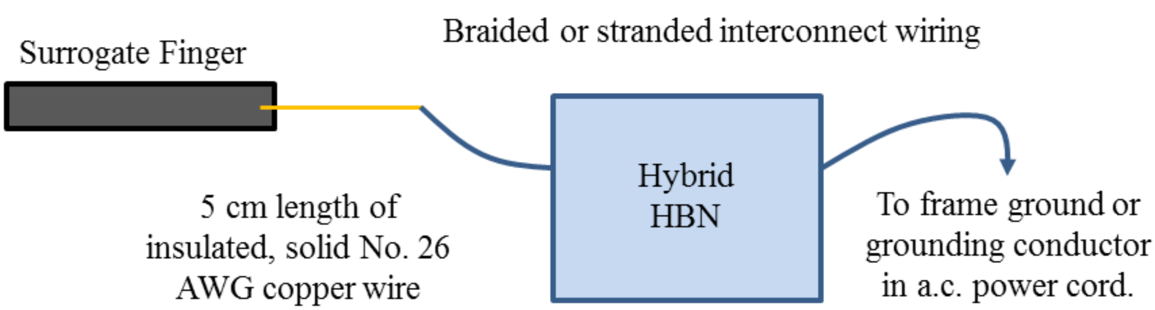


Figure 28. Representation of the electrical connection of the surrogate finger and HBN network.

AIM System Detection Signal Limitations

Electromagnetic phenomena, such as transmission line and antenna radiation, can affect the efficacy of the hybrid HBN when the wavelength of detection signals begins to become comparable to the physical size, arrangement, and length of wiring used in this test setup. In view of those, and considering the frequencies of detection signals used on table saws that are currently available to consumers, the previously discussed circuitry and test setup are limited to detection signals with a fundamental frequency of 5 MHz or less. Table saws using detection signals beyond this range may require different circuity, wiring, and physical arrangement to validate their operation correctly.

2. Test Results

CPSC staff tested a SawStop JSS-MCA jobsite table saw and a Bosch REAXX™ jobsite table saw for AIM technology performance in accordance with the above test protocol. All test runs used the respective manufacturer's 10-inch diameter blades. Tests were run with the probe connected to the HBN, which is connected to the table saw's ground wire, as discussed in the previous section.

Staff tested 11 HBN settings/configurations to represent the effect of mutual capacitance between the human body and its surroundings that increases the capacitance of the human body beyond its minimum self-capacitance of 50 pF in 50 pF steps up to 500 pF, plus an additional short circuit test. ES staff tested both table saws with 11 test probe activations at an approach rate of 1 m/s, and determined the probe depth of cut for each test run. The results are shown in Table 1. For all capacitance values, both the SawStop and Bosch table saws produced cuts that were under the 3.5 mm threshold for allowable depth of cut into the probe. The depth of cut for the SawStop table saw tests ranged from 1.5 mm to 2.8 mm, and the depth of cut for the Bosch table saw tests ranged from 1.9 mm to 2.5 mm.

Table 1. Depth of Cut Values for SawStop and Bosch Table Saws

Test Run	HBN Capacitance (pF)	Depth of Cut (mm)	
		SawStop	Bosch
1	50	2.3	2.2
2	100	2.8	2.1
3	150	2.5	1.9
4	200	2.5	2.2
5	250	2.7	2.1
6	300	2.1	1.8
7	350	1.5	2.4
8	400	2.1	2.5
9	450	2.7	2.5
10	500	2.6	2.5
11	Short circuit	2.6	2.5

As discussed in the previous section, to reduce the number of tests for the proposed performance requirement while covering the full expected range of human capacitance, staff recommends only five test probe activations using capacitance values of 50 pF, 66 pF, 100 pF, and 200 pF, as well as a final short-circuit activation.

3. Exploratory Test Work on Bench Saw

Currently, AIM technologies are available on two cabinet saw models, one contractor saw model, and two jobsite saw models. However, many comments to the table saw ANPR question whether the technology can be applied to small bench saws that weigh around 40 pounds and cost $100 to $150, without drastically increasing the weight of the table saw. For comparison, the SawStop and Bosch jobsite table saws weigh around 90 pounds and cost around $1300.

ES staff modified a small, 41- pound bench saw by adding internal framing using lightweight aluminum beams to hold a standard SawStop brake cartridge for a 10-inch saw blade at a position to stop the saw blade (see Figure 29, Figure 30, and Figure 31). No effort was made to retract the blade during activation, only to stop the blade from spinning. Therefore, all the energy required for stopping the blade was absorbed by the brake cartridge and the internal structure. The additional structure added about 8 pounds to the table saw, including the brake cartridge. Staff did not attempt to construct the sensing portion of an AIMS system for this work, which was intended to investigate the mechanical parameters necessary for providing the blade-stopping mechanism and to withstand the forces related to stopping the blade from spinning.

With the table saw switched on and the blade spinning at full speed, staff remotely activated the brake cartridge with an external electrical signal. Test results show that the rotation of the blade was stopped immediately upon activation of the brake. The impact of the blade stopping caused the table saw to jump approximately 1 to 2 inches. Visual examination after the first test showed the table saw was able to withstand the forces without major structural failure, with only minor deformation of the table top surface. The test saw was turned on and the blade spun normally. After four activations (*i.e.*, four simulated near-amputations), the table saw's top surface showed visible warping, as shown below in Figure 32.

Figure 29. Bench Saw Modified by ES Staff

Figure 30. Internal Framing to Add Brake Cartridge

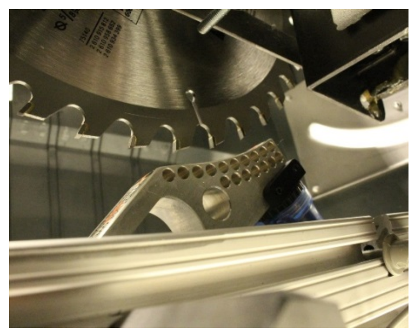


Figure 31. Brake Cartridge in Modified Bench Saw

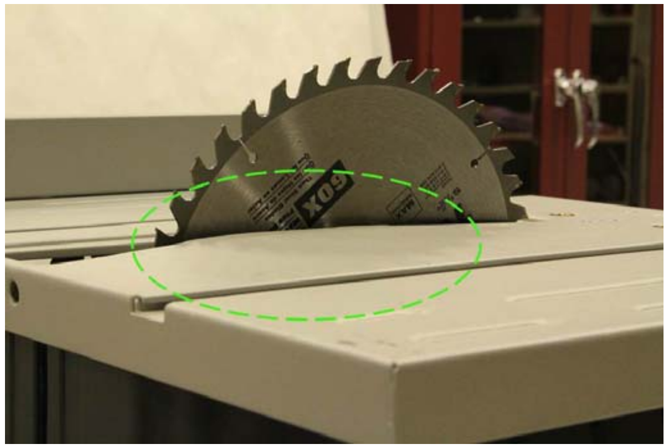


Figure 32. Warped Table Surface After Four Activations

ES staff modified a second small bench saw of the same model, this time with an additional strut (adding about half a pound more to the table saw) between the arbor and the brake, and conducted two tests with the SawStop brake cartridge. With the additional reinforcement, the impact load of the brake cartridge was more evenly distributed throughout the supporting structure, and the table saw top surface was not permanently warped after two tests. The saw jumped less than 1 inch during impact, and staff saw so no damage to the table top. Therefore, staff did not test the modified table saw further.

The test results on the small bench saws indicate that the minor structural changes made to the table saw reduced damage to the table saw by distributing the force caused by the SawStop brake cartridge activation. Based on this testing ES staff believes AIM technology can be applied to small bench saws without drastically increasing the weight of the table saw.

Engineering considerations that staff believes are feasible for table saw manufacturers to produce small bench saws with AIM capability successfully include:

- Reinforce table saw internal structure
- Design trunnion to distribute force of AIM system
- Insulate blade/arbor from universal motor
- Apply signal to blade
- Adapt design to smaller forces created by smaller size motor

III. STAFF RECOMMENDATION

CPSC staff recommends a performance requirement for table saws that limits the depth of cut to a test probe, upon making contact with the saw blade at a radial approach rate of 1.0 m/s, to 3.5 mm. The test probe shall have the appropriate properties (such as electrical, optical, thermal, electromagnetic, ultrasound, etc.) to indicate human body/finger contact with the saw blade and shall have the appropriate physical properties to measure depth of cut. The test probe and test method described in this memo and Appendix A are considered appropriate for the evaluation of AIM systems using an electrical detection system. This test method should be used for such systems and will be used by CPSC staff in evaluating such systems. For AIM systems using a different detection approach, the method should be modified based on sound material science and engineering knowledge to ensure that triggering of the AIM system would properly function as a surrogate for human blade contact, and maintain the physical properties of the probe to assure that the depth of cut can be properly measured. Staff seeks comments on how different detection methods may be applied as part of an AIM system and appropriate changes to the test method to properly evaluate the triggering of AIM systems employing these detection methods.

Staff believes that a performance requirement that limits the depth of cut to a test probe that contacts a saw blade to 3.5 mm will significantly reduce the severe lacerations, fractures, amputations, and avulsions associated with operator blade-contact incidents on table saws because the probe will have the appropriate properties to indicate human body/finger contact with the saw blade and the equivalent injury mitigation on a real human finger will avoid most microsurgery. Most microsurgery will be avoided because the neurovascular bundle in a human little finger, which contains nerves and arteries, is at a depth of approximately 3.5 mm below the 0.5 mm thick epidermal layer of the skin. In this manner a 3.5 mm depth of cut into a conductive test probe is a surrogate for a 4mm depth of cut into a finger with insulating epidermis over conductive tissue. For probes that are based on detection of other human body properties, the 3.5 mm depth of cut limitation still translates to an injury that will avoid most microsurgery for the reasons stated before regarding location of the neurovascular bundle in a human little finger. Additionally, incidents that occur under conditions that increase AIM performance (such as slower approach rate of the hand/finger to the saw blade and/or circumstances that increase detection) may result in injury severity that may not require medical attention beyond a bandage.

Staff recognizes there may be some scenarios, such as kickback that causes the operator's hand to be "pulled" into the blade at a high rate of speed or the operator reaching as fast as possible for a falling workpiece, where the radial velocity of the hand/finger exceeds 1 m/s when it contacts the saw blade. At approach speeds greater than 1 m/s, AIM performance may result in injury severity that requires extensive medical attention, including the microsurgical repair of nerves, blood vessels, and tendons, for an incident that might otherwise have resulted in an amputation or the involvement of several digits or a wider area. The only available data on radial approach rates during kickback and non-kickback related table saw blade-contact incidents indicate the approach rate does not exceed 0.368 m/s[32]; however staff recognizes there may be some incidents that occur under conditions so demanding that AIM performance is unable to prevent a severe injury from occurring. Nevertheless, staff believes the majority of operator blade-contact injuries on table saws can be mitigated by the proposed performance requirements.

[32] Gass, S. (2012). Retrieved from: https://www.regulations.gov/document?D=CPSC-2011-0074-1106.

Appendix A
Test Method for Evaluating Depth of Cut to a Finger Surrogate after Blade Contact with a Table Saw

I. Probe-to-blade contact test.

Staff recommends that the performance requirement for table saw safety be based on the depth of cut to a probe as determined by the probe-to-blade contact test. To evaluate the depth of cut to a finger surrogate after blade contact with a table saw, staff developed the following test procedure with the aim of defining the mechanical parameters for evaluating approach speed and depth of cut, for the specific example of AIMs systems with electrical sensing systems. In general, the test probe shall have the appropriate properties (such as electrical, optical, thermal, electromagnetic, ultrasound, etc.) to indicate human body/finger contact with the saw blade and shall have the appropriate physical properties to measure depth of cut. The test probe and test method below are considered appropriate for the evaluation of AIM systems using an electrical detection system. This test method should be used for such systems and will be used by CPSC staff in evaluating such systems. For AIM systems using a different detection approach, the method should be modified based on sound material science and engineering knowledge to ensure that triggering of the AIM system would properly function as a surrogate for human blade contact, and maintain the physical properties of the probe described below to assure that the depth of cut can be properly measured. Staff seeks comments on how different detection methods may be applied as part of an AIM system and appropriate changes to the test method to properly evaluation the triggering of AIM systems employing these detection methods.

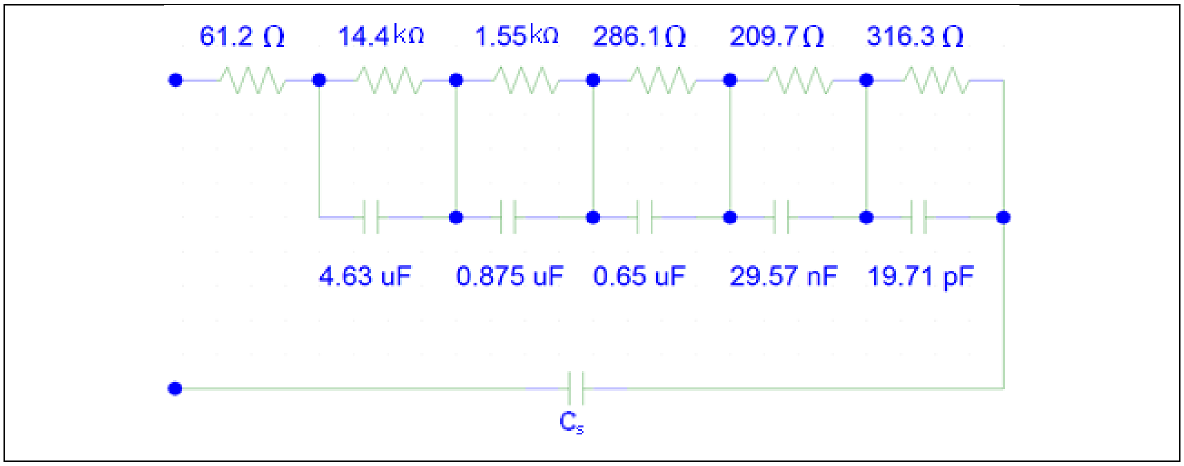
The following test procedures apply to an active injury mitigation (AIM) system based on electrical detection of the human body. The depth of cut to the probe is measured after the saw blade contacts the probe and the table saw active injury mitigation (AIM) system has completed activation.

1) Acceptance limits and requirements. The depth of cut to a test probe upon blade contact, at an approach rate of 1.0 m/s, shall be 3.5 mm or less during each test run.

2) Table saw test sample. The table saw test sample shall be assembled per the manufacturer's instructions and recommendations with the exception of the blade guard. The blade guard shall be removed for all tests. The manufacturer's recommended blade shall be used for all tests.

3) Test Equipment.

   a. Linear actuator with a minimum travel distance of 500 mm and a travel speed up to 2 m/sec.
   b. Human body network (HBN).
      i. The HBN consists of the resistors and capacitors shown below.



c. Test probe (Figure AA)

i. Material: Low-resistance, conductive silicone rubber, Stockwell Elastomers, Inc., part number SE65-CON, or equivalent, having a volume resistivity of 10 Ω cm, and a minimum bending rigidity of 70 kN/m.

ii. Dimensions: 12.5 mm ± 0.5 mm x 12.5 mm ± 0.5 mm x 60 mm ± 1.0 mm homogenous block

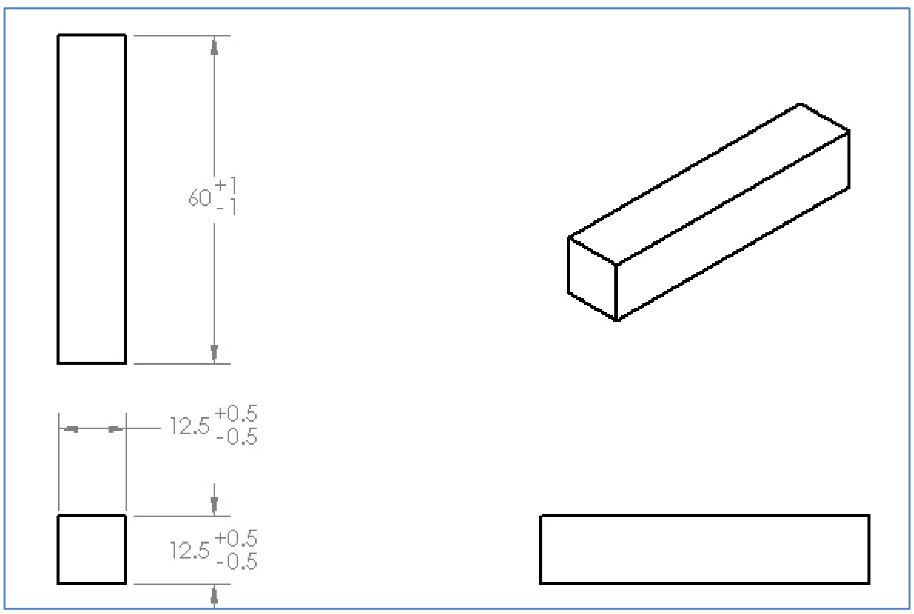


Figure AA (Drawing of probe)

d. Probe holder (Figure AB)

i. Material: Rigid non-conductive plastic or equivalent

ii. Dimensions: See Figure AB

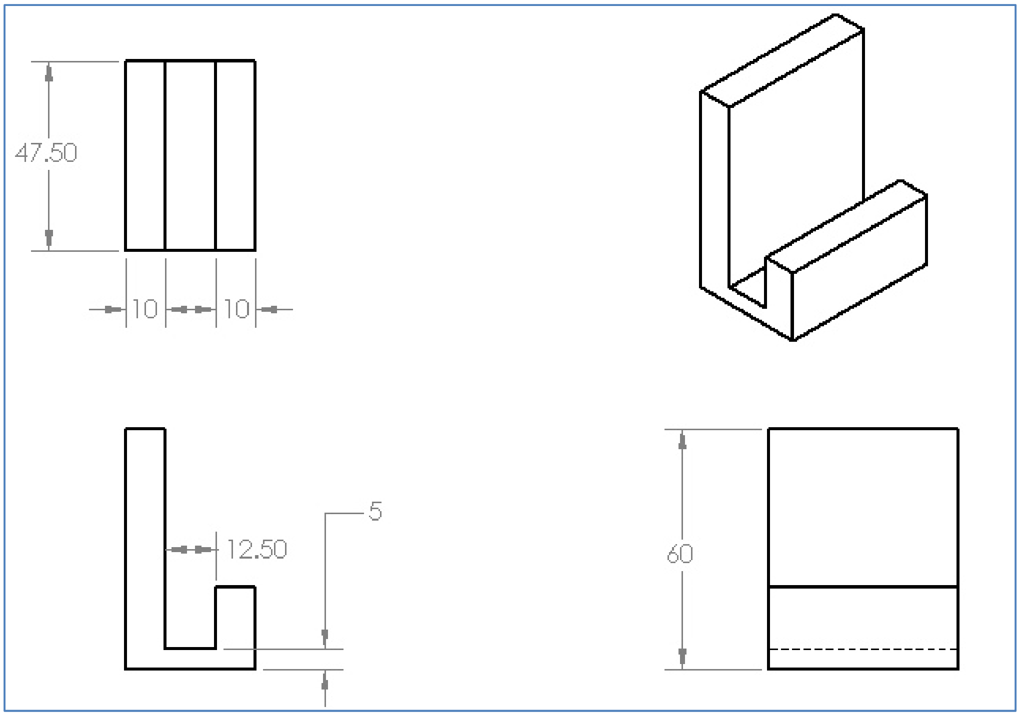


Figure AB (Drawing of probe holder)

e. Probe stabilizer strip (Figure AC)
  i. Material: Impact-resistant UHMW polyethylene strip
  ii. 12.5 mm ± 0.5 mm x 3 mm ± 0.25 mm x 60 mm ± 1.0 mm

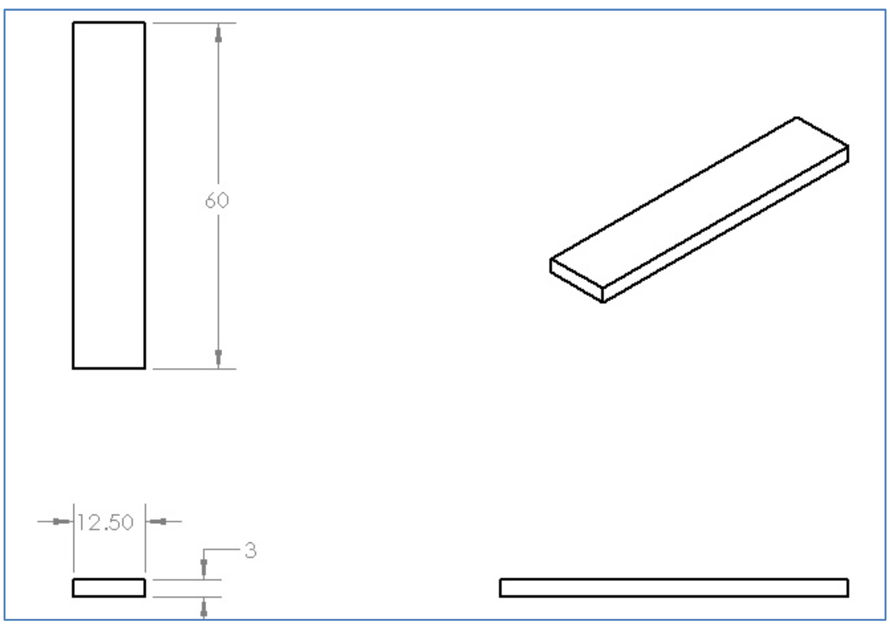


Figure AC (Drawing of probe stabilizer strip)

4) Test Method.

a. Mount the test probe horizontally (long axis parallel to the table saw top and perpendicular to the saw blade) in the probe holder except for a 12.5 mm portion of the probe extending past the holder. The test probe shall rest on the probe stabilizer strip for its entire length (Figure AD). The center axis of the test probe shall be 15 ± 2 mm above the table saw top surface.

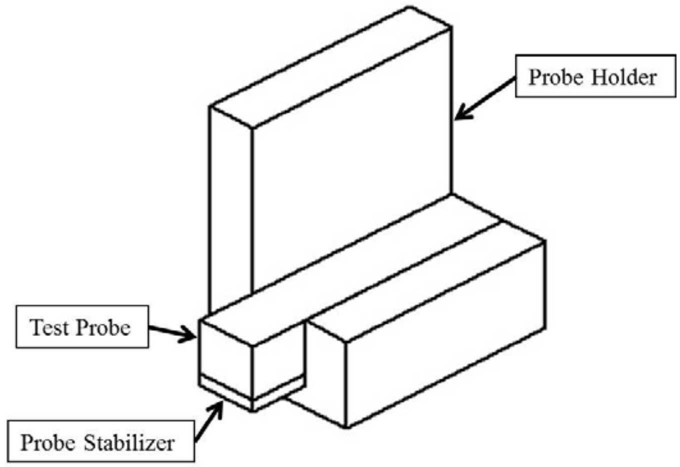


Figure AD (Probe assembly)

b. Connect the HBN to the test probe using a minimum 26 gage wire, as shown in Figure AE. The capacitance (C_s) of the HBN shall be initially set to 50 pF with subsequent sequential values of 66 pF, 100 pF, 200 pF, and a short circuit.

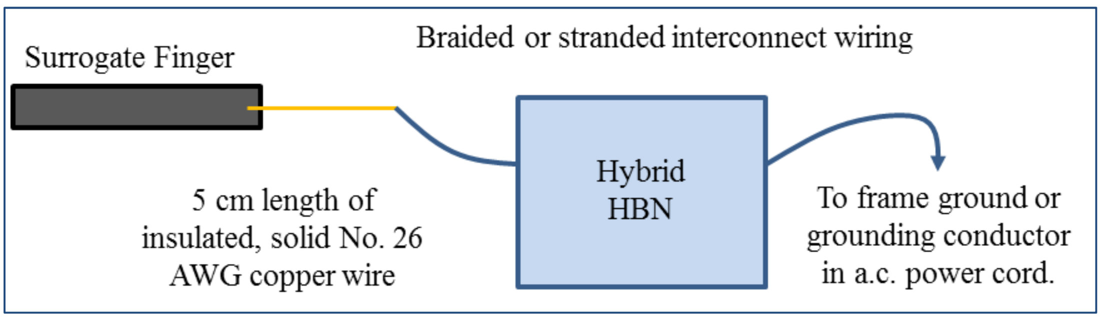


Figure AE (HBN connection)

c. Program the linear actuator to advance at a rate of 1 m/s and with a travel distance that ensures that the probe will fully contact the saw blade (Figure AF).

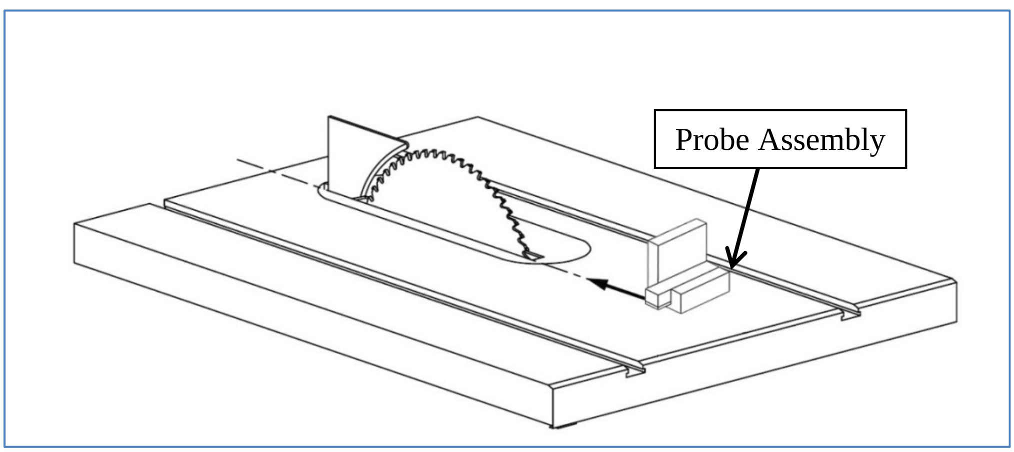


Figure AF (Probe Assembly on table saw)

5) Test Procedure

a. Set the table saw blade to its maximum height at 0 degree bevel.

b. Set the HBN capacitance (C_s) to 50 pF. Plug the table saw into an appropriate outlet and turn on power to table saw, allowing the AIM system to self-test.

c. Initiate rotation of table saw blade and allow it to spin at its normal speed.

d. Advance the test probe towards the spinning saw blade at the programmed rate of 1 m/s.

e. Upon activation of the AIM system, power off the table saw and remove the test probe for inspection.

f. Reset the AIM system

g. Repeat steps c. through f. with the next sequential HBN capacitance ($C_{s)}$.

h. Conduct on additional test run where HBN capacitance (C_s) is replaced by a short jumper, acting as a short circuit.

i. A table saw test sample may be replaced with a new table saw sample only if it becomes unusable, otherwise one table saw shall be used for all tests. Upon completion of AIMS testing, each table saw test sample shall comply with either (1) the dielectric voltage withstand test from the voluntary standard UL 987, *Stationary and Fixed electric Tools*, or (2) the electric strength test from the voluntary standard UL 62841-1, *Electric Motor-Operated Hand-Held Tools, Transportable Tools And Lawn And Garden Machinery - Safety - Part 1: General Requirements.*

6) Performance requirement.

a. For all five test runs, the depth of cut to the probe shall be 3.5 mm or less.

b. The depth of cut shall be determined by measuring the external horizontal (X) and vertical (Y) cuts on the probe to the nearest 0.1 mm and the following equation (Figure AF):

$$\text{Depth of Cut} = X \cdot Y/(X^2 + Y^2)^{1/2}$$

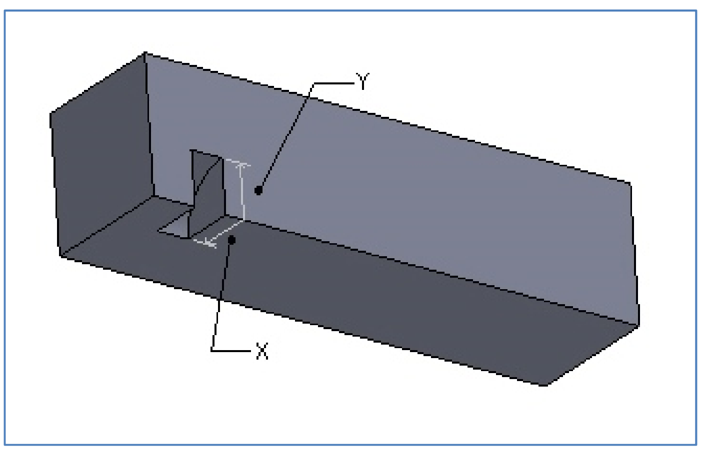


Figure AF (probe cut showing X and Y dimensions)

TAB B

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

Memorandum

Date: November 17, 2016

TO : Caroleene Paul
Table Saw Project Manager
Division of Mechanical and Combustion Engineering

THROUGH : Kathleen Stralka
Associate Executive Director
Directorate for Epidemiology

Steve Hanway
Director
Division of Hazard Analysis

FROM : Sarah Garland, Ph.D.
Mathematical Statistician
Division of Hazard Analysis

SUBJECT : Table Saw Blade-contact Injury Analysis*

Introduction

The National Electronic Injury Surveillance System (NEISS) is a national stratified probability sample of emergency departments in the United States and its territories, which provides the data to generate national estimates of emergency department-treated injuries related to consumer products. There are five strata in the NEISS: children's hospitals, small hospitals, medium hospitals, large hospitals, and very large hospitals. Within each stratum is a sample of hospitals that make up the primary sampling units (PSUs) of the NEISS. For each hospital in the sample, every first-time emergency department visit for an injury associated with a consumer product is recorded.[1] To facilitate injury estimates associated with a product or product group, each injury has a product code that identifies the type of product involved. Other product-specific information, such as the product manufacturer or events leading to the incident, is not recorded in the NEISS. Information abstracted from the emergency department medical record (and included in the NEISS) for each injury includes sex, age, diagnosis, disposition, and body part, among other information. Additional information about the NEISS can be found online at: http://www.cpsc.gov/en/Research--Statistics/NEISS-Injury-Data.

In 2001, the Consumer Product Safety Commission (CPSC) performed a NEISS special study[2] for stationary power saw-related injuries.[3] The results were published in a memorandum, "Injuries

[1] NEISS does not record return visits to the emergency department or other follow-up medical visits for the same injury.
[2] A NEISS special study is a follow-up survey of cases in the NEISS, completed as phone interviews of the patients or of someone with knowledge of the incident and injury, to gain further information about the product, incident, and injury associated with the emergency room visit. Using the statistical structure of the NEISS, additional methods are employed to allow for national estimates of emergency department treated injuries at more detailed

*This analysis was prepared by CPSC staff. It has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

Associated with Stationary Power Saws, 2001" (2001 NEISS special study).[4] In 2007, CPSC staff launched another stationary power saw special study, running through 2008. The report, "Survey of Injuries Involving Stationary Saws: Table and Bench Saws, 2007-2008" (2007-2008 NEISS special study), presented estimates of the numbers and types of emergency department-treated injuries related to table saws in this 2-year study and was published in March 2011.[5] In 2007, the voluntary standard, UL 987, seventh edition,[6] was published, which included requirements for a modular blade guard system, among other changes, with the effective date of January 31, 2010. Thus, conformance to the seventh edition was staggered, with some manufacturers conforming in 2007, and most manufacturers conforming to the standard by early 2010. In late 2011, CPSC's ANPR for table saws was published in the *Federal Register*.[7] The ANPR used the 2007-2008 NEISS special study estimates as the analytical backbone for discussion of table saw-related injuries. However, public comments submitted to the CPSC suggested that the 2007-2008 special study yielded a contradiction between the estimated numbers for each type of table saw and the estimated injuries of direct and indirect drives. CPSC staff conducted a re-analysis of the saw type and drive type responses provided by the injury victims in the 2007-2008 special study. Results of the re-analysis, published in June 2014, led staff to recommend that response integrity be considered when referencing saw type estimates from the 2007-2008 special study.[8]

Because the results from the June 2014 re-analysis indicated that the type of table saw reported in the 2007-2008 special study had inconsistencies that raised questions about the distribution of type of table saw in table saw-related injuries, staff initiated a 2014-2015 NEISS special study. This study, conducted by a contractor, collected computer-aided telephone interview (CATI) responses from individuals treated for stationary saw injuries, which included table saws, and unidentified type of saw-related injuries in emergency departments of NEISS member hospitals between July 2014 and December 2015. For injuries determined to be table saw-related, interviewers read definitions for each table saw type to the participants, and interviewers asked additional questions when the participant declared that the saw and drive type were not compatible.

Upon completion of the 2014-2015 NEISS special study CATI interviews and compilation of the data, CPSC subject matter experts and statisticians discovered unexpected patterns in participant response data across the 275 completed table saw surveys. Ninety-four percent (259) of the completed surveys were conducted by two interviewers from one company. Statistically significant differences between responses collected by the two interviewers were detected for critical questions, such as the type of table saw involved in the injury, use of safety features and activities preceding the injury. The "2014-

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levels than what is available through the NEISS alone. These studies are not performed on all cases in the NEISS, but on cases as CPSC staff has funding and need to perform. Special studies use the NEISS structure (that is, are in addition to the NEISS structure), but are not required as part of the NEISS structure.

[3] Stationary refers to the saw being stationary during operation, not the saw's portability.

[4] https://www.cpsc.gov/s3fs-public/pdfs/powersaw.pdf

[5] http://www.cpsc.gov//PageFiles/118311/statsaws.pdf

[6] The first edition of UL 987 was published in 1971. This original standard contained a blade guard requirement, which included a hood, spreader, and an anti-kickback device.

[7] ANPR Briefing Package: https://www.cpsc.gov/s3fs-public/pdfs/foia_tablesaw_0.pdf

[8] http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Home%20Maintenance%20and%20Construction/CoverpageandMemoofStaffAnalysisofTableSawTypeinNEISSSpecialStudy.pdf

2015 Table Saw Special Study Cautionary Statement" memorandum, dated November 21, 2016,[9] provides more details about the findings. CPSC senior statisticians recommend that the CATI interviewer-collected participant responses to the 2014-2015 NEISS special study results not be used for regulatory development.

In this memorandum, staff is relying only on data abstracted from NEISS for injuries related to product code 0841 (table or bench saws) for nationally representative estimates of table saw and/or blade-contact injuries. Staff's review includes estimates for the number of emergency department-treated, table saw blade-contact injuries for 2015, and trend analyses for table saw blade-contact injuries treated in emergency departments in the United States. In addition, staff compared the estimated table saw blade-contact injuries to the estimated number of all other consumer product-related injuries for 2015, and compared the estimated table saw blade-contact injuries to all other woodworking-related product-related injury estimates for 2015. Staff also analyzed the incidents reported to CPSC staff involving table saw blade-contact injuries and fatalities that are stored in other CPSC databases, other than the NEISS, from 2004 through 2015. The results are provided in this report.

Emergency Department-Treated, Table Saw Blade-Contact Injury Analysis Results for 2015

Starting with all of the NEISS cases associated with product code 0841 (all injuries recorded in the NEISS as associated with a table or bench saw) treated in 2015, CPSC staff reviewed and categorized the data, removing any cases that were not related to an operational table saw, and also classifying whether the injury could have been due to blade contact.[10]

In 2015, there are an estimated 33,400 table saw-related, emergency department-treated injuries. Of these, an estimated 30,800 (92 percent) are likely related to the victim making contact with the blade. As described in the Methodology section, the NEISS case narrative contains limited information related to the details of the incident; thus, these estimates may include some cases that do not involve blade contact, but no information is available to ascertain this. However, CPSC staff believes that most included in the blade-contact category are indeed blade-contact related. This leads to an overestimate in blade-contact injuries. However, also noted in the Methodology section of this memorandum in further detail, there are two product codes that are used with unspecified saw types (0845=*saws, not specified* and 0895=*power saws, other or not specified*), in which there are likely table saw-related injuries, including further blade-contact cases that were not utilized in generating estimated table saw blade-contact injury estimates in this memorandum. This leads to underestimates of table saw and blade-contact injuries. It is unknown to CPSC staff to what extent these two scenarios affect the estimates provided in this memorandum.

Table 1 provides the emergency department-treated, blade-contact injury estimates for the NEISS variables for age (provided in age groups in the table), sex, body part injured, diagnosis, disposition, and locale. Males represent the majority of blade-contact injuries (96.4%). There were no cases of children under age 12 among the blade-contact injuries; and there were only 16 cases of victims ages 12 through 20, which is not a sufficient number to generate a stable estimate of the number of blade-contact

[9] Tab F of the "Briefing Package, Notice of Proposed Rulemaking: Performance Requirements to Address Table Saw Blade-contact Injuries," CPSC, 2017.

[10] Further details are available in the Methodology section of this report.

injuries for the "≤20" age group. Approximately 75 percent of the estimated blade-contact injuries are within the age range of 41 through 80. The body part most frequently injured for blade-contact injuries is the finger (93.8%). The most common diagnosis in blade-contact injuries is laceration (58.8%), followed by fractures (19.0%) and amputations (15.2%); note that the proportions of amputations and fractures are not different statistically. Treated and released is the disposition for the majority of blade-contact injury victims (87.1%); however, a non-trivial proportion of injuries (12.3%) requires hospitalization.[11]

[11] Hospitalization refers to the combination of two NEISS dispositions: Treated and transferred, Treated and admitted.

Table 1: Victim and Injury Characteristics of Table Saw Blade-contact Injuries, 2015

	n	Injury Estimate: Estimate	CV†	95% Confidence Interval	Percent of Total: Estimate
Total	**642**	**30,800**	**0.09**	**25,400—36,200**	**100%**
Age Group					
≤20	16	*	*	*	*
21-30	51	2,200	0.16	1,500—2,800	7.0
31-40	76	3,800	0.18	2,500—5,200	12.5
41-50	96	4,100	0.15	2,900—5,300	13.2
51-60	133	6,400	0.14	4,600—8,100	20.7
61-70	153	8,200	0.14	5,900—10,400	26.6
71-80	88	4,300	0.16	3,000—5,600	14.0
81+	29	1,300	0.20	800—1,800	4.1
Sex					
Male	622	29,700	0.09	24,400—34,900	96.4
Female	20	*	*	*	*
Body Part					
Finger	592	28,900	0.10	23,200—34,500	93.8
Hand	46	1,600	0.18	1,100—2,200	5.3
Other	4	*	*	*	*
Diagnosis					
Laceration	372	18,100	0.11	14,200—22,000	58.8
Fracture	112	5,900	0.17	3,900—7,800	19.0
Amputation	119	4,700	0.18	3,000—6,300	15.2
Avulsion	37	2,000	0.24	1,100—2,900	6.5
Other	2	*	*	*	*
Disposition					
Treated and Released	537	26,800	0.10	21,600—32,100	87.1
*Hospitalized***	98	3,800	0.20	2,300—5,300	12.3
Other	7	*	*	*	*
Locale Where Injury Occurred					
Home	416	20,600	0.11	16,200—25,100	67.0
Unknown	223	10,100	0.19	6,400—13,900	32.9
Other	3	*	*	*	*

Cells marked by "" indicate an estimate that does not meet CPSC reporting limits.
**Hospitalization refers to the combination of two dispositions: treated and transferred, treated and admitted.
†Coefficient of variation (CV) is a measure of the dispersion of the data as a ratio of the standard deviation to the estimate. The higher the CV, the larger the dispersion is; for estimates derived from the NEISS, a CV over 0.33 is high.

Table Saw Blade-Contact Injuries Versus All Other Consumer Product-Related Injuries, 2015

Table 2 compares table saw blade-contact[12] emergency department-treated injuries from the 2015 NEISS to all other consumer product-related, emergency department-treated injuries in the same timeframe (January 1, 2015 through December 31, 2015). Note that all but one comparison show that there are statistically significant differences in the distribution of each variable for table saws versus all other consumer product-related injuries.

Using the age groups defined in other sections of this report, differences in the injury distributions of age groups are seen when comparing table saw blade-contact injuries to all other consumer product-related injuries. Older age groups represent larger proportions in table saws than with all other products. As noted, approximately 75 percent of the estimated table saw blade-contact injuries are within the age range of 41 through 80.[13] The proportion of all other consumer product-related injuries for the 41 through 80 age groups is approximately 30 percent.[14] Almost all injuries involving table saw blade contact involve males; whereas, with all consumer products, there is only a slightly larger male proportion. Thus, table saw blade-contact injuries affect a different age population and affect primarily one sex than for consumer products in general ($p<0.0001$ for both variables).

Injuries are more likely to occur at a home for table saw injuries than all other consumer product-related injuries ($p<0.0001$), although some caution is warranted in any conclusions, due to the substantial proportion in the “unknown” locale category. Therefore, the location where the injury occurred could be distributed across any of the locale categories in many ways if the information were known.

Body part, diagnosis, and disposition categories were collapsed to facilitate comparisons. Table saw blade-contact injuries have a much larger proportion of fingers than injuries associated with all other types of consumer products. The distribution of body parts injured for table saws is statistically different[15] than injuries associated with all other consumer products ($p<0.0001$). The distribution of diagnosis for table saw blade-contact injuries is statistically different than for all other consumer products ($p<0.0001$). Table saws injuries have significantly larger proportions of diagnoses for laceration and amputation. Table saws have a larger proportion, although a relatively small difference, in the

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[12] The caveats regarding the limitations in the data for blade contact (mentioned previously) remain: (1) There is limited information regarding the incident within the NEISS; thus, cases are likely included that are not blade contact within the 0841 product code and the methodologies applied, leading to overestimates in blade-contact injuries for that product code. (2) Table saw blade-contact cases are likely included within product codes 0845 and 0895; however, due to the limited information available in the NEISS regarding the product and incident scenario, these are not included in the estimates provided. This leads to underestimates of table saw blade-contact injuries. CPSC staff does not know to what extent either of these caveats affects the results.

[13] See Table 2 percentage of total column for table saws: 13.2 percent, 20.7 percent, 26.6 percent, and 14.0 percent for the 41-50, 51-60, 61-70, and 71-80 age groups, respectively.

[14] See Table 2 percentage of total column for all other consumer products: 8.9 percent, 9.2 percent, 7.4 percent, and 6.1 percent for the 41-50, 51-60, 61-70, and 71-80 age groups, respectively.

[15] Statistically different refers to a comparison that yield sufficient mathematical differences to say the differences in the estimates is not merely due to chance, concluding that there is likely a true difference in the population. When two estimates are not statistically different, any differences in estimates may be due merely by changes, and one cannot conclude that there are differences in the population.

hospitalized disposition for table saw blade-contact injuries than all other consumer products ($p=0.0095$).

An estimated 18.6 percent of all amputations in the NEISS are related to table saws (95% confidence interval of 14.4% to 22.8%).

Table 2: Comparison of Victim Characteristics for Table Saw Blade-Contact Injuries Versus All Other Consumer Product-Related Injuries, 2015

	Domain							
	Table Saws				*All Consumer Products (excluding table saws)*			Rao-Scott χ^2 p-value
	n	Estimate*	% of 30,800‡		n†	Estimate*	% of 14,098,700‡	
Total	**642**	**30,800**	**100%**		**358,425**	**14,098,700**	**100%**	N/A
Age Group***								
≤20	16	*	*		168,496	5,513,200	39.1	<0.0001
21-30	51	2,200	7.0		40,098	1,709, 000	12.1	
31-40	76	3,800	12.5		30,973	1,384,500	9.8	
41-50	96	4,100	13.2		27,878	1,257,700	8.9	
51-60	133	6,400	20.7		29,082	1,290,600	9.2	
61-70	153	8,200	26.6		22,123	1,039,900	7.4	
71-80	88	4,300	14.0		17,817	860,200	6.1	
81+	29	1,300	4.1		21,923	1,042,900	7.4	
Sex**								
Male	622	29,700	96.4		195,134	7,438,000	52.8	<0.0001
Female	20	*	*		163,291	6,660,800	47.2	
Locale								
Home	416	20,600	67.0		161,190	6,564,100	46.6	<0.0001
Unknown	223	10,100	32.9		98,418	3,820,100	27.1	
Other	3	*	*		98,817	3,714,600	26.3	
Body Part								
Finger	592	28,900	93.8		29,987	1,209,800	8.6	<0.0001
Hand	46	1,600	5.3		17,089	732,000	5.2	
Other	4	*	*		311,349	12,157,000	86.2	
Diagnosis								
Laceration	372	18,100	58.8		63,727	2,510,600	17.8	<0.0001
Fracture	112	5,900	19.0		54,210	2,037,500	14.5	
Amputation	119	4,700	15.2		584	20,400	0.1	
Other	39	2,200	7.0		239,904	9,530,200	67.6	
Disposition								
Treated and Released	537	26,800	87.1		323,369	12,768,300	90.6	0.0095
Hospitalized#	98	3,800	12.3		29,203	1,120,300	7.9	
Other	7	*	*		5,853	210,100	1.5	

*CVs for the table saws for reported estimates range from 0.09 to 0.24. CV's for estimates for the other products range from 0.07 to 0.25.
**Two observations are classified as unknown sex in the NEISS in the timeframe. These two observations were omitted to facilitate comparisons. This does not affect any conclusions or comparisons.
***To facilitate comparisons, 35 observations with unknown ages are not used in the age group analysis; thus, the statistics provided for age group do not necessarily sum exactly to totals. This does not affect any conclusions.
†This "n" is smaller than all of the NEISS, due to cases omitted from the product code 0841 (see Methodology section) as not related to a table saw or blade contact.
‡Percentages are calculated prior to rounding. #Hospitalization refers to the combination of two dispositions: treated and transferred, treated and admitted.

Table Saw Blade-Contact Injuries Versus All Other Workshop Product-Related Injuries, 2015

Notably, all consumer product-related injuries follow different distributions for the NEISS variables (that is, there are different sets of proportions of injuries for categories for each variable) than the more specific group of wood working or home improvement workshop product-related injuries (hereafter called "workshop products").[16] These workshop products range across power and manual tools, such as sanders, routers, lathes and drills, as well as an array of other tools and equipment. Thus, it is of value also to compare table saw blade-contact injuries[17] to the specific group of workshop product-related injuries to identify table saw-specific hazard patterns, compared to all other workshop products, if any. This section summarizes the results from the comparison of table saw blade-contact injuries to all other workshop product-related injuries.

Table 3 compares table saw blade-contact emergency department-treated injuries from the 2015 NEISS to all other workshop product-related, emergency department-treated injuries in the same timeframe (January 1, 2015 through December 31, 2015). Note that all comparisons show that there are statistically significant differences in the distribution of each variable for table saw blade-contact injuries versus all other workshop product-related injuries.

Table saw blade-contact injuries affect a different age population and also affect a specific sex than workshop products in general ($p<0.0001$ for both). Almost all injuries related to table saw blade-contact involve males; whereas, with all other workshop products, there is a larger male proportion than female, but not as pronounced as with table saw blade-contact injuries. When comparing table saw blade-contact injuries to all other workshop product-related injuries, differences in the distributions of age groups exist. Older age groups represent larger proportions for table saw blade-contact than other workshop products. As noted previously, approximately 75 percent of the estimated table saw blade-contact injuries are within the age range of 41 through 80. The proportion of all other workshop product-related injuries for the 41 through 80 age groups is approximately 50 percent, which is a larger proportion than all other consumer product-related injuries, but still less than table saw blade-contact injuries. Considered differently, the estimated mean age for table saw blade-contact injuries is 55.6 years old, with a 95 percent confidence interval of (54.2, 57.0); whereas, all other workshop product-related injuries have an estimated mean age of 42.7 years, with a 95 percent confidence interval of (41.9, 43.6). This approximate 13-year difference in the mean age of injuries is a statistically significant

[16] Workshop products are defined as the NEISS product codes: 0803, 0804, 0805, 0807, 0808, 0809, 0814, 0823, 0827, 0828, 0829, 0830, 0832, 0834, 0836, 0841, 0842, 0843, 0845, 0847, 0855, 0856, 0857, 0858, 0862, 0864, 0869, 0870, 0871, 0875, 0878, 0879, 0881, 0882, 0893, 0894, 0895, 0897, 0898, and 0899. As mentioned in other sections of this report, product codes 0845 and 0895 may contain reports of table saws, but it is not possible to ascertain which cases are related to table saws based on the information available in the NEISS.

[17] The caveats regarding the limitations in the data for blade contact (mentioned previously) remain: (1) There is limited information regarding the incident within the NEISS; thus, cases are likely included that are not blade contact within the 0841 product code and the methodologies applied, leading to overestimates in blade-contact injuries for that product code. (2) Table saw blade-contact cases are likely included within product codes 0845 and 0895; however, due to the limited information available in the NEISS regarding the product and incident scenario, these are not included in the estimates provided. This leads to underestimates of table saw blade-contact injuries. CPSC staff does not know to what extent either of these caveats affects the results.

difference (p-value < 0.0001), indicating that table saw blade-contact injuries involve older victims than injuries related to all other workshop products.

Injuries are more likely to occur at a home for table saw blade-contact injuries than all workshop products, in general (p=0.0049), although some caution is warranted in drawing any conclusions due to the substantial proportion of the "unknown" location category. Thus, the location where the injury occurred could be distributed across any of the locale categories in many ways, if the information were known.

Body part, diagnosis, and disposition categories were collapsed to facilitate comparisons. Table saw blade-contact injuries represent a larger proportion of injuries to fingers than injuries associated with all other workshop products; the distribution of body parts injured for table saw blade-contact is statistically different than the distribution of injuries associated with all other workshop products (p<0.0001). The distribution of diagnosis for table saw blade-contact injuries is statistically different than for all other workshop products (p<0.0001); table saw blade-contact injuries have significantly larger proportions of diagnoses for laceration, amputation, and fractures, than injuries associated with all other workshop products.

When table saw blade-contact injuries are compared to workshop product-related injuries, there is a statistically significant difference detected in the distribution of the disposition of table saw blade-contact injuries than injuries related to all other workshop products (p<0.0001). The proportion of hospitalized table saw blade-contact injuries is larger than the hospitalizations associated with all other workshop products.

Table saw blade-contact amputations account for an estimated 52.4 percent of all amputations related to workshop products (table saws plus all other workshop products), with a 95 percent confidence interval of 44.8 percent to 60.0 percent.

Table 3: Comparison of Victim Characteristics for Table Saw Blade-Contact Injuries Versus All Other Workshop Product-Related Injuries, 2015

	Domain							
	Table Saws				*All Workshop Products (excluding table saws)*			Rao-Scott
	n	Estimate*	% of 30,800†		n	Estimate*	% of 270,500†	χ^2 p-value
Total	**642**	**30,800**	**100%**		**5,313**	**270,500**	**100%**	
Age Group								
≤20	16	*	*		702	29,500	10.9	<0.0001
21-30	51	2,200	7.0		943	46,300	17.1	
31-40	76	3,800	12.5		952	50,400	18.6	
41-50	96	4,100	13.2		979	50,400	18.6	
51-60	133	6,400	20.7		887	46,000	17.0	
61-70	153	8,200	26.6		536	30,000	11.1	
71-80	88	4,300	14.0		243	13,800	5.1	
81+	29	1,300	4.1		71	4,100	1.5	
Sex								
Male	622	29,700	96.4		4,582	234,600	86.7	<0.0001
Female	20	*	*		731	35,900	13.3	
Locale								
Home	416	20,600	67.0		2,976	158,900	58.8	0.0049
Unknown	223	10,100	32.9		2,152	103,300	38.2	
Other	3	*	*		185	8,300	3.1	
Body Part								
Finger	592	28,900	93.8		2,022	101,800	37.6	<0.0001
Hand	46	1,600	5.3		838	44,400	16.4	
Other	4	*	*		2,453	124,300	46.0	
Diagnosis								
Laceration	372	18,100	58.8		2,562	132,100	48.8	<0.0001
Fracture	112	5,900	19.0		378	18,600	6.9	
Amputation	119	4,700	15.2		108	4,200	1.6	
Other	39	2,200	7.0		2,265	115,600	42.8	
Disposition								
Treated and Released	537	26,800	87.1		5,027	258,400	95.5	<0.0001
Hospitalized‡	98	3,800	12.3		219	8,700	3.2	
Other	7	*	*		67	3,300	1.2	

*CVs for the table saws for reported estimates range from 0.09 to 0.24. CV's for estimates for the all other workshop products range from 0.08 to 0.20.
†Percentages are calculated prior to rounding.
‡Hospitalization refers to the combination of two dispositions: treated and transferred, treated and admitted.

Emergency Department-Treated, Table Saw Blade-Contact Injury Trend Analysis, 2004-2015

Applying the same data processing methods for product code 0841 in the NEISS for 2015 to all years from 2004 through 2015, CPSC staff assessed trends for table saw blade-contact injuries. As such, the caveats previously mentioned apply: (1) There is limited information regarding the incident within the NEISS; thus, cases are likely included that are not blade contacts within the 0841 product code, leading to overestimates in blade-contact injuries for that product code. (2) Table saw blade-contact cases are likely included within product codes 0845 and 0895; however, due to the limited information available in the NEISS regarding the product and incident scenario, these are not included in the estimates provided. This leads to underestimates of table saw blade-contact injuries. CPSC staff does not know to what extent either of these caveats affects the results.

This set of years includes a timespan before the voluntary standard requiring the modular blade guard was implemented or fully implemented (2004-2009) and a timespan after the implementation of the voluntary standard (2010-2015). Table saws that are manufactured prior to the current voluntary standard remain in use throughout this whole time period. However, in more recent years after the current voluntary standard became effective, there is an increasing proportion of table saws in use that conform to the current voluntary standard. Thus, if the voluntary standard was impacting the number or severity of injuries, there would be a steady decrease in the number of injuries or severity of injuries as the proportion of compliant saws increase.

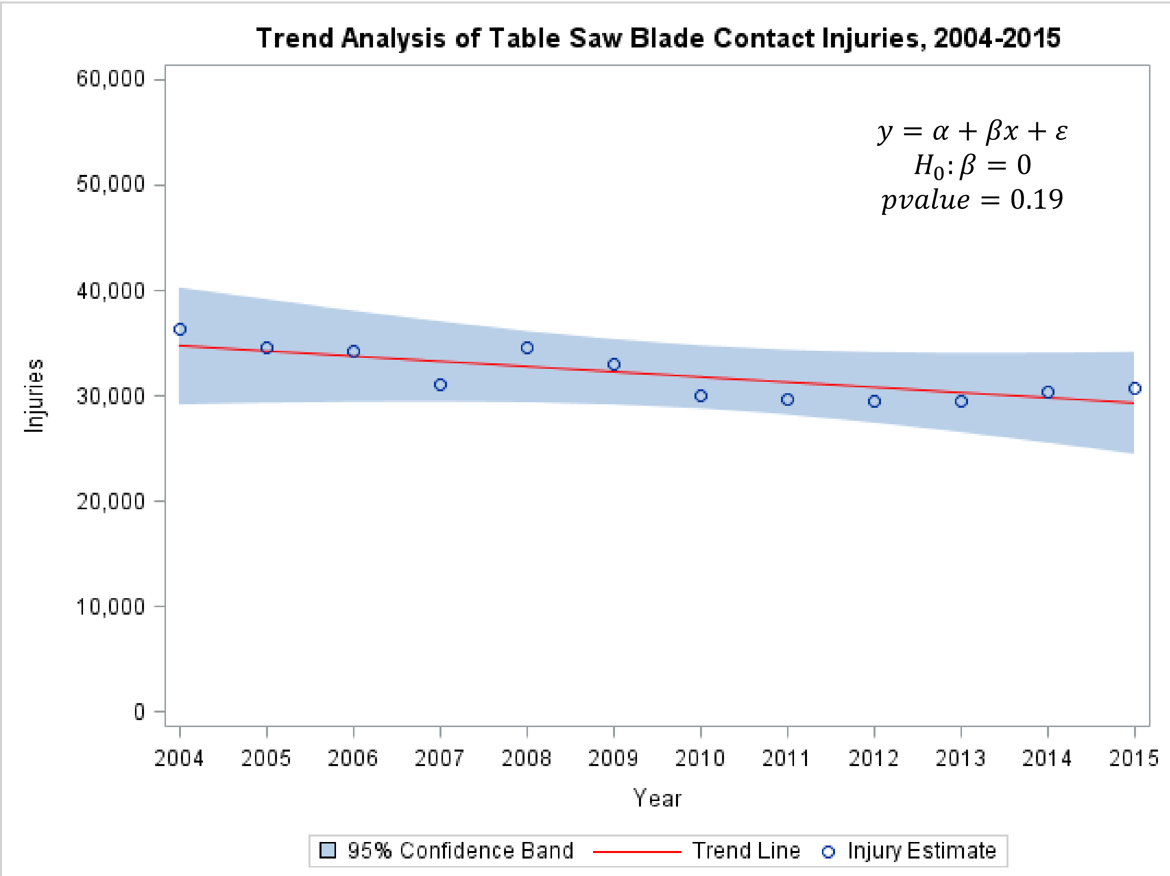
Table 4 provides the estimated numbers of table saw blade-contact, emergency department-treated injuries from 2004 through 2015.

Table 4: NEISS Estimates for Table Saw Blade-Contact Injury Estimates, 2004-2015

	Table Saw Blade-contact Injury Estimates			
Year	**n**	**Estimate**	**CV**	**95% Confidence Interval**
2015	642	30,800	0.09	25,100—36,500
2014	631	30,300	0.08	25,300—35,300
2013	662	29,500	0.09	24,500—34,500
2012	648	29,500	0.09	24,100—34,900
2011	632	29,600	0.09	24,300—35,000
2010	657	30,100	0.10	24,000—36,200
2009	714	33,000	0.10	26,500—39,500
2008	723	34,600	0.09	28,700—40,500
2007	694	31,100	0.09	25,400—36,700
2006	766	34,200	0.09	27,900—40,400
2005	812	34,500	0.09	28,300—40,700
2004	773	36,300	0.09	29,600—43,100

Figure 1 provides the estimated blade-contact injuries associated with table saws and the fitted trend line with a 95 percent confidence band for the fitted line from 2004 through 2015. The p-value associated with the slope of the fitted line is 0.19, which indicates that there is not a statistically significant trend in blade-contact injuries associated with table saws.

Figure 1: Trend Analysis of Table Saw Blade-Contact-Related Injuries, 2004-2015



To assess any changes across time in the severity of table saw blade-contact injuries, CPSC staff performed trend analyses for blade-contact amputations, hospitalizations (includes two dispositions: treated with admission and treated with transfer), and finger/hand injuries. No trend was detected in any of these analyses (p-values=0.44, 0.53, and 0.17 for amputations, hospitalizations, and finger/hand injuries, respectively). Table 5 provides the estimated number of blade-contact injuries from 2004 through 2015, for amputations, hospitalizations, and finger/hand injuries from blade contact, with the percentage of each to the total number of estimated blade-contact injuries (Table 4).

Table 5: NEISS Injury Estimates for Table Saw Blade-Contact Amputations, Hospitalizations, and Finger/Hand Injuries, 2004-2015

	Amputations		Hospitalizations		Finger/Hand Injuries	
Year	*Estimate (95% CI)*	*% of blade contact injuries*	*Estimate (95% CI)*	*% of blade contact injuries*	*Estimate (95% CI)*	*% of blade contact injuries*
2015	4,700 (3,100—6,300)	15.2%	3,800 (2,300—5,300)	12.3%	30,500 (24,900—36,100)	99.1%
2014	4,000 (2,400—5,500)	13.1%	3,100 (1,700—4,400)	10.1%	29,400 (24,600—34,300)	97.2%
2013	3,400 (2,300—4,600)	11.7%	3,000 (1,800—4,200)	10.2%	29,200 (24,300—34,200)	99.2%
2012	4,100 (2,700—5,600)	13.9%	2,900 (1,300—4,400)	9.8%	29,100 (23,700—34,400)	98.7%
2011	3,900 (2,700—5,100)	13.2%	2,900 (1,900—3,900)	9.9%	29,400 (24,200—34,700)	99.3%
2010	3,500 (2,500—4,500)	11.6%	2,800 (2,000—3,600)	9.2%	29,800 (23,700—36,000)	99.2%
2009	4,100 (3,000—5,200)	12.5%	3,000 (2,000—3,900)	9.0%	32,500 (26,100—38,900)	98.5%
2008	3,700 (2,700—4,600)	10.6%	2,600 (1,700—3,400)	7.4%	34,200 (28,300—40,100)	98.7%
2007	3,900 (2,600—5,200)	12.6%	3,000 (1,800—4,100)	9.5%	30,700 (25,100—36,200)	98.7%
2006	4,300 (3,100—5,500)	12.5%	2,700 (1,600—3,800)	7.9%	33,700 (27,500—39,900)	98.7%
2005	4,600 (3,100—6,200)	13.5%	2,800 (2,000—3,600)	8.2%	34,100 (28,000—40,200)	98.9%
2004	5,100 (3,600—6,700)	14.1%	2,900 (1,900—3,900)	8.0%	36,000 (29,300—42,800)	99.2%

Considering all analysis results, there is insufficient evidence to conclude that the number of blade-contact injuries and the type or severity of blade-contact injuries has changed in the given timeframe, 2004-2015.

Thus far, trend analyses have not included the rate of injury; that is, the trend is for the number of injuries, not the risk of injury (*i.e*., the rate of injury, measured by numerator as the estimated number of injuries and a denominator of exposure estimate). Additional data are required for risk analysis. Using the population of the United States as a surrogate denominator is not informative in this situation, as there is a relatively small and unknown proportion of the U.S. population exposed to table saws. Possible trend analysis on the rate of injuries could include the number of injuries by population of table saw users, the number of table saws in use, or the number of hours table saws are in use in a non-occupational setting. Of these, CPSC staff has access to only one, the estimated number of table saws in use for each year.[18] The following summarizes the analysis of the estimated number of injuries per 10,000 table saws in use.

Table 6 gives the estimated blade-contact injuries per 10,000 table saws in use for each year in the analysis, 2004-2015. Figure 2 provides the trend analysis results for the estimated number of injuries per 10,000 table saws in use including the fitted trend line with a 95 percent confidence band. The p-value associated with the slope of the fitted line is 0.29, which indicates that there is not a statistically significant trend.[19]

[18] CPSC's Directorate for Economics provided the estimated numbers of table saws in use for this analysis.
[19] This analysis does not account for usage patterns of table saws.

Table 6: Estimated Table Saw Blade-Contact Injuries per 10,000 Table Saws in Use, 2004-2015

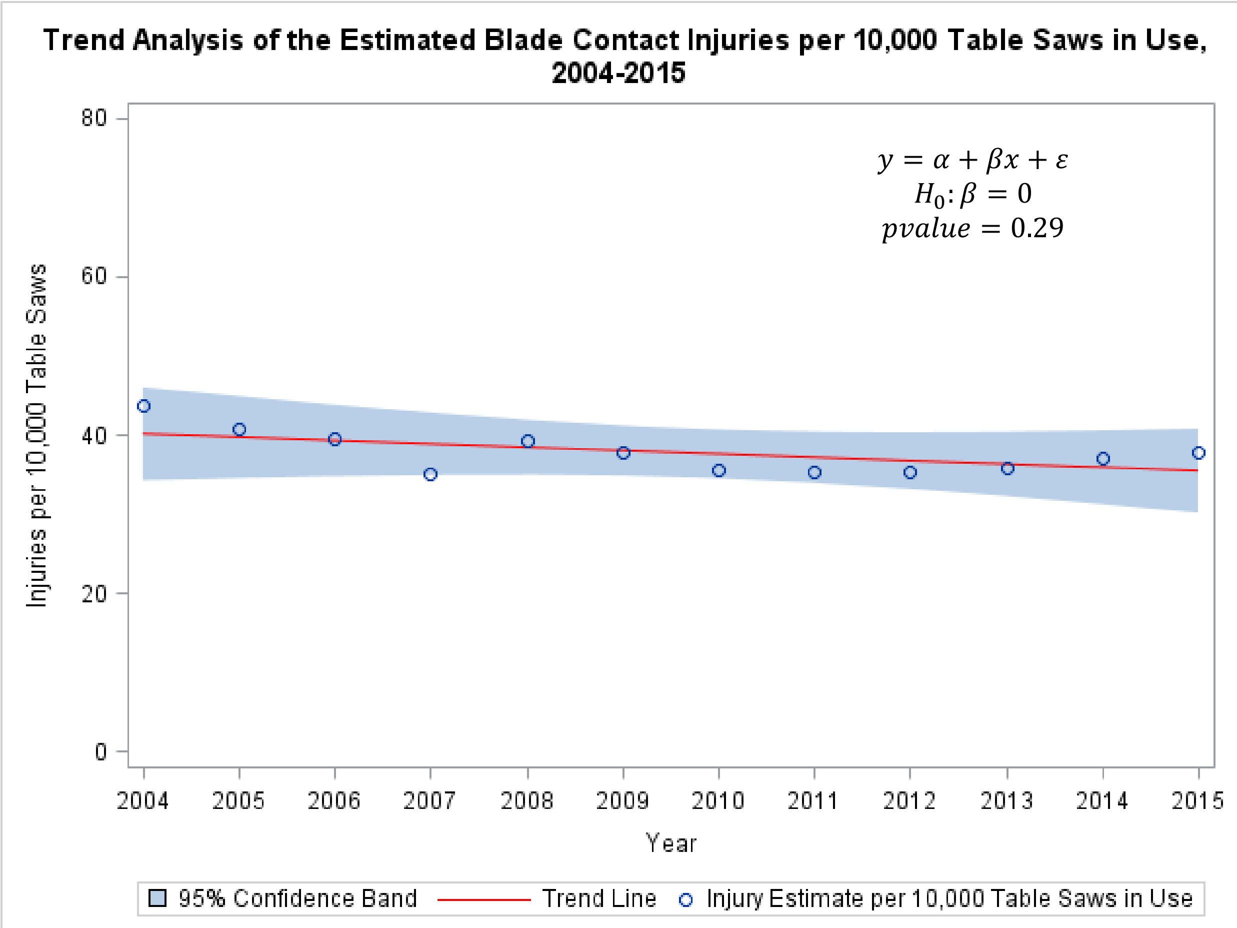
Year	Table Saw Blade-contact Injury Estimates		Estimated Number of Table Saws in Use (in 10,000s)*	Estimates** of Table Saw Blade-contact Injury per 10,000 Table Saws in Use	
	Blade Contact Injury Estimate	95% Confidence Interval	Table Saws in Use Estimate[20]	Estimate[21]	95% Confidence Interval
2015	30,800	25,100—36,500	813.8	37.8	30.9—44.8
2014	30,300	25,300—35,300	818.6	37.0	30.8—43.2
2013	29,500	24,500—34,500	824.0	35.8	29.8—41.8
2012	29,500	24,100—34,900	832.5	35.4	28.9—41.9
2011	29,600	24,300—35,000	838.9	35.3	29.0—41.7
2010	30,100	24,000—36,200	847.7	35.5	28.3—42.7
2009	33,000	26,500—39,500	873.1	37.8	30.3—45.3
2008	34,600	28,700—40,500	881.5	39.3	32.6—45.9
2007	31,100	25,400—36,700	882.5	35.2	28.8—41.5
2006	34,200	27,900—40,400	865.0	39.5	32.2—46.7
2005	34,500	28,300—40,700	846.3	40.8	33.5—48.0
2004	36,300	29,600—43,100	829.4	43.8	35.7—51.9

*CPSC's Directorate for Economics provided the estimated numbers of table saws in use for this analysis.
**Estimates are calculated from the exact number of injuries point estimate, not the rounded estimate.

[20] No estimates of variance or covariance associated with the number of table saws in use were calculated. CPSC staff determined that the ability to detect trend is increased by omission of the variance-covariance associated with the denominator variable (thus, creating a more conservative approach). Variance for will increase if using both numerator and denominator variance and covariance structures; this makes it harder to detect trend mathematically. However, CPSC staff determined that there is minimal impact on the analyses performed, and conclusions are unlikely to change if another method was chosen.

[21] CVs for estimates are equivalent to the CVs for injury estimates, due to no variance estimates being used for the denominator estimates.

Figure 2: Blade-Contact Injuries per 10,000 Table Saws in Use Trend Analysis, 2004-2015



Reported Incidents with Table Saw Blade-Contact Injuries (CPSRMS), 2004-2015

Table saw-related incidents are not commonly reported to CPSC through means other than the NEISS. However, CPSC staff has received a small number of reports of table saw-related injuries through other means, such as news articles, consumer-submitted reports, attorney-submitted reports, and manufacturer and retailer reports. Table saw incidents reported through means other than the NEISS are stored in CPSC's Consumer Product Safety Risk Management System (CPSRMS) database.

CPSC staff reviewed all reports in the CPSRMS associated with the product code 0841 (table saws) with incident dates of January 1, 2004 through December 31, 2015. The incident dates chosen match the trend analysis performed on the NEISS for table saws. This data set was then pared down by removing records:

(1) when no injury occurred;
(2) when the injury was not related to blade contact;[22]
(3) associated with the NEISS;[23]
(4) associated with an occupational injury;
(5) when the saw was reported to have certain types of defects, such as the saw turning on without operator input, not turning off when the off switch was activated, or the motor exploding[24]; or
(6) identified as a duplicate report of an incident.

Additional review of the incidents by subject matter experts yielded variables for the type of saw, the type of blade guard the saw was equipped with originally,[25] stock movement during the incidents, the use of the blade guard at the time of the incidents, and an injury description.

Thus, this analysis is strictly limited in scope, and in the possible conclusions that can be drawn. This is not a representative sample of all blade-contact injuries. Injury estimates from the NEISS should be used

[22] For example, the saw or blade guard breaking and hitting the victim is not a blade-contact injury. If an injury was not explicitly stated to have been from the victim contacting the blade, then the record was removed; although it seems likely that a laceration or amputation is related to contact with the blade, this is not the only way such an injury can occur. Also, blade contact was not assumed to have resulted in an injury, although it does seem likely; an injury had to be stated explicitly in the record to have been included, although the nature of the injury did not have to be described. Thus, CPSRMS incident inclusion criteria are more stringent than the NEISS case review for blade contact. This was done based on the capability of reported incidents to contain more detailed descriptions of the incidents and the anecdotal nature of the analyses related to these reported incidents.

[23] Automatically excluded reports are retailer reports that were submitted based on the retailer receiving a NEISS special study completed IDI and then reporting that incident back to CPSC. Also excluded was any case directly from the NEISS. This was done to reduce the duplication of information within this report.

[24] However, reports of blade-contact injury, where defects were possibilities for the blade guard, rip fence, splitter, and/or riving knife were not removed.

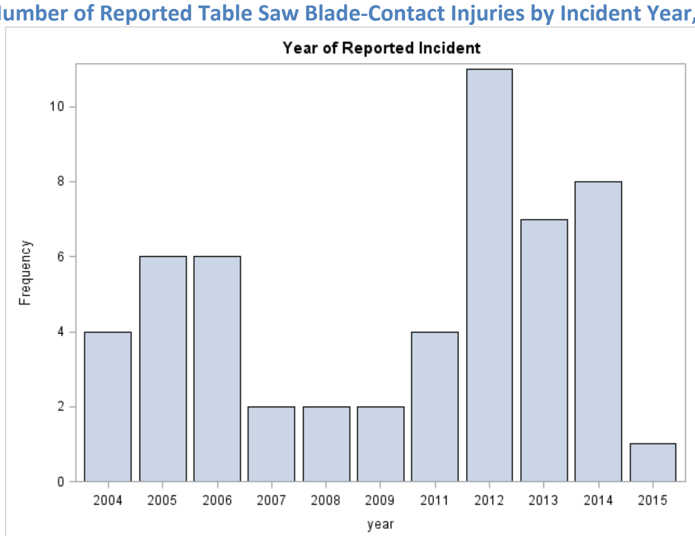
[25] Some assumptions were used in coding the type of blade guard that the saw was equipped with originally. Prior to 2007, the blade guard, if present, is almost certainly a traditional blade guard, and incidents occurring prior to 2007 have blade guard type reflecting this. In 2007, UL 987 seventh addition (with modular blade guard requirements) was released with the effective date of 1/31/2010. Thus, between 2007 and 2010, the blade guard on a newly manufactured table saw could have been either (though more likely to be modular as the time frame moves on, and less likely at the start of that time frame); thus, if a type of blade guard could not be discovered for a saw purchased during this time period, then "unknown" coding was used. After 2010, it is assumed that any newly manufactured table saw is equipped with a modular blade guard, and so coded, if the details in the report supported a saw manufactured in this timeframe.

for nationally representative estimates of table saw and/or blade-contact injuries. Incident reports stored in CPSRMS are anecdotal reports of blade-contact injuries. Any reported incidents that were not definitively blade-contact injuries were removed. Thus, this analysis is not a comparison of blade-contact injuries versus no blade-contact injuries (again, see the NEISS for any such analyses). Also, one cannot use these reports to understand trend or magnitude of the number of blade-contact injuries; again, any such analysis should come from the NEISS. Instead, this analysis is used to understand scenarios and the injuries associated with table saw blade-contact injuries that cannot be discovered within the NEISS or a NEISS special study.

After review of all incident reports, there are a total of 53 incidents reported to CPSC by March 1, 2016, and reported to have occurred between January 1, 2004 and December 31, 2015. Note that data collection is ongoing for the years 2013, 2014, and 2015, and it is possible for CPSC staff to receive additional reports of blade-contact injuries that occurred during this timeframe. This section summarizes the 53 reported blade-contact injuries.

Figure 3 shows the number of reported incidents by year. As stated previously, these reports cannot be used to determine the frequency of table saw blade-contact injuries. However, Figure 3 shows that CPSC staff has received more reports of blade-contact injuries in recent years, with 26 of the 53 reports (49 percent) occurring in 2012, 2013, or 2014. This could be driven by changes in reporting, which, in addition to the small number of reported table saw blade-contact injuries, makes comparisons, before and after the introduction of the modular blade guard, difficult. See the NEISS trend analysis section in this report for analysis of the frequency of table saw blade-contact injuries across time.

Figure 3: Number of Reported Table Saw Blade-Contact Injuries by Incident Year, 2004-2015



Age of the victim was unknown in 28 of the 53 reported incidents. Of the remaining 25 reports with known victim age, the median age is 56 years. The victim's sex was known for all 53 incidents; 50 of the 53 victims were male. These are similar to the distributions seen in the NEISS analyses reported in previous sections of this report.

Table 7 provides the distribution of the type of table saw in reported incidents.

Table 7: Table Saw Type for Reported Blade-Contact Injuries, 2004-2015

Saw Type	Frequency	Percent
Bench saw[26]	26	49.1
Contractor saw	22	41.5
Cabinet saw	2	3.8
Unknown	3	5.7
Total	**53**	**100.0**

* Due to rounding errors, totals may not equal 100.

Also recorded in the review of incidents was any incident with unexpected stock movement. Table 8 summarizes incidents according to whether there was any unexpected stock movement. There is a majority of unknown statuses, thus, making conclusions difficult. However, of the incidents with known status, most experienced some type of unexpected stock movement.

Table 8: Unexpected Stock Movement for Reported Table Saw Blade-Contact Injuries, 2004-2015

Unexpected Stock Movement	Frequency	Percent
Yes	20	37.7
No	4	7.5
N/A[27]	1	1.9
Unknown	28	52.8
Total	**53**	**100.0**

* Due to rounding errors, totals may not equal 100.

[26] One incident involved a 4-inch table saw, also known as a mini or micro table saw.
[27] Stock movement is "N/A" in one incident where the victim was not performing a cut at the time of blade contact. Reportedly, the victim started the saw accidently, and a nearby object pulled the victim's hand into the blade.

For each of the 53 reported incidents, the type of blade guard that came with the saw was recorded, and also whether the blade guard was in use at the time of the incident. Table 9 provides the frequency of the type of blade guard by the use of the blade guard. There are large proportions of unknowns for the blade guard use, making conclusions difficult.

Table 9: Type of Blade Guard by Blade Guard Use for Reported Table Saw Blade-Contact Injuries, 2004-2015

Frequency (Row Percent)	**Blade Guard in Use**				
Type of Blade Guard	*Yes*	*No*	*Unknown*	*N/A*[28]	**Total**
Modular	1 9.1%	1 9.1%	9 81.8%	0 0.0%	**11**
Traditional	7 19.4%	7 19.4%	19 52.8%	3 8.3%	**36**
Other/Unknown[29]	1 16.7%	2 33.3%	3 50.0%	0 0.0%	**6**
Total	**9**	**10**	**31**	**3**	**53**

[28] Blade guard use is recorded as "N/A" in three incidents, when blade guard use was either impossible (Dado cut, molding attachment on a saw from the 1950s), or the victim started the saw accidently, and his hand was pulled into the blade by a nearby object.

[29] For the six incidents in the blade guard type of "Other/Unknown": one incident is in the "other" category where the blade guard description did not fully meet the traditional description, but the saw manufactured in the time span of traditional blade guards; the remaining 5 incidents in this category were classified as "unknown" blade guard type due to the limited information provided.

Figure 4 displays the number of incidents by blade guard type, while Figure 5 shows blade guard use by incident year, for the 53 reported incidents. The type of blade guard starts changing in 2012, in the reported incidents with the first known modular blade guard saw involved in a reported injury. Changes in blade guard use patterns are not possible to ascertain from this analysis, due to the large proportions of unknowns.

Figure 4: Blade Guard Type by Incident Year for Reported Table Saw Blade-Contact Injuries, 2004-2015

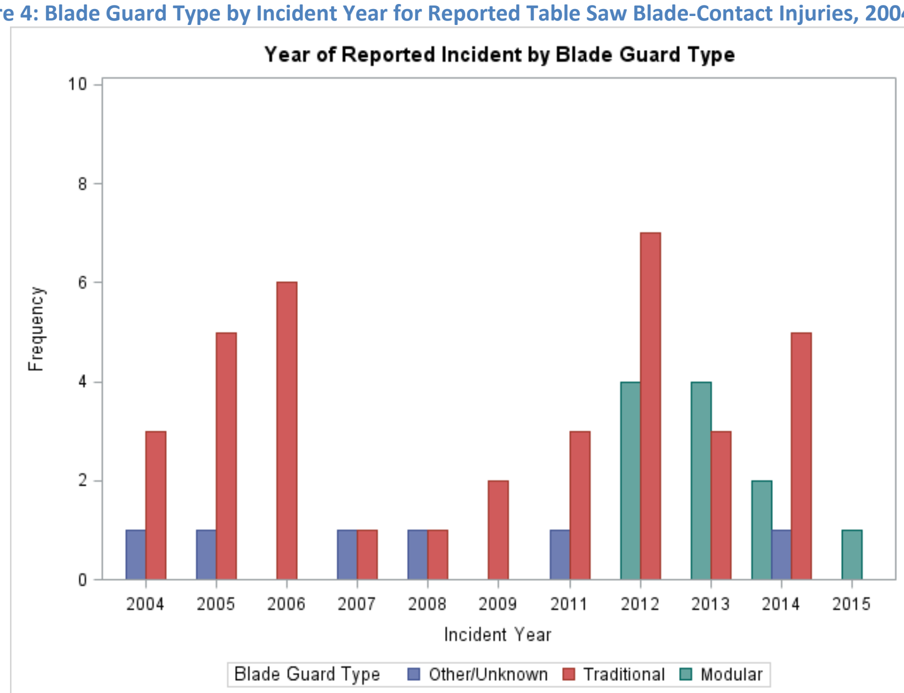
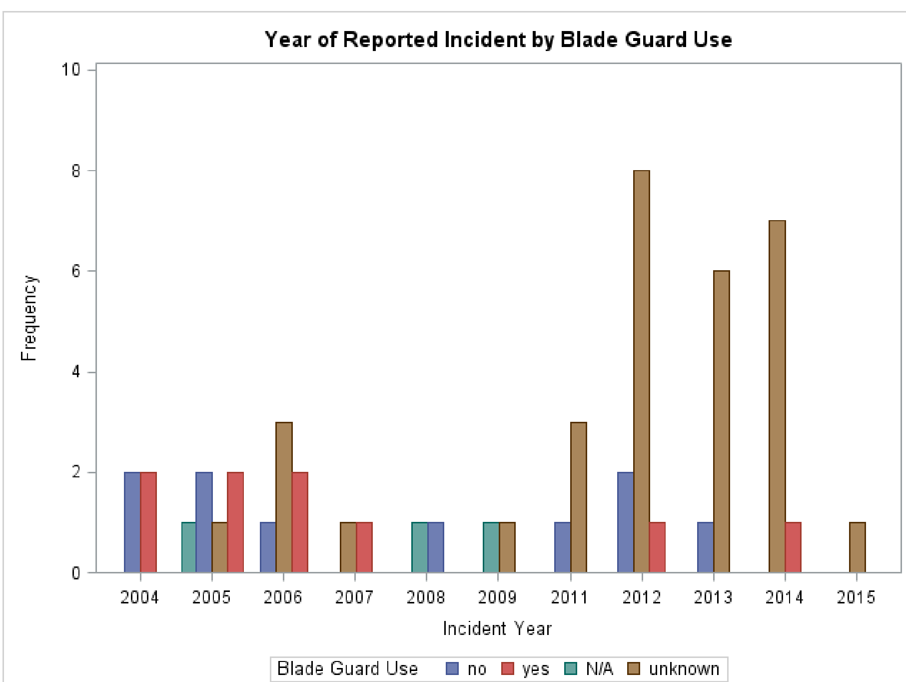


Figure 5: Blade Guard Use by Incident Year for Reported Table Saw Blade-Contact Injuries, 2004-2015



The type of injury was recorded for each incident. Again, the distribution is different than the NEISS, with the majority of reported incidents having amputations. Table 10 shows the distribution of injuries in the reported incidents.

Table 10: Injury Description for Reported Table Saw Blade-Contact Injuries, 2004-2015

Injury	Frequency	Percent
Amputation	29	54.7
Amputation and Laceration	4	7.5
Fatal Laceration	1	1.9
Laceration	7	13.2
Laceration and Fracture	1	1.9
No Details Provided	11	20.8
Total	**53**	**100.0**

There were three victims recorded as a death in CPSRMS for table saws. Two of the victims had amputation injuries from the table saw and underwent reattachment or transplant surgery. It was reported that one died from "complications to reattachment surgery" with other medical conditions contributing, and the other from "pulmonary thromboembolizations." CPSC's Directorate for Health Sciences staff determined that the exact cause of death is unclear or the cause of death is related to the medical treatment received. Therefore, these two deaths are not attributable directly to the table saw, and are counted as injuries, not fatalities, in relation to the table saw blade contact. This leaves only one fatality related directly to a table saw, where a 56-year-old male lacerated his right wrist due to blade contact. Subsequently, he died due to the blood loss from the laceration.

Table 11 shows the frequency of the scenarios based on the type of blade guard by injury type. Scenario descriptions are presented for some of the reported injuries for both modular and traditional blade guards. Again, limited conclusions can be drawn from the analysis of reported incidents, and the NEISS results should be used for statistical conclusions. However, this section offers insight into the scenarios surrounding injuries related to table saws.

Table 11: Injury Description by Type of Blade Guard for Reported Table Saw Blade-Contact Injuries, 2004-2015

Injury	Type of Blade Guard*			
	Modular	*Traditional*	*Other/Unknown/NA*	**Total**
Amputation	4	21	4	**29**
Amputation and Laceration	0	3	1	**4**
Fatal Laceration	0	1	0	**1**
Laceration	2	4	1	**7**
Laceration and Fracture	1	0	0	**1**
No Details Provided	4	7	0	**11**
Total	**11**	**36**	**6**	**53**

*Table 9 shows that it is often unknown whether a blade guard was in use at the time of the incident. This table does not breakdown the type of injury and type of guard by whether the blade guard was in use or not.

The remainder of this section extracts text from incident reports describing the incident scenario leading to the injury. Note: Not all 53 reports are summarized, but only a small selection of the reported incidents. This section is intended to provide the reader with an understanding of specific types of scenarios reported to CPSC staff regarding blade-contact injuries.

Provided for each report description in this section is a unique identifier of the report in the CPSRMS database. Also provided for each is the type of table saw in the incident, whether the blade guard was in use or not, and the injury description. The reports are split into two subgroups: one for the traditional blade guards and one for the modular blade guards.

<u>Blade-contact Injury Scenarios Related to Table Saws with Traditional Blade Guards</u>

Of the 36 reported incidents involving a table saw with a traditional blade guard, three incident scenarios are quoted below from the incident reports.

060822CNE1370 (contractor saw; blade guard in use; amputation):

> The victim was a handyman and had 38 years of experience conducting home repairs to customers and his own home. He had numerous other electric hand tools and saws and used them daily. The victim had used a table saw previously but had not owned one. No one else used the table saw….
>
> On this day he was repairing six foot slats for the wooden fence that surrounded his home. He had pulled the table saw outside to allow him sufficient room to wield the wooden pales [sic].
>
> At approximately 1500 hours, without describing the actual incident…the victim indicated that the pieces of wood would occasionally jamb at the point the wood would contact the safety mechanism behind the rotating blade. Please see the photographs in the exhibits. This would not happen often but it would occur periodically.

The table saw completely severed the victim's 2nd and 3rd finger, and the 4th finger was dangling by a piece of skin of his left hand. The 5th finger was cut in half approximately. The two severed fingers struck the victim's chest and gently stuck to the front of his T-shirt.

081027HCC1109 (contractor saw; no blade guard in use; fatal laceration):

According to the police investigator, the man was experienced in doing hobby type woodworking. His wife told investigators that her husband was building kitchen cabinets for their son. He used his heated attached garage area for the project. The man had a history of diabetes but controlled it with medication.

The day of the incident the man did not have any alcoholic beverage. He was in his heated garage assembling the cabinets. He wife was not home. His son last talked to him at three PM.

Sometime between 3 PM and 4:30 the man was cross cutting a two by two piece of pine. A ripping blade was installed in the table saw. The typical, clear plastic, floating guard for the saw was not installed over the blade. The filler plate around the blade itself was installed. His exact motions or position are unknown.

The man apparently placed his right wrist in the blade area and lacerated his wrist. He then went to a table area and tried to use a rag to stop the bleeding. He died.

The man's wife returned home and when she looked for her husband she found him dead. He was lying on the floor of the work shop / garage. The police report and autopsy are attached. The incident was ruled as accidental.

141120CNE0001 (cabinet saw; blade guard in use; amputation and laceration):

…student was hospitalized after severing a finger and cutting two other fingers while using a table saw in a technology class. The student was taken to a local hospital and later transferred to a metropolitan hospital in another state where surgeons re-attached the finger. The table saw was equipped with a blade guard; the saw was properly grounded; and the student was wearing protective eyewear at the time of the incident. The superintendent for the school district stated that the student is expected to make a full recovery but may be left with some stiffness in the re-attached finger…

According to the school's technology teacher, the student was using a 35 to
40 year-old table saw with a two year-old 3.0 horsepower replacement motor capable of 3480 rpm. The saw was equipped with a grounded 4 pronged twist electrical plug with 220V power supplied through the lab's circuit breaker panel. The instructor stated that the table saw received regular maintenance and is "tuned up" each fall when a new blade is installed; and routine annual maintenance, including fence adjustment (if necessary), lubrication and belt replacement, is completed by the instructor or by the supervisor of building and grounds…

> Both the technology instructor and the superintendent of schools explained that the student saw the piece of wood begin to ride up on the saw blade and, contrary to all safety instructions and warnings, reached in past the guard to push the wood back down; accordingly, the student's hand came into contact with the spinning blade, severing a finger and cutting two other fingers as well.

Blade-Contact Injury Scenarios Related to Table Saws with Modular Blade Guards

Of the 11 reported incidents involving a table saw with a modular blade guard, two incident scenarios are quoted below from the incident reports.

131022HCC1048 (contactor saw; no blade guard in use; laceration injury):

> The female victim indicated that she took shop classes at her high school and was familiar with the use of a table saw. She stated that on the day of the incident she had prepared to rip pine 2 X 2s down to 1 X 2s to be utilized on a section of fence. The lumber was used lumber rather than new.
>
> She also indicated that her husband at some point had changed the ten inch blade which came with the saw and placed another brand blade on it….The saw fence and square were original saw components.
>
> She stated that the saw has been moved to the garage area but at the time of the incident it was located in a room off of the garage where their wood burning stove is located….
>
> The victim said that her husband had taken the guard off of the saw and she did not know where he had placed it. She stated that the 2 X 2s were four to five feet in length.
>
> The victim stated that on March 09, 2012, she began ripping the four to five foot long 2 X 2s in half (lengthwise), which would create one inch board widths. The victim said she had the saw fence set to approximately a one inch width from the blade. She also said that in the ripping process the boards were directly against the fence. She stated that she had ripped seven or eight boards and that she was actually ripping the last board when the incident occurred. She said that she had her right hand to the front of the board and her left hand pushing from the rear, which was closest to her body. In doing so the board kicked back. When the board kicked, it pushed the board and her right hand upward and away from the saw blade. During that upward action the rear of the board was pulled toward the blade along with her left hand and thumb. She suffered a severe laceration to her left thumb from the blade."

H1210179A (portable bench saw; blade guard in use; laceration injury):

"The consumer says the guard does not cover the blade completely. The consumer says about 4 inches of the blade is exposed. The consumer says he has run these machines for over 40 years...The unit comes with a plastic push kit but he says his thumb came into contact with the blade and is going to require surgery."

Conclusions

Table Saw Blade-Contact Injury Analysis

Starting with all the NEISS cases associated with product code 0841 (*i.e*., all injuries recorded in the NEISS as associated with a table saw), CPSC staff reviewed and categorized the data, removing any cases that were not related to an operational table saw, and also classifying whether the injury could have been due to blade contact.[30] In 2015, there are an estimated 33,400 table saw, emergency department-treated injuries. Of these, it is estimated that 30,800 (92 percent) are likely related to the victim making contact with the blade.

- Males represent the majority of blade-contact injuries (96.4%).
- There were no cases of children under age 12 among the blade-contact injuries, and there were only 16 cases of victims ages 12 through 20, which is not a sufficient number to generate a stable estimate of the number of blade-contact injuries for the "≤20" age group. Approximately 75% of injuries are within the age grange of 41 through 80.
- The body part most frequently injured for blade-contact injuries is the finger (93.8%).
- The most common diagnosis in estimated blade-contact injuries is laceration (58.8%), followed by fractures (19.0%) and amputations (15.2%); note that the proportions of amputations and fractures are not different statistically.
- Treated and released is the disposition for the majority of blade-contact injury victims (87.1%); however, a non-trivial proportion of injuries (12.3%) are hospitalized.

Comparisons for Hazard Pattern Identification

Table saw blade contact emergency department-treated injuries were compared to all other consumer product-related emergency department-treated injuries, which enables identification of demographic groups and hazard patterns that are specific to table saw blade contact emergency department-treated injuries. Also performed were comparisons between table saw blade-contact injuries and all other woodworking workshop product-related injury estimates to identify any demographic groups and hazard patterns that are specific to table saw blade-contact injuries within groups that are more likely to have been exposed to table saws.

- Table Saws Blade-contact Injuries Versus All Other Consumer Product-Related Injuries
  - There is a statistically significant difference in the distributions between table saw blade-contact injury estimates and all other consumer products injury estimates for age group, sex, diagnosis, body part injured, and locale. When compared to all other consumer products, table saw blade-contact injuries present for males and in older age groups, and most commonly involve laceration and amputation injuries of the finger.

[30] Further details are available in the Methodology section of this report, however, two caveats should be considered in drawing any conclusions for any blade-contact injury estimates in this memorandum: (1) There is limited information regarding the incident within the NEISS; thus, cases are likely included that are not blade contact within the 0841 product code and the methodologies applied, leading to overestimates in blade-contact injuries for that product code. (2) Table saw blade-contact cases are likely included within product codes 0845 and 0895; however, due to the limited information available in the NEISS regarding the product and incident scenario, these are not included in the estimates provided. This leads to underestimates of table saw blade-contact injuries. CPSC staff does not know to what extent either of these caveats affects the results.

    - An estimated 18.6 percent of all amputations in the NEISS are related to table saw blade contact (95% confidence interval of 14.4% to 22.8%).

- Table Saws Blade-contact Injuries Versus All Other Workshop Product-Related Injuries
    - There is a statistically significant difference in the distributions between table saw blade-contact injury estimates and woodworking workshop product-related injury estimates for age group, sex, disposition, diagnosis, body part injured, and locale. Though the differences were not as pronouced as with all other conusmer products, when compared with all other workshop products, older males with laceration and amputation injuries of the finger present as the demographic and hazard pattern for table saw blade-contact injuries.
    - Table saw blade-contact amputations account for an estimated 52.4 percent of all amputations related to workshop products, with a 95 percent confidence interval of 44.8 percent to 60.0 percent.

<u>Trend Analysis of Injuries and Injuries per 10,000 Table Saws in Use</u>
Trend in table saw blade-contact injuries was assessed from 2004 through 2015:

- For table saw blade-contact injuries from 2004-2015, the p-value associated with the slope of the fitted line is 0.19, which indicates that there is not a statistically significant trend in the number of injuries associated with table saw blade contact.
- Other trend analyses performed on table saw blade-contact injury data for this time frame include: trend on amputations, hospitalizations (includes two dispositions: treated with admission and treated with transfer), and finger/hand injuries. No trend was detected in any of these analyses (p-values = 0.44, 0.53, and 0.17 for amputations, hospitalizations, and finger/hand injuries, respectively).
- CPSC staff concludes that there is no discernible change in the number of blade-contact injuries or type of injuries related to table saw blade contact from the timespan before the voluntary standard was implemented (2004-2009) to the time span after the voluntary standard's implementation (2010-2015).

Possible analyses on the rate of blade-contact injuries for table saws could include the number of blade-contact injuries by population of table saw users, the number of table saws in use, or the number of hours table saws are in use in a non-occupational setting, among others. Of these, CPSC staff has access to only one, the estimated number of table saws in use for each year, which is calculated by CPSC's Directorate for Economic Analysis.

- The trend analysis for the estimated blade-contact injuries per 10,000 table saws found insufficient evidence to show trend in the estimated blade-contact injuries per 10,000 table saws in use (p-value = 0.29). CPSC staff concludes that there is no trend in the in estimated blade-contact injuries per 10,000 table saws in use from 2004-2015.

<u>Other Reported Table Saw Blade-contact Injuries</u>
Table saw blade-contact incidents are not commonly reported to CPSC through means other than the NEISS; however, CPSC staff has received a small number of reports (53) of table saw blade-contact injuries through means such as news articles, consumer-submitted reports, attorney-submitted reports, and manufacturer and retailer reports. CPSC staff reviewed all reports associated with the product code 0841 (table saws) with incident dates January 1, 2004 through December 31, 2015.

- Any statistical comparisons, trend, and hazard pattern analyses should be completed through the NEISS results. Analysis of anecdotal reports received by CPSC staff indicate that these reports do not follow the NEISS statistically representative injury results, and this anecdotal analysis should be used only to understand reported scenarios in further detail.

- Of the 53 reported blade-contact injuries, 29 are classified as amputations, 4 as an amputation and laceration, 7 as lacerations, 1 as a laceration and fracture, and 1 as a fatal laceration.
- Of the 53 reported blade-contact injuries, 36 are associated with a traditional blade guard as part of the original equipment on the table saw. Of those 36, seven were reported to be using the blade guard at the time of injury, seven were reported to not be using the blade guard, 19 had an unknown guard use status, and three were not able to use the blade guard ("N/A" guard use status).
- Of the 53 reported blade-contact injuries, 11 are associated with a modular blade guard as part of the original equipment on the table saw. Of those 11, one was reported to be using the blade guard at the time of injury, one was reported to not be using the blade guard, and nine have unknown guard use status.

Methodology for the NEISS Analyses

As stated previously, the NEISS is a national stratified probability sample of emergency departments in the United States and its territories, which provides the data to generate national estimates of emergency department-treated injuries related to consumer products. There are five strata in the NEISS: children's hospitals, small hospitals, medium hospitals, large hospitals, and very large hospitals. Within each stratum is a sample of hospitals which make up PSUs of the NEISS. For each hospital in the sample, every first-time emergency department visit for an injury associated with a consumer product is recorded.[31] To facilitate injury estimates associated with a product or product group, each injury has a product code which identifies the type of product involved. Other product-specific information, such as the product manufacturer or events leading to the incident, is not recorded in the NEISS. Information abstracted from the emergency department medical record (and included in the NEISS) for each injury includes sex, age, diagnosis, disposition, and body part, among other information. Further information about the NEISS can be found online at http://www.cpsc.gov/en/Research--Statistics/NEISS-Injury-Data.

The NEISS provides product information associated with each case by recording up to two product codes associated with a case. The product code for table saws is 0841. Starting with all the NEISS cases associated with product code 0841 (this is, all injuries recorded in the NEISS as associated with a table or bench saw), CPSC staff reviewed and categorized the data, removing any cases that were not related to an operational table saw, and also classifying whether the injury could have been due to blade contact. This was completed on every case associated with the product code 0841, with date of treatment recorded as January 1, 2004 through December 31, 2015, resulting in a review of 9,300 NEISS cases.

For each of the 9,300 cases associated with the table saw product code (0841) with treatment years 2004 through 2015, the first level of review involved removing any cases where the injuries were not related to an operational table saw. Thus, cases not saying "table saw" were excluded (*e.g.*, cases that only use the word "saw" not "table saw," cases where the injury was related to a park bench, or cases where the saw was a homemade table saw). Cases indicating a "circular table saw" were removed. Cases where it was unclear that the injury was from a table saw were removed (*e.g.*, cases using wording like "table saw v chain saw," where it is not absolutely certain that the saw was a table saw). Cases were removed when a victim tripped over, fell into, or ran into a table saw and the table saw was not operational. Cases were removed when the injury was related to the table saw being transported, such as the table saw being carried or lifted. Finally, cases were omitted that were related to sore knees, elbows, backs, shoulders, etc. from using the product for an extended period of time, overuse injuries. There are cases where it is possible that although "table saw" was used to describe the type of saw, narratives also included descriptions such as "table saw which slipped" which might indicate a circular saw instead of a table saw; however, because "table saw" is used to identify the saw type, these are included in the table saw category.

Different types of injuries can occur when using a table saw, some of which do not include blade contact, such as injuries related to only kickback of the stock. Thus, the next level of review for each case was to include the case in blade contact or not. First, diagnoses of lacerations, fractures, amputations, and avulsions that were for body parts below the elbow (not including the elbow), were all classified as blade contact, then staff reviewed the NEISS narratives to determine if any were described as not blade

[31] NEISS does not record return visits to the emergency department or other follow-up medical visits for the same injury.

contact. CPSC staff assumes blade contact unless there is specific evidence otherwise (based on body part, diagnosis, and narrative), because there is such little and inconsistent information across NEISS narratives related to the incident. Thus, unless otherwise stated in the NEISS narrative, staff considered these combinations of diagnosis and body part to involve blade contact. CPSC staff reviewed the cases for the remaining combinations of diagnosis and body part for any that could be blade contact. Cases were included from this group only if the NEISS narrative indicated a hazard pattern of blade contact while using a table saw.

Given the limited amount of information related to the incident available within the NEISS, CPSC staff applied this methodology for assessing if blade contact occurred or not. Thus, some cases are likely included that are not blade contact within the 0841 product code, leading to overestimates in blade-contact injuries. However, table saw blade contact cases are likely included within product codes 0845 (saws, not specified) and 0895 (power saws, other or not specified). Due to the limited information available in the NEISS regarding the product and incident scenario, these cases are not identifiable as table saw and blade contact, and these are not included in the estimates provided. This leads to underestimates of table saw blade-contact injuries. CPSC staff does not know to what extent either of these caveats affects the results.

The variance-covariance matrix for each trend model was built, which accounts for the survey structure of the NEISS (*i.e.*, the dependent relationship between yearly estimates in the NEISS). A heterogeneous first-order autoregressive variance-covariance matrix structure was chosen as suitable for accessing each trend scenario for table saw blade-contact injuries.

TAB C

Preliminary Regulatory Analysis of the Draft Proposed Rule for Table Saws

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U.S. Consumer Product Safety Commission
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Executive Summary

There are three primary categories of table saws: bench, contractor, and cabinet. Bench saws tend to be lightweight, portable, and with several exceptions, are generally priced from about $150 to $1,000. Bench saws are generally intended for consumer use, but are also used at work-sites. Contractor saws are larger, heavier, and more powerful than bench saws, and are generally priced from $500 to $2,000. Cabinet saws (also referred to as stationary saws) weigh from about 300 to 1,000 pounds, are not portable, and are generally priced from about $1,200 to $5,000. While these saws are all used by consumers to some extent, contractor and cabinet saws are more likely to be used by professional and occupational users.

A total of 22 firms are known to supply table saws in the U.S. market. Annual sales averaged about 675,000 units during the 2002 to 2014 time frame. Bench saws may account for about 75 percent of sales, while contractor and cabinet saws account for the remainder. The larger manufacturers tend to produce the bench saws, while most of the contractor and cabinet saws are produced by smaller firms.

The draft proposed rule would address table saw blade-contact injuries by setting performance requirements for table saws that would limit the depth of cut to a test probe to 3.5 millimeters, under specified test conditions. To meet this performance requirement, table saws would use an active injury mitigation (AIM) system, an unspecified technology that actively serves to mitigate blade-contact injury resulting from a rotating saw blade, by braking or retracting the saw blade.

Based on estimates from National Electronic Injury Surveillance System (NEISS) and the CPSC's Injury Cost Model (ICM), the draft proposed rule would address an estimated 54,850 medically treated blade-contact injuries annually. The societal costs of these injuries (in 2014 dollars and using a 3 percent discount rate) amounted to about $4.06 billion in 2015. Amputations accounted for about 14 percent of the medically treated blade-contact injuries but almost two-thirds of the injury costs. Overall, medical costs and work losses account for about 30 percent of these costs, or about $1.2 billion. The intangible costs associated with pain and suffering account for the remaining 70 percent of injury costs.

Because of the substantial societal costs attributable to blade-contact injuries, and the expected high rate of effectiveness of the proposed requirements in preventing severe blade-contact injuries, the estimated *gross* benefits of the draft proposed rule (*i.e.*, the expected reduction in societal costs) could amount to an average of about $2,300 to $4,300 per saw. Based on one year's production and sale of table saws, aggregate gross benefits could range from about $970 million to $2,450 million annually.

The draft proposed rule would also be costly and would result in some disruption of the table saw market. Under the rule, table saw manufacturers would need to develop their own AIM technology, without impinging on existing patents. Or, what is more likely, they would license the patented AIM technology that already exists. Most, if not all, table saw models not already incorporating the AIM technology would require major design changes and the retooling of production facilities, a process that would likely take 2 years or more to accomplish.

Additionally, higher manufacturing costs may lead to sharply rising retail prices, reduced sales, and the exit of some firms from the U.S. market.

Estimates of the increased manufacturing cost, as well as the expected costs of replacement parts for the AIM system, range from about $230 to $540 per bench saw, to about $375 to $925 per contractor saw, and to about $400 to $950 per cabinet saw. These higher costs would likely be mitigated, somewhat, over time, but the extent of any future cost reduction is unknown. Based on 1 year's production and sale of table saws, aggregate gross costs could range from about $170 million to $340 million annually.

Because of the increased costs of producing table saws, and the resulting increase in retail prices, some consumers who would have purchased table saws at the lower pre-regulatory prices will choose not to purchase new table saws. The cost impact of the draft proposed rule on market sales may be substantial, potentially reducing aggregate sales by as much as 14 percent to 38 percent annually. In addition to the adverse impact on table saw producers, the sales decline will result in lost utility to consumers who choose not to purchase table saws because of the higher prices. Furthermore, some difficult to quantify reductions in consumer utility may result from the added weight, and hence, reduced portability associated with the AIM systems.

Because of these likely impacts, several small manufacturers recently interviewed have indicated that the prospective cost of redesigning their saws to incorporate the AIM technology may be too great, relative to their sales volume, to support such a redesign. They reported that they might respond by reducing or eliminating their offerings of table saws to the U.S. market.

Based on our benefit and cost estimates, net benefits (*i.e.*, benefits minus costs) for the market as a whole (*i.e.*, combining the three types of table saws together) amounted to an average of about $1,500 to $4,000 per saw. Aggregate net benefits on an annual basis could amount to about $625 million to about $2,300 million. Net benefits varied, but they generally remained positive in our sensitivity analysis.

Because we had no information on the distribution of injuries across saw types (*i.e.*, bench, contractor, and cabinet saws), we were unable to evaluate directly the benefits and costs for each type of saw. However, based on several assumptions, we were able to conduct a breakeven analysis by estimating the approximate number of injuries that would have to be substantially mitigated for each type of saw for the benefits to equal or exceed the costs. This analysis suggested that, under most plausible injury distributions, the benefits would be likely to exceed the costs for each saw type.

Our analysis also discussed several alternatives to the draft proposed rule, including:

- a no action alternative;
- pursuing further improvement in the table saw voluntary standard;
- extending the effective dates for a rule;
- exempting certain categories of table saws from the draft proposed rule;
- limiting the applicability of the performance requirements to some, but not all, table saws;
- pursuing an information and education campaign to better inform the public of the hazards of blade contact, and the benefits of the AIM technology.

These alternatives would reduce the expected benefits of the draft proposed rule, but they would also mitigate costs and potential disruptions in the marketplace. In particular, the alternatives could, individually or in combination, reduce the adverse impacts of the draft proposed rule on manufacturers (including small manufacturers), allow for greater choice in the types and safety characteristics of the table saws that consumers can purchase, reduce the impact of the draft proposed rule on table saws intended for commercial or professional use, and directly address the market failures resulting in the need for a product safety rule in the first place.

1. Introduction

In April 2003, Stephen Gass, David Fanning, and James Fulmer, representing SawStop, petitioned the Consumer Product Safety Commission (CPSC) to promulgate a mandatory standard for a system to reduce or prevent severe injuries from contact with the blade of a table saw. The petitioners asserted that 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 spinning blade during operation (CPSC, 2011). The request was docketed as CP03-2 and published in the *Federal Register* for comment (CPSC, 2003).

In July 2006, CPSC voted to grant Petition CP03-2, and directed staff to draft an advance notice of proposed rulemaking (ANPR). However, the CPSC lost its quorum in 2006, and was unable to publish an ANPR at that time. The ANPR was ultimately published in the *Federal Register* in 2011 (CPSC, 2011). The Commission is now considering a draft proposed rule that would address blade-contact injuries with a performance requirement intended to actively stop the blade or otherwise limit exposure to a rotating table saw blade when it detects flesh.

1.1. Draft Proposed Rule

The draft proposed rule is intended to address blade-contact injuries involving table saws. The proposal includes a performance requirement that would limit the depth of cut to a test probe of 3.5 millimeters (mm) when approaching the operating blade at a rate of 1 meter per second. The limit of 3.5 mm was selected for the requirement because such a limit would generally prevent serious injuries – those requiring the need for microsurgery (Amodeo and Gill, 2016, at Tab A]). According to Backstrom et al. (2014), a depth of 4 mm (0.16 inches) is the maximum depth for a cut to a finger before serious injury is sustained.

To meet this performance requirement, table saws would use an active injury mitigation (AIM) system, an unspecified technology that actively serves to mitigate or prevent a severe blade-contact injury resulting from a rotating saw blade (*e.g.*, by braking or retracting the blade). Conceptually, AIM technology is a two-phased system that: (1) *detects* contact between the rotating blade and a finger or a hand, and (2) *reacts* to mitigate a blade-contact injury. The AIM technology currently in the marketplace relies on electrical detection of contact between a table saw operator and the rotating saw blade. The reaction system then limits the potential for laceration, by stopping and/or removing the rotating blade from the point of body contact (Amodeo and Gill, 2016, at Tab A).

To conduct the test for conformance to the draft proposed rule, the table saw would be assembled according to manufacturer's instructions and recommendations, with the exception that any blade guard will have been left off or removed (Amodeo and Gill, 2016, at Tab A). Then, under specified test conditions, a probe is made to approach the operating blade at a rate of 1 meter per second. After the probe contacts the blade and the AIM system has been activated, and the power to the table saw has been turned off, the probe is examined. The table saw passes the test if the depth of cut in the probe is 3.5 millimeters or less.

The draft proposed rule would also prohibit the manufacture or importation of noncomplying table saws in any period of 12 consecutive months between the date of promulgation of the final rule and the effective date, at a rate that is greater than 120 percent of the rate at which they manufactured or imported table saws during the base period for the manufacturer. The base period is any period of 365 consecutive days, chosen by the manufacturer or importer, in the 5-year period immediately preceding promulgation of the rule. Thus, the stockpiling limit would allow manufacturers and the industry to meet any foreseeable increase in the demand for table saws, without allowing large quantities of table saws to be stockpiled.

2. Need for the Rule

With the publication of the 2011 ANPR (CPSC, 2011), the Commission initiated a regulatory proceeding to consider whether a new performance safety standard is needed to address an unreasonable risk of injury posed by table saw blade contact. In describing hazards associated with table saw blade contact, the ANPR discussed the results of a study of table saw blade-contact injuries conducted in 2007-2008 by CPSC staff. The study estimated approximately 66,900 blade-contact injuries over the 2-year period (Chowdhury and Paul, 2011).

More recently, during 2015, there was an estimated 30,800 blade-contact injuries treated in U.S. hospital emergency departments (Garland, 2016, at Tab B). This estimate was based on injuries reported through the CPSC's National Electronic Injury Surveillance System (NEISS), a statistical sample of about 96 hospital emergency departments (ED) located throughout the United States (Schroeder and Ault, 2001). Based on these reported ED-treated injuries, about 15.2 percent resulted in amputations, usually of a finger or fingers; overall, table saws account for about one-fifth of all consumer product-related amputations reported through NEISS, more than any other single NEISS product category. The remainder of NEISS-estimated blade-contact injuries consisted mainly of lacerations (58.8 percent), fractures (19.0 percent), and avulsions (6.5 percent). About 12 percent of the blade-contact injuries resulted in hospitalization.

An active injury mitigation (AIM) system for table saws, which is intended to mitigate potentially severe table saw injuries from blade contact, was developed in the early 2000s by Dr. Stephen Gass of SawStop LLC. SawStop attempted to license this technology to other U.S. table saw manufacturers, but these early efforts were unsuccessful (IEc, 2016b).

More recently, Dr. Gass has said that SawStop will not license its technology to other manufacturers, unless the Commission issues a rule mandating the technology on all table saws (Gass, 2015; IEc, 2016b). Consequently, before June 2016, when the Robert Bosch Tool Corporation introduced a bench saw model with the AIM technology, SawStop LLC had been the only firm manufacturing and marketing table saws with the AIM technology in the United States.[1] However, the SawStop models, which account for a relatively small share of the overall table saw market, have been consistently priced at the upper end of the price range in each of the

[1] According to SawStop's website (and IEc, 2016a), the AIM technology has been available on SawStop cabinet saws since 2004, contractor saws since 2008, and on SawStop bench saws since 2015.

three primary table saw categories (*i.e.*, bench, contractor, and cabinet), thereby limiting the quantity demanded. For example, while consumer bench saws (the least expensive type of saws available) are typically priced from about $150 to $300, the SawStop bench saw model (which was first marketed in 2015) retails for about $1,300 to $1,400 per unit.

The Robert Bosch Tool Corporation developed and marketed a table saw with AIM technology beginning in June 2016. This single Bosch model (the "Bosch GTS1041A REAXX") has been the only non-SawStop model with AIM technology available in the United States. It is a bench saw model with a retail price of about $1,500. Like the available SawStop bench model with the AIM technology, the Bosch model is at the upper end of the bench saw price range. Moreover, like the SawStop model, the relatively high price of the Bosch model limits the quantity demanded by consumers. However, the future of the Bosch model is unclear. In a 2015 patent infringement lawsuit, SawStop requested that the International Trade Commission (ITC) order U.S. Customs to exclude the Bosch REAXX saws from entering the U.S. market. On September 9, 2016, an administrative law judge (ALJ) made an initial determination that the Bosch model infringes on SawStop patents (Wilcove and Nicholson, 2016). Subsequently, on November 10, 2016, the ITC decided not to review the ALJ's initial determination and requested that the interested parties provide written submissions on the issues of remedy, the public interest, and bonding (ITC, 2016).

According to the Office of Management and Budget's *Circular A-4* on regulatory analysis (OMB, 1993), a key element of a good regulatory analysis is a statement of the need for a rule and a description of the problem that the rule is intended to address. By a "statement of need," the circular is referring to an explanation of why private markets failed to provide sufficient safety.[2] In other words, if an improvement in safety is needed, why have private markets been unable to efficiently provide it? Such a market failure provides an economic justification for regulatory intervention. The major types of market failure, as described in OMB's *Circular A-4* and elsewhere (OMB, 2003; Asch, 1988), concern: (1) inadequate or asymmetric information, (2) externalities, and (3) market power.

The most immediate market impediment to the more widespread adoption of the AIM safety technology appears to have been the market power currently exercised by SawStop LLC over their AIM technology. Market power exists when firms can exert some control over the price of the product (by limiting production), or when firms can create barriers that prevent other firms from entering and competing in the marketplace (Viscusi, Harrington, and Vernon, 2005; Asch, 1988). In the case of table saws, patents acquired by SawStop on their AIM technology (in combination with the firm's efforts to prevent patent infringement) appear to have provided SawStop with sufficient market power to limit the ability of other firms to develop and market similar safety devices. SawStop has, in fact, pursued patent infringement lawsuits against other manufacturers that have attempted to market their own AIM technology. As noted, Bosch

[2] Although Executive Order 12866 of 1993 does not apply to independent agencies, such as the CPSC, it says that "Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American People."

introduced a single bench saw model with its version of the AIM technology, but patent litigation initiated by SawStop casts doubt on the continued legal viability of the Bosch model.

Dr. Gass has said that he will not accept royalties for the SawStop AIM technology at this time because the other table saw manufacturers are his competitors; he has expressed the concern that if he licensed the SawStop technology to competitors, but they undercut his price, competitors could drive him out of the market (Gass, 2015; IEc, 2016a). On the other hand, Dr. Gass said he would license the SawStop AIM technology at a rate of 8 percent of wholesale price of the table saw models, if the Commission were to establish a mandatory standard applicable to all table saws because, under those circumstances, he believes he could earn sufficient royalties to justify the licensing (Gass, 2012; Gass, 2015; IEc, 2016a)). There has been no public discussion that we are aware of regarding the licensing of the Bosch AIM technology, but it seems unlikely that there would be any such discussion until the ongoing litigation is resolved.

Promulgating the draft proposed rule would make table saws with the AIM technology more widely available and, presumably, would result in a substantial reduction in the severity of blade-contact injuries. Competition among table saw manufacturers, who would either license the technology, or develop their own AIM technology, would probably also lead to some reduction in prices for table saws incorporating AIM technology, relative to the prices of saws currently offered by SawStop and Bosch. Such a rule would also allow SawStop (and potentially Bosch, depending upon the outcome of the patent litigation) to take greater advantage of its market power, by requiring other manufacturers to pay licensing fees for the AIM technology.

Another market impediment could be inadequate information concerning the hazard. Inadequate information may exist when consumers underestimate, or are generally unaware of, the risks posed by risky products, or are unable to interpret or adequately process the risk information. The risks associated with the use of table saws are not hidden; the risks of injury, as well as the potential severity of injury when users come into contact with a moving blade, are obvious. It is unlikely that any user is unaware that rotating table saw blades can cause severe injury to their hands or arms, if they come into contact with the blade. This awareness is no doubt also underscored by the noise and vibration of table saws, primarily the small bench saws with noisy universal motors, when being operated. Table saws also come with extensive safety warnings and safety devices (such as blade guards, riving knives, splitters and anti-kickback pawls) that are intended to reduce the risk of blade contact directly or reduce the risk of kickback, which may result indirectly in blade contact. Hence, it would be difficult to argue that the risks of table saw use are unknown or somehow hidden from the consumer.

Conversely, it is possible that some of the injured have not been trained in proper table saw use, or they have not paid close attention to product warnings. Non-occupational users may operate their table saws only sporadically and may forget or simply neglect safety procedures. A small proportion of the injured may be children or adolescents, who are still undergoing cognitive development and may not fully grasp the danger to themselves. Again, this is not to suggest that the risks are not known. However, casual users may be unaware of how quickly and how violently an injury can occur, if, for example, a cut results from kickback. Additionally, some risks may be poorly understood by consumers; casual users, for example, may be unaware that the sudden movement of the workpiece from kickback, can cause the operator to lose control of the workpiece and cause their hands or fingers to fall into or be "pulled" into the blade. Even momentary distractions, or lapses of attention, can lead to serious blade-contact injury. Consequently, in some cases, consumers could underestimate the actual risks they face, even though the overall risk is small, but obvious. In addition, it may be difficult for occasional users to interpret or process the risk information in a way that allows them to take the appropriate level of safety precautions. A rule mandating AIM technology would address this possible market failure by mitigating blade-contact injuries that might be related to the user's inexperience or lack of training with proper safety procedures.

Externalities, a third type of market failure, exist when one party's actions impose uncompensated benefits or costs on another party. For table saws, the externalities are largely financial and would exist when the costs of medical treatment and work losses resulting from blade contact are shifted to the public through medical insurance premiums and unemployment compensation. However, the likelihood of significant market failure due to externalities in the table saw market is probably small. Table saw users, as opposed to bystanders, are the primary victims of table saw injury. Moreover, it seems unlikely that users will be less careful when operating a table saw because they are aware that, given an injury, their medical costs or lost wages will be partially shifted to the public.

In summary, there may be some market impediments to a more widespread adoption of the AIM safety technology by table saw manufacturers and consumers. The most immediate impediment appears to result from the market power exercised by SawStop LLC. However, even if market power were not being exercised, inadequate information concerning the complexities of the hazard by consumers might also limit the adoption of table saws equipped with the AIM safety technology by the consuming public.

3. Market Information[3]

3.1. Product Categories

A table saw is a stationary power tool consisting of a circular saw blade, mounted on an arbor driven by an electric motor (either belt driven or gear driven). The blade protrudes through the surface of a table, which provides support for the material, usually wood, being cut. Table saws generally fall into three product types**:** *bench saws, contractor saws, and cabinet (or, stationary) saws.* Although there is no exact dividing line, the distinctions among these types of saws is generally based on size, weight, portability, power transmission and price. These characteristics are summarized below in Table 1. In addition to these three primary product types, we note two additional types of table saws available in the U.S. market: sliding table saws and hybrid table saws.

[3] This section is based largely on a contract study conducted by Industrial Economics, Incorporated, for the CPSC (IEc, 2016a) under Contract CPSC-D-15-0004 for Economic Analysis Support.

Table 1. Table Saw Characteristics, by Table Saw Type

	Table Saw Characteristics					
Table Saw Type	Retail Price (USD)	Weight (lb)	Amperage (amps)	Voltage (volts)	Horsepower (hp)	No. of models
Bench	$129-$1,499	34-233	5.7-15	110-240	1.5-4.4	35
Contractor	$529-$2,049	198-414	5.7-16	110-240	1.5-3.0	23
Cabinet	$1,199-$5,349	321-1,040	4.7-34	115-600	1.75-10	71
Sliding	$2,850-$24,995	606-2,932	3.0-10	220-440	3.0-10	22
Hybrid	$675-$1,595	225-432	6.5-16	110-240	1.75-2.0	7

Bench saws (*e.g.*, benchtop and portable saws; see Fig. 1) tend to be lightweight and portable, weighing as little as 34 pounds. Two bench saw models incorporating AIM technology are heavier: SawStop's JSS-MCA weighs 79 pounds (108 pounds with stand), and the Bosch GTS1041A weighs 78 pounds (133 pounds with stand). Bench saws are popular with professional carpenters due to the ease of transporting them to job sites where they can be placed on a work bench or stand. Most of the bench saw models (26 out of 35) come with some form of stand, either a rolling, folding, or fixed stand. For models including a stand, the stand is included in the retail price. Bench saws generally require only 110-120 volts, and thus, they can run on ordinary household electric wiring (most home outlets are wired for 110-120 volts). Most bench saws are gear driven; that is, no belts are used to transmit power from the electric motor to the blade. Based on available information, bench saws account for approximately 75 percent of the table saw market by unit volume; estimates of bench saws as a segment of the table saw market range from 70 percent to 85 percent (IEc, 2016a; Grizzly Industrial, Inc. (Grizzly), 2012; Power Tool Institute (PTI), 2012).

Fig. 1. Example of a Bench Saw

Fig. 2. Example of a Contractor Saw

Contractor saws (Fig. 2) are larger and more powerful than bench saws, typically weighing 198 to 414 pounds. Most contractor saws come with a fixed or rolling stand. Contractor saws typically run on 120 or 240 volts; many models offer both configuration options. Power ratings are in horsepower and typically, ratings are in the 1.5 to two horsepower range. The blade is usually driven with a single belt.

Cabinet saws (also called "stationary saws", see Fig. 3) are larger, heavier, and more powerful than contractor saws, and their blades are enclosed in a cabinet. They weigh from 321 to 1,040 pounds. They also generally require 230-240-volt power, and some require three-phase wiring, which may make it difficult for these saws to run on typical household current without rewiring. Power ratings are usually in the two to five horsepower range, but can sometimes exceed this range. Some cabinet saws can accommodate larger blade sizes than the 10-inch blade size available with bench and contractor saws. The blade is driven with one or more belts.

Fig. 3. Example of a Cabinet Saw

Five suppliers offered a total of seven hybrid saws. This product type blends components of both contractor and cabinet saws. Specifically, hybrid saws have the energy requirements, weight, and mobility of contractor saws with the structure, accuracy, and dust control features of cabinet saws. This product type typically operates in single phase with a voltage range of 110-240 volts generating 1.75 to two horsepower depending on the model.

Finally, sliding saws are similar to the cabinet saws in that they are belt driven, but typically are equipped with an extension that allows for cutting of large panels. This type of saw can be wired for either single phase or three phase operation; however, three phase wiring is a more common feature for sliding table saws. Sliding saws operate in the 220-440 volt range. A primary difference between the two types of saws is that sliding table saws have a greater rip capacity for processing sheet goods.

3.2. Retail Prices

As shown in Table 1, the range of prices generally overlaps for three products: bench, contractor, and hybrid saws. Bench saws are the least expensive, ranging in price from $129 to $975, with the exception of Dewalt's DWE7499GD ($799 - $1,165), General's 50-090RK ($1,490), the SawStop JSS-MCA ($1,299 - $1,399), and the Bosch GTS1041A REAXX ($1,299 -1,499).

Prices for contractor saws range from $529 to $2,049, and prices for hybrid saws range from $675-$1,595. Generally, cabinet and sliding saws are more expensive. Prices for cabinet saws range from $1,199 to $5,349. The price range for sliding table saws ($2,850-$24,995) overlaps with the range for cabinet saws, but sliding saws are typically more expensive.

The SawStop models containing the AIM technology are consistently priced at the upper end of the price range in each of the three primary table saw categories (bench, contractor, and cabinet). Aside from the Bosch and General bench saws priced at just under $1,500, the SawStop bench saw is most expensive in the bench saw category at $1,299 -$1,399, depending on the distributor. Similarly, the three SawStop contractor saws, ranging in price from $1,599-$2,049, represent some of the most expensive models in that product category, including the highest-priced offering. The SawStop cabinet models range in price from $2,299-$5,349, depending on power and performance. The SawStop model priced at $5,349 represents the highest priced cabinet saw.

3.3. Types of Table Saws Commonly Used By Consumers

Based on discussions with industry representatives, electrical requirements and power appear to provide the best distinction between table saws typically used by consumers and those used most often in industrial settings. Two industry representatives we spoke with indicated that saws operating at 1.75 horsepower or greater likely cannot be run on typical household wiring. Most consumers do not have the necessary electrical wiring, specifically the specialized outlets and adapters, to accommodate power tools with horsepower ratings greater than 1.75 or requiring 220-240 volt power. Sliding table saws and many other cabinet saws require such electrical capabilities and, therefore, are less likely to be used by consumers. However, one manufacturer indicated they have begun development of a sliding saw aimed at the high-end do-it-yourself (DIY) market, and a representative from another firm indicated some serious woodworking hobbyists may wire their home workshops to accommodate the more powerful saws.

Table 2 summarizes the number of table saw models by voltage requirements. Of the 158 table saw models identified in our market research, 62 models can run on 110 – 120 volts, including 28 bench saw, 23 contactor, 6 cabinet and 5 hybrid models. The cabinet saws that can run on 110 – 120 volts are supplied by four firms: DMT Holdings (General Manufacturing), Shopsmith, Inc., Steel City Tool Works, and Walter Meier, Ltd. A total of 89 cabinet, hybrid, and sliding models run solely on 220-240 volts. Given wiring requirements, these 89 higher-voltage models are less likely to be used by typical consumers.

Table 2. Voltage Requirements, by Table Saw Type

Table Saw Type	Models that run solely on 110-120 volts	Models that run on both 110-120 and 220-240 volts	Models that run solely on 220–240 volts	Models with unknown voltage
Bench	26	2	0	7
Contractor	3	20	0	0
Cabinet	0	6	65	0
Sliding	0	0	22	0
Hybrid	1	4	2	0
TOTAL	30	32	89	7

4. Suppliers

A total of 22 firms are known to supply table saws to the U.S. market. A list of these firms along with their associated brands is presented in Table 3. 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, since there are a number of Asian table saw manufacturers not included who may have achieved some U.S. distribution.

The Power Tool Institute estimates that its member companies account for 80 percent of all table saws sold in the United States (PTI, 2012). Most of the companies are large, diversified international corporations with billions of dollars in sales, such as Stanley Black and Decker, Robert Bosch, Makita, and Techtronic Industries Co., Ltd. These four large, diversified firms are currently supplying table saws to the U.S. market, but table saws make up a relatively small part of their revenues, probably less than one percent. PTI tends to represent the mass market bench table saw manufacturers distributed through retail outlets such as Home Depot and Lowe's, while many of the smaller suppliers are primarily in the cabinet and contractor saw market segments.

With the exception of two firms that sell only table saws or multi-purpose tools incorporating table saws (*i.e.*, SawStop and Shopsmith, respectively), anecdotal information for the smaller, more specialized firms supplying table saws to the U.S. market suggests that table saws are generally not a large percentage of firms' sales. One company reported that table saw sales contribute a negligible fraction of its $15 million annual revenue. Another company with an annual revenue of $20 to $40 million stated that table saws represent approximately five percent of total sales (IEc, 2016a). Similarly, a third business we interviewed attributed 7 to 8 eight percent of total revenue to table saw sales. These small producers of contractor and cabinet saws tend to distribute through specialized tool and woodworking outlets.

Table 3. List of Table Saw Firms and Brand Names

Current Suppliers	Associated Brands	No. of models
Baileigh Industrial	Baileigh	12
DMT Holdings	General, General International	5
Felder Group USA	Hammer	5
Grizzly Industrial, Inc.	Grizzly, Shop Fox	26
Harbor Freight	Central Machinery, Chicago Electric	1
Laguna Tools	Laguna	10
Makita USA, Inc.	Makita	2
Oliver Machinery	Oliver	3
Rexon Industrial Corp., Ltd.	Tradesman, Task Force	2
Richpower Industries	Genesis	1
Rikon Power Tools	Rikon	1
Robert Bosch Tool Corp.	Bosch, Skil	6
SawStop, LLC	SawStop	9
Sears Holdings Corp.	Craftsman	6
Shopsmith, Inc.	Shopsmith	1
Stanley Black and Decker, Inc.	DeWalt, Delta, Porter-Cable, Rockwell	17
Steel City Tool Works	Steel City, Orion	6
Techtronic Industries Co., Ltd., One World Technologies	Ryobi, Milwaukee, Ridgid	3
Terratek	Terratek	3
True Value Company	Master Mechanic	1
Walter Meier, Ltd.	Jet, Powermatic	32
Woodworker's Supply	Woodtek, Proxxon	5

3.5. Shipments

According to PTI, total annual shipments of all table saws to the U.S. market from 2002 to 2014 have ranged from 429,000 to 850,000. (Table 4) Estimates of sales value are not readily available industry-wide. As indicated above, bench saws are estimated to account for about 75 percent of the units sold. For purposes of this report, hybrid saws are included in all estimates of contractor saws, and sliding saws are included with cabinet saws.

Table 4. Annual Shipments of Table Saws to the U.S. Market

Year	Table Saw Shipments (Units Shipped)	Year	Table Saw Shipments (Units Shipped)
2002	725,000	2008	650,000
2003	750,000	2009	589,000
2004	775,000	2010	429,000
2005	800,000	2011	600,000
2006	800,000	2012	625,000
2007	850,000	2013	600,000
Source: Power Tool Institute		2014	625,000

3.6. Imports and Exports

While the design and engineering of table saws may occur in the United States, interviews and public comments indicate that most table saws are currently manufactured overseas; several firms we spoke with indicated that their saws are manufactured in Taiwan (IEc, 2016a). As an example, Grizzly Industrial, Inc., indicated that it operates quality control offices in Taiwan and China, and imports saws from Asia (Grizzly, 2012). This is supported by data from the U.S. International Trade Commission, which indicates that in 2014 approximately 99 percent of imported table saw units were built in Taiwan and China.[4] Additionally, a small volume of expensive saws intended for industrial use were imported from European and Canadian manufacturers.[5]

3.7. Population of Table Saws in Use

The annual number of table saws in use, a measure of risk exposure, was estimated with the CPSC's Product Population Model (PPM), a computer model that projects the number of products in use given estimates of annual product sales and product failure rates (Lahr and Gordon, 1980). Table saw sales were based on PTI estimates of annual shipments described above. Bench saws were estimated to account for about 75 percent of shipments. We assumed that contractor saws (including hybrids) and cabinet saws account for 20 percent and 5 percent, respectively. The failure rate (*i.e.*, the rate at which table saws go out of use) was assumed to follow a gamma distribution, a commonly used distribution for the failure of products, with an average product life of 10 years for bench saws, 17 years for contractor saws, and 24 years for cabinet saws. These average product life estimates were provided by PTI, the industry trade association.[6] Using these parameters, we project a total of about 8.2 million table saws in use in the United States in 2015, including about 5.1 million bench saws, 2.3 million contractor saws, and 0.8 million cabinet saws. Thus, bench, contractor, and cabinet saws account for about 62 percent, 28 percent, and 10 percent of the table saw population, respectively.

CPSC staff would welcome comments from the public concerning the proportion of table saw sales, by table saw type, or additional information on the expected product life of table saws.

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[4] Data compiled from tariff and trade data from the U.S. Department of Commerce and the U.S. International Trade Commission for Harmonized Tariff Schedule classification numbers 8465910036 (Tilting arbor table saw, woodworking) and 8465910078 (Sawing machines, woodworking, NESOI). Data accessed on January 29, 2016 at: https://dataweb.usitc.gov/scripts/user_set.asp.

[5] For example, a $25,000 computerized numerically controlled (CNC) panel saw designed to cut large pieces of wood, like large sheets of plywood.

[6] Estimates based on information provided by Peter Domeny, on behalf of PTI, in a meeting with Commissioner Adler on March 2, 2011.

4. Preliminary Regulatory Analysis

The preliminary regulatory analysis, which compares the benefits and costs of the draft proposed rule, is conducted from a societal perspective, considering all of the significant costs and health outcomes (Gold et al., 1996; Haddix, Teutsch, and Corso, 2003; Neumann et al, 2016). Benefits and costs are calculated on a per-product, in-use basis, an approach that has been found useful at the CPSC (Rodgers and Rubin, 1989; Tohamy, 2006; Smith, 2007; Franklin, 2014; Rodgers and Garland, 2016).

We begin by discussing the characteristics and societal costs of table saw blade-contact injuries. The benefits of the rule are measured as the estimated reduction in the societal costs of injuries resulting from the use of saws containing the AIM technology. The costs of the rule are defined as the added costs associated with the incorporation of the AIM technology in the table saws. Our primary outcome measure is the expected net benefits (*i.e.*, benefits minus costs) of the rule. As noted, our primary analysis calculates the benefits and costs of the rule on a per-product in use basis. However, aggregated estimates of the benefits and cost on annual basis can be readily calculated given projections of annual table saw sales.

Because of the differences in the physical characteristics, the use patterns, and the likely population of users of each of the table saw types (*i.e.*, bench, contractor, and cabinet saws), it is important to independently evaluate the benefits and costs for each. Because of the differences just noted, it is possible that the costs of the draft proposed rule exceed the benefits for one or more saw types, even though, in aggregate, benefits exceed costs for the market as a whole. However, because we have no information on the types of saws involved in the injuries, we cannot determine directly the societal costs or benefits of the rule by saw type. Nevertheless, we do have information on the potential costs of the draft proposed rule, by table saw type. Consequently, we can conduct a breakeven analysis for the various saw types – an analysis that allows us to estimate the number of potentially severe injuries for each of the saw types that would need to be substantially mitigated for the benefits of the draft proposed rule to equal or exceed the costs. Although we will not know the actual distribution of injuries by table saw type, we can compare breakeven estimates for the various saw types to possible hypothetical distributions of injuries to gain insight into this question.

4.1. Estimated Benefits

4.1.1. Injuries involving Blade Contact

The draft proposed rule is intended to address table saw injuries resulting from blade contact. In the absence of survey data confirming that the injury involved blade contact, the Directorate for Epidemiology estimated that there were about 30,800 injuries reported through NEISS during 2015 that were likely to have involved blade contact. As noted by Garland (2016, at Tab B), however, the NEISS case narrative contains limited information related to the details of the incident. Thus, the NEISS estimates may include some cases that did not involve blade contact.[7]

In addition to injuries initially treated in hospital EDs, many product-related injuries are treated in other medical settings, such as, among others, physicians' offices, clinics, and ambulatory surgery centers. Some injuries also result in direct hospital admission, bypassing the hospital ED entirely. The number of table saw injuries treated outside of hospital EDs is estimated with the CPSC's Injury Cost Model (ICM), which uses empirical relationships between the characteristics of injuries (diagnosis and body part) and victims (age and sex) initially treated in hospital EDs and the characteristics those initially treated in other settings. A detailed discussion of the ICM and these methods is given in Miller et al. (2000), Bhattacharya et al. (2012), and Lawrence (2013). The ICM estimate of injuries treated outside of hospitals or hospital EDs (*e.g.*, in doctors' offices, clinics, etc.) is based on data from the Medical Expenditure Panel Survey (MEPS).

The MEPS is a nationally representative survey of the civilian, non-institutionalized population that quantifies individuals' use of health services and corresponding medical expenditures. It combines data from a panel of participants interviewed quarterly over a two-year time period with data from the respondents' medical providers. The MEPS is administered by the Agency for Healthcare Research and Quality (AHRQ). The ICM uses the MEPS data, in combination with a classification tree analysis technique, to project the number and characteristics of injuries treated outside of hospitals.

To project the number of direct hospital admissions which bypass hospital EDs, the ICM uses data from the Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP-NIS), which was also analyzed using a classification tree analysis technique. HCUP is a family of healthcare databases and related software tools and products developed through a federal-state-industry partnership and sponsored by AHRQ. The HCUP-NIS provides information annually on approximately 3 to 4 million in-patient stays from about 1,000 hospitals.

The classification tree analysis technique (also called decision tree) is a statistical tool that divides and sorts data into smaller and smaller groups for estimating the ED share of injuries until no further gains in predictive power can be obtained. This technique allows for more precise estimates of injuries treated in doctor visits or injuries admitted directly to the hospital than other regression techniques. For example, where data permits, the age and sex of the victim can have an influence on the estimates of the number of injuries treated outside the emergency department. When we combine the national estimates of the NEISS with the non-ED estimates from the ICM using classification tree techniques, we obtain total medically treated injuries.

Based on the annual estimate of about 30,800 blade-contact injuries initially treated in hospital EDs, the ICM projects approximately 24,050 blade-contact injuries treated in other treatment settings. Combined with the ED-treated injuries, there were an estimated annual total

[7] However, as noted in Garland (2016), the above NEISS estimates do not account for possible table saw blade-contact injuries that might have been classified in NEISS codes for unspecified saw types, such as (0845=saws, not specified) or (0895=power saws, other or not specified).

of about 54,850 medically treated blade-contact injuries. These results are shown in Table 5, which describes the disposition of the injuries by treatment site. Rows (b) and (c) of Table 5 include the approximately 30,800 blade-contact injuries reported through NEISS: about 26,940 (87.4 percent) were treated and released from hospital EDs and about 3,850 (12.5 percent) were admitted to the hospital following initial treatment in the ED. Rows (a) and (d) project blade-contact injuries treated outside of hospital ED; these include about 22,840 injuries treated in doctors' offices or clinics and about 1,211 injuries that resulted in direct hospital admission, bypassing the ED. Overall, about 9.2 percent of the medically treated injuries resulted in hospitalization (*i.e.*, either hospitalized following treatment in hospital EDs or direct hospital admissions).

Table 5. Treatment Settings of Blade-contact Injuries, by Table Saw Type (annual, based on 2015 data)

Medical Treatment Setting	Blade-contact Injuries	
	Total	Percent
(a) Doctor/Clinic	22,840	41.6%
(b) Emergency Department (ED) Treated and Released	26,941	49.1%
(c) Hospital, Admitted via ED	3,851	7.0%
(d) Direct Hospital Admission	1,211	2.2%
(e) Total	54,843	100%

The NEISS ED estimates indicate that about 29,700 of the injuries (96.4 percent) involved males (Garland, 2016, at Tab B). Only 7 of the 642 NEISS injury cases (1.1 percent) involved children or adolescents under the age of 18 years.[8] An estimated 93.8 percent of the injuries involved fingers, with almost all of the remainder involving the hand. Almost all injuries are believed by CPSC staff to have involved the table saw operator, as opposed to bystanders.

Table 6 describes the disposition of the projected medically treated blade-contact injuries by the major injury diagnoses: amputations, lacerations, fractures, and avulsions. About 13.7 percent of the *medically treated* injuries involved amputations, 56.9 percent involved lacerations, 22.8 percent involved fractures, and 6.1 percent involved avulsions.[9] About 27.5 percent of the amputations resulted in hospital admission, compared to about 4.0 percent of lacerations and 12.1 percent of fractures. About 31.5 percent of the amputations were projected to be treated in the doctors' offices/clinics and other non-hospital settings, compared with about 41.0 percent of lacerations, 50.3 percent of fractures, and 38.7 percent of avulsions.

[8] These included one injury each for children aged 12, 14, 15, and 16 years, and three injuries involving 17 year-olds.

[9] Note that the Table 6 proportions of medically treated table saw injuries, by injury diagnosis, differ from the NEISS estimates presented in Garland (2016) because the NEISS cases are limited to those initially treated in hospital emergency departments.

Table 6. Medically Treated Blade-contact Injuries, by Injury Diagnosis and Medical Treatment Setting (estimated annual, based on 2015 data)

Medical Treatment Setting	Injury Diagnoses						
	Amputation	Laceration	Fracture	Avulsion	Other	Total	Percent
(a) Doctor/Clinic	2,363	12,801	6,299	1,286	92	22,840	41.4%
(b) Emergency Dept. (ED)[1]	3,066	17,180	4,703	1,895	98	26,941	49.4%
(c) Hospital, Admitted via ED	1,601	915	1,158	102	75	3,851	7.0%
(d) Direct Hospital Admission	460	332	352	36	31	1,211	2.2%
(e) Total	7,490	31,227	12,512	3,319	295	54,843	100.0%
(f) Percent	13.7%	56.9%	22.8%	6.1%	0.5%	100.0%	

[1]Treated and released

Table 7 presents information that allows us to estimate table saw blade-contact injury rates. Blade-contact injuries per 100,000 saws are provided in row (c), and are calculated by dividing medically treated injuries (row a) by the estimated number of table saws in use (row b). Overall, the blade-contact injury rate for table saws amounted to about 670 medically treated injuries per 100,000 saws. An approximate 95 percent confidence interval for medically treated injuries, based on estimates of the coefficient of variation (CV) from the NEISS injury estimates (Garland, 2016, at Tab B), ranges from about 550 to 790 medically treated injuries per 100,000 saws in use.

Table 7. Annual Medically Treated Blade-Contact Injuries, and Annual Rates of Injury (based on 2015 injury data)

	Total
(a) Medically Treated Blade Contact Injuries	54,843
(b) Saws Available for Use (millions)	8.2
(c) Injuries per 100,000 saws ([row (a) ÷ row (b)] × 100,000)	670
(d) 95% Confidence Interval for Injury Rate (per 100,000 saws)[1]	550 – 790

[1]An approximate 95% CI, based on estimates the coefficient of variation (CV) from the NEISS injury estimates (Garland, 2016, at Tab B).

4.1.2. Injury Costs of Blade-contact Injuries

The societal costs of blade-contact injuries represent the pool from which the benefits of a blade-contact rule are derived. The societal costs of these injuries are quantified with the ICM. The ICM is fully integrated with NEISS, and, in addition to providing estimates of the societal costs of injuries reported through NEISS, it also estimates the costs of medically treated injuries that are initially treated outside of hospital emergency departments. The major aggregated societal cost components provided by the ICM include medical costs, work losses, and the intangible costs associated with lost quality of life or pain and suffering.[10]

Medical costs include three categories of expenditures: (1) medical and hospital costs associated with treating the injury victim during the initial recovery period and in the long run, including the costs associated with corrective surgery, the treatment of chronic injuries, and rehabilitation services; (2) ancillary costs, such as costs for prescriptions, medical equipment, and ambulance transport; and (3) costs of health insurance claims processing. Cost estimates for these expenditure categories were derived from a number of national and state databases, including the Medical Expenditure Panel Survey, the Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP-NIS), the Nationwide Emergency Department Sample (NEDS), the National Nursing Home Survey (NNHS), MarketScan® claims data, and a variety of other federal, state, and private databases.

Work loss estimates are intended to include: (1) the forgone earnings of the victim, including lost wage work and household work, (2) the forgone earnings of parents and visitors, including lost wage work and household work, (3) imputed long term work losses of the victim that would be associated with permanent impairment, and (4) employer productivity losses, such as the costs incurred when employers spend time juggling schedules or training replacement workers. Estimates are based on information from the, the Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP-NIS), the Nationwide Emergency Department Sample (NEDS), Detailed Claims Information (a workers' compensation database), the National Health Interview Survey, U.S. Bureau of Labor Statistics, and other sources.

The intangible, or non-economic, costs of injury reflect the physical and emotional trauma of injury as well as the mental anguish of victims and caregivers. Intangible costs are difficult to quantify because they do not represent products or resources traded in the marketplace. Nevertheless, they typically represent the largest component of injury cost and need to be accounted for in any benefit-cost analysis involving health outcomes (Rice et al., 1989; Haddix, Teutsch, and Corso, 2003; Cohen and Miller, 2003; Neumann et al, 2016). The ICM develops a monetary estimate of these intangible costs from jury awards for pain and suffering. While these awards can vary widely on a case-by-case basis, studies have shown them to be systematically related to a number of factors, including economic losses, the type and severity of injury, and the age of the victim (Viscusi, 1988; Rodgers, 1993; Cohen and Miller, 2003).

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[10]A detailed description of the cost components, the general methodology and data sources used to develop the CPSC's Injury Cost Model, and Injury Cost Model Updates, can be found in Miller et al. (2000), Lawrence (2008), Lawrence (2013), Lawrence (2014), Bhattacharya, et al., (2012), Lawrence (2015a, 2015b, 2015c).

Estimates for the ICM were derived from regression analysis of jury awards in nonfatal product liability cases involving consumer products compiled by Jury Verdicts Research, Inc.

Based on ICM estimates, the aggregate present value of the injury costs associated with the estimated 54,843 medically-treated table saw injuries amounted to about $4.06 billion (in 2014 dollars) when future injury losses (primarily those associated with long term work loss) were discounted at 3 percent. This suggests injury costs of about $74,050 per injury (*i.e.*, $4.06 billion ÷ 54,843 injuries). When future losses were discounted at 7 percent, the aggregated present value amounted to about $3.65 billion, or about $66,650 per injury (*i.e.*, $3.65 billion ÷ 54,843 injuries).

OMB (2003) recommends discounting future benefits (or costs) using both 3 percent and 7 percent discount rates. The 7 percent discount rate is intended to reflect the rate of return to private capital in the U.S. economy. The 3 percent rate is intended to represent what is sometimes called the "social rate of time preference," which is more consistent with the rate which "society" discounts future consumption flows to their present value (OMB, 2003; Gold et al., 1996; Haddix, Teutsch, and Corso, 2003). Using the lower social discount rate means that future benefits are valued somewhat more highly than they would be with the a higher discount rate.[11] Most sources suggest that the social rate of time preference is more appropriate when evaluating health-related interventions (Gold et al, 1996; Haddix, Teutsch, and Corso, 2003; Neumann et al, 2016), such as the draft proposed rule for table saws. Consequently, the 3 percent discount rate is probably the more appropriate discount rate for evaluating the benefits and costs of the draft proposed rule. However, presenting most results using both the 3 percent and 7 percent, as recommended by OMB, shows the sensitivity of the results to variations in the discount rate.

The distribution of injury costs, by medical treatment setting (using the 3 percent discount rate) is illustrated in Table 8. Overall, medical costs and work losses accounted for roughly 30 percent of the total, while the non-economic losses associated with pain and suffering accounted for 70 percent. Injury cost estimates for non-hospitalized injuries ranged from about $28,000 for blade-contact injuries treated outside of hospitals and EDs, to about $42,000 for injuries initially treated in hospital EDs (but not admitted). Injury costs for hospitalized injuries, in contrast, averaged about $450,000 per injury.

[11] Hence the present value of $4.06 billion in societal costs at 3 percent and $3.65 billion at 7 percent.

Table 8. Annual Societal Costs Associated with Table Saw Blade-contact Injuries, by Medical Treatment Setting and Injury Cost Component (2014 dollars; 3 percent discount rate)

Medical Treatment Setting	Medically Treated Injuries (Annual Est.)	Average Cost per Injury, by Cost Component			
		Medical	Work Loss	Pain and Suffering	Total
Doctor/Clinic	22,840	$602	$5,963	$21,579	$28,144
Emergency Department (ED)[1]	26,941	$1,998	$6,492	$33,848	$42,337
Hospital, Admitted via ED	3,851	$18,618	$145,611	$291,109	$455,338
Direct Hospital Admission	1,211	$18,464	$139,378	$275,238	$433,080
Total Injuries	54,843				
Aggregate Costs (Millions $)		$161.6	$1,040.7	$2,859.2	$4,061.5

[1]Treated and released

The high injury cost estimates presented in Table 8 are largely driven by the costs associated with the amputations. Although amputations accounted for only13.7 percent of the medically treated blade-contact injuries (Table 6), they accounted for almost 64 percent of the annual estimate of $4.06 billion in societal costs resulting from blade contact. The average imputed cost per amputation injury amounted to about $345,000, and ranged from $120,000 to $195,000 for non-hospitalized amputations to about $825,000 per hospitalized amputation.[12] If amputations were excluded from the injury cost estimates, the injury costs would have been reduced from about $74,050 per injury to about $31,200 per injury.

In contrast to the average injury cost of about $345,000 per medically treated amputation, the average imputed cost for lacerations (which accounted for about 56.9 percent of medically treated injuries) amounted to about $19,500. The average imputed cost for fractures (accounting for about 22.8 percent of injuries) and avulsions (6.1 percent of injuries) amounted to about $48,250 and $72,900, respectively.

[12] About 29.3 percent of the amputation injury costs were attributed to medical costs and work loss; 70.7 percent were attributed to pain and suffering.

4.1.3. Societal Costs, per Table Saw in Use

Table 9 presents estimates of the present value of societal costs, per table saw in use. Row (a) shows the aggregate annual societal costs, by discount rate. Row (c) shows annual societal costs *per saw*, and the results are calculated by dividing the aggregate annual societal costs (row a) by table saws in use (row b).

Row (e) presents the present value of societal costs, and the results were calculated using the row (c) estimate of annual societal costs and a 3 percent and 7 percent discount rate over the saw's expected useful product life (row d). For this analysis, the expected product life was based on an average for the three saw types, weighted by the proportion of saws in use for each table saw type. The present value figure is quite large, amounting to about $5,400 per table saw using a 3 percent discount rate and about $3,800 at 7 percent; this present value estimate represents the maximum per unit benefits that could be derived from a rule addressing blade contact if such a rule prevented all blade-contact injuries.

Table 9. Present Value of Societal Costs per Table Saw in Use

	Discount Rate	
	3 Percent	7 Percent
(a) Aggregate Annual Societal Costs (Billions $)	$4.06	$3.65
(b) Table Saws in Use (Millions)	8.2	8.2
(c) Societal Costs per Table Saw [(a) ÷ (b)]	$495	$445
(d) Expected Useful Product Life (years)	13.3	13.3
(e) Present Value of Societal Costs, per Table Saw	$5,366	$3,772

4.1.4. Effectiveness and Expected Benefits of the Proposed Rule

The benefits of the draft proposed rule are measured as the reduction in the societal costs of injuries resulting from the use of the safer saws. Consequently, we need to estimate the expected effectiveness of the draft proposed rule in mitigating or preventing severe blade-contact injuries. Effectiveness cannot be determined precisely. Injuries will not be entirely prevented, because the AIM system activates after the hand or finger comes into contact with an operating blade. Moreover, it will not mitigate all severe blade-contact injuries: It will not mitigate potentially severe blade-contact injuries that occur: (1) when the blade is operating but the AIM system has been deactivated; (2) when the operator's hand is moving into the blade so quickly that contact with the blade cannot be reduced sufficiently to prevent serious injury; or (3) when the AIM technology leads to complacency or reductions in safety efforts on the part of users that result in injury. Additionally, as noted in Garland (2016, at Tab B), the NEISS cases used to make the national estimate of blade-contact injuries may have included some that did not involve blade contact.

While we have insufficient information to quantify the impact of these factors, we do know there are situations in which they arise. The existing AIM technology cannot be used when cutting conductive materials, such as non-ferrous metals (*e.g.*, aluminum) or wood that is wet enough to conduct sufficient electricity to activate the AIM system. Consequently, existing table saws with the AIM systems have a bypass mode that temporarily deactivates the AIM system to prevent nuisance tripping. Although the SawStop saws automatically reset to safety mode whenever restarted, some consumers might deactivate the AIM system even when it is not necessary to do so because they think it is not needed or because they are concerned about a misfiring activation of the AIM system which might require the purchase of a new cartridge and blade. Graham and Chang (2014) suggest a failure rate of about 2 percent due to the system being deactivated at the time of injury.

PTI (2012) asserts that many kickback blade-contact injuries will not be prevented because the kickback is so violent that the hand is sometimes thrown into the blade at speeds greater than 1 meter/sec. While there is little evidence to suggest that kickback-related blade-contact injuries would not be addressed by the AIM technology, according to Backstrom et al. (2014), "in the area of kickback, the effect of hand approach speeds still remains unresolved."

CPSC engineering staff considers AIM technology to be an additional safety device to be used in conjunction with an existing blade guard and riving knife. However, the AIM system can mitigate a blade-contact injury even if the blade guard or riving knife is removed or fails to function properly (Amodeo and Gill, 2016, at Tab B). Based on testing experience, ES staff believes the recommended performance requirements can significantly reduce the severity of injury involving blade contact and will result in the avoidance of most microsurgery. Some injuries may result in injury severity that may not require medical attention beyond a band aid. However, according to Amodeo and Gill (2016): "Staff recognizes there may be some scenarios, such as kickback that causes the operator's hand to be "pulled" into the blade at a high rate of speed or the operator reaching as fast as possible for a falling workpiece, where the radial velocity of the hand/finger exceeds 1 m/s when it contacts the saw blade. At approach speeds greater than 1 m/s, AIM performance may result in injury severity that requires extensive medical attention, including the microsurgical repair of nerves, blood vessels, and tendons, for an incident that might otherwise have resulted in an amputation or the involvement of several digits or a wider area. The only available data on radial approach rates during kickback and non-kickback related table saw blade-contact incidents indicate the approach rate does not exceed 0.368 m/s; however staff recognizes there may be some incidents that occur under conditions so demanding that AIM performance is unable to prevent a severe injury from occurring."

Finally, it is possible that the AIM technology could lead to complacency or some reduction in safety efforts on the part of users that might offset somewhat the injury reduction expected from the rule (Smith, 2016, at Tab D). For example, based on an incident reported in a woodworking forum cited by Grizzly (2012), a high school teacher noticed that the riving knife was never installed on the school's table saw. When he mentioned this to the shop instructor, the instructor's response was that "the saw has a blade brake so it doesn't need [the riving knife]." However, riving knives address kickback injuries which can occur independently of blade contact. PTI (2016) provides another example, suggesting that a "sense of security" with the

AIM technology might lead to a reduction in the use of blade guards, which could increase the rate of injury caused by kickback or by high velocity particles ejected by the saw blade.

Given the uncertainty regarding the effectiveness of the AIM system, and the possibility that some of the NEISS cases did not involve blade contact, we assume that the AIM technology will not prevent or mitigate all blade-contact injuries but will substantially mitigate 70 percent to 90 percent of blade-contact injuries. The estimate of 90 percent effectiveness assumes that all blade-contact injuries, including blade-contact injuries initiated by kickback, will be addressed by the AIM technology, but that about 10 percent of blade-contact injuries will not be substantially mitigated because of the reasons noted above. The estimate of 70 percent effectiveness assumes that about 40 percent of blade-contact injuries involved kickback, based on Choudhury and Paul (2011), and that only about half of the kickback injuries would be substantially mitigated. Additionally, we assume that the mitigated accidents that would have resulted in amputations, avulsions, and fractures are not prevented entirely, but become medically treated lacerations, and that accidents that would have resulted in medically-treated lacerations are mitigated to injuries that do not require medical treatment.[13]

Table 10 provides estimates of the benefits of the rule, per table saw in use. Rows (a) and (b) present benefit estimates assuming that the saws with the AIM technology substantially mitigate 70 percent and 90 percent of the blade-contact injuries, respectively. At 70 percent effectiveness, estimated per-product benefits amounted to about $3,300 per saw at a 3 percent discount rate, and $2,300 per saw at a 7 percent discount rate. At a 90 percent effectiveness estimate, benefits would amount to about $4,300 per saw at 3 percent, and $3,000 per saw at 7 percent. We note that the benefits at 70 and 90 percent effectiveness at rows (a) and (b), result, respectively, in about a 62 percent and 80 percent reduction in the estimated societal costs described in Table 9 because of our assumption that amputations, fractures, and avulsions are not entirely prevented, but rather, are reduced in severity and become medically treated lacerations.

Table 10. Expected Benefits, per Table Saw, Over the Saw's Expected Product Life

Effectiveness	3 Percent	7 percent
(a) Benefits at 70% Effectiveness	$3,335	$2,345
(b) Benefits at 90% Effectiveness	$4,288	$3,015

[13] CPSC staff would welcome comments from the public that either support these effectiveness estimates or that help us adjust them appropriately.

4.2. Cost Considerations[14]

This section discusses the types of costs that would result from a rule that would require an AIM safety technology to meet the draft proposed performance requirements, and quantifies some estimates of these costs provided by industry participants in a series of interviews with Industrial Economics, Incorporated (IEc), and EC staff. In the next section, we discuss costs on a per-product, in use basis.

Table saw manufacturers are likely to incur three primary types of costs to incorporate AIM technology into their table saws, including:

*Costs to develop AIM technology***.** Manufacturers will have to either design and develop their own AIM technology or license the AIM technology developed and owned by another party.

Redesign and retooling costs. Incorporating AIM technology into existing models will require manufacturers to redesign each model and retool the facilities where the saws are manufactured. All table saw models not currently incorporating the AIM technology likely will require redesign to provide room for blade retraction, to allow access for users to change the cartridge and blade, and to withstand the force of the AIM system being triggered.

Materials costs. The combination of the addition of a brake cartridge, or other means of stopping or retracting the blade after contact with flesh, and the redesign of the table saw to accommodate the additional electronic components and wiring, the required clearances, and the weight and dimensions of the AIM technology, will result in increased materials costs.

Each of these types of costs is discussed below, based largely on data collected through interviews with SawStop and other table saw manufacturers.

4.2.1. Development of the AIM Technology

Currently, we are aware of two manufacturers and one inventor who have developed AIM technology, although only two types of AIM technology are currently available to consumers. These include:

(1) SawStop LLC. SawStop's AIM technology induces a small electrical signal onto the saw blade that is partially absorbed by the human body, if blade contact is made. When the reduction of the signal in the blade (due to the body's absorption) is detected, the system applies a brake to the blade, which stops and retracts the blade below the table surface in less than 5 milliseconds. SawStop cabinet saws have been available to consumers since 2004, contractor saws since 2008, and a new benchtop saw was introduced in March 2015.[15]

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[14] The cost analysis contained in sections *4.2 and 4.3* is based on a contract study conducted by Industrial Economics, Incorporated, for the CPSC (IEc, 2016b). The analysis was conducted under Contract CPSC-D-15-0004 for Economic Analysis Support, and included interviews with several table saw manufacturers.

[15] SawStop website. Accessed on January 23, 2016, at: http://www.sawstop.com/.

(2) Robert Bosch Tool Corporation. Bosch's Active Response Technology™ rapidly detects human flesh that comes into contact with the blade (through electronic sensors) and initiates an explosive cartridge that drives the saw blade below the tabletop. This system builds on the results of the PTI Joint Venture effort among Hitachi, Bosch, Stanley Black and Decker, and Techtronics that was completed in 2009. Bosch announced this technology in a March 2015 press release,[16] and Bosch began marketing a single bench saw model with the technology on June 1, 2016.

However, given the current litigation between Bosch and SawStop, which is described below, the future of the Bosch AIM technology is unknown.

(3) Whirlwind Tool Company. Whirlwind's Black Box flesh-sensing prototype, which does not involve a blade retraction system, uses a fixed protective guard and a very rapid, non-destructive motor-braking to stop the saw blade when the operator's hand is too close to the spinning blade. Whirlwind's website indicates that it is currently looking for funding to develop its technology.

4.2.1.1. Patent Issues

According to Dr. Gass of SawStop LLC, the primary patent holder for the existing AIM technology, the initial development and design of the SawStop technology required significant time and financial commitment. Dr. Gass (2015) indicated that he raised "a couple of million dollars" to fund the development of the first saw incorporating SawStop's flesh sensing technology.

Various stakeholders have expressed concern that a mandatory rule could impose a monopoly for SawStop technology, given the numerous patents that have been filed by Dr. Gass. PTI reports that Dr. Gass has filed more than 140 patent applications, and has more than 100 issued patents that pertain to SawStop technology (PTI, 2016).

Several companies asserted that they had attempted to license the SawStop technology.[17] Grizzly Industrial, Inc., indicated in its 2012 comment letter that it tried several times, from early 2007 to the present, to license SawStop's technology, but could not agree with SawStop because of what it considered SawStop's "unrealistic demands to convert every existing Grizzly model to include the flesh-sensing technology" (Grizzly, 2012). Grizzly also said that SawStop refused to allow Grizzly to distribute SawStop saws, stating: "It does not make sense for SawStop to distribute saws through Grizzly given SawStop's current distribution network" (Grizzly, 2012).

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[16] Bosch, 2015. Press release titled: Bosch GTS1041 REAXX™ Portable Jobsite Table Saw Takes User Safety to the Next Level, and Saves the Blade Too. Accessed on January 20, 2016 at: http://www.boschtools.com/About BoschTools/PressRoom/Pages/031815_reaxxsaw.aspx.

[17] To our knowledge, the only company to partner with SawStop, to date, has been Griggio, SA, an Italian manufacturer that collaborated with SawStop to develop a sliding table saw, which was demonstrated in May 2015 at a trade show in Germany. FDMC, May 2015. SawStop and Griggio to develop safer panel saw. Accessed December 8, 2015 at: http://www.fdmcdigital.com/ArticleDetails/tabid/162/ArticleID/95172/Default.aspx.

In *Osorio v. Ryobi*, the plaintiff, Carlos Osorio, suffered a hand injury in a construction accident involving one of Ryobi's table saws. Osorio claimed that Ryobi's table saw was unacceptably dangerous due to a defective design. Dr. Gass testified that Ryobi had been given an opportunity to license the SawStop technology in 2000, before SawStop launched its own line of saws.[18] Similarly, other manufacturers noted that they had discussions with SawStop before SawStop launched its line of saws, but they were unable to agree with SawStop on terms. Some of the areas on which they could not agree with SawStop included the percentage of a prospective royalty, the minimum unit volume for licensing, and the requirement that all of their saws would have to use the SawStop technology, not just one or two models (IEc, 2016b).

Grizzly (2012) has said that mandating AIM technology during the life of the SawStop patents will cause numerous businesses to be unable to stay in the table saw business. PTI has also expressed concerns that "there can be no assurance that petitioners and SawStop would be willing to license their patent technology at *any* price, notwithstanding any of their assertions to the Commission to the contrary" (PTI, 2012; PTI, 2016).

Currently, there is ongoing patent infringement litigation that will have a bearing on SawStop or other companies' willingness to license their AIM technologies. On July 16, 2015, SawStop filed a complaint in the U.S. District Court in Oregon for patent infringement against Robert Bosch. On the same date, SawStop also filed a complaint against Bosch with the U.S. International Trade Commission (ITC), requesting a permanent order excluding from entry into the United States certain table saws incorporating AIM technology and components that infringe on SawStop's patent claims.[19] The complaint filed in the district court in Oregon is on hold, pending the final decision of the ITC. The ITC has not yet decided SawStop's request for a stay on the sale of the Bosch REAXX saw with AIM technology. However, as noted, an ALJ recently issued an initial determination that the Bosch REAXX bench saw infringes on two of SawStop patents (Wilcove and Nicholson, 2016). On November 10, 2016, the ITC decided not to review the ALJ's initial determination and requested that interested parties provide written submissions on the issues of remedy, the public interest, and bonding, by November 22, 2016, with reply submissions due on December 2, 2016. Although the briefs have been filed, the ITC has not yet issued a final decision. SawStop stated that the infringing patents will expire in 2020 and 2022 (ITC, 2016). Once the ITC issues a final disposition on the remedies, then the U.S. Trade Representative, as delegated by the President, would have 60 days to approve or disapprove the ITC's action.

The outcome of ongoing lawsuits involving the SawStop technology will determine some of the impacts that may result from a mandatory rule requiring AIM technology in table saws. If the courts determine that the patents covering the SawStop technology allow for companies to manufacture their own saws with alternative AIM technologies (such as the Bosch REAXX saw), then some manufacturers may choose to try to develop their own proprietary technology or license the Bosch technology (if available) as an alternative to the SawStop technology.

[18] Osorio v. One World Technologies, Inc. 659 F3d 81, 83 (1st Cir 2011).
[19] SawStop website. Accessed on January 23, 2016 at: http://www.sawstop.com/company/news/press-releases/sawstop-sues-bosch-to-protect-inventions.

Alternatively, if the court decides that alternative technologies do, in fact, infringe upon SawStop patents, then SawStop may effectively have a monopoly on the technology needed to comply with a mandatory rule. Other manufacturers likely would license the SawStop technology for use in their saws, or leave the table saw market. PTI and SawStop agree that this is the case. The level at which the royalty payments are set will play a significant role in determining the economic impacts that the CPSC's rule would have on table saw manufacturers. We note that some of the infringed upon patents may expire in 2020 and 2022. However, we do not know what other SawStop patents may be impacted by companies that attempt alternative AIM technologies, nor do we know the expiration dates of the other existing SawStop patents (McHardy, 2016).

The royalty fee for licensing the AIM technology from SawStop is uncertain. Dr. Gass has said that SawStop would accept royalty payments of 8 percent of a saw's wholesale price, but there is no certainty that SawStop would actually license the technology under terms that would be acceptable to other manufacturers. Moreover, Dr. Gass has conditioned the 8 percent royalty on a rule that requires AIM technology on all table saws. Otherwise, according to Dr. Gass, licensing the patent would harm SawStop's business, allowing competitors to underprice SawStop saws and potentially force him out of business (Gass, 2015). The scenario he envisions is that, in licensing a competitor, the competitor could produce one or two models and underprice SawStop for several years. In his opinion, the royalties earned would be very modest, and would be partially offset by reduced sales of SawStop saws. Once SawStop stopped production of its own saws and disbanded its distribution network, the competitor could then suspend production of the AIM-compliant saw. Thus, the technology would no longer be available to the public, and SawStop would earn neither profits from sales of saws, nor royalties on its AIM technology (Gass, 2015).

4.2.2. Redesign and Retooling

Interviews with several manufacturers, as well as a review of public comments provided by PTI, revealed general agreement that implementing a rule requiring AIM technology would require a complete redesign of all saws that do not currently incorporate the AIM technology (IEc, 2016a). More specifically, the trunnion system would have to be redesigned,[20] and the cabinet/interior of the saw would need to be modified to incorporate the technology and allow access to change out the brake cartridge or to allow clearance for blade retraction. The support structure, such as the stand, would also likely need to be redesigned to bear the extra weight of the AIM system and to absorb the force applied by the triggering of the AIM mechanism. PTI estimates that the cost to redesign and retool existing table saws would range from $2 million to $10 million per company.[21]

SawStop agrees that the entire table saw would need to be redesigned, but suggests that the total cost would not be in the multi-million dollar range indicated by PTI. Rather, Dr. Gass said that SawStop's tooling costs were approximately $200,000 for its first cast iron (*i.e.*,

[20] A trunnion is an assembly that holds a saw's arbor to the underside of the saw table.
[21] Graham, J. 2010. Expert report of Dr. John D. Graham. (April 27). Submitted with the PTI public comments (PTI, 2012).

contractor/cabinet) table saw, and that costs were approximately $700,000 for its first benchtop table saw. He also stated that there are not as many distinct models as advertised. Some models are minor variations and share the same basic structure (Gass, 2015).

SawStop's estimates are within the range of estimates provided by other firms. For example, several companies indicated that the cost to redesign saws could be approximately $500,000 per saw (IEc, 2016b). Another table saw manufacturing representative indicated that retooling could cost $100,000 to $200,000. An additional cost of several hundred thousand dollars may be necessary, depending on the level of engineering required for the redesign (IEc, 2016b). According to one company, a redesign of the trunnion system alone may cost $200,000 (IEc, 2016b).

Uncertainty exists concerning the allocation of the retooling costs. In some instances, Taiwanese and Chinese manufacturers may produce saws for multiple U.S. firms; thus the costs of retooling might be spread across several of their customers, if the designs are similar enough. A representative of one firm also suggested that U.S. manufacturers may be able to work with their respective overseas contract manufacturers to absorb some of the retooling costs. For example, he indicated that when they redesigned products to incorporate new riving knife standards, the manufacturers they contract with in Taiwan absorbed much of the retooling cost (IEc, 2016b).

Interviews with several companies suggested that the redesign and retooling of table saws, at least on the initial models, would be expected to take 1 to 3 years. However, redesigning and retooling subsequent models would require a shorter period and cost less (IEc, 2016b).

Four small firms interviewed indicated that the cost of redesigning their saws to incorporate AIM technology may be too great, relative to their sales volume, to support such a redesign. They indicated that they might respond by reducing or eliminating their offerings of table saws to the U.S. market (IEc, 2016b).

4.2.3. Materials Costs

In addition to the redesign and tooling costs, additional costs would result from the additional components and the increased use of raw materials associated with inclusion of the AIM system. For SawStop models, the additional cost associated with the AIM system is approximately $58 (including brake cartridge, cartridge key, cartridge cable, cartridge bracket, insulation on arbor, electrode shell assembly, and power supply/motor control) (Gass, 2012). Public comments provided by SawStop on the ANPR also included an estimate from Black & Decker of $74 (including cartridge, electronics, and mechanical parts) (Gass, 2012).

The AIM technology also will affect the weight of the table saws, adding to material costs. Although the added weight is applicable to all tables saws equipped with the AIM technology, the added weight will particularly affect the bench saws, which can typically be transported by a single person. Currently, the lightest bench saws weigh 35 to 40 pounds. Although the various components needed for AIM compliance may only weigh a few pounds, the structure of some saws may need to be strengthened to be stable and to withstand the shock of blade braking and/or retraction. This need for strength may contribute substantially to the added weight of some complying saws. Adding the AIM technology could effectively double the weight of some of the lightest saws, reducing the portability and utility of lightweight bench saws.

4.3 Estimated Costs[22]

Based on the available information, there is considerable uncertainty concerning the per-unit manufacturing cost impact of a rule requiring the use of AIM technology on table saws. Consequently, based largely on discussions with manufacturers, we present both low and high estimates, by table saw type. Our estimates are presented below. CPSC staff would welcome any comments that would allow us to make more precise estimates or narrow the range we present.

Most manufacturers provided estimates in terms of expected retail price impacts. Consequently, for purposes of this analysis, we assume that the projected retail price impacts of the proposed rule provided by manufacturers also represent the manufacturing cost impacts. In other words, we assume that the costs associated with the rule are fully pushed forward to consumers, and that the expected price increases are reflective of the underlying costs of production.

Note also that these cost impacts do not include royalty fees, which are payments that manufacturers would have to make if they license the AIM technology, rather than develop their own system. From a societal perspective, royalties represent a transfer payment from one party or sector to another. Because royalties essentially move money from one pocket to another, and are not payments for goods or services, they are not technically costs, for purposes of the benefit-cost analysis (OMB, 2003). Nevertheless, the royalties will have distributional impacts on manufacturers and consumers that need to be discussed.[23]

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[22] Most of the information on costs for this analysis was collected in 2015. However, because the injury cost and benefits estimates are available only in 2014 dollars, and because the cost information collected from manufacturers and other sources was provided as general terms (rather than as precise estimates), we will, for purposes of this analysis, treat the cost information as if it were in 2014 dollars. Any bias that might be introduced by this assumption is likely to be negligible, but could potentially result in a slight overestimate of the costs relative to the benefits.

[23] Distributional effects refers to the concept that, although the net resources available to society have not changed, some entities will benefit, while others experience costs.

4.3.1. Low-End Direct Manufacturing Costs

SawStop has reported in both a presentation to CPSC and in court testimony that retail prices for bench saws would increase by no more than $150 per unit as result of the rule.[24] The $150 cost estimate was also suggested in a recent phone interview with Dr. Gass. Dr. Gass estimates that in the short term (*i.e.*, within the first 5 years following promulgation of the rule), the cheapest saws available (*i.e*., probably inexpensive bench saws that currently cost about $150) will have a price of approximately $299 (Gass, 2015). Hence, SawStop implicitly projects a short-term cost increase of about $150. In the absence of more specific information about manufacturing costs, we use this figure as the basis for the low-end estimate of manufacturing cost increases for bench saws.

For contractor and cabinet saws, the low-end expected cost impacts were based on discussions with other industry members. One manufacturer estimated that the retail price of the single table saw model that they produce would increase by about 30 percent as a result of the rule, including the cost of royalties (IEc, 2016b). Excluding royalties, this estimate suggested a cost increase associated with redesign, retooling, and materials of about $256 (IEc, 2016b). For this analysis, we assume that this $256 low-end cost increase can be applied to all contractor and cabinet saws.

4.3.2. High-End Direct Manufacturing Costs

For bench saws, the high-end cost increase is based on information provided by PTI, whose members produce primarily bench saws. PTI estimates that the increase would be $100 to $800 per saw, excluding royalties (PTI, 2012). In the absence of more specific estimates, we use the midpoint of this range, $450 per saw, as the short-term high-end estimate for bench saws (IEc, 2016b).

For contractor and cabinet saw models, we apply the high-end of the range estimated by PTI and other manufacturers. One table saw manufacturer provided an estimate ranging from $500 to $800 for “larger saws,” excluding royalties (IEc, 2016b). Another manufacturer estimated that the retail price of saws would increase 20 percent, excluding the cost of royalties (IEc, 2016b). Applying this percentage to the company’s cabinet saw models results in added costs of about $260 to $800. Consequently, we assume the high-end incremental cost increase is $800, the upper bound of each range suggested by PTI and these two manufacturers (IEc, 2016b). In the longer term, after about 5 years, we would expect that the incremental cost would decrease, although the magnitude of such a decrease is uncertain.

4.3.3 Replacement Parts Costs

In addition to the direct costs of the rule just described, there also will be the added costs of replacement parts related to the AIM system. For purposes of our analysis, we base the cost of replacement parts on the SawStop system, which requires replacement of the brake cartridge and

[24] SawStop, LLC. 2009. Presentation to CPSC, December 8 & 9. Also, Osorio v. One World Technologies, Inc., 659 F3d 81, 83 (1st Cir 2011).

blade after activation of the system. Replacement part prices are estimated to include $69 for a replacement brake cartridge (based on current online prices), and $30 to $90 for a replacement blade (PTI, 2016). Based on sales of replacement brake cartridges, SawStop estimates that the AIM system may activate about once every 9 years of use.[25] At a replacement rate of once every 9 years (and assuming $60 per replacement blade), this results in an annual per-unit replacement part cost of approximately $14 [($69 + $60) ÷ 9]. However, because blades depreciate and would require periodic replacement, even in the absence of an AIM activation, we assume that the need for replacement blades, due to an activation, costs an average of about $30 every 9 years (rather than $60), for an average of about $11 annually [($69 + $30) ÷ 9]. The present value of this expected annual cost of $11 over the life of a typical table saw, and discounted at a rate of 3 percent, would amount to about $94 for bench saws (with a 10-year expected product life), $145 for contractor saws (with an estimated 17-year product life), and $186 for cabinet saws (with an expected 24-year product life). With a discount rate of 7 percent, the present value of expected costs would amount to about $77, $107, and $126, for bench, contractor, and cabinet saws, respectively. For purposes of this cost analysis, we use the midpoint of this range. Hence, we estimate that replacement part costs for the AIM system would amount to about $86 for bench saws, $126 for contractor saws, and $156 for cabinet saws.

The direct manufacturing and replacement costs are presented in Table 11, and rely on the low- and high-end direct manufacturing costs (from sections *4.3.1.* and *4.3.2*) and the SawStop replacement costs just described.

Table 11. Direct Manufacturing and Replacement Costs

Table Saw Type	Direct Manufacturing Costs		Replacement Parts Costs	Total Direct + Replacement Costs	
	Low-End Estimates	High-End Estimates		Low-End Estimates	High-End Estimates
Bench	$150	$450	$86	$236	$536
Contractor	$256	$800	$126	$382	$926
Cabinet	$256	$800	$156	$412	$956

There are a couple caveats to the Table 11 estimates for replacement costs. Another cost of the SawStop AIM system not included in Table 11 is the additional optional hardware needed to perform dado cuts.[26] This includes an $89 dado brake cartridge.[27] The dado brake cartridge is not included in the analysis because the frequency and importance of dado cuts are unknown. Nonetheless, the brake cartridge constitutes an added expense for users who wish to make dado cuts.

[25] SawStop, March 2011, Information Package for Petition CP-03-02. As cited in CPSC (2011). Table Saw Blade Contact Injuries; Advance Notice of Proposed Rulemaking. September 14.

[26] Any cut that does not extend through the top surface of the workpiece is called a non-through cut. A dado cut is a type of non-through cut that produces a simple channel in the width of the workpiece.

[27] This cost estimate is based on a Google ad for Woodcraft Supply, accessed on June 30, 2016

Additionally, the Bosch REAXX bench saw, introduced on June 1, 2016, uses a $100 cartridge usable for two activations. Because the blade is not destroyed by the activation, the Bosch system has lower replacement part costs. Because the Bosch bench saw was only recently marketed in June 2016, we have no information on how frequently the cartridge will be activated. If, however, the Bosch cartridge activates once every 9 years, based on the SawStop experience (and we have no evidence that the user of a Bosch saw would trigger a blade stoppage with a different frequency than SawStop users), and the cost is $100 for two activations, then the expected annual per-unit replacement cost would be about $5.55 annually (($100/2) ÷ 9). The present value of this expected annual cost of $5.55 over an average product life of 10 years for a bench saw (discounted at a rate of 3 percent) would amount to about $47 per saw, about half the expected costs of the SawStop system. Additionally, the Bosch system does not require any additional dado hardware related to the AIM system. Consequently, if the Bosch REAXX becomes popular and legally viable, then our baseline estimates of replacement costs might be reduced.

4.3.4 Impact on Product Usability Utility

The additional weight associated with an AIM system will have an impact on the utility of lightweight bench saws. According to Dr. Gass, his system will add only 4 or 5 pounds of weight to a lightweight bench saw. However, SawStop's existing "jobsite" bench saw (the term jobsite is applied to large bench saws intended for commercial users), which has been marketed since 2015, weighs about 78 pounds without the stand, and it is at the high end of the bench saw weight range.

Bosch's AIM system is quite different in some respects and provides an instructive basis for comparison. The Bosch jobsite bench saw with AIM technology is the GTS1041A REAXX. The same table saw without the AIM technology and other electronic features is the Bosch 4100 model. The GTS1041A REAXX (78 pounds, priced at about $1,500) weighs about 18 pounds more than the 60-pound 4100 model (with a price of about $700). The 4100 model is also sturdier and heavier than an inexpensive 40-pound bench saw, and the additional 18 pounds on the 4100 model (on top of the 60 pounds of the base model) may be needed to provide the stability necessary to withstand the shock of blade retraction for the Bosch AIM system.

An additional 4 or 5 pounds is not a major weight penalty on a 40-pound bench saw, but an 18-pound increase would reduce portability. An additional 20 pounds (on top of the 18 pounds) for a more substantial jobsite saw-type structure, if necessary, would further decrease portability. For contractor saws, with wheels and stands, the weight penalty would not be substantial. Cabinet saws are not portable at all, so the weight penalty may make no real difference.

Another impact of the SawStop system is the need to change the brake cartridge to a dado cartridge when making dado cuts. Replacing the cartridge at the same time the dado blade is installed would require a minor additional effort on the part of the user.

CPSC staff welcomes public comments on the impact of the AIM technology on the utility of table saws and possible methods of quantifying these impacts.

4.3.5. Baseline Sales, Retail Prices, and Per-Unit Costs and Royalty Fees

Table 12 provides baseline sales and median retail price estimates,[28] along with the total per-product compliance cost estimates, including both the costs associated with manufacturing the redesigned table saws and the expected costs of replacement parts over the expected product life of a table saw. Table 12 also provides an estimate of the expected royalty fee, under the assumption, based on Dr. Gass's statements that the fee would amount to 8 percent of a saw's wholesale price (Gass, 2015; IEc, 2016b). The per-unit cost and royalty fee estimates are provided for both the low-end and high-end cost estimates.[29]

Table 12. Baseline Annual Table Saw Shipments, Retail Prices, and Per-Unit Compliance Cost Estimates and Royalty Fees

Table Saw Type	Pre-Regulatory Baseline Estimates		Per Unit Cost Estimates*		Per Unit Royalty Fees	
	Shipments**	Median Price (Per Unit)	Low-End Estimates (% of Baseline)	High-End Estimates (% of Baseline)	Low-End Cost Estimates	High-End Cost Estimates
Bench	499,000	$400	$236 (59.0%)	$536 (134%)	$37	$57
Contractor	133,000	$1,225	$382 (31.2%)	$926 (75.6%)	$99	$135
Cabinet	33,000	$2,550	$412 (16.2%)	$956 (37.5%)	$187	$223

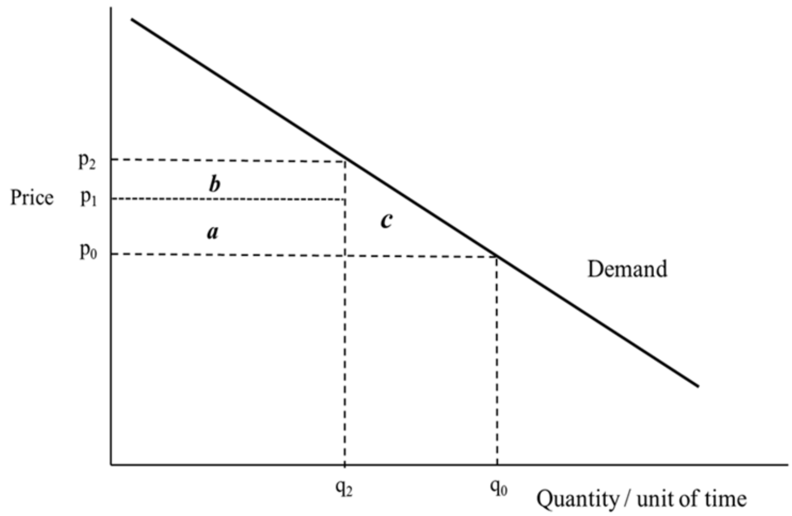
* Includes direct manufacturing and replacement part costs
** Excludes 10,000 units assumed to contain the AIM technology

4.3.6. Impact of Higher Prices on Sales and Lost Consumer Surplus

The increasing retail prices of table saws, as costs are passed on to consumers, will result in a reduction in table saw sales. Consequently, and in addition to the price impacts on consumers who continue to purchase saws, consumers who decide not to purchase table saws because of the higher prices will experience a loss in consumer surplus. These impacts are illustrated conceptually in Fig. 4 below. For purposes of this analysis, we assume that cost increases, as well as royalties, are pushed forward to consumers.

[28] Retail price information was collected for all table saw models listed in Table 1. However, we were unable to calculate a weighted average retail price for each category of saws because we do not have sales information for the various models. Consequently, we apply the median price advertised for each category as baseline pre-regulatory retail prices.
[29] In our 2015 telephone interview, Dr. Gass (2015) suggested that SawStop would accept royalty payments of 8 percent of a saw's wholesale value, if a rule is promulgated requiring AIM technology on all table saws.

Figure 4. Demand for Table Saws



The downward sloping curve in Figure 4 represents the demand for table saws; p_0 and q_0 represent, respectively, the pre-regulatory price and quantity of table saws demanded. After the regulation becomes effective, table saw prices rise to p_2, and the quantity of table saws purchased declines to q_2. The change in price from p_0 to p_1 represents the direct costs of the rule per table saw. The area given by the rectangle ***a*** represents the aggregate direct costs of the rule over the time period being considered (*e.g.*, one year); it is equal to the product of the increase in table saw price ($p_1 - p_0$) and the quantity demanded during the period (*i.e.*, q_2).

As noted above, royalty fees represent a transfer from one party to another and are therefore not counted as a cost of the rule. Nevertheless, from the point of view of an individual manufacturer who pays the royalty, the payment represents a cost and is assumed to be pushed forward to consumers in the form of higher prices. Thus, in evaluating the impact of the rule on sales, both the direct costs (but excluding the expected costs of replacement parts) and the royalty fee will affect consumer decisions and reduce the quantity of table saws demanded. The price impact of the royalty fee is reflected in the increase in price from p_1 to p_2. Thus, the total price increase is given by $p_2 - p_0$, and the quantity of table saws demanded at that higher price is given by q_2 in the figure. The area given by the rectangle ***b*** represents the royalties being transferred. It is equal to the product of the increase in table saw price associated with the royalties ($p_2 - p_1$) and the post-regulatory quantity demanded (*i.e.*, q_2).

The triangle ***c*** represents an additional loss in consumer surplus, which is a cost to consumers in the form of reduced utility. It represents a value over and above what consumers would have paid for the product before the regulation, but which is lost to the consumers who do not purchase a table saw at the higher price, p_2.[30]

[30] In general, consumer surplus represents the difference between the market clearing price and the maximum amount consumers would have been willing to pay for the product. Ideally, we would like to measure the costs of lost producer surplus (*i.e.*, a measure of revenue accruing to firms that produce and sell products over and above the

Given information on the pre-regulatory price (p_0) and quantity demanded (q_0), the expected impact of the rule on product prices, and information on the elasticity of demand for table saws (*i.e.*, the percentage change in quantity demanded given a percentage change in price), we can estimate the expected reduction in sales ($q_0 - q_2$), and the lost consumer surplus represented by ***c*** in the above graph.

Table 12 describes pre-regulatory baseline sales and prices. Baseline sales are estimated to be about 675,000 annually, which was the average number of table saw shipments during the 2002 to 2014 time period. We assume that SawStop sells about 10,000 table saws annually that are likely to be compliant with the draft proposed rule, and are therefore excluded from this analysis. Of the 665,000 noncompliant saws, we assume that 75 percent were bench saws, 20 percent were contractor saws, and 5 percent were cabinet saws. Consequently, the pre-regulatory baseline sales of table saws likely to be affected by the rule, by table saw type, are estimated at about 499,000 bench saws (665,000 × 0.75), 133,000 contractor saws (665,000 × 0.20), and 33,000 cabinet saws (665,000 × 0.05).

Additionally, for this analysis, we apply an elasticity estimate of −0.3367 for home goods from Taylor and Houthakker (2010), representing the measure of the sensitivity of changes in quantity demanded to changes in price.[31] An elasticity of −0.3367 suggests that a 1 percent increase in the price of table saws results in a reduction in the quantity demanded of about one-third of a percent.[32]

Consider, for example, the *low-end* cost estimates for bench saws. From Table 12, the pre-regulatory baseline price for bench saws was about \$400, and sales amounted to about 499,000 annually. Given these parameters, and combining the *low-end* direct cost estimate (but excluding the costs of replacement parts)[33] of \$150 with the royalty payment of \$37, shown in Table 12, sales might decline by about 15.74 percent ([(\$150 + \$37)/\$400] × −0.3367), a reduction of about 78,500 bench saws (0.1574 × 499,000) annually. Additionally, the lost

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price that they would have been willing to supply the products), as well as lost consumer surplus. However, to do so would require information on the supply and demand curves for table saws, which is not available. As an alternative, we assume that the cost of the regulation is borne by consumers in the form of higher prices, and we estimate the change in consumer surplus resulting from increased prices. Additionally, although information needed to derive a well-specified demand curve is not currently available, we employ an assumption about the slope of the demand curve, based on an estimate of price elasticity of demand for home goods. (Note also that while we have referred to the area of the triangle ***c*** in Figure 4 as the loss in consumer surplus for consumers not willing to pay the higher price p_2, technically, the entire area ***a*** + ***b*** + ***c*** represents the lost consumer surplus relative to the original pre-regulatory price of p_0.)

[31] "Home goods" are defined to include products such as "floor coverings; picture frames; mirrors; art products; portable lamps; window coverings and hardware; telephone equipment; writing equipment; and hand, power, and garden tools."

[32] The elasticity of demand value from Taylor and Houthakker (2010) would apply to the purchases of residential consumers and exclude commercial users.

[33] Although the expected cost of replacement parts is a real cost of the proposed rule, it is excluded from an analysis of the impact of the rule on the quantity demanded (or sales) under the assumption that consumers do not consider the costs of replacing the AIM technology as part of the purchase decision.

consumer surplus (represented by the area of triangle *c* in the graph above), amounts to about \$7.3 million (*i.e.*, $0.5 \times (p_2 - p_0) \times (q_0 - q_2)) = 0.5 \times \$187 \times 78{,}500$).

If the estimate of lost consumer surplus is spread over the remaining bench saws sold, the estimated lost consumer surplus, per product sold, might amount to about \$17 per bench saw (\$7.3 million ÷ 420,500 bench saws). If this per-unit consumer surplus loss is combined with the *low-end* direct and replacement parts costs, the aggregate per-unit costs of the rule are estimated to be about \$261 per bench saw (*i.e.*, \$244 in direct manufacturing costs and replacement costs + \$17 in lost consumer surplus).

Table 13 shows the expected reduction in annual sales and the expected lost consumer surplus. Reduced sales could range from 93,400 table saws under the low-end cost estimates (column a), to about 251,700 under the high-end cost estimates (column d), representing a sales reduction of about 14.0 percent to 37.8 percent, respectively. The annual loss in consumer surplus ranges from about \$10.0 million under the low cost estimates (column c), to about \$72.3 million, under the high cost estimates (column f).

Table 13. Aggregate Expected Post-Regulatory Annual Table Saw Sales, Sales Reduction, and Lost Consumer Surplus, by Cost Level and Table Saw Type

Table Saw Type	Low-End Cost Estimate			High-End Cost Estimate		
	(a) Expected Sales Reduction	(b) Expected Post-Regulatory Sales	(c) Aggregate Lost Consumer Surplus (millions \$)	(d) Expected Sales Reduction	(e) Expected Post-Regulatory Sales	(f) Aggregate Lost Consumer Surplus (Millions \$)
Bench	78,500	420,500	\$7.3	213,000	286,000	\$54.0
Contractor	13,000	120,000	\$2.3	34,200	98,800	\$16.0
Cabinet	1,900	31,100	\$0.4	4,500	28,500	\$2.3
Total	93,400	571,600	\$10.0	251,700	413,300	\$72.3

Table 14 presents the total costs per table saw, including the direct manufacturing costs, replacement part costs, and lost consumer surplus. The direct manufacturing and replacement part cost estimates, per table saw, are from Table 11. The lost consumer surplus, per table saw, is calculated as the aggregate lost consumer surplus (from Table 13, columns c and f) divided by the post-regulatory estimate of sales (Table 13, columns b and e). Total per-unit costs range from roughly \$253 to \$725 per bench saw, to roughly \$400 to \$1,000 per unit for contractor and cabinet saws.

Table 14. Total Costs of the Proposed Rule, per Table Saw, by Cost Level and Table Saw Type

Table Saw Type	Low-End Cost Estimates, per Table Saw			High-End Cost Estimates, per Table Saw		
	(a) Direct + Replacement Costs	(b) Lost Consumer Surplus	(c) Total (a) + (b)	(d) Direct + Replacement Costs	(e) Lost Consumer Surplus	(f) Total (d) + (e)
Bench	$236	$17	$253	$536	$189	$725
Contractor	$382	$19	$401	$926	$162	$1,088
Cabinet	$412	$13	$425	$956	$81	$1,037

The annual aggregate costs of the rule are estimated in columns (c) and (f) of Table 15, and range from about $170 million, based on our low-end cost estimates, to about $345 million, based on our high-end cost estimates. Bench table saws account for about 63 percent of the total, under the low-end annual cost estimates, and about 60 percent of the costs under the high-end estimates.

Table 15. Annual Post-Regulatory Sales, Per-Unit Cost Estimates, and Aggregate Annual Costs of the Proposed Rule, by Cost Level and Table Saw Type

Table Saw Type	Low-End Cost Estimates			High-End Cost Estimates		
	(a) Annual Post-Regulatory Table Saw Sales	(b) Per Unit Costs (Direct Costs + Replacement Costs + Lost Consumer Surplus)	(c) Aggregate Costs (millions $) (a) × (b)	(d) Annual Post-Regulatory Table Saw Sales	(e) Per Unit Costs (Direct Costs + Replacement Costs + Lost Consumer Surplus)	(f) Aggregate Costs (millions $) (d) × (e)
Bench	420,500	$253	$106.4	286,000	$725	$207.4
Contractor	120,000	$401	$48.1	98,800	$1,088	$107.5
Cabinet	31,100	$425	$13.2	28,500	$1,037	$29.6
Total	571,600		$167.7	413,300		$344.5

Over time, we would expect the costs of the AIM technology to decrease. If, for example, we assume that the annual aggregate costs remain constant for years 1 through 5, but decline by about one-third in years 6 through 10, the present value of the aggregate costs over 10 years (using a 3 percent discount rate) would range from about $1,200 million to $2,500 million; on an annualized basis, this would amount to about $140 million to $290 million. Alternatively, if annual aggregate costs remain constant for years 1 through 5, but decline by about two-thirds in years 6 through 10, the present value of the aggregate costs over 10 years (using a 3 percent discount rate) would range from about $990 million to $2,000 million; on an annualized basis, this would amount to about $120 million to $240 million (IEc, 2016b).

4.3.7. Royalty Fees

In addition to the direct manufacturing and replacement parts costs and the lost consumer surplus, there are likely to be some $30 million to $35 million annually in royalty fees for the AIM technology, which will accrue to patent holders. This estimate is based on the assumption that royalty fees will amount to about 8 percent of the wholesale costs of table saws when a rule would become effective. Because these royalties represent transfers from manufacturers to a patent holder, they are not included as costs for purposes of the benefit-cost analysis (OMB, 2003). This is because, from a societal standpoint, the royalty fees represent a transfer from one market segment to another (*i.e.*, from table saw manufacturers to patent holders) and remain available (by a different party) for productive use. Nevertheless, from the point of view of an individual manufacturer who pays the royalty, the payment represents a cost. Consequently, the royalty transfers represent an impact of the rule that needs to be considered. Table saw manufacturers who would be paying royalties to a competitor, in effect, would be reducing their competitiveness, relative to the patent holder receiving the royalties.

4.4. Benefit Cost Findings

The expected benefits and costs of the draft proposed rule are presented and compared in Table 16. The estimated benefits per table saw in rows (a) and (b) are drawn from the estimates provided in Table 10. The estimated costs per table saw are shown in rows (c) and (d). Cost estimates were developed from Table 15; they represent the average lower- and upper-bound cost estimates, weighted by projected sales. Net benefits per table saw are estimated in rows (e) and (f), and range from about $2,500 to $4,000, with a 3 percent discount rate, and about $1,500 to $2,700 at 7 percent.

Table 16. Estimates of Benefits, Costs and Net Benefits, by Table Saw (2014 dollars)

Categories			Discount Rate		Row
			3 Percent	7 Percent	
Estimates per Table Saw, Over its Expected Product Life	Expected Benefits per Table Saw	70% Effective	$3,335	$2,345	(a)
		90% Effective	$4,288	$3,015	(b)
	Expected Costs per Table Saw	Lower Bound Cost Estimates	$293	$293	(c)
		Higher Bound Cost Estimates	$833	$833	(d)
	Range of Expected Net Benefits per Table Saw	(a) – (d) (b) – (c)	$2,502 to $3,995	$1,512 to $2,722	(e) (f)
Expected Annual Sales	Low Cost Estimate		571,600	571,600	(g)
	High Cost Estimate		413,300	413,300	(h)
Aggregate Annual Estimates, Based on One Year of Sales	Range of Expected Benefits (Millions $)	(a) × (h) (b) × (g)	$1,378 to $2,450	$969 to $1,723	(i) (j)
	Range of Expected Costs (Millions$)	(c) × (g) (d) × (h)	$168 to $344	$168 to $344	(k) (l)
	Range of Expected Net Benefits (Millions $)	(i) − (l) (j) − (k)	$1,034 to $2,282	$625 to $1,555	(m) (n)

Given table saw sales estimates, as shown in rows (g) and (h) of Table 16, we can provide aggregate annual estimates of the benefits and costs of the draft proposed rule. As shown in rows (i) and (j), estimates of *aggregate annual benefits* range from about $970 million to $2,450 million, and aggregate costs, shown in rows (m) and (n), range from about $170 million to about $345 million. Aggregate net benefits, from rows (m) and (n), range from about $1,030 million to $2,280 million with a 3 percent discount rate, and from about $630 million to $1,560 million at 7 percent.

4.4.1. Sensitivity Analysis

The benefit-cost analysis above described our methodology and the results of our reference case analysis. This section presents an analysis to help us evaluate the sensitivity of the results to variations in some of the key parameters and assumptions of the analysis. Such an analysis is needed to account for uncertainty in the values of the input variables. The variables we examine include: (1) the expected product life of table saws, (2) the number of table saws in use, (3) the national estimate of medically treated injuries involving table saws, and (4) our estimates of injury costs.

Relative to the reference case analysis, the sensitivity analysis allows the expected product life of table saws to vary by about 20 percent, the number of table saws in use to vary by 25 percent, and the national estimate of medically treated injuries by the upper- and lower-bounds of an approximate 95 percent confidence interval. Finally, we evaluate the results of the analysis when benefits are limited to the economic costs of injury (*i.e.*, medical costs and work loss), and the intangible costs associated with pain and suffering are excluded. This exclusion of pain and suffering is not intended to suggest that the intangible costs are not important; rather it simply shows the impact of limiting the costs to the economic losses associated with medical costs and work losses.

Table 17 (below) describes the results of the sensitivity analysis. Only changes in *net benefits* per table saw are shown in the table. Aside from varying the input variables, the methodology used to estimate net benefits in the sensitivity analysis was identical to what we presented in the reference case analysis.

Variations in the expected product life of the table saws had a relatively small impact on net benefits (See Table 17, Part B, rows b and c). This is not surprising. A longer expected product life reduces societal costs per table saw on an annual basis (because there would be more saws in use), but increases the number years over which benefits are accumulated in the present value calculation. Conversely, a shorter expected product life increases the annual societal costs per table saw (because there would be fewer saws in use), but decreases the number of years over which the benefits are accumulated. In all cases, net benefits remained positive and significant, and roughly equal to estimates from the reference case.

Variations in the number of saws in use, which might result if sales were systematically under- or over-estimated, had a somewhat greater impact on net benefits (Table 17, Part B, rows d and e). Net benefits rose when fewer saws were assumed to be in use because injury costs were apportioned over a smaller population of saws. Conversely, net benefits decreased when more saws were assumed to be in use. Nevertheless, net benefits remained positive.

Table 17. Sensitivity Analysis: Expected Net Benefits Associated with Variations in Input Values

Part A: Reference Case Results.*			
Row	Input Value	Range of Expected Net Benefits per Table Saw, by Discount Rate	
		3 Percent	7 Percent
a	Reference Case Analysis* (Rows (i) and (j) from Table 16)	$2,502 to $3,995	$1,512 to $2,722
* Reference Case Inputs: 3% discount rate; expected product life, 13.3 years; saws in use, 8.2 million; medically treated blade-contact injuries, 54,843 per year; including100% of pain and suffering estimates in injury cost calculation;			

Part B: Alternative Inputs for Sensitivity Analysis			
Row	Input Variable and Value(s) Used in Sensitivity Analysis	Range of Expected Net Benefits by Discount Rate	
		3 Percent	7 Percent
Expected Product Life (years)			
b	Lower expected product life: 10.8 years	$2,817 to $4,400	$1,834 to $3,136
c	Higher expected product life: 16.2 years	$2,502 to $3,995	$1,414 to $2,596
Saws in Use			
d	25% fewer saws in use: 6.1 million	$3,651 to $5,472	$2,319 to $3,760
e	25% more saws in use: 10.3 million	$1,822 to $3,121	$1,034 to $2,107
Medically Treated Injuries (per year)			
f	Approximate lower 95% CI: 45,150	$1,914 to $3,239	$1,098 to $2,190
g	Approximate upper 95% CI: 64,500	$3,088 to $4,749	$1,924 to $3,252
Exclusion of Pain and Suffering Estimates from Injury Costs			
h	Medical costs and work losses only, excluding imputed costs of pain and suffering.	$279 to $1,136	−$52 to $711

Variations in the national estimate of medically treated injuries (rows f and g) were based on the lower and upper bounds of an approximate 95 percent confidence interval, based on estimates of the coefficient of variation (CV) from the NEISS injury estimates (Garland, 2016, at Tab B). The upper-bound estimates increased net benefits substantially, as would be expected, while the lower-bound estimates lowered them.

Finally, net benefits were significantly reduced when benefits were limited to the reduction in economic losses associated with medical costs and work losses, excluding the intangible costs associated with pain and suffering (Table 17, Part B, row h). This is not surprising, given that the intangible costs of pain and suffering accounted for about 70 percent of the societal costs associated with blade-contact injuries. Nevertheless, although net benefits appear to have remained positive using a 3 percent discount rate, benefits were generally comparable to costs when a 7 percent discount rate was applied.

4.5. Breakeven Analysis

The preceding analysis evaluated the expected benefits and costs of the draft proposed rule over the table saw market as a whole, combining all of the saw types into a single category. However, because we had no information on the distribution of injuries by saw type, we were unable to evaluate the relationship between benefits and costs for each of the three major saw categories: bench saws, contractor saws, and cabinet saws.

Such a detailed analysis of benefits and costs, by saw type, is important because the saw types have different physical characteristics and different patterns of usage. Contractor saws, in general, are heavier, less mobile, and more expensive than bench saws; similarly, cabinet saws are heavier, less mobile, and more expensive than contractor saws. Some types of table saws may be used more frequently or more intensively than others. Contractor and cabinet saws may be more likely to be used by hobbyists or occupational users who may, relative to bench saw users, have more expertise or experience in the safe use of table saws. On the other hand, many consumers use table saws only occasionally. These types of consumers may be less likely to fully understand table saw risks (*e.g.*, how quickly and unexpectedly kickback injuries can occur) or to remember safety procedures; they are also probably more likely to purchase the inexpensive bench saw models. Consequently, because of the different characteristics and potentially varying use patterns associated with the various saw types, it is possible that the costs of the draft proposed rule exceed the benefits for one or more table saw types, even though, in aggregate (as shown above), benefits exceed costs for the market as a whole.

Although we cannot conduct a benefit-cost analysis of the individual saw types, we can perform a breakeven analysis that may provide some insight into the relationship between benefits and costs of the draft proposed rule by saw type. To do this, for each saw type, we will estimate the number of injuries that would have to be substantially mitigated for benefits to equal or exceed the costs. This is called a breakeven analysis, and the number of injuries that would have to be substantially mitigated before benefits would equal costs can be called the breakeven estimate. We will then develop several hypothetical distributions of injuries across saw types and then compare the expected injury reduction for each to the breakeven estimates.

The analysis will be applied to table saw sales from a single year. This will allow us to calculate the breakeven injury estimate from information that we have already presented in this regulatory analysis. We will then follow the single years' worth of table saw sales through their useful product lives to determine (with our hypothetical risk distributions and our effectiveness estimates from section *4.1.4.*) the expected number of injuries that would likely be substantially be mitigted by the draft proposed rule.

4.5.1. Calculation of the Breakeven Injury Estimates

Breakeven injury estimates, by saw type, are presented at row (a) in Table 18. These estimates are derived from (1) the expected post-regulatory sales, and (2) the aggregate cost estimates, by saw type, presented in Table 15. For example, to calculate the breakeven injury estimate for bench saws, we begin with the aggregate cost estimates of \$106.4 million to \$207.4 million. The \$106.4 million was based on our lower-bound cost estimate for bench saws (annual sales of 420,500 bench saws × \$253 cost per bench saw), and \$207.4 million was based on our upper-bound cost estimate (annual sales of 286,000 bench saws × \$725 cost per bench saw).

If we divide these aggregate cost estimates by the average cost per injury (*i.e.*, \$74,050 with a 3 percent discount rate and \$66,550 at 7 percent), we can estimate a range of injuries that would have to be substantially mitigated[34] for benefits to equal or exceed costs. For bench saws, using a 3 percent discount rate, the breakeven estimates range from 1,437 injuries (\$106.4 million ÷ \$74,050) to 2,801 injuries (\$207.4 million ÷ \$74,050). Using a 7 percent discount rate, the breakeven estimates range from about 1,599 injuries (\$106.4 million ÷ \$66,550) to about 3,116 (\$207.4 million ÷ \$66,550). If, for simplicity, we combine these ranges, we have an overall breakeven range from about 1,437 (based on the lower-bound cost estimate injury costs discounted at 3 percent) to 3,116 injuries (based on the upper-bound cost estimate and injury costs discounted at 7 percent).

What this breakeven estimate means is that *if* the draft proposed rule could substantially mitigate at least 1,437 to 3,116 bench saw injuries over the expected product life of 1 year's production and sale of bench saws, then the benefits of the draft proposed rule would equal or exceed the costs for that saw type. Using the same methodology, the breakeven injury estimate for contractor saws ranges from 650 to 1,615, and the breakeven estimate for cabinet saws ranges from 178 to 445.

Note that throughout this breakeven analysis, we are implicitly assuming that the types of injuries experienced, and hence, the societal costs, are the same across the three types of table saws. However, in reality, the distribution of injuries and the resulting societal costs, by saw type, are likely to vary for the reasons mentioned in the second paragraph of section *4.5*.

The next step is to propose several hypothetical blade-contact injury distributions and to estimate the number of injuries that would likely be substantially mitigated by the draft proposed rule.

[34] Note that we are using the term "substantially mitigated" rather than "prevented" because, as described in section *4.1.4*. (the section concerning the effectiveness and expected benefits of the draft proposed rule), the currently available AIM systems do not generally activate until after the hand or finger comes into contact with the operating blade. Consequently, blade contact will result in some injury, though the injury may be minor and may not require medical attention beyond that of a band aid.

Table 18. Breakeven injury estimates and the expected injury reduction associated with 1 year of table saw sales, by table saw type

		Type of Saw		
Row		Bench	Contractor	Cabinet
a	Breakeven Injury Estimates	1,437 – 3,116	650 – 1,615	178 – 445
Hypothetical Injury Distributions				
b	1. Every Saw Has the Same Annual Risk of Injury	Bench	Contractor	Cabinet
c	Annual Risk per Saw	0.00669	0.00669	0.00669
d	Estimated Annual Injuries	1,913 – 2,812	661 -- 803	191 – 208
e	Present Value of Annual Injury Estimate	13,435 – 23,990	6,451 – 10,567	2,186 – 3,323
f	Present Value of Expected Injury Reduction*	8,330 – 19,192	4,000 – 8,454	1,355 – 2,818
g	2. Equivalent risks for the saw types, over expected product life	Bench	Contractor	Cabinet
h	Annual Risk per Saw	0.00808	0.00475	0.00337
i	Estimated Annual Injuries	2,312 – 3,399	470– 571	96 – 105
j	Present Value of Annual Injury Estimate	16,237 – 28,993	4,586 – 7,512	1,101 – 1,774
k	Present Value of Expected Injury Reduction*	10,067 – 23,194	2,843 – 6,010	682 – 1,419
l	3. Injury Risks Proportional to the Median Saw Price	Bench	Contractor	Cabinet
m	Annual Risk per Saw	0.00318	0.00974	0.02027
n	Estimated Annual Injuries	910 – 1,337	962 – 1,169	578 – 631
o	Present Value of Annual Injury Estimate	6,389 – 11,408	9,396 – 15,389	6,628 – 10,679
p	Present Value of Expected Injury Reduction*	3,961 – 9,126	5,825 – 12,311	4,109 – 8,543
q	4. Injuries are Proportional to Median Saw Price	Bench	Contractor	Cabinet
r	Annual Risk per Saw	0.00103	0.00700	0.04187
s	Estimated Annual Injuries	295 -- 433	691 -- 840	1,193 – 1,302
t	Present Value of Annual Injury Estimate	2,070 – 3,696	6,749 – 11,054	13,687 – 22,053
u	Present Value of Expected Injury Reduction*	1,283 – 2,957	4,184 – 8,843	8,486 – 17,642

* Assumes 70 percent to 90 percent of the blade-contact injuries are substantially mitigated by the draft proposed rule.

4.5.2. Hypothetical Injury Distribution1: Risks for Saws Equivalent on an Annual Basis

Because we have no information on the actual distribution of blade-contact injuries across saw types, we present four hypothetical distributions. The first assumes that injuries are proportional to saws in use, and that every table saw has an equal likelihood of injury on an annual basis. Thus, the risk for a bench saw, over the course of a year, is equal to the risk for contractor and cabinet saws.

Based on this hypothetical distribution, each saw was assumed to have an annual injury risk of about 0.00669 per year (row c), which is simply equal to the quotient of the estimated 54,843 blade-contact injuries in 2015, divided by an estimated 8.2 million table saws in use. Given the distribution of an estimated 8.2 million table saws in use (*i.e.*, 5.1 million bench saws, 2.3 million contractor saws, and 0.8 million cabinet saws), this injury distribution would suggest that about 62.2 percent of the 54,843 blade-contact injuries in 2015 involved bench saws, 28.0 percent involved contractor saws, and 9.8 percent involved cabinet saws.

The product of the injury risk (row c of Table 18) and annual sales estimates from Table 15 provides an estimate of injuries that would occur in the first year of use. Continuing with the bench saw example, the product of the injury risk (0.00669 per year) and annual bench saw sales (286,000 to 420,000 units annually) yields injury estimates ranging from about 1,913 to 2,812 per year (row d of Table 18). The present value of these two injury estimates over the expected 10-year product life of bench saws ranges from 13,435 to 19,753 (with a 7% discount rate) to 16,317 to 23,990 (with a 3 percent discount rate). Combining these two ranges suggests an overall range of about 13,435 to 23,990, as shown in row (e).

Finally, if we apply our assumption from section *4.1.4.*, that 70 percent to 90 percent of the blade-contact injuries would be substantially mitigated, and that amputations, fractures, and avulsions are not entirely prevented, but rather, become medically treated lacerations, the present value of the expected injury reduction for bench saws (*i.e.*, the benefits of the rule) would range from 8,330 (0.62 × 13,435) to 19,192 injuries (0.8 × 23,990) injuries substantially mitigated (row f). We use 0.62 and 0.80 in these calculations because, as we noted in section *4.1.4.*, the benefits at 70 percent effectiveness amounted to a reduction of about 62 percent in societal costs, and benefits at 90 percent effectiveness amounted to a reduction of about 80 percent in societal costs because of our assumption that amputations, fractures, and avulsions would not be entirely prevented, but rather, would become lacerations.

Note that the breakeven injury estimates in Table 18 represent *present values*. This is because the direct manufacturing costs of the draft proposed rule were already accounted for at the time of sale; or, in the case of replacement parts, already discounted to provide a present value. Consequently, the estimated present value of the expected injury reduction derived in the previous paragraph (*i.e.*, the expected benefits of the action) can be compared directly to the breakeven estimates (which are reflective of costs). Thus, because the present value of the expected injury reduction for bench saws ranges from 8,330 to 19,192 and exceeds the breakeven range of 1,437 to 3,116, we can say that the benefits are very likely to exceed the costs for bench saws *for this hypothetical injury distribution*.

Using the same process, the present value of substantially mitigated injuries ranges from 4,000 to 8,454 injuries for contractor saws, and from 1,355 to 2,818 injuries for cabinet saws (row f). Because the present value of each of these ranges exceeds the breakeven range (650–1,615 for contractor saws and 178–445 for cabinet saws), we can say that for this distribution of injuries, the estimated benefits of the draft proposed rule are likely to exceed the costs for all three table saw types.

4.5.3. Hypothetical Injury Distribution 2: Risks for Saws Equivalent Over Their Expected Product Lives

The second hypothetical injury distribution assumes that the risks for the saw types are equal to one another over their expected product lives. Consequently, given the expected product life of about 10 years for bench saws, 17 years for contractor saws, and 24 years for cabinet saws, the annual risk for contractor saws, on an annual basis, would be about 59 percent (10 years ÷ 17 years) of the risk for bench saws, and the risk for cabinet saws would be about 42 percent (10 years ÷ 24 years) of the risk for bench saws.

Given the distribution of an estimated 8.2 million table saws currently in use by saw type, this hypothetical injury distribution would suggest that about 75.2 percent of the 54,843 blade-contact injuries in 2015 involved bench saws, 19.9 percent involved contractor saws, and 4.9 percent involved cabinet saws.

A possible justification for this type of risk distribution might be that users of contractor saws are more experienced, and hence, safer than bench saw users, and that users of cabinet saws are more experienced than users of contactor saws.

Relative to the proportional distribution of risks identified in section *4.5.2.*, this injury distribution suggests increased injury risk for bench saws, but indicates lower risks for contractor and cabinet saws (row h). Nevertheless, the present value of injuries substantially mitigated (row k) would continue to exceed the breakeven levels (row a).

4.5.4. Hypothetical Injury Distribution 3: Injury Risks by Saw Type Are Proportional to the Median Retail Price of Table Saws

Our third injury distribution assumes that the blade-contact risk for the three table saw types is proportional to their median retail prices. Given the median retail prices from Table 12 (*i.e.*, $400 per bench saw, $1,225 per contractor saw, and $2,550 per cabinet saw), the annual risk on a contractor saw would be about 3.06 times the risk for a bench saw (*i.e.*, $1,225 ÷ $400); and the annual risk on a cabinet saw would be about 6.37 times the risk for a bench saw (*i.e.*, $2,550 ÷ $400). Given the distribution of the estimated 8.2 million table saws currently in use by saw type, this hypothetical injury distribution would suggest that about 29.6 percent of the 54,843 blade-contact injuries in 2015 involved bench saws, 40.8 percent involved contractor saws, and 29.6 percent involved cabinet saws.

A possible justification for assuming this injury distribution might be that the risk of table saw injury is proportional to usage, and that table saw usage is proportional to price (*i.e.*, the more someone expects to use a table saw, the more they would be willing to pay for it).

Relative to the first two hypothetical injury distributions, this injury distribution would suggest that injury risks are lower on bench saws, but higher on contractor and cabinet saws (row m). The results suggest that the present value of injuries substantially mitigated (row p) would exceed the breakeven levels.

4.5.5. Hypothetical Injury Distribution 4: Annual Injuries Are Proportional to the Median Retail Price of Table Saws

Whereas our third hypothetical injury distribution suggested that *injury risks* (row m) were proportional to median prices, our fourth hypothetical injury distribution assumes that estimated *blade-contact injuries,* by table saw type, are proportional to the median retail prices. Consequently, the annual number of blade-contact injuries on contractor saws would be about 3.06 times the number of bench saw injuries, and the number of injuries on cabinet saws would be about 6.37 times the number of bench saws. Given the distribution of the estimated 8.2 million table saws currently in use by saw type, this hypothetical injury distribution would suggest that about 9.6 percent of the 54,843 blade-contact injuries in 2015 involved bench saws, 29.3 percent involved contractor saws, and 61.1 percent involved cabinet saws.

Relative to the earlier hypothetical injury distributions, this distribution suggests that annual table saw risks (row r) are much lower on bench saws (0.00103 per year), but much higher on cabinet saws (0.04187 per year). This distribution also suggests that the annual risk per cabinet saw would be about 40 times the annual risk on bench saws (*i.e.*, from row r, 0.04187 ÷ 0.00103). The hypothetical risk on cabinet saws (relative to the risk on bench saws) is substantial and produces an injury distribution that is similar to that reported in the CPSC's 2007-2008 table saw survey, in which roughly 70 percent of blade-contact injuries were reported to have involved cabinet saws, but only about 11 percent were reported to have involved bench saws (Choudhury and Paul, 2011). Consequently, although there were some inconsistencies in the 2007-2008 survey results that made the tabulated responses to the table saw type questions unreliable, it may be useful, nevertheless, to compare the expected injury reduction from this hypothetical distribution to the breakeven estimates.

Comparing the present value of the expected injury reduction (row u) with the breakeven injury estimates (row a) suggests that the expected injury reduction would exceed the breakeven level. However, for bench saws, the present value of injury reduction (1,283 to 2,957) appears to be generally comparable to, or slightly lower than, the breakeven level (1,437 to 3,116).

4.5.6. Sensitivity Analysis of Breakeven Results

The breakeven analysis evaluated four hypothetical injury distributions and found (for the most part) that the expected injury reduction for each of the saw types substantially exceeded the breakeven estimates, regardless of the hypothesized injury distribution. This section conducts a sensitivity analysis of the breakeven results by allowing variation in some key parameters and assumptions underlying the analysis, including variations in the number of table saws in use, the national estimate of medically treated injuries, and estimates of injury costs.

4.5.6.1. Variations in the Numbers of Table Saws in Use and Medically Treated Injuries

Results are presented in Table 19, which shows the *present value of the expected injury reduction* for the four injury distributions presented in Table 18, when estimates of the number of tables saws (by type) were either 25 percent lower or 25 percent higher than in the base analysis and when estimates of medically treated injury estimates were set equal to the lower and higher bounds of an approximate 95 percent confidence interval, based on the coefficient of variation from the NEISS blade-contact injury estimates.

As suggested by rows (b) through (p) of Table 19, the present value of the expected injury reductions from the first three hypothetical injury distributions remain uniformly higher than the breakeven estimates (row a), as do the projected injury reductions for contractor and cabinet saws from the fourth hypothesized injury distribution (rows q through u). However, considering *bench saws* from the fourth injury distribution, the present value injury estimates appear to be generally comparable, or marginally lower, than the breakeven injury estimates when (1) the estimate of bench saws in use was assumed to be 25 percent higher than the reference case (row s), and when (2) bench saw injuries were estimated at the lower bound of an approximate 95 percent confidence interval for medically treated injuries (row t).

Table 19. Sensitivity Analysis for Breakeven Results

		Type of Saw		
Row		Bench	Contractor	Cabinet
A	Breakeven Injury Estimates	1,437 – 3,116	650 – 1,615	178 – 445
Hypothetical Injury Distributions and Present Values for Expected Injury Reductions, Conditional on the Described Input Variation				
B	1. Every Saw Has the Same Annual Risk of Injury	Bench	Contractor	Cabinet
C	25% fewer Table Saws in Use	11,106 – 25,590	5,333 – 11,271	1,807 – 3,758
D	25% more Table Saws in Use	6,664 – 15,354	3,200 – 6,762	1,084 – 2,254
E	Lower bound Estimate of Medically Treated Injuries	6,860 – 15,806	3,294 – 6,962	1,117 – 2,320
F	Upper bound Estimate of Medically Treated Injuries	9,799 – 22,578	4,705– 9,945	1,595 – 3,315
G	2. Equivalent risks for the saw types, over expected product life	Bench	Contractor	Cabinet
H	25% fewer Table Saws in Use	13,420 – 30,920	3,791 – 8,011	910 – 1,892
I	25% more Table Saws in Use	8,052 – 18,552	2,274 – 4,807	595– 1,135
J	Lower bound Estimate of Medically Treated Injuries	8,291 – 19,104	2,342 – 4,950	562 – 1,169
K	Upper bound Estimate of Medically Treated Injuries	11,843 – 27,287	3,346 – 7,070	803 – 1,670
L	3. Injury Risks Proportional to the Median Saw Price	Bench	Contractor	Cabinet
M	25% fewer Table Saws in Use	5,281 – 12,169	7,767 – 16,414	5,479 – 11,391
N	25% more Table Saws in Use	3,168 – 7,310	4,660 – 10,089	3,287 – 6,834
O	Lower bound Estimate of Medically Treated Injuries	3,262 – 7,517	4,798 – 10,139	3,384 – 7,036
P	Upper bound Estimate of Medically Treated Injuries	4,660 – 10,736	6,853 – 14,482	4,834 – 10,050
Q	4. Injuries are Proportional to the Median Saw Price	Bench	Contractor	Cabinet
R	25% fewer Table Saws in Use	1,710 – 3,942	5,579 – 11,790	11,314 – 23,523
S	25% more Table Saws in Use	1,027 –2,364	3,347 – 7,074	6,788 – 14,114
T	Lower bound Estimate of Medically Treated Injuries	1,057 – 2,435	3,446 – 7,283	6,989 – 14,530
U	Upper bound Estimate of Medically Treated Injuries	1509 – 3,477	4,922 – 10,402	9,982 – 20,754

4.5.6.2. Excluding the Intangible Costs Associated with Pain and Suffering

Finally, we consider the sensitivity of the results to the exclusion of the intangible costs associated with pain and suffering. Again, we are not suggesting that the intangible costs are unimportant; rather, the analysis simply shows the impact of limiting the costs to the economic losses associated with medical costs and work losses.

By implicitly reducing injury costs, we are, in effect, changing the breakeven estimates which, as shown in section *4.5.1.*, were estimated as the quotient of aggregate injury costs for each type of saw, divided by the average injury cost. Using a 3 percent discount rate, and excluding the pain and suffering component, the average injury cost would be reduced from about $74,050 to $21,900; using a 7 percent discount rate, the average injury cost would be reduced from about $66,550 to $17,300. Consequently, following the bench saw example discussed earlier, the breakeven estimate, excluding the intangible costs associated with pain and suffering, would range from 4,854 injuries (106.4 million ÷ $21,900) to 9,461 injuries ($207.4 million ÷ $21,900) when discounted at 3 percent. When discounted at 7 percent, the breakeven estimate would range from 6,150 injuries ($106.4 million ÷ $17,300) to 11,994 injuries ($207.4 million ÷ $17,300). Thus, for bench saws, the overall range for the breakeven injury estimate is 4,854 to 11,994. Using the same methodology, the breakeven injury estimate for contractor and cabinet saws would range from 2,194 to 6,217 and from 602 to 1,711, respectively.

The breakeven injury estimates for the three types of saws, excluding pain and suffering, are presented in Table 20 and compared to the present value of the expected injury reductions developed in Table 18.

Table 20. Breakeven Injury Estimates (Excluding Pain and Suffering) and the Present Value of Expected Injury Reductions Associated with 1 Year of Table Saw Sales, by Table Saw Type

		Type of Saw		
Row		Bench	Contractor	Cabinet
A	Breakeven Injury Estimates	4,854 – 11,988	2,194 – 6,214	602 – 1,711
Hypothetical Injury Distributions				
B	1. Equivalent risks for the saw types, on an annual basis			
C	Present Value of Expected Injury Reduction*	8,330 – 19,192	4,000 – 8,454	1,255 – 2,818
D	2. Equivalent risks for the saw types, over expected product life			
E	Present Value of Expected Injury Reduction*	10,067 – 23,194	2,843 – 6,010	682 – 1,419
F	3. Injury Risks Proportional to the Median Saw Price			
G	Present Value of Expected Injury Reduction*	3,961 – 9,126	5,825 – 12,311	4,109 – 8,543
H	4. Injuries are Proportional to Median Saw Price			
I	Present Value of Expected Injury Reduction*	1,283 – 2,957	4,184 – 8,843	8,486 – 17,642

* Assumes 70 percent to 90 percent of the blade-contact injuries are substantially mitigated by the draft proposed rule.

The results suggest that, even without the pain and suffering component, the expected injury reduction would exceed the breakeven estimates for most of the saw types and injury distributions. However, there were several exceptions. First, the present value of the expected injury reduction was generally comparable to the breakeven injury estimates for contractor and cabinet saws under the second hypothetical injury distribution (row e). Second, the present value estimates were generally comparable to, or slightly less than, the breakeven estimates for bench saws under the third hypothetical injury distribution (row g). And third, the present value estimates were lower than the breakeven estimates for bench saws under the fourth hypothetical injury distribution (row i).

4.5.6.3. Summary of Sensitivity Analysis

Generally, the sensitivity analysis of the breakeven estimates suggested that estimates of the present value of the expected injury reduction were either comparable to, or substantially exceeded, the breakeven injury estimates for the various saw types and across all of the hypothetical injury distributions. The primary exception involved bench saws under the fourth hypothetical injury distribution, in which the relative risk on cabinet saws was roughly 40 times the risk on a bench saw.

5. Regulatory Alternatives

5.1. No Action Alternative

Under this alternative, the status quo would be maintained, at least in the short term. This option might be selected on the grounds that passive safety devices, such as blade guards, riving knives, and pawls, are already provided to purchasers of new table saws and can be used by consumers to prevent many types of blade-contact injury. Additionally, table saws with the AIM technology are already available for consumers who want and can afford them.

Over the longer term, changes in the voluntary standard may increase the level of safety with table saws. Sales of table saws with AIM technology may also gradually increase as consumers become more familiar with the improved safety characteristics of saws that can substantially mitigate blade-contact injury. Table saws with AIM systems are now available for purchase by consumers in all table saw categories, including the introductions of the SawStop bench saw model in March 2015, and the introduction of the Bosch REAXX jobsite saw in June 2016. Moreover, sales of saws with AIM technology could expand, if prices decline. However, for now, the price differentials between a table saw with AIM, and a comparable saw without AIM, are substantial, particularly for bench saws.

We cannot estimate the benefits and costs that would be associated with this alternative because the estimates would be affected by several factors, such as the extent to which manufacturers introduce new table saws with AIM technology, the price of the table saws, and the rate at which consumers would choose to purchase table saws with AIM technology in the absence of a rule. However, because the rate at which AIM technology would be adopted in the absence of a mandatory rule would probably be substantially lower than the rate under a mandatory rule, both the benefits and costs of this alternative would be lower than those under the draft proposed rule.

5.2. Improve the Voluntary Standard for Table Saws

Another alternative might be for Commission staff to continue participating and encouraging safety improvements to the voluntary standard for table saws, UL 987. Although this option would be similar to the "no action alternative," the Commission could direct staff to pursue safety improvements in the voluntary standard, including adopting AIM safety technology over time, as a conditional alternative to a mandatory standard. The Commission could then reconsider a mandatory standard if efforts to improve the voluntary standard remain unsatisfactory.

Staff has supported recent changes in the voluntary standard with requirements for improved blade guards, riving knives, and anti-kickback pawls, and staff considers the newer blade guard systems required in the 7^{th} Edition of the UL 987 voluntary standard for table saws to be a significant improvement over earlier systems (Smith, 2011). However, there is little evidence that improvement in these passive safety devices has effectively reduced injuries (Garland, 2016, at Tab B). Additionally, voluntary standards committees have twice rejected initiatives by UL to adopt voluntary standards that include AIM systems for table saws. Consequently, it does not appear that the voluntary standards process is likely to lead to a requirement for AIM technology, at least in the short run.

5.3. Later Effective Dates

The draft proposed rule includes an effective that is 3 years after the final rule is published in the *Federal Register.* Given the complexities and costs that would be associated with developing (or licensing) the AIM technology, redesigning virtually all table saw models, and retooling production facilities, an effective date later than 3 years could further reduce the impact of the rule on small manufacturers because it would allow them additional time to spread the costs of developing or negotiating for the rights to use an AIM technology, modify the design of their table saws to incorporate the AIM technology, and retool the factories for the production. For manufacturers that might choose to exit the table saw market, perhaps because their volume of table saw sales does not justify the cost of redesigning the table saws, the additional delay might also provide them with more time to consider alternative business opportunities. A later effective date might especially benefit manufacturers of bench saws because of the added technical difficulties in engineering small bench saws to incorporate an AIM technology.

Although later effective dates would mitigate somewhat the impact of the draft proposed rule on some manufacturers, it could also delay the introduction of table saws with AIM technology into the market. Moreover, the delay could possibly discourage manufacturers from introducing table saws with AIM technology earlier than the effective date, and it might penalize manufacturers that did so. Given the substantial net benefits per unit expected from incorporating AIM technology, delaying the introduction of table saws would be expected to result in lower aggregate net benefits.

5.4. Exempt Contractor and Cabinet Saws from a Product Safety Rule.

The Commission could exempt cabinet and/or contractor saws on the grounds that they tend to be used by (and are generally intended for) professional, commercial, or industrial users. There is no clear dividing line between consumer and professional saws, except at the very highest levels of price and performance. Additionally, we have little information on the proportion of occupational purchasers for contractor saws and cabinet saws. However, SawStop has claimed on its website that it is the largest manufacturer of cabinet saws. It also has stated that 75 percent of its sales are to professional or commercial users. This implies that professional or commercial users constitute a large proportion of the market for cabinet saws. Exempting cabinet and/or contractor saws would also substantially reduce the adverse impact of the rule on small manufacturers because most small manufacturers market contractor and cabinet saws.

Under this alternative, the benefits and costs would be limited to those associated with bench saws, which constitute the bulk of the saws sold. However, as noted, we do not have estimates of the injuries by type of saw. Therefore, we are unable to estimate the net benefits of this alternative. If, as suggested by the breakeven analysis, there would be positive net benefits by including contractor and cabinet saws within the scope of the rule, the net benefits of this option would be lower than the net benefits of the draft proposed rule.

5.5. Exempt a More Narrowly Defined Category of Table Saws

As a more narrowly defined exemption than that described in section *5.4.*, the Commission could exempt industrial saws with certain size, weight, power, and electrical specifications. For this alternative, the Commission would need to define "industrial saws." Although there is no clear dividing line between consumer and industrial saws, it seems extremely unlikely, for example, that a consumer would purchase a $25,000 computerized numerically controlled (CNC) panel saw (a panel saw or sliding table saw is designed to cut large pieces of wood, like sheets of plywood). Industrial users tend to purchase more expensive, capable, and durable machines, and probably dominate the cabinet saw market.

In general, a more expensive table saw is more powerful, larger, heavier, and has more features, and these characteristics apply particularly to cabinet saws. The availability of 12- or 14-inch blades is one indicator of power and capability. Although horsepower or amperage ratings are one indicator of power, other electrical specifications are probably the best indicator. A table saw that requires a minimum of 220, 440, or higher voltage, or three-phase wiring, is geared toward the professional user; most homes are wired for 110-120 volts, and few, if any, homes, have wiring that will accommodate three-phase wiring without substantial rewiring. Although horsepower ratings for table saws can sometimes be misleading, horsepower ratings for table saws with three-phase wiring capability are generally in the 5 to 10 horsepower range. The weights for these high-end saws are also high, in the 500-pound to 1,000-pound range. We would characterize any cabinet saw with minimum requirements of three-phase wiring, voltage requirements of 220 or more, and a weight of 700 pounds or more as intended for industrial use. Consequently, the Commission could exclude from the scope of the draft proposed rule table saws geared toward industrial use, without resulting in a significant reduction in expected benefits to consumers.

5.6. Limiting the Applicability of the Performance Requirements to Some, but Not All, Table Saws

Rather than require all table saws to meet the requirements of the draft proposed standard, the Commission could require that only a subset of table saws do so. For example, if a firm produces only bench saws, the Commission might require the firm to produce at least one bench saw model that meets the requirements of the standard. Similarly, if a firm produces bench saws *and* contractor saws, the Commission might require the firm to produce at least one bench saw model and one contractor saw model that meet the requirements of the standard. Or, as a variation, the Commission might allow each manufacturer to produce at least one bench saw model that does not meet the requirements of the standard, as long as their other bench model saws conform to the requirements of the rule.[35]

There would be some drawbacks to this approach. Most obviously, this approach would address only a portion of blade-contact injuries. If, for example, the requirement led to about 50 percent of table saws being equipped with the AIM technology, the expected benefits would be on the order of about 50 percent of the benefits described in the reference case analysis (or somewhat higher if consumers with the greater risks were more likely to purchase the safer table saws).[36] Such a rule might be somewhat more difficult to enforce than a requirement that all table saws contain the AIM technology.

Conversely, limiting the requirement for the AIM technology to a subset of table saws would have several advantages. Saws with the AIM technology would be available in substantially greater numbers than they have been in recent years. This approach would also address the market failure associated with one firm's market power over the AIM technology that seems to have impeded its distribution (see section *2*), and would allow consumers to choose table saws without AIM technology if they prefer. According to one commenter, there is usually a substantial heterogeneity in consumer preferences. Consequently, consumers who place a great value on safety, or who face greater-than-average risks will find the safer table saws more desirable and will be more likely to buy them. Consumers who do not want the safer but more expensive saws (or do not need them because they have lower than average risks) can decide to purchase saws without the AIM technology. In this way, consumer preferences might be better matched with the characteristics of the products purchased.

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[35] This variation in requirements would be somewhat analogous to the requirements for child-resistant packaging under the Poison Prevention Packaging Act.

[36] We cannot predict what proportion of table saw sales would ultimately contain the AIM technology under this alternative. If consumers place a high value on safety, and prices are reduced or moderated over time, the proportion might be high. If, however, consumers would generally prefer saws without the AIM technology because of the lower prices or for other reasons, the proportion would be lower. Product liability concerns on the part of manufacturers would probably increase the proportion of table saws with the AIM technology. Once the table saws with AIM technology become more commonplace, table saws without the technology would be more likely to be challenged in product liability suits. We can already see this tendency in some recent product liability lawsuits against table saw manufacturers.

If licensing agreements satisfactory to all parties could be arranged (perhaps at 8 percent of wholesale prices as described earlier), this alternative would also alleviate (though not eliminate) the burden of the rule on some small manufacturers because it would not require that all of their saws contain the AIM technology. However, as noted, Dr. Gass has said that his willingness to license the SawStop AIM technology at an 8 percent royalty fee is conditioned on CPSC promulgating a rule that requires all table saws to contain the technology. Consequently, if SawStop would be unwilling to license its technology at rates acceptable to other manufacturers, or if SawStop refused to do so because a CPSC rule did not cover all table saws, then small manufacturers might be faced with an even greater burden. Additionally, if there were only one monopoly producer under this scenario, consumers could potentially face even higher prices.

5.7. Information and Education Campaign

The Commission could conduct an information and education campaign, informing consumers about blade-contact hazards, how easily and quickly blade-contact injuries can occur, and the benefits of the AIM technology. This alternative could be implemented on its own, in the absence of other regulatory options, or it could be implemented in combination with any of the alternative options. Moreover, this alternative could directly address the potential market failure associated with inadequate information, as described in section *2*.

Such a campaign would be particularly important if the Commission chose an alternative that excluded some table saws from the scope of the draft proposed rule. For example, if the Commission chose the option described at section *5.6.*, allowing manufacturers to market table saw models without the AIM technology as long as one or more models were equipped with the safety technology, such a campaign for information and education could be aimed at helping to ensure that consumers make an informed choice in their table saw purchase. However, as described in Smith (2016, at Tab D), the effectiveness of such information and education approaches is likely to be limited.

6. Summary and Conclusions

The results of this analysis show substantial benefits associated with the draft proposed rule. It would address the approximately 54,850 medically treated table saw blade-contact injuries that occur annually. The societal cost of these injuries, estimated to be about $3.65 billion to $4.06 billion, annually, represents the pool from which the benefits would be derived. Medical costs and work losses, the economic losses associated with these injuries account for about 30 percent of the total; the intangible, or non-economic costs associated with pain and suffering account for the remaining 70 percent of the total. The proposed rule would be expected to substantially mitigate 70 percent to 90 percent of the medically treated blade-contact injuries.

The results also show substantial net benefits (*i.e.*, benefits − costs) for the proposed blade-contact rule. Estimates of net benefits, across all saw types, average about $1,500 to $4,000 per saw over its expected product life. Aggregate net benefits over 1 year's production and sale of table saws could amount to about \$625 million to about \$2,300 million. Net benefits varied, but they generally remained positive in our sensitivity analysis.

Because we had no information on the distribution of injuries across saw types (*i.e.*, bench, contractor, and cabinet saws), we were unable to compare directly the benefits and costs for each. However, based on several assumptions, we were able to conduct a breakeven analysis by estimating the approximate number of injuries that would have to be substantially mitigated for each type of saw for the benefits to equal or exceed the costs. This analysis suggested that, under most plausible injury distributions, the benefits would be likely to exceed the costs for each saw type.

Notwithstanding the high level of expected net benefits, the draft proposed rule would also be costly and would result in disruption of the table saw market. Under the rule, table saw manufacturers would need to develop their own AIM technology, without impinging on existing patents or, what is more likely, license the patented AIM technology that already exists.[37] Most, if not all, table saw models not already incorporating the AIM technology would require major design changes and the retooling of production facilities, a process that would likely take 2 years or more to accomplish. The cost impact of the draft proposed rule on market sales might also be substantial, potentially reducing aggregate sales by about 14 percent to 38 percent annually. In our discussions with manufacturers, four indicated that the cost of redesigning their saws to incorporate the AIM technology may be too great, relative to their sales volume, to support such a redesign. These firms indicated that they might respond by reducing or eliminating their offerings of table saws to the U.S. market (IEc, 2016a). We would expect that other firms, especially those with only a small market share of sales, would also consider such actions.

Although the draft proposed rule would substantially reduce blade-contact injuries and the societal costs associated with those injuries, the impact of increasing table saw production costs on consumers would also be considerable. The prices for the least expensive bench saws now available are expected to more than double to \$300 or more. In general, the retail prices of bench saws could increase by as much as \$200 to \$500 per unit, and the retail prices of contractor and cabinet saws could rise by as much as \$350 to \$1,000 per unit.[38] These higher prices may be mitigated in the longer run, but the extent of any future price reductions is unknown.

Additionally, because of the likely decline in sales following promulgation of a rule, consumers who choose not to purchase a new saw, due to the higher price, will experience a loss in utility by forgoing the use of table saws, or because they continue to use older saws that they would have preferred to replace. There may also be some other utility impacts. The inclusion of

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[37] When discussing the need for the rule at section *2*, the most immediate market impediment to the more widespread adoption of the AIM technology appeared to be the market power exercised by the primary holder of the AIM technology patents. Ordinarily, when the market failure is related to excessive market power, the remedy is to reduce the market power or to mitigate its effects. In this case, the proposed rule would likely consolidate the power of the patent holder, by forcing most table saw manufacturers to adopt the AIM technology via licensing agreements.

[38] The current retail prices of the nine SawStop models and the single Bosch model currently marketed are consistent with the upper end of these possible price increases.

the AIM technology, for example, will increase the weight and (potentially) the size of table saws to accommodate the new technology, to allow access to change the brake cartridge, and to mitigate the effects of the force associated with the activation of the brake cartridge. Although this factor may have a relatively small impact on the heavier and larger contractor and cabinet saws, the impact on some of the smaller and lighter bench saws could markedly reduce their portability.

Our analysis also discussed several alternatives to the draft proposed rule. These alternatives, which were described in section 5, would reduce the expected benefits of the draft proposed rule, but they would also mitigate its costs and potential disruptions in the marketplace. In particular, individually or in combination, they could reduce the adverse impacts of the draft proposed rule on manufacturers (including small manufacturers), allow for greater choice in the types and safety characteristics of the table saws that consumers can purchase, reduce the impact of the draft proposed rule on table saws intended for commercial or professional use, and directly address the market failures resulting in the need for a product safety rule in the first place.

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TAB D

Mandatory Safety Standard for Table Saws: Draft Initial Regulatory Flexibility Analysis

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December 1, 2016

Mandatory Safety Standard for Table Saws: Draft Initial Regulatory Flexibility Analysis

The Commission is considering a draft proposed rule that would establish performance requirements for table saws that would reduce the risk of severe injury if a body part contacted the blade. The draft proposed rule would not require a specific technology, but it is anticipated that to meet the requirements, most, if not all, table saws would need to incorporate an "active injury mitigation" (AIM) technology that is capable of automatically detecting when the hand, arm, or other body part of the operator contacts the blade and stopping and/or retracting the blade before a serious injury can occur. Whenever an agency is required to publish a notice of proposed rulemaking, the Regulatory Flexibility Act (5 USC 601 – 612) requires that the agency prepare an initial regulatory flexibility analysis (IRFA) that describes the impact that the rule would have on small businesses and other entities. The IRFA must contain –

(1) a description of why action by the agency is being considered;
(2) a succinct statement of the objectives of, and legal basis for, the proposed rule;
(3) a description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;
(4) a description of the projected reporting, recordkeeping and other compliance requirements of the proposed rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and
(5) an identification to the extent practicable, of all relevant Federal rules which may duplicate, overlap or conflict with the proposed rule.

An IRFA must also contain a description of any significant alternatives that would accomplish the stated objectives of the applicable statutes and that would minimize any significant economic impact of the proposed rule on small entities. Alternatives could include: (1) the establishment of differing compliance or reporting requirements that take into account the resources available to small businesses; (2) the clarification, consolidation, or simplification of compliance and reporting requirements for small entities; (3) the use of performance rather than design standards; and (4) an exemption from coverage of the rule, or any part of the rule thereof, for small entities. This report provides an IRFA examining the potential impact of the draft proposed rule on small businesses and other small entities.

Reason for Agency Action

The Commission is considering the draft proposed rule for table saws to reduce an unreasonable risk of injury associated with table saws. CPSC staff estimates that there are around 54,800 medically treated blade-contact injuries annually, based on 2015 injury data and estimates from the Commission's Injury Cost Model (ICM). Amputations accounted for 14 percent of the injuries, about 23 percent of the injuries involved fractures, and lacerations accounted for about 57 percent. Technology is available that can significantly mitigate the severity of injuries caused by a victim's hand or other body part contacting the blade while the table saw is in operation.

CPSC staff recommends that the Commission issue a proposed rule that would establish performance requirements to address the risk of injury associated with table saws.

Objectives of, and Legal Basis for, the Rule

The objective of the rule is to reduce the risk of serious injury due to the hand or other body part of a table saw operator coming into contact with the saw blade while the saw is operating. The proposed rule would be issued under the authority of Sections 7 and 9 of the Consumer Product Safety Act.

Small Entities to Which the Rule Will Apply

The rule will apply to manufacturers, importers, and private labelers of table saws that are sold in the United States. As of February 2016, CPSC is aware of 22 firms that supply table saws to the U.S. market. Of these 22 firms, at least eight and possibly 10 are "small" according to criteria established by the U.S. Small Business Administration (SBA).[1] According to the SBA criteria, a table saw manufacturer is considered "small" if it has fewer than 500 employees; a table saw importer is considered to be "small" if it has fewer than 100 employees. Private labelers of table saws are considered to be "small" if their annual revenue exceeds $38.5 million in the case of home centers, $32.5 million in the case of department stores, and $7.5 million in the case of hardware stores.[2]

Small table saw manufacturers supply mostly contractor and cabinet saws, which are typically more expensive and heavier than bench saws. Contractor saws generally retail for $529 to $2,049 and weigh about 198 and 414 pounds. Cabinet saws typically retail for $1,199 to $5,349 and weigh about 321 and 1,040 pounds. One small company sells a multipurpose machine that includes a table saw, lathe, drill press, sander, and router, among other tools. The cost of this multipurpose machine starts at about $3,379. As of March 2016, only three bench saw models were being offered by small manufacturers. One of these was a bench saw that was much heavier (233 pounds) and more expensive ($1,499) than most other bench saws. Another bench saw, offered by SawStop, already incorporates an AIM technology and retails for around $1,300. The size and weight of the third bench is more typical of the bench table saws offered by the larger manufacturers.[3]

[1] "Revised Table Saw Market Research Report," Memorandum from Jane Israel, Matthew Baumann, and Jennifer Baxter (Industrial Economics, Incorporated) to William Zamula and Robert Franklin (Consumer Product Safety Commission, Directorate for Economic Analysis (March 28, 2016).

[2] Under the North American Industrial Classification System (NAICS) manufacturers of table saws are classified in category 333243 (Sawmill, Woodworking, and Paper Machinery Manufacturing). Importers or private labelers of table saws include some department stores (NAICS category 4452111, home centers (NAICS category 444110), and some hardware stores (NAICS category 444130).

[3] Industrial Economics, Inc., Final Market Research Report – Table Saw Models, February 29, 2016 (spreadsheet provided to CPSC).

Although the design and engineering of table saws may occur in the United States, most U.S.-based suppliers contract the actual manufacture of the table saws to manufacturers based in Taiwan or China. A small number of table saws are manufactured in Canada, Germany, Austria, and Italy.[4] Shopsmith, the manufacturer of the multipurpose machine that includes a table saw, is the only small manufacturer that is believed to manufacture its product in the United States.

Compliance Requirements of the Draft Proposed Rule, Including Reporting and Recordkeeping Requirements

Table saw manufacturers, importers, and private labelers will be required to ensure that all table saws comply with the requirements in the draft proposed rule. The draft proposed rule would establish performance requirements that involve moving a test probe at a rate of 1 meter per second towards the spinning blade of the table saw. To pass, the test can result in a cut no more than 3.5 millimeters deep on the test probe. Although the draft proposed rule does not specify the means by which the table saw must comply with the requirements, all existing table saws that would meet the requirements do so by incorporating an AIM technology that rapidly stops the rotation of the saw blade, or quickly retracts the blade, or both.

If the Commission issues a final rule under section 14 of the CPSA, manufacturers, importers, and private labelers of table saws will be required to certify, based on a test of each product, or upon a reasonable testing program, that their tables saws comply with the requirements of the rule. Each certificate of compliance must identify the manufacturer or private labeler issuing the certificate and any third party conformity assessment body on whose testing the certificate depends. The certificate must be legible and in English and also include the date and place of manufacture, the date and place where the product was tested, including the full mailing address and telephone number for each party, and the contact information for the person responsible for maintaining records of the test results. The certificates may be in electronic format and must be provided to each distributor or retailer of the product. Upon request, the certificates must also be provided to the CPSC.[5]

Costs of Draft Proposed Rule that Would Be Incurred By Small Manufacturers

To comply with the draft proposed rule, table saw manufacturers would need to license or develop an AIM technology. In order to license a technology, manufacturers will have to pay a royalty to the owner of the patents on the technology. The royalty cost for licensing an AIM technology is uncertain. Dr. Stephen Gass of SawStop has stated that he would be willing to license the SawStop AIM technology for a royalty payment of 8 percent of the wholesale price of the saw, but only if the Commission establishes a mandatory standard requiring AIM technology. However, there is no certainty that SawStop actually would license its technology under terms

[4] Ibid (IEc).

[5] The regulations governing the content, form, and availability of the certificates of compliance are codified at 16 CFR 1110.

that would be acceptable to other manufacturers even if a mandatory standard were established. Several companies have asserted that they had attempted to license the SawStop technology but were unsuccessful. For example, Grizzly Industrial, Inc., indicated in its 2012 comment letter that it tried several times, from early 2007 to the present, to license SawStop's technology. According to Grizzly, it was unable to come to an agreement with SawStop because of what it considered SawStop's "unrealistic demands to convert every existing Grizzly model to include the flesh-sensing technology." Bosch uses an AIM technology on its REAXX bench saw that was developed, in part, through a joint venture of several members of the Power Tool Institute. The terms under which this technology may be available for license are not known and may be affected by ongoing patent infringement litigation.[6]

If a manufacturer wished to avoid royalty or license fees, the manufacturer would have the challenge of developing its own AIM technology. At a minimum, such an effort would likely cost at least several hundred thousand dollars and perhaps several million dollars, based on the estimated costs of developing the existing technologies. However, to avoid royalty payments, a manufacturer would be faced with the challenge of developing a new technology that did not infringe upon an existing patent. Stephen Gass of SawStop has reportedly asserted that it is probable that any practical AIM technology would infringe upon one or more of the patents associated with the SawStop technology.[7]

After acquiring an AIM technology, manufacturers will need to redesign their table saws and retool their manufacturing facilities to incorporate the technology. According to several manufacturers, incorporating an AIM technology would require a redesign of each table saw. Speaking in reference to the existing SawStop or Bosch technologies, the manufacturers stated that the trunnion,[8] the cabinet, and interior of the saw would need to be redesigned to incorporate the parts required for the AIM technology and to allow access to the interior of the saw to replace the brake cartridge or allow for clearance of the blade retracting, if the technology were triggered. The support structure of the table saw, including the stand, might have to be strengthened to bear the added weight of the system and to absorb the force that could result from the system being triggered.[9]

Estimates of the redesign and retooling costs ranged from a low of about $100,000 per model to $700,000. The redesign and retool process would be expected to take 1 to 3 years, depending upon the problems encountered in the process. The redesign and retooling costs for subsequent models might be somewhat less than the costs associated with the first model.[10]

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[6] "Revised Table Saw Market Research Report," Memorandum from Jane Israel, Matthew Baumann, and Jennifer Baxter (Industrial Economics, Incorporated) to William Zamula and Robert Franklin (Consumer Product Safety Commission, Directorate for Economic Analysis (March 28, 2016).

[7] Susan M. Young, Comment of Power Tool Institute on the Advance Notice of Proposed Rulemaking Regarding Table Saw Blade-contact Injuries, Docket No. CPSC-2011-0074 (March 16, 2012).

[8] A trunnion is an assembly that holds a saw's arbor to the underside of the saw table.

[9] "Revised Table Saw Market Research Report," Memorandum from Jane Israel, Matthew Baumann, and Jennifer Baxter (Industrial Economics, Incorporated) to William Zamula and Robert Franklin (Consumer Product Safety Commission, Directorate for Economic Analysis (March 28, 2016), pp 19-20.

[10] Ibid., (IEc), p. 20.

There is some uncertainty as to how the redesign and retooling costs will affect manufacturers. One manufacturer noted that the redesign and retooling costs have to be paid upfront, and that manufacturers generally desire to amortize these costs over 3 years. However, most table saw brand owners contract with Chinese or Taiwanese manufacturers to actually manufacture the table saws. In some cases, the Chinese or Taiwanese manufacturers may produce table saws for more than one firm and may be willing to absorb some of the costs in order to remain in the market.[11]

In addition to the redesign and retooling costs, there will be added costs due to the additional components required on saws that incorporate an AIM technology. Depending upon the specific system used, the additional parts may include a brake cartridge, cables, additional parts or brackets to secure the brake cartridge, electrodes and assemblies and a power supply or motor control. These additional components are expected to add $58 to $74 to the manufacturing cost of a table saw.[12]

Impact on Small Manufacturers

As stated above, most small manufacturers are expected to attempt to license an AIM technology instead of developing their own technology. The costs of attempting to develop their own AIM technology would probably be too high for most small manufacturers, especially given the challenge of developing a technology that did not infringe upon an existing patent. However, there is no certainty that small manufacturers would be able to negotiate acceptable licensing agreements with SawStop or another patent holder. If small manufacturers are unable to negotiate acceptable licensing agreements for AIM technology, it is likely that all small table saw manufacturers, with the exception of SawStop, will exit the U.S. table saw market.

If small table saw manufacturers are able to license AIM technology, they would be expected to evaluate the sales volume of each table saw model and the likely cost of redesigning and retooling the model and decide whether to continue offering the model in the United States. If the manufacturer does not believe that the sales volume would be sufficient to recoup these costs in a reasonable amount of time, it is likely that the manufacturer would discontinue the sale of the model (at least in the United States).[13] The fact that some small table saw manufacturers might license the AIM technology from SawStop would mean that these manufacturers would be paying royalties to a competitor. This would be expected to reduce their competitiveness in the table saw market. Four firms indicated to CPSC staff that they would likely reduce or eliminate the table saws that they currently offer in the United States if AIM technology is mandated.[14]

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[11] Ibid. (IEc), p. 20.

[12] Ibid. (IEc), p. 20.

[13] One small manufacturer stated that they would want to be able to amortize the redesign and retooling costs over a 3-year period (Telephone conversation on November 30, 2015).

[14] “Revised Table Saw Market Research Report,” Memorandum from Jane Israel, Matthew Baumann, and Jennifer Baxter (Industrial Economics, Incorporated) to William Zamula and Robert Franklin (Consumer Product Safety Commission, Directorate for Economic Analysis (March 28, 2016), p. 20.

Except for SawStop and one other firm, most small table saw manufacturers also supply other types of woodworking or metal working equipment. Anecdotal information suggests that U.S. sales of table saws account for a small percentage of the total revenue of most small firms. Information supplied by one manufacturer suggests that U.S. table saw sales accounted for about 1 percent of the firm's total revenue. Two other firms estimated that U.S. table saw sales accounted for between 5 and 8 percent of their total revenue.[15] Actions that impact a firm's revenue by more than 1 percent are potentially significant. Therefore, given that it is likely that small table saw manufacturers would drop one or more table saws from the U.S. market if the draft proposed rule were adopted, and may leave the market entirely if they are unable to license an AIM technology, the draft proposed rule could have a significant impact on small manufacturers. However, the draft proposed rule is not likely to cause most small manufacturers to fail completely. One small manufacturer, SawStop, would significantly benefit from promulgation of the draft proposed rule because it already manufactures table saws with AIM technology and owns multiple patents that cover AIM technology.

Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rule

The Occupational Safety and Health Administration (OSHA) has established standards that cover woodworking equipment used in workplace settings. These standards are codified at 29 C.F.R. § 1910.213. Generally, these requirements cover issues such as blade guards and hoods. The OSHA standards do not mandate the use of AIM technology on table saws; neither do the standards prohibit AIM technology.

Alternatives for Reducing the Adverse Impact on Small Entities

CPSC staff considered several alternatives to the draft proposed rule that could reduce the impact on small manufacturers while accomplishing the stated objectives. These alternatives include: taking no regulatory action, working to improve the voluntary standard for table saws, later effective dates for the draft proposed rule, excluding certain categories of table saws from the scope of draft proposed rule, and limiting the applicability of the performance requirements to some, but not all table saws. Each of these is discussed in more detail below.

Take No Regulatory Action and Rely Upon Voluntary Standards

Under this alternative, the status quo would be maintained, at least in the short term. Manufacturers would not be required to modify their table saws to incorporate AIM technology, but could do so if they concluded that it was in their interest (perhaps because increased familiarity with this technology on the part of consumers may increase the demand for table saws with AIM technology over time). However, under this option, for most table saws, the main safety devices likely would be the passive devices that are required by the voluntary standard, including blade guards, riving knives, and pawls. According to the most recent table saw special

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[15] Ibid. (IEc), p. 12.

study (Garland and Tu, 2016), there is little evidence that improvements in these passive safety devices has increased their usage or effectively reduced injuries.

CPSC staff is engaged in efforts to improve the table saw voluntary standard(UL 987) as directed by the Commission,however, staff is not aware of any improvements to the voluntary standard that could significantly reduce injuries, short of requiring AIM technology on table saws. Given that the voluntary standards committees have twice rejected initiatives by UL to develop voluntary standards that include AIM systems for table saws, it seems unlikely that such a requirement will be added to the voluntary standard, at least in the short run. Therefore, although taking no mandatory regulatory action and instead, relying upon compliance with the voluntary standard would minimize the impact on small table saw manufacturers, it would be unlikely to significantly mitigate the injuries that are associated with table saw blade contact, at least in the short run, which is the intent of the draft proposed rule.

Later Effective Date

The draft proposed rule includes an effective date that is 3 years after the final rule is published in the Federal Register. Given the complexities and costs that would be associated with developing (or licensing) the AIM technology, redesigning virtually all table saw models, and retooling production facilities, later effective dates could reduce the impact of the rule on small manufacturers because a later date would allow manufacturers to spread the costs of developing or negotiating for the rights to use an AIM technology, modify the design of their table saws to incorporate the AIM technology, and retool the factories for the production. For manufacturers who might choose to exit the table saw market, perhaps because their volume of table saw sales does not justify the cost of redesigning the table saws, the additional delay might also provide them with more time to consider alternative business opportunities.

Although later effective dates would mitigate somewhat the impact of the draft proposed rule on some small manufacturers, it could also delay the introduction of table saws with AIM technology into the market and possibly discourage manufacturers from introducing table saws with AIM technology earlier than the effective date and possibly penalize manufacturers who do.

Exclude Certain Categories of Table Saws from Draft Proposed Rule

The Commission could exclude cabinet and perhaps contractor saws from the scope of the draft proposed rule on the grounds that these type of saws tend to be used by (and are generally intended for) professional, commercial, or industrial users. This alternative would reduce the impact on small table saw manufacturers because cabinet and contractor saw manufacturers tend to be small. (Manufacturers of bench saws, on the other hand, tend to be large.) There is no clear dividing line between consumer and professional saws, except at the very highest levels of price and performance; and we have little information on the proportion of occupational purchasers for contractor saws and cabinet saws. However, on its website, SawStop has claimed that it is the largest manufacturer of cabinet saws. It has also stated that 75 percent of its sales are to industrial users. This implies that industrial users constitute a large proportion of the market for cabinet saws. Although contractor saws are probably used by a larger proportion of consumers than cabinet saws, they are still generally intended for professional use.

However, although most cabinet and contractor saws are used by professionals or in commercial settings, they are available for sale to consumers, and a substantial number of serious consumer woodworkers and hobbyists use these saws. Cabinet and contractor saws are also frequently used in schools and other educational settings. Finally, the break-even analysis within the regulatory analysis found that mandating AIM technology on cabinet and contractor saws would likely result in substantial net benefits under the various scenarios modelled.

Limiting the Applicability of the Performance Requirements to Some, but not All Table Saws

Rather than requiring all table saws to contain the AIM technology, an alternative would be to require that only a subset of table saws contain it. For example, if a firm produces only bench saws, the Commission might require the firm to produce at least one bench saw model with the AIM technology. Similarly, if a firm produces bench saws *and* contractor saws, the Commission could require the firm to produce at least one bench saw model and one contractor saw model with the AIM technology. Or, as a variation, the Commission might allow each manufacturer to produce at least one bench saw model without the AIM technology, as long as their other bench models conform to the requirements of the rule.[16] This alternative would reduce (though not eliminate) the burden of the rule on some small manufacturers because it would not require that all of their saws contain the AIM technology.

Limiting the requirement for the AIM technology to a subset of table saws would have several advantages. If patent holders are willing to license AIM technology even though not all table saws were required to have it, this alternative may address the market failure associated with one firm's market power over the AIM technology that seems to have impeded its distribution. Thus, saws with the AIM technology might be available in greater numbers than they have been in recent years. It would also allow consumers to choose table saws without AIM technology if they prefer. Consequently, consumers who place a great value on safety or who face greater than average risks may find the AIM technology-equipped table saws more desirable and will be more likely to buy them; and consumers who do not want the safer but more expensive saws (or do not need them because they have lower than average risks) could decide to purchase saws without the AIM technology. In this way consumer preferences might be better matched with the characteristics of the products purchased. However, this alternative assumes that small manufacturers would still be able to license AIM technology and the licensing fee would still amount to roughly 8 percent royalty on the wholesale price of a saw, even though Dr. Gass conditioned his 8 percent royalty fee proposal on a rule that requires all table saws contain the AIM technology. If patent holders are not willing to license their technology under these conditions, the impact on small manufacturers could be greater than under the draft proposed rule because they would need either to incur greater costs to develop their own technology or exit the table saw market.

[16] This variation in requirements would be somewhat analogous to the requirements for child-resistant packaging under the Poison Prevention Packaging Act.

There would be some drawbacks to this approach. Most obviously, it would address only a portion of blade-contact injuries. If, for example, the requirement led to about 50 percent of purchased table saws being equipped with the AIM technology, the expected benefits would be on the order of about 50 percent of the benefits described in the reference case analysis.[17] Such a rule might also be somewhat more difficult to enforce than a requirement that all table saws contain the AIM technology.

[17] We cannot predict what proportion of table saw sales would ultimately contain the AIM technology under this alternative. If consumers place a high value on safety, and prices are reduced or moderated over time, the proportion might be high. If, however, consumers would generally prefer saws without the AIM technology because of the lower prices or for other reasons, the proportion would be lower. Product liability concerns on the part of manufacturers would probably increase the proportion of table saws with the AIM technology. Once the table saws with AIM technology become more commonplace, table saws without the technology would be more likely to be challenged in product liability suits. Staff has already see this tendency in some recent product liability lawsuits against table saw manufacturers.

TAB E

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
ROCKVILLE, MD 20850

MEMORANDUM

DATE: November 15, 2016

TO: Caroleene N. Paul, Project Manager, Table Saws Project, Division of Mechanical and Combustion Engineering, Directorate for Engineering Sciences

THROUGH: Joel R. Recht, Ph.D., Associate Executive Director, Directorate for Engineering Sciences

Rana Balci-Sinha, Ph.D., Director, Division of Human Factors, Directorate for Engineering Sciences

FROM: Timothy P. Smith, Senior Human Factors Engineer, Division of Human Factors, Directorate for Engineering Sciences

SUBJECT: Human Factors Assessment of Blade-Contact Scenarios and Responses to ANPR Public Comments

BACKGROUND

On July 11, 2006, the Commission granted Petition CP 03-2, *Performance Standards for Table Saws*, and directed staff of the U.S. Consumer Product Safety Commission (CPSC or Commission) to draft an advance notice of proposed rulemaking (ANPR) to address blade-contact injuries associated with table saws. CPSC staff provided a briefing package to the Commission on September 14, 2011. The Commission voted to approve publication of the ANPR, and the ANPR was published in the *Federal Register* on October 11, 2011 (76 FR 62678).

CPSC staff has since received public comments on the ANPR and has prepared a draft notice of proposed rulemaking (NPR) for Commission consideration. This memorandum, prepared by staff of CPSC's Directorate for Engineering Sciences, Division of Human Factors (ESHF), discusses the likely scenarios and human factors issues that can lead to blade-contact injuries on table saws, and responds to public ANPR comments pertaining to unsafe behaviors in response to the proposed performance requirements and the likely effectiveness of training, education, and labeling on reducing blade-contact injuries.

DISCUSSION

LIKELY BLADE-CONTACT INJURY SCENARIOS

As ESHF staff has discussed previously (Smith, 2011), the most basic and common cutting operations performed on a table saw are ripping, which involves narrowing the width of a piece of wood or other “workpiece” by sawing along its length, and crosscutting, which involves shortening the length of a workpiece by sawing across its width. Anecdotally, ripping appears to be the more common of these two operations in the context of table saw use.

Ripping

The standard ripping procedure after selecting the blade, setting the blade height, setting the rip fence parallel to the blade, and installing the blade guard system, if applicable, involves the following steps or tasks:

1. Place the workpiece flat on the table with one long side against the rip fence.
2. Switch on the table saw and let the saw blade get up to speed.
3. Slowly push or “feed” the workpiece through and past the blade, while keeping the workpiece flat against the fence.

The workpiece should be pushed entirely through and past the blade before switching off the saw. Once the saw has been switched off, the consumer should wait until the saw blade has come to a complete stop before moving or reaching for the workpiece or cutoff, or before otherwise moving the hands toward the blade. Consumers generally push the workpiece through the blade with the hands, but might use a push stick or similar object while ripping to help keep their hands away from the blade. Owner’s manuals and table saw literature commonly recommend the use of push sticks, particularly when the space between the blade and fence is narrow—for example, about 2 to 6 inches.

Blade contact may be more likely to occur while the consumer is ripping a workpiece, rather than crosscutting, because consumers often using their hands alone to feed the workpiece into the blade while ripping. Additionally, ripping has greater potential to result in kickback compared to crosscutting. Kickback can be defined as the binding of a workpiece in the blade and the consequent thrusting of that workpiece back toward the consumer. As staff described above, ripping involves the cut workpiece passing between the spinning blade and a rip fence, which forms a fixed boundary that constrains the movement of the workpiece. Thus, any lateral movements or rotation of the workpiece may cause the workpiece to bind and be thrown or propelled at the consumer.

The sudden movement of the workpiece from kickback can cause the consumer to lose control of the workpiece and lead to blade contact in a number of ways. For example:

- The consumer’s hand or push stick can slip off the workpiece, causing the hand to move into the blade.

- The workpiece can strike the consumer's arm or hand, sending the hand into the blade.

- The consumer can reflexively reach for the workpiece to regain control and inadvertently move the hand into the blade.

- The consumer's hand, if positioned behind the blade to hold, support, or remove the workpiece or cutoff, can be "pulled" into the blade with the workpiece.

Many of the scenarios above may be possible even when a blade guard is in use, because blade guard systems generally are designed to allow free passage of the workpiece—and therefore other objects such as hands and fingers—into the blade from the front. Thus, although blade guard systems can reduce the likelihood of blade contact from certain angles and certain approaches, the potential for contact remains.

Hand or finger contact with the blade can also occur even without kickback. Possible blade-contact scenarios during ripping that are unrelated to kickback include the following:

- The consumer's hand gets too close to the blade while feeding the workpiece, particularly a small workpiece, and the fingers contact the blade. In some cases, the consumer may be wearing gloves for protection, or because of cool temperatures, and the blade catches the glove and pulls the hand into the blade.[1]

- The consumer reaches near or past the blade to regain control of a workpiece that is slipping, lifting up, falling off the table, or otherwise moving in an unexpected way, and the hand contacts the blade.[2]

- The consumer reaches for a cutoff or brushes debris from the table while the blade is still spinning and the hand contacts the blade. Saw blades can continue spinning for some time after a table saw has been switched off, so some consumers might contact the blade after having already switched off the table saw, but before the blade has come to a complete stop. Furthermore, consumers who are aware of the potential for kickback might be motivated to remove a cutoff immediately to prevent a cut piece from kicking back or otherwise being thrown.

- The consumer gets distracted and turns or looks away, causing the hand to move into the blade. Such a distraction may not be merely daydreaming, but can include cases in which someone enters the room and attention is necessary to make sure the other person is not placing themselves in a hazardous situation. This may be especially likely if the other person is someone for whom the consumer is responsible, such as a child.

[1] For example, see IDI no. 121018CNE1304.
[2] For example, see IDI nos. 080415CCC2550 and 141120CNE0001. Note that in IDI no. 141120CNE0001, a blade guard was in use.

- The consumer slips, stumbles, or otherwise loses balance and inadvertently moves a hand into the blade, possibly as a natural motor response to regain balance. Similarly, if a consumer is startled by something or someone, the consumer may reflexively move or jerk a hand toward the blade.

- The consumer's hand or push stick slips off the workpiece, causing the hand to move into the blade. This scenario is similar to the one cited earlier in the context of kickback, but is not necessarily preceded by a sudden movement of the workpiece.

Many of the scenarios described above may be more likely if the consumer is tired or if the view of the blade, or cut, is impaired in some way. Working with a table saw for long periods would likely contribute to fatigue, which in turn can degrade a consumer's decision-making abilities, judgment, reaction time, and vigilance (Sharit, 2006).[3] Blade guard systems themselves might contribute to difficulties in seeing where a cut is being made, and consumers sometimes report this as a reason for having removed blade guard systems.[4] ESHF staff also notes that consumers typically are instructed to wear eye protection when operating a table saw.[5] Eye protection is important to limit eye injuries from projectiles, but eye protection also may affect one's ability to see a cut clearly, particularly if the eyewear is scratched or partially covered in debris, such as sawdust.

Crosscutting

The standard crosscutting procedure after selecting the blade, setting the blade height, moving or removing the rip fence, and installing the blade guard system, if applicable, involves the following steps or tasks:

1. Place the workpiece flat on the table with one long side against a miter gauge, crosscut sled, or similar jig that slides in a track in the table that runs parallel to the blade.
2. Switch on the table saw and let the saw blade get up to speed.
3. Slowly feed the workpiece through and past the blade using the miter gauge, while firmly holding the workpiece against the miter gauge.

As in the case of ripping, the workpiece should be pushed entirely through and past the blade before switching off the saw, and once the saw has been switched off, consumers should wait until the saw blade has come to a complete stop before moving the workpiece or cutoff, or otherwise moving the hands toward the blade.

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[3] ESHF staff also notes that, when ripping, consumers must make sure the workpiece maintains contact with the rip fence for the entire cut. Thus, a consumer's attention is likely to be where the workpiece meets the fence, rather than the blade, for at least part of the cut. This necessarily means that adequate attention cannot be given to the position of the hands relative to the blade. If, instead, attention is focused on the fingers relative to the blade, the workpiece may move off the rip fence and lead to kickback, which also can cause the fingers to contact the blade.

[4] See Smith (2011) for a detailed discussion of the reasons consumers might remove blade guard systems.

[5] For example, general safety instructions for all power tools, published by the Power Tool Institute (PTI), states that one should "[a]lways wear eye protection," and the section of the document that is specific to table saws states, in part: "Always wear safety goggles or safety glasses with side shields." See http://www.powertoolinstitute.com/pti-includes/pdfs/Tool-Specific-Files/Table-Saws.pdf.

Blade-contact scenarios involving crosscutting are likely similar to those involving ripping, as many of the same potential issues can arise such as the consumer feeding the hand too close to the blade, reaching past the blade for a cutoff, or becoming distracted. Although the potential for kickback seems less likely for crosscutting relative to ripping, kickback still occurs and the consequent loss of workpiece control can result in the hand contacting the blade.

In addition, during a crosscut, the workpiece may become "jammed" in the blade guard or anti-kickback device. This may be more likely if the workpiece shifts position or rotates away from the miter gauge. In such a scenario, the consumer may reach toward the blade to adjust the workpiece position or to move the offending portion of the guard system, and inadvertently contact the blade with the fingers.

RELEVANT ADULT AGING ISSUES

Staff of CPSC's Directorate for Epidemiology, Division of Hazard Analysis (EPHA), has found that about 45 percent of all estimated table saw-related, emergency department-treated injuries that likely related to the victim making contact with the blade involved consumers older than 60 years of age, and further noted (Tab B; Garland, 2016):

> "… the estimated mean age for table saw blade-contact injuries is 55.6, with a 95% confidence interval of (54.2, 57.0); whereas, all other workshop product-related injuries have an estimated mean age of 42.7, with a 95% confidence interval of (41.9, 43.6). This approximate 13-year difference in the mean age of injuries is a statistically significant difference (p-value < 0.0001), indicating that table saw blade-contact injuries involve older victims than to injuries related to all other workshop products."

Staff cannot say if these findings are due to older consumers having greater exposure to these products, but adult aging is known to be associated with declines in many perceptual, cognitive, and physical abilities (Smith, 2005).[6] Some of these age-related deficits likely contribute to blade-contact incidents with table saws. For example:[7]

- *Vision*: Vision generally deteriorates with age, and virtually everyone requires some form of visual correction by their late 50s. By 60 to 65 years of age, losses in the flexibility of the eye's lens means that objects are in sharp focus only when at a limited, fixed distance from the eye. Older adults have greater difficulty detecting peripheral objects, and declines in acuity tend to be greater for peripheral targets. Age-related changes to the eye also reduce the amount of light that ultimately reaches an older adult's retina. Declines in these and other visual functioning may limit the extent to which an older consumer will notice and effectively avoid a spinning blade. Age-related declines in peripheral vision

[6] In addition, one of the general criteria that the Commission must apply when establishing priorities for action under the five acts the Commission administers is the "vulnerability of the population at risk," which notes: "… the Commission will usually place a higher priority … on preventing product related injury to children, the handicapped, and *senior citizens*" (emphasis added). 16 C.F.R. § 1009.8(c)(5).
[7] See Smith (2005) for a detailed discussion of these and other age-related differences in the adult consumer population.

may especially impact an older consumer's ability to detect a peripheral spinning blade while focusing on maintaining workpiece contact with the rip fence.

- *Attention and Inhibitory control*: Older adults have more difficulty than younger adults with focusing on target information and inhibiting attention to distractors and other irrelevant material. In addition, aging appears to be associated with a change in the patterns of peak mental alertness or arousal, and therefore cognitive performance, over the course of a day. For example, older adults tend to reach peak mental alertness in the morning and then decline over the day. Inhibitory processing and control has been found to be impaired at off-peak times, meaning that over the course of the day older adults may be even more susceptible to distracting, irrelevant information.

- *Muscle strength*: Muscle strength tends to decline after one's 20s or 30s, and strength losses seem to accelerate with age, particularly after the age of 70. Hand and grip strength show clear declines with age, particularly once one enters his or her 50s. Declines in muscular strength may limit the extent to which a consumer can maintain control over a workpiece.

- *Muscular power*: Age-related declines in muscular power, which involves the rapid generation of force such as that required to recover from a stumble or to correct for an unexpected loss of balance, are even greater than declines in strength.

- *Motor control and coordination*: Research indicates that movement variability increases with age and that motor coordination consequently deteriorates. Older adults also are less able to effectively stop a movement once it has begun.

- *Balance*: The ability to maintain balance depends on the sensory, cognitive, and motor control systems. Age-related declines in some or all of these systems are likely to be responsible for observed age-related deficits in balance.

The degree of age-related deficits among these and other capabilities can be highly variable among individuals, and not all older adults will exhibit the changes described here. Nevertheless, the examples above illustrate why older adults might be particularly susceptible to blade-contact injuries with table saws, despite the tendency for people to become more cautious with increasing age.[8]

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[8] The literature is somewhat mixed, but research generally indicates that people become more cautious or risk averse with increasing age (Botwinick, 1984, as cited in Sternberg & Lubart, 2001; National Research Council, 2000; Panek, 1997; Sanfey & Hastie, 2000; Shaie & Willis, 2002; Vercruyssen, 1997). However, older adults also increasingly rely on accumulated knowledge and experience rather than seeking out new information that might contradict their previously held beliefs or expectations (Davis & Loftus, 2005; National Research Council, 2000; Park & Gutchess, 2000; Peters, Finucane, MacGregor, & Slovic, 2000; Sanfey & Hastie, 2000; Schaie, 2004).

RESPONSES TO PUBLIC COMMENTS

On October 11, 2011, the Commission published an ANPR in the *Federal Register* that solicited public comments on, among other things, the risk of injury associated with blade contact on table saws, the regulatory alternatives available to the Commission, and other means of addressing the risk of injury (76 FR 61678). CPSC received more than 1,600 comments. Some of these comments pertained to human factors issues such as the potential for unsafe behaviors in response to the proposed performance requirements and the likely effectiveness of training, education, and labeling on reducing blade-contact injuries. Summaries of these comments and ESHF staff's responses to the comments appear below.

Warnings, Instructions, Education, and Training

Staff identified 39 comments that claim warnings or instructions are all that is needed to address blade-contact injuries. Another 147 comments state that injuries are best reduced by training and educating users on the safe operation of table saws. Many of the comments assert that mandatory training or certification is needed; others state that instructional videos should be provided with the purchase of every saw.

ESHF staff agrees that warnings, instructions, and other methods of educating consumers about the proper use of table saws is important. However, the effectiveness of such approaches is known to be limited. For example, safety and warnings literature consistently identifies a classic hierarchy of approaches that one should follow to control hazards. The use of warnings is viewed universally as less effective at eliminating or reducing exposure to hazards than either designing the hazard out of a product or guarding the consumer from the hazard, and, therefore, is lower in the hazard control hierarchy than these other two approaches (Laughery & Wogalter, 2011; Vredenburgh & Zackowitz, 2005; Wogalter, 2006; Wogalter & Laughery, 2005). Warnings are less effective because they do not prevent consumer exposure to the hazard, and instead rely on educating consumers about the hazard and then persuading consumers to alter their behavior in some way to avoid the hazard. In addition, to be effective, warnings rely on consumers behaving consistently, regardless of situational or contextual factors that influence precautionary behavior such as fatigue, stress, or social influences. Thus, one should view warnings as "last resort" measures that supplement, rather than replace, redesign or guarding, unless these higher level hazard-control efforts are not feasible.

Educational programs may offer more opportunities to present hazard information in varied ways and in greater detail than is possible in a warning label. However, educational programs suffer from limitations similar to those that undercut warnings because, like all hazard communications, the effectiveness of such programs depends on affected consumers not only receiving and understanding the message, but also being persuaded to heed the message. Mere knowledge or awareness of a hazard is not necessarily enough. Some versions of the hazard control hierarchy, particularly those in the context of industrial or organizational settings, include "training" as a separate approach at the same approximate level as warnings (for example, see Lehto & Clark, 1990 as cited in Lehto & Cook, 2012), because training also involves educating consumers about potential hazards and proper actions or procedures to avoid those hazards. In fact, instructional materials that accompany products can be viewed as a form of training. Thus, warnings, instructions, educational programs, and training serve similar functions and have similar weaknesses.

The discussion above is not meant to suggest that warnings and similar educational efforts are totally ineffective. To the contrary, ESHF staff supports the use of these approaches, including providing consumers with instructional videos. However, human error is inevitable, even among expert woodworkers. People are known to be the weakest link in a safety system and to be at least occasionally inattentive, distracted, hurried, and forgetful (Reason, 1990; Woodson, Tillman, & Tillman, 1992). Thus, even consumers who are fully aware of the hazards and how to avoid them may suffer from slips or lapses that could lead to blade contact and injury despite the consumer's best intentions to use a product safely. Performance requirements that can detect and react to blade contact in a way that lessens the consequences makes the table saw system more forgiving of such errors and expected behaviors, so that the results are not catastrophic (see Hammer, 1972; Senders & Moray, 1991; Woodson, 1998; see also Czaja & Nair, 2012).

Unsafe Behaviors in Response to Performance Requirements

Staff identified 67 comments that claim a flesh-sensing performance requirement will give users a false sense of security and increase unsafe behaviors, which will translate into increased injuries with other power tools.

Staff's proposed performance requirement would require some type of active injury mitigation (AIM) system, which is intended to reduce the severity of injury when blade contact occurs, and would be an obvious and likely advertised feature of the product. Thus, consumers clearly would be aware of the presence of an AIM system, and this awareness at least creates the opportunity for behavioral adaptations of the type described in the comments. However, the extent and type of behaviors performed in response to this awareness likely depends on the awareness level, type of information available to consumers about the system, and, perhaps most importantly, how consumers naturally are inclined to use the product based on their goals.[9] If consumers currently use the product differently than they would like *because* of the potential hazard associated with blade contact, then a reduction in perceived risk associated with blade contact might lead consumers to use the product differently.

For example, the use of blade guard systems can be inconvenient and can make certain cuts difficult, if not impossible; consumers often remove blade guards for these and other reasons.[4] Consumers choose, and are encouraged, to use blade guards despite these challenges to prevent blade contact. Research has found that risk or hazard perceptions associated with consumer products are driven strongly by the severity level of the expected injury (Riley, 2006; Vredenburgh & Zackowitz, 2006; Wogalter, Brelsford, Desaulniers, & Laughery, 1991). Thus, if consumers believe that the AIM system is likely to be effective at reducing severe injuries from blade contact, then some of those consumers might be less likely to use the blade guard systems

[9] This is consistent with research, reported by Williams and Noyes (2011), that found most user actions with products are guided by the afforded "ease of use" and the goals of the task.

that they prefer not to use in the first place, especially if they already have doubts about the efficacy of guards at preventing blade-contact injuries.

However, people also tend to fear dread risks, which can be defined as “low-probability, high-consequence events” (Gigerenzer, 2004), and such risks have a substantial influence on risk perception. One could argue that severe injuries from blade contact on a table saw that employs an AIM system would fall under the category of a dread risk because the consequences of such a system failing could be quite severe—involving possible amputation, which would likely evoke visceral feelings of dread or horror—even if the probability of such a failure is low. In addition, consumers would likely be motivated to avoid blade contact even if the consequences of such contact are not severe. Most consumers are unlikely to be ambivalent about being injured by a spinning blade with sharp teeth, even if the resulting injury is minor. In addition, triggering an AIM system would likely introduce time and effort to return the table saw to a functional state, as well as possible costs associated with replacement AIM system activation cartridges or saw blades, if applicable.

Taken as a whole, ESHF staff finds it difficult to predict whether consumers will take less care when using a table saw with an AIM system relative to current table saws, but some consumers might be less inclined to use blade guards, which many consumers already remove even in the absence of an AIM system.[4] Regardless, a key factor in assessing the ultimate effect of an AIM system is not just whether consumers will be less careful when cutting with a table saw employing the system, or even whether the incidence of blade contact is likely to increase, but whether such changes will likely result in a decrease in serious injuries. If the system is effective and works as intended, the severity of an injury resulting from blade contact will be lessened, which would likely reduce the overall number of severe injuries associated with table saws. Staff is unaware of any evidence that would support the contention that consumer behavior with a table saw employing an AIM system would translate into increased injuries with other power tools.

CONCLUSIONS

ESHF staff has identified several possible and likely scenarios that can lead to blade-contact injuries on table saws, many of which are likely to occur even when a blade guard is in use. ESHF staff also has responded to public comments on the 2011 ANPR for table saws.

Staff agrees that warnings, instructions, and other methods of educating consumers about the proper use of table saws is important and supports the use of these methods to help reduce the incidence of injuries. However, the effectiveness of such approaches is known to be limited. Human error is inevitable, even among expert woodworkers, so even consumers who are fully aware of the hazards and how to avoid them may suffer from slips or lapses that could lead to blade contact and injury despite the consumer’s best intentions to use a product safely. Performance requirements that can detect and react to blade contact in a way that lessens the consequences makes the table saw system more forgiving of such errors and expected behaviors, so that the results are not catastrophic.

Staff finds it difficult to predict whether consumers will take less care when using a table saw with an AIM system relative to current table saws. However, even if true, a key factor in assessing the ultimate effect of an AIM system is whether such a system will likely result in a decrease in serious injuries. If the system is effective and works as intended, the severity of an injury resulting from blade contact will be lessened, which would likely reduce the overall number of severe injuries associated with table saws.

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TAB F

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: November 21, 2016

TO : Caroleene Paul
Table Saw Project Manager
Division of Mechanical and Combustion Engineering

THROUGH : George Borlase
Assistant Executive Director
Office of Hazard Identification & Reduction

Duane Boniface
Deputy Assistant Executive Director
Office of Hazard Identification & Reduction

FROM : Kathleen Stralka, Associate Executive Director
Directorate for Epidemiology

SUBJECT : 2014-2015 Table Saw Special Study Cautionary Statement

Senior statisticians in the CPSC's Directorate for Epidemiology advise against using data collected during the 2014-2015 table saw special study to inform recommendations for CPSC's Notice of Proposed Rulemaking for performance requirements to address table saw blade contact injuries.

Upon completion of the contractor-conducted computer aided telephone interviews (CATI) of individuals treated for table saw-related injuries in emergency departments of National Electronic Injury Surveillance System (NEISS) member hospitals, CPSC subject matter experts and statisticians noticed that the distribution of participant responses across the 275 completed surveys appeared to differ depending on which interviewer collected the responses. Ninety-four percent (259) of the completed surveys were conducted by two interviewers from one company. Statistically significant differences between responses collected by the two interviewers suggest an interviewer effect.[1] This interviewer effect involved critical questions such as the type of table saw involved in the injury, use of safety features and activities preceding the injury. The attached memorandum provides more details about the findings.

Neither follow-up discussions with the interviewers nor additional analyses of the participant responses explains the observed interviewer effect. The presence of this effect implies that the responses may not be reliable or reproducible. Furthermore, there is insufficient information to determine if one of the interviewers more reliably captured participant responses. Thus, we cannot recommend using participant responses from this study.

[1] The term "interviewer effect" refers to the tendency for answers provided by respondents to vary depending upon which interviewer is assigned for the interview.

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

Date: October 12, 2016

TO	:	George Borlase Assistant Executive Director Office of Hazard Identification & Reduction
THROUGH	:	Kathleen Stralka, Associate Executive Director Directorate for Epidemiology
FROM	:	Stephen Hanway, Director Division of Hazard Analysis
SUBJECT	:	2014-2015 Table Saw Special Study

To support staff's development of a Notice of Proposed Rulemaking (NPR) that would establish performance requirements to mitigate table saw blade contact injuries, CPSC began a National Electronic Injury Surveillance System (NEISS) special study in July 2014 to gather details about saw-related injuries captured in the NEISS. The study had two goals. The main goal was to determine the type of table saw involved among blade-contact injuries, which is not defined in the original NEISS case. The secondary goal was to understand the use or non-use of the modular blade guard, including the reason the modular blade guards might be removed.

A similar special study was conducted in 2007-2008.[2] However, it became clear in staff's analysis of the 2007-2008 special study that respondents could have been confused about specific details related to the type of table saw that was in use. In particular, the responses to questions about the drive type were not consistent with those about the table saw type.[3] The inconsistencies in the 2007-2008 study prevented CPSC from using the table saw type estimates for the NPR. In order to be confident about the type of table saw involved, the questionnaire was revised for a 2014-2015 special study included expanded questions to clarify the question and answer choices, included logic to highlight inconsistencies to the respondent when they appeared, and allowed the respondent to reconsider their response about the saw table type in use.

Staff's analysis of the 2014-2015 contractor-conducted special study began after the 2015 NEISS survey weights were finalized in April 2016. Some of the responses were provided to subject matter experts (SMEs) for review and classification. It became apparent in SME review that responses to an open-ended question about why a blade guard was removed used similar or identical language in many cases. Forty-four of 135 responses to the blade guard question included the word "interferes" or "interfered" (See Table 1).

[2] http://www.cpsc.gov//PageFiles/118311/statsaws.pdf
[3] http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Home%20Maintenance%20and%20Construction/CoverpageandMemoofStaffAnalysisofTableSawTypeinNEISSSpecialStudy.pdf

Although the techniques and technologies employed by telephone interviewing contractors vary, it is not uncommon for the interviewer to be asked to quickly capture the essence of a respondent's open-ended remarks during the interview in sufficient detail for them to return at the conclusion of the interview to more fully replicate the respondent's verbatim response. This is done to keep the interview moving and decrease the likelihood that a respondent will become impatient and hang up the phone. The extent to which the final modification of these responses is completed has been known to vary from interviewer to interviewer.

Table 1: Frequency of Q53 Responses for the Word "Interfere"

Q53: Please describe as specifically as you can why the blade guard was removed.	
Q53	**Frequency**
'INTERFERES WITH MY VISUAL SITE LINE OF THE CUT'	1
BLADE GUARD INTERFERED WITH THE CUT.	1
BLADE GUARD REMOVED BECAUSE HE FELT IT INTERFERED WITH THE CUT.	1
FEELS IT INTERFERES WITH THE CUT	2
FEELS THE GUARD INTERFERES WITH THE CUT	1
HE FEELS IT INTERFERES WITH THE CUT	1
HE FEELS IT INTERFERES WITH THE CUT.	6
HE FEELS THE BLADE GUARD INTERFERES WITH THE CUT.	8
HE REMOVED BLADE GUARD BECAUSE HE FELT IT INTERFERED WITH THE CUT.	1
IT WAS REMOVED BECAUSE IT INTERFERED WITH THE CUT.	1
PATIENT FEELS IT INTERFERES WITH THE CUT	1
PATIENT FEELS IT INTERFERES WITH THE CUT.	5
PATIENT FEELS THE BLADE GUARD INTERFERED WITH THE CUT.	1
PATIENT FEELS THE BLADE GUARD INTERFERES WITH THE CUT	1
PATIENT FEELS THE BLADE GUARD INTERFERES WITH THE CUT.	7
PATIENT FEELS THE BLAGE GUARD INTERFERES WITH HIS CUT.	1
PATIENT FELT IT INTERFERED WITH THE CUT.	1
PATIENT REMOVED IT OVER 12 YEARS AGO & HE FEELS THAT IT INTERFERES WITH THE CUT.	1
PATIENT SAID THE BLADE GUARD INTERFERED WITH THE CUT.	1
THE BLADE GUARD INTERFERED WITH HIS CUT.	1
VICTIM SAYS THE BLADE GUARD INTERFERES WITH THE CUT.	1
Total	**44**

Although these similarly-worded responses may simply reflect an unfortunate synopsizing that an interviewer or interviewers failed to flesh out at the conclusion of the interview, the responses could raise questions about data integrity. Thus, additional information was collected from the primary contractor (the one that had completed 94% of the interviews) in order to allow for additional investigation of possible interviewer-related effects.

Interviewer effects are a long-studied phenomenon in surveys (*e.g.*, Groves and Magilavy, 1986[4]). Survey interviewer effects refer to the tendency for answers provided by respondents to vary depending upon

[4] "Measuring and Explaining Interviewer Effects in Centralized Telephone Surveys", Robert M. Groves and Lou J. Magilavy, *Public Opinion Quarterly*, Vol. 50, No. 2 (Summer, 1986), pp. 251-266

which interviewer is assigned for the interview. Past scholarly work (*ibid.*) had noted some evidence of older respondents being more susceptible to these effects. The mean age of an injured table saw victim interviewed in the 2014-2015 special study was 58, twenty years above the age of the average American.

When reviewing responses in the 2014 -2015 contractor-conducted special study, staff identified 11 survey questions where statistically significant differences existed between one interviewer and another (see Table 2). Staff could identify no significant differences in terms of the profile of the respondents (*i.e.*, the variables collected by the NEISS prior to the special study interview such as age, sex, body part, diagnosis, disposition, or date of interview).

Table 2: Eleven Questions that Differed by Interviewer

Question
Q21: Was the table saw involved in the injury a portable bench saw, a contractor saw, or a cabinet saw?
Q23: Is the blade of the table saw driven directly or indirectly by the motor?
Q29: Do you know any information about the saw, such as manufacturer, model, or horsepower?
Q46: Was your hand approaching the front of the blade or the back of the blade when the injury occurred?
Q48: Did your hand fall into the blade or was your hand pulled into the blade?
Q50 and 55 combined: Q50 and Q55: Was the blade guard that you had a traditional blade guard or a modular blade guard?
Q57: Was a riving knife, spreader, splitter, or nothing like these used at the time of the injury?
Q58: Were anti-kickback pawls attached to the saw at the time of the injury?
Q61_recode: Were you cutting the length of the stock (ripping), cutting the width of the stock (cross cutting), cutting at an angle, or cutting the stock in some other way?
Q63: Was the blade on the saw a crosscut blade, rip blade, combination blade, dado blade, or some other type of blade?
Q68: Were you pushing, pulling, or holding the stock at the time of the injury?

Among the 11 questions with response distributions that differed by interviewer was a question about the type of table saw, which was an important input measure for a cost-benefit analysis (see Question 21 in Table 2 above). The responses showed significant differences in the number of bench and contractor saws that were identified by the respondents as the type of table saw involved in the injury. This implies that responses to the question were related to which interviewer asked the question, which undermines confidence in the reliability of the responses. Table 3 shows the differences observed in the table saw type responses by interviewer.

Table 3: Saw Type by Interviewer ID

Frequency Row Percent	**Q21: TYPE OF TABLE SAW**			
Interviewer ID	*Bench saw*	*Contractor saw*	*Cabinet saw*	**Total**
4KS	70 48.0%	62 42.5%	14 9.6%	146
4SS	88 78.6%	16 14.3%	8 7.1%	112
Total	158	78	22	258

χ^2 p-value < 0.0001

The cause of the observed differences is unknown. Debriefing with the interviewers by CPSC staff revealed that some questions gave respondents difficulty. In particular, the term “contractor saw” was not always a familiar one for respondents. The interviewers may have resorted to differing strategies in helping respondents to understand the question which in turn may have influenced their responses. For example, the interviewer may have explained the response options differently when the respondent expressed uncertainty in how to respond. In the absence of any additional record regarding the interview, CPSC staff cannot determine whether one interviewer or another was more successful in capturing the correct saw type or whether neither can be relied upon. As such, we do not consider the special study results to be a reliable or defensible source for information and are in the process of developing a protocol for field investigators to obtain additional information about table saw injuries.