



**UNITED STATES  
CONSUMER PRODUCT SAFETY COMMISSION  
WASHINGTON, DC 20207**

**Memorandum**

Date: May 23, 2002

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Office of Hazard Identification and Reduction

THROUGH: Hugh M. McLaurin, Associate Executive Director *HMM*  
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**SUBJECT:** Evaluation of pneumatic nailers

**INTRODUCTION:** The Directorate for Engineering Sciences (ES) conducted an analysis and evaluation of pneumatic nailers (commonly known as "nail guns"). The purpose of the evaluation was to gain a hands-on understanding of nailers, document their operating and safety characteristics, and correlate those characteristics to the performance of each nailer that was evaluated. ES obtained nine pneumatic nailers to analyze and evaluate. Seven of these were framing nailers that are commonly used for attaching framing lumber in home construction, and two were finish nailers that are commonly used for attaching trim and small pieces of wood.

**BACKGROUND:**

Injury Data

Portable pneumatic fastener driving tools, commonly known as nail guns or nailers, have been identified as a product with an increasing trend in injury incidents. Estimated injuries associated with nailers have steadily increased since 1996. Based on the National Electronic Injury Surveillance System (NEISS) data for the calendar years 1996 through 2000, the annual estimated injuries associated with nailers are presented below:

NEISS Injuries 1996-2000

<u>Year</u>	<u>Est. Injury</u>	<u>Injuries to Hand/Finger</u>	<u>Puncture/Foreign Body Injuries To Hand/finger</u>
1996	8,989	5,618 (62.5%)	4,813 (85.7%)
1997	8,728	5,037 (57.7%)	3,858 (76.6%)
1998	10,507	7,139 (67.9%)	6,050 (84.7%)

*CPSC 6 2002 Closed* *6/27/02*

\_\_\_\_ No Mfrs/Products or  
Products Identified

\_\_\_\_ Exempted by \_\_\_\_\_

\_\_\_\_ Firms Notified \_\_\_\_\_

\_\_\_\_ Comments Attached \_\_\_\_\_

### NEISS Injuries 1996-2000 (continued)

<u>Year</u>	<u>Est. Injury</u>	<u>Injuries to Hand/Finger</u>	<u>Puncture/Foreign Body Injuries To Hand/finger</u>
1999	11,947	7,806 (65.3%)	6,663 (85.3%)
2000	12,982	9,124 (70.3%)	7,841 (85.9%)
<b>Total</b>	<b>53,153</b>	<b>34,724 (65.3%)</b>	<b>29,225 (84.2%)</b>
<b>Average</b>	<b>10,631</b>	<b>6,945 (65.3%)</b>	<b>5,845 (84.2%)</b>

By applying the weighted regression method to the annual estimates for 1996 to 2000:

1. the injuries related to nailers marginally increased ( $p=0.0595$ ) at a rate of 1,355 per year;
2. the injuries to hand/finger increased significantly ( $p=0.0343$ ) at a rate of 1,218 per year; and
3. a puncture/foreign body injury to the hand/finger increased significantly ( $p=0.0385$ ) at a rate of 1,105 per year.

To better identify specific hazards associated with nailers and the conditions under which they occurred, the Division of Hazard Analysis (EPHA) conducted phone interviews with people involved in NEISS incidents from August 2000 through July 2001. A review of the collected data indicates that many injuries occurred due to accidental contact/firing of a nail.

### CPSC Activities

Staff from the Division of Mechanical Engineering (ESME) presented concerns regarding the increasing trend in nailer injuries and accidental contact injuries associated with nailers to the industry via correspondence (in April 1998) and meetings (in December 1998) with the International Staple, Nail, and Tool Association (ISANTA). ISANTA responded (in July 1999) by proposing a revision to ANSI SNT-101-1993 *Safety Requirements for Portable, Compressed-Air-Actuated, Fastener Driving Tools*. The proposed revision expanded the trigger section from a generic description of nailer triggers into detailed descriptions of safer trigger mechanisms that should be available on nailers. However, the proposal allowed the use of these mechanisms to be optional. In addition, the industry has formed a Power Safety Alliance (PSA) consisting of safety professionals, trade unions, homebuilders and regulators. To date the PSA has developed a safety video on nailer use that advises the user to: 1) choose a touch trip or sequential trigger system based on the intended use of the product; 2) keep fingers off the triggers when not using the nailers; 3) wear safety goggles; and, 4) read and understand all safety instructions provided with the nailers.

ESME staff believes that a video is insufficient to address the injuries, and that revisions to the voluntary standard that would include performance requirements to address the injuries are needed. ESME staff purchased several nailer models for test and evaluation. Staff undertook this testing and evaluation in order to obtain the information needed to help develop appropriate performance requirements.

## PRODUCT REVIEW:

### Pneumatic Nailers

Pneumatic nailers use compressed air to drive a piston that 'hammers' a nail out the tool nozzle into the work material. This system works very well, even in driving thick nails through hard material. The depth of nail penetration can be adjusted either by the compressed air pressure (higher pressures result in deeper nail penetration) or by adjusting the distance between the nail's exit from the tool and the surface of the work material (the closer the exiting nail is to the material, the deeper it will penetrate).

The basic components of a pneumatic nailer are: an air chamber, a piston and its chamber, a trigger, a work/safety contact piece, a nail source, and an exhaust (see Figure 1). The two most popular types of trigger systems are the touch trip and the sequential trip triggers. The touch trip trigger requires the operator to push both the contact piece and the trigger at the same time to fire a nail. This trigger type is the most prevalent type used in nailers. It is popular due to the ease of operating the nailer by holding the trigger down and firing by simply pushing the contact against the work piece (also known as "bump firing"). The sequential trigger requires the operator to depress the contact before the trigger is depressed each time the gun is fired.

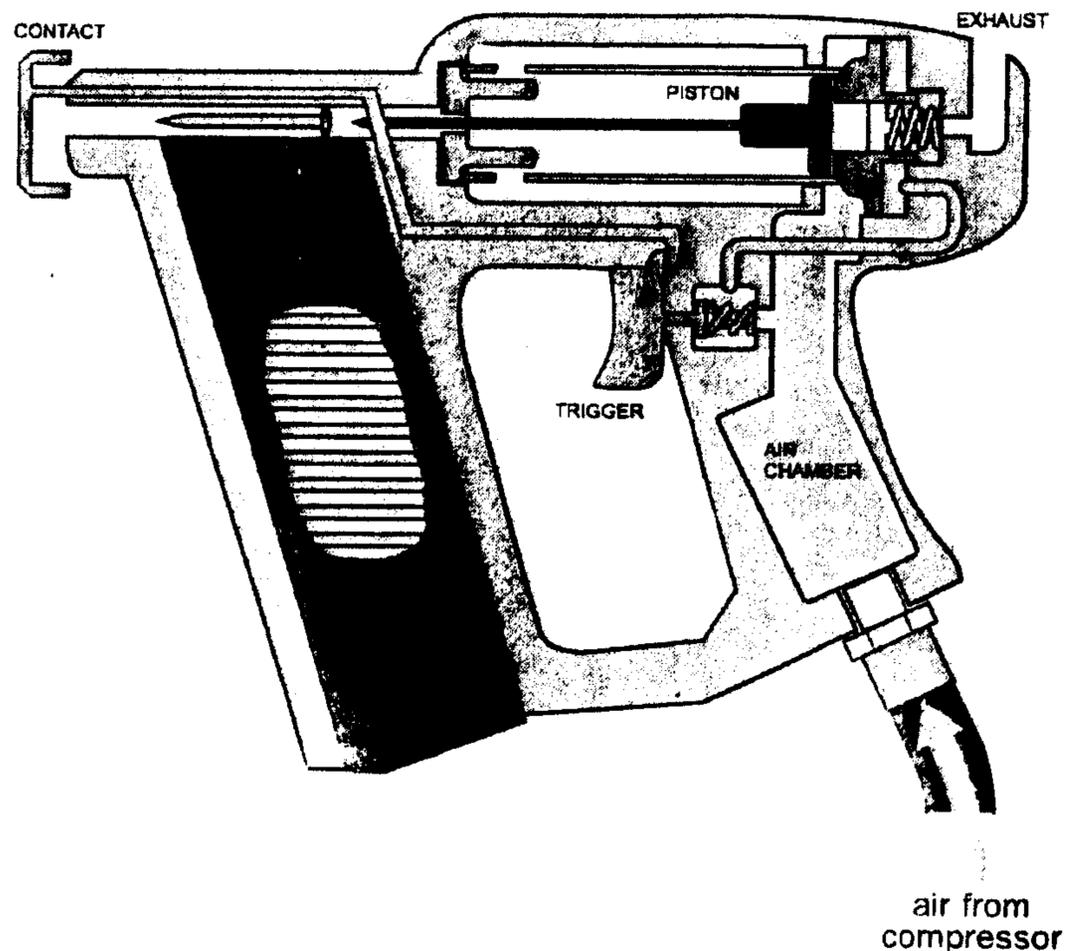


Figure 1. Typical Pneumatic Nailer

## Nail-Loading Mechanisms

There are two types of nail-loading mechanisms (as shown in Figures 2 and 3) -- coil feed and nail strip feed. Coils of nails are formed by welding nails to a wire which is then wound up into a coil. The coil is loaded into a cylindrical holder, and one end is fed to the "barrel" of the nailer. Coil nailers tend to be top heavy as the weight of the nailer head and the coil of nails is concentrated in a small area above and below the handle and trigger. The compact size of coil nailers allows access to tight areas such as the standard 16 inch width between framing studs. Strips of nails are formed by gluing nails together with paper or by joining nails together with a plastic material. The joining material is referred to as the collation material. If the nails in the strips have a full round head, the collation material is usually plastic. If the nails in the strips have only half of the nail head, the nails can be lined up right against each other and are called clipped nails. Clipped nail strips use paper collation. The nails in a strip stack at an angle, and this angle is referred to as the collation angle. Round head nail strips stack in the 20 to 22 degree range, whereas clipped head nail strips stack between 30 to 36 degrees. The nail strip is loaded into a magazine, which feeds into the "barrel" of the nailer. Nailers that use strips of nails are referred to as stick nailers. They are lighter and more balanced as the weight of the nails is distributed, but the length of the magazine limits their use in tight working spaces.



Figure 2. Coil of nails

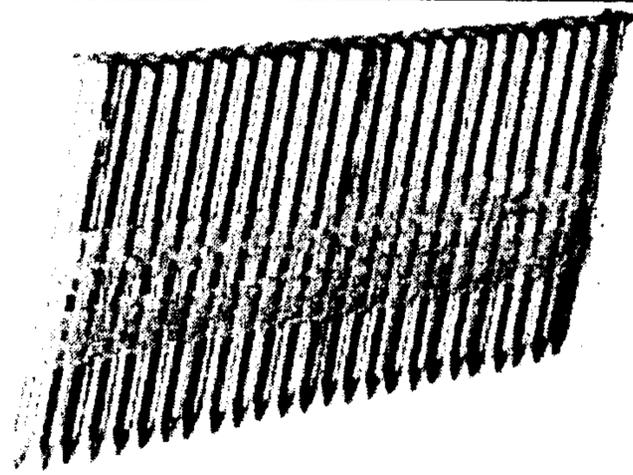


Figure 3. Strip of full round head nails.

## Types of Pneumatic Nailers

There are a variety of pneumatic nailers, but the most common categories are roofing nailers, framing nailers, and finish nailers. Roofing nailers, as the name implies, are designed to nail roofing material. They are typically coil nailers that use shorter nails with wide heads to maximize surface area. The air pressure range for these nailers is typically 80 –120 pounds per square inch (psi). Due to the hazardous applications involved in roofing, staff reasoned that few consumers would purchase this type of nailer. In addition, the difference between roofing nailers and coil framing nailers is minimal; therefore, characteristics found with the coil framing nailers will be similar to roofing nailers.

Framing nailers are designed to drive 2 to 3.5 inch nails. These nailers are typically used to build any type of framing (drywall, home construction, etc) and most come equipped with a touch trip trigger. Framing nailers are readily available as both coil and stick nailers, and range in price from \$250 to \$350. The air pressure range for these nailers is typically 80 –120 psi. Staff found nail velocities to be around 130 feet per second. Because these nailers are particularly useful in refinishing basements, deck building, and framing of additions, staff reasoned that many consumers would purchase this product and thus staff concentrated much of the nailer evaluation on framing nailers.

Finish nailers are designed to drive small nails or brads in applications such as trim work or picture frame fabrication. These nailers are lighter, and require slightly less air pressure to operate (typically in the 70-100 psi range). The smaller volume and pressure of air required to operate the finish nailer results in lower nail velocity, less noise, and less recoil during operation. Most finish nailers use the sequential trigger, while some small gauge nailers (in the range of 19 gauge) have no contact piece at all and only require depression of the trigger to fire a nail. Finish nailers are readily available as stick nailers (horizontal and angled) and range in price from \$80 to \$300. Only two finish nailers were obtained for test and evaluation because staff reasoned that the severity of injury would be low due to the small nail size and low nail velocity.

## **MARKET ASSESSMENT**

Preliminary data from EPHA’s phone survey of NEISS incidents indicated that 5 brands were involved in nailer incidents. The Journal of Light Construction reviewed the same nailer brands as well as the latest models from other nailer manufacturers. The Journal reviewed framing nailers as that product is the most versatile and popular type nailer used in both residential and professional construction.<sup>1</sup>

ESME staff reviewed catalogs, the Internet, and various local hardware stores and obtained the following brand nailers (the aforementioned nailer brands are included) for testing and evaluation:

- Brand A coil framing nailer
- Brand B coil framing nailer
- Brand C stick framing nailer
- Brand D stick framing nailer
- Brand E stick framing nailer
- Brand F stick framing nailer
- Brand G stick framing nailer
- Brand H finish nailer
- Brand I finish nailer

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<sup>1</sup> Borden, Eric. Journal of Light Construction Online (2001) [Online: [http://www.jlconline.com/jlc/archive/tools/framing\\_nailers/index.html](http://www.jlconline.com/jlc/archive/tools/framing_nailers/index.html)]

## **NAILER TEST PLAN**

Testing of the nailers was separated into two categories: an assessment of the use of the nailers and objective measurements of physical characteristics. Both categories of testing were required to identify hazardous characteristics and to determine if any physical characteristics correspond to those hazardous characteristics.

The assessment of the use of the nailers involved loading and using the nailers to build simple framing structures out of common 2x4 lumber. Particular attention was given to the balance/feel of the nailer, tendency to double fire (the unintended firing of an additional nail), ease of toe-nailing (nailing at an angle into a piece of wood that is perpendicular to a second piece of wood), ease of depth adjustment, and work space limitations.

The objective part of the testing involved measurement of the nail velocity, the nailer's weight, the trigger force required to fire a nail, the contact force required to fire a nail, and the location of the nailer's center of gravity.

To measure the trigger force, the nailer was secured at its handle with its contact piece tied back and its nozzle pointing "up". A bucket hanging from the trigger was filled with lead shot until the nailer fired a nail. To measure the contact force, the nailer was again secured with its nozzle pointing "up". A block of wood on a vertical sliding rail was positioned on the contact piece. A bucket on top of the wood was filled with lead shot until the contact depressed, and the nailer was triggered. To measure the center of gravity, the nailer was suspended by a wire and allowed to come to rest. A plumb line suspended from the same point as the wire was used to mark a vertical line through the nailer. This process was repeated with a different suspension point on the nailer. The intersection of the two vertical lines on the nailer marked the center of gravity.

## **PRODUCT EVALUATION**

### Product A

Product A is a coil framing nailer that accepts nails 2 to 3.5 inches in length. The sample nailer tested weighs 6.91 lbs (empty), and feels top heavy. The head to toe dimension is 16 inches and the front to back dimension is 12 inches. The head to toe dimension refers to the distance between the safety contact piece (often called the toe) and the end of the piston head chamber. The front to back dimension refers to the distance between the end of the handle to the opposite end of the nailer. The center of gravity is next to the trigger, towards the head of the nailer. Two useful features on product A are the trigger action and the depth adjustment -- both are easily set with the turn of a dial. On the left side of the nailer is a well marked three position trigger selector switch that allows the trigger to be changed from a locked position to a sequential trip action or a touch trip action. According to the owner's manual, the touch trip trigger action is referred to as "Continuous Nailing" and defined as the method used for pulling the trigger first and placing the contact piece continuously to drive nails. The sequential trip action is referred to as "Intermittent Nailing" and defined as the method used for placing the contact piece first and

then pulling the trigger for accurate and careful placement of a nail. The markings for the trigger selections are pictorial and easy to understand. Underneath the trigger is a numbered dial for setting the nail depth penetration. A pictorial marking indicates that a higher numbered setting results in shallower nail penetration. This feature was useful when trying to keep nails flush with the material.

The depth adjustment prevented over penetration and splitting of wood, and the adjustable sequential trip trigger selection allowed easy operation of the nailer in the mode least likely to double fire during operation. The nailer did not exhibit double fire during use in the "Intermittent Nailing" mode, or during use in the "Continuous Nailing" mode when bouncing the nailer along in the vertical "down" position. However, during use in the "Continuous Nailing" mode, the nailer double fired on occasion when used in the horizontal direction and during toe-nailing. Situations where the user was less likely to hold the nailer firmly often resulted in double firing of nails. The contact piece on this nailer is aggressive and "bites" into the work piece. This is particularly desired when trying to toe-nail.

The contact force required to activate the nailer as evaluated by ESME is 5.34 lbs, which is lower than its overall weight of 6.91 lbs. Given that the center of gravity is close to the nailer's trigger, the weight of the nailer already contributes to depression of the contact when the nailer is used in the vertical "down" position. The trigger force required for activation is 4.09 lbs. This particular nailer exhibited a pronounced recoil during the trigger force measurements that resulted in multiple double firing of nails. Although the nailer was secured at the handle, the nailer "bounced" upon activation. Even with the trigger set in the sequential mode, the nailer's recoil caused the nailer to fire one to two additional times, and each of those times was a double fire. The sequential action/intermittent nailing mechanism did not prevent the firing of additional nails.

### Product B

Product B is a coil framing nailer that accepts nails 2 to 3.5 inches in length. The sample nailer tested weighs 8.42 lbs (empty), and feels top heavy. The head to toe dimension is 14 inches and the front to back dimension is 12 inches. The head to toe dimension refers to the distance between the safety contact piece (often called the toe) and the end of the piston head chamber. The front to back dimension refers to the distance between the end of the handle to the opposite end of the nailer. The center of gravity is near the trigger, towards the head of the nailer. The nailer operates on the touch trip trigger action, and the nail depth adjustment is made by moving the contact piece location (this action requires the use of a tool). However, a sequential trip kit is provided with the nailer should the user wish to convert the trigger system from touch trip to sequential. The recoil force on this nailer is substantial, which led to many double fired nails, especially during toe-nailing as the teeth on the contact piece often did not "bite" into the wood to prevent the tip of the nailer from slipping. A firm hold on the nailer was required to control the recoil; otherwise double firing of nails often occurred.

The contact force required to activate the nailer as evaluated by ESME is 9.86 lbs, which is higher than its overall weight of 8.42 lbs. Given that the center of gravity is close to the nailer's

trigger, the weight of the nailer already contributes to depression of the contact when the nailer is used in the vertical “down” position. The trigger force required for activation is 2.99 lbs. This particular nailer exhibited a pronounced recoil during the trigger force measurements that resulted in multiple double firing of nails. Although the nailer was secured at the handle, the entire nailer moved substantially upon activation. When measuring the trigger force, the nailer double fired up to 3 times during one trial.

### Product C

Product C is a stick framing nailer that accepts strips of full round head nails with a collation angle of 22 degrees, and 2 to 3.25 inches in length. The sample nailer tested weighs 8.51 lbs (empty), and the nailer is well balanced and feels light for its size. The head to toe dimension is 13.38 inches, and the front to back dimension is 21.18 inches. The head to toe dimension refers to the distance between the safety contact piece (often called the toe) and the end of the piston head chamber. The front to back dimension refers to the distance between the end of the handle to the opposite end of the nailer. The center of gravity is directly at the trigger in its depressed configuration, and the trigger is located at the joining of the handle and nailer head. The nailer operates on the touch trip trigger system, which is very sensitive and prone to double fire. The trigger in particular is extremely sensitive and any rebound during operation quickly fires an additional nail. This is especially true when trying to use the nailer in a sequential manner by placing and pressing the contact piece first, then pressing the trigger.

The contact force required to activate the nailer as evaluated by ESME is 7.85 lbs, which is lower than its overall weight of 8.51 lbs. Given that the center of gravity is close to the nailer's trigger, the weight of the nailer already contributes to depression of the contact when the nailer is used in the vertical “down” position. The trigger force of 2.08 lbs is the second lowest measured, and as stated before, the trigger is very sensitive. Although the nailer was secured at the handle during the trigger force test, the nailer “bounced” upon activation. When measuring the trigger force, the nailer double fired up to 2 times as the nailer bounced and the weighted trigger fired an additional nail. Only when the trigger was very carefully and gradually weighted did the nailer resist double firing.

### Product D

Product D is a stick framing nailer that accepts strips of full round head nails with a collation angle of 22 degrees, and 2 to 3.25 inches in length. The sample nailer tested weighs 8.69 lbs (empty), and the nailer is well balanced and does not feel too heavy. The head to toe dimension is 13.75 inches and front to back dimension is 21.25 inches. The head to toe dimension refers to the distance between the safety contact piece (often called the toe) and the end of the piston head chamber. The front to back dimension refers to the distance between the end of the handle to the opposite end of the nailer. The center of gravity is directly at the trigger in its depressed configuration, and the trigger is located at the joining of the handle and nailer head. Two useful features on the nailer are the trigger action and the depth adjustment. On the left side of the nailer is a well marked three-position trigger selector switch that allows the trigger to be changed

from a locked position to a sequential trip action or a touch trip action. According to the owner's manual, the touch trip trigger action is referred to as "Continuous Nailing" and defined as the method used for pulling the trigger first and placing the contact piece continuously to drive nails. The sequential trip action is referred to as "Intermittent Nailing" and defined as the method used for placing the contact piece first and then pulling the trigger for accurate and careful placement of a nail. The markings for the trigger selections are pictorial and easy to understand. Underneath the trigger is a numbered dial for setting the nail depth penetration. A pictorial marking indicates that a higher numbered setting results in shallower nail penetration. This feature helped to keep nails flush with the material. The depth adjustment prevented over penetration and splitting of wood, and the adjustable sequential trip trigger selection allowed easy operation of the nailer in the mode least likely to double fire during operation. The nailer did not exhibit double fire during use in the "Intermittent Nailing" mode, or during use in the "Continuous Nailing" mode when bouncing the nailer along in the vertical "down" position. However, during use in the "Continuous Nailing" mode, the nailer double fired on occasion when used to nail in the horizontal direction and during toe-nailing. The contact piece on this nailer is aggressive and "bites" into the work piece. This is particularly desired when trying to toe-nail.

The contact force required to activate the nailer as evaluated by ESME is 4.36 lbs, which is lower than its overall weight of 8.69 lbs. Given that the center of gravity is close to the nailer's trigger, the weight of the nailer already contributes to depression of the contact when the nailer is used in the vertical "down" position. The trigger force required for activation is 4.59 lbs. The nailer did not exhibit double firing of nails during trigger force measurements.

### Product E

Product E is a stick framing nailer that accepts clipped head nails with a collation angle of 30 degrees, and 2 to 3.5 inches in length. The sample nailer tested weighs 8.31 lbs (empty), and the nailer is well balanced and does not feel top heavy. The head to toe dimension is 13 inches and front to back dimension is 19.5 inches. The head to toe dimension refers to the distance between the safety contact piece (often called the toe) and the end of the piston head chamber. The front to back dimension refers to the distance between the end of the handle to the opposite end of the nailer. The center of gravity is next to the trigger, towards the head of the nailer. The nailer operates on the touch trip trigger action, and the nail depth adjustment is made by moving the contact piece location (this action requires the use of a tool). The trigger is spring loaded and thus provides a tactile sense of where the trigger is located. Product E is the only nailer tested that provides a spring loaded trigger. The contact piece is aggressive and "bites" into the work piece. This is particularly desired when toe-nailing. The nailer did not exhibit double firing when used in the "bump" mode by simply bouncing the nailer along in the vertical "down" position. When trying to use the nailer in a "sequential" manner by placing and pressing the contact piece before pulling the trigger, the nailer often double fired. Situations, such as toe-nailing, where the user was less likely to hold the nailer firmly often resulted in double firing. The recoil and firing of the second nail occurs well before the trigger can be released.

The contact force required to activate the nailer as evaluated by ESME is 7.22 lbs, which is lower than its overall weight of 8.31 lbs. Given that the center of gravity is close to the nailer's trigger, the weight of the nailer already contributes to depression of the contact when the nailer is used in the vertical "down" position. The trigger force required for activation is 4.09 lbs. During the trigger force testing, an audible release of air occurred before each activation.

### Product F

Product F is a stick framing nailer that accepts strips of round head nails with a collation angle of 22 degrees, and 2 to 3.5 inches in length. The sample nailer tested weighs 8.20 lbs (empty) and feels somewhat top heavy. The head to toe dimension is 14.62 inches and front to back dimension is 20.50 inches. The head to toe dimension refers to the distance between the safety contact piece (often called the toe) and the end of the piston head chamber. The front to back dimension refers to the distance between the end of the handle to the opposite end of the nailer. The center of gravity is directly at the trigger in its depressed configuration, and the trigger is located at the joining of the handle and the nailer head. The nailer operates on the touch trip trigger action, and the nail depth adjustment is made by moving the contact piece location (this action requires the use of a tool). The contact piece did not "bite" aggressively into the work piece, which made it difficult to prevent the tip of the nailer from slipping during toe-nailing. The nailer did not exhibit double firing when used in the "bump" mode when bouncing the nailer along in the vertical "down" position. When trying to use the nailer in a "sequential" manner, by placing and pressing the contact piece before pulling the trigger, the nailer often double fired. Situations, such as toe-nailing, where the user was less likely to hold the nailer firmly often resulted in double firing.

The contact force required to activate the nailer as evaluated by ESME is 6.71 lbs, which is lower than its overall weight of 8.20 lbs. Given that the center of gravity is close to the nailer's trigger, the weight of the nailer already contributes to depression of the contact when the nailer is used in the vertical "down" position. The trigger force of 1.90 lbs is the lowest measured of all the nailers. During the trigger force testing the nailer did not exhibit double firing.

### Product G

Product G is a stick framing nailer that accepts strips of clipped nails with a collation angle of 30 degrees, and 2 to 3.5 inches in length. The sample nailer tested weighs 8.24 lbs (empty), and the nailer is well balanced and feels light for its size. The head to toe dimension is 13.25 inches and front to back dimension is 15 inches. The head to toe dimension refers to the distance between the safety contact piece (often called the toe) and the end of the piston head chamber. The front to back dimension refers to the distance between the end of the handle to the opposite end of the nailer. The center of gravity is directly at the trigger in its depressed configuration, and the trigger is located at the joining of the handle and nailer head. The nailer operates on the touch trip trigger action, and the nail depth adjustment is made by moving the contact piece location (this action requires the use of a tool). The contact piece on this nailer is very aggressive and "bites" into the work piece. This is particularly desired when trying to toe-nail. The nailer did

not exhibit double firing when used in the “bump” mode when bouncing the nailer along in the vertical “down” position. When trying to use the nailer in a “sequential” manner, by placing and pressing the contact piece before pulling the trigger, the nailer often double fired. Situations, such as toe-nailing, where the user was less likely to hold the nailer firmly often resulted in double firing.

The contact force required to activate the nailer is 5.91 lbs, which is lower than its overall weight of 8.24 lbs. Given that the center of gravity is close to the nailer's trigger, the weight of the nailer already contributes to depression of the contact when the nailer is used in the vertical “down” position. Complete depression of the contact piece is required in order for the nailer to operate. The trigger force required for activation is 3.78 lbs. While the nailer did recoil during the trigger force testing, double firing did not occur.

### Product H

Product H is a stick finish nailer that accepts 16 gauge finish nails or brads. The sample nailer tested weighs 4.47 lbs. The center of gravity is directly on the trigger at the finger contact point. The finish nail strips are horizontal; therefore, the magazine and handle are parallel to each other and extend horizontally from the nailer head. Overall the nailer is very lightweight and easy to handle. The nailer operates on the sequential touch trip system. Finish nailers are used to precisely place a nail. Markings on the contact piece indicate the exact exit point of the nail. The nailer is so light weight that little to no recoil occurs.

The contact force required to activate the nailer as evaluated by ESME is 3.54 lbs. The trigger force required for activation is 3.00 lbs. No double firing or recoil occurred during testing.

### Product I

Product I is a stick finish nailer that accepts 16 gauge straight finish nails or brads. The sample nailer tested weighs 4.01 lbs. The center of gravity is directly on the trigger at the finger contact point. The finish nail strips are horizontal; therefore, the magazine and handle are parallel to each other and extend horizontally from the nailer head. Overall the nailer is very lightweight and easy to handle. The nailer operates on the sequential touch trip system. Finish nailers are used to precisely place a nail. Markings on the contact piece indicate the exact exit point of the nail. The nailer is so light weight that little to no recoil occurs.

The contact force required to activate the nailer is 3.54 lbs. The trigger force required for activation is 2.52 lbs. No double firing or recoil occurred during testing.

The following table summarizes the test results, including an assessment of use and physical characteristics measured on each nailer:

Brand/Model	Product A	Product B	Product C	Product D	Product E	Product F	Product G	Product H	Product I
Type	coil framing	coil framing	stick framing	stick framing	stick framing	stick framing	stick framing	finish nailer	finish nailer
Nail (clipped or full head)	full head	full head	full head	full head	clipped head	full head	clipped head	16 gauge finish	16 gauge finish
Collation angle	NA	NA	22 degree	22 degree	30 degree	22 degree	30 degree	na	na
Collation type	welded wire	welded wire	plastic	plastic	paper	plastic	paper	glue	glue
Trigger	touch/seqntl	touch trip	touch trip	touch/seqntl	touch trip	touch trip	touch trip	sequential	sequential
Trigger adjust	switch	none	none	switch	none	none	none	none	none
Dimension Head/Toe Front/Back	16 inches 12 inches	14 inches 12 inches	13.38 inches 21.18 inches	13.75 inches 21.25 inches	13 inches 19.5 inches	14.62 inches 20.50 inches	13.25 inches 15 inches	9.5 inches 11.5 inches	11.5 inches 11.25 inches
Weight	6.91 lbs	8.42 lbs	8.51 lbs	8.69 lbs	8.31 lbs	8.20 lbs	8.24 lbs	4.47 lbs	4.01 lbs
Balance	top heavy	top heavy	very good	very good	very good	fair	very good	very good	very good
Comfort	fair	fair	good	very good	very good	fair	very good	very good	very good
Double Fire During use Trigger test	yes significant	yes significant	yes significant	yes no	yes no	yes no	yes no	no no	no no
Trigger force	4.09 lbs	2.99 lbs	2.08 lbs	4.59 lbs	4.06 lbs	1.90 lbs	3.78 lbs	3.00 lbs	2.52 lbs
Contact force	5.34 lbs	9.86 lbs	7.85 lbs	4.36 lbs	7.22 lbs	6.71 lbs	5.91 lbs	3.54 lbs	3.54 lbs
Nail velocity	137 ft/s	123 ft/s	na	128 ft/s	134 ft/s	141 ft/s	114 ft/s	na	na
Center Gravity	at trigger	at trigger	at trigger	at trigger	at trigger	at trigger	at trigger	at trigger	at trigger
Recoil	significant	significant	significant	not significant	not significant	not significant	not significant	none	none

## **NEW TECHNOLOGY**

ESME staff is aware of passive trigger designs currently available on two different brand nailers. One passive trigger technology allows both touch trip and sequential action depending on the order of depression of the contact piece and the trigger. If the contact piece is depressed first, the nailer will operate as a single-shot tool and will not fire again until the trigger is released. If the trigger is depressed first, then the nailer may be placed against the work piece and operated in bump mode. Similarly, another technology features a "smart trigger" that allows passive trigger selection linked to a microprocessor "smart chip" that temporarily disables the tool when idle. The system combines a mechanical pre-set scenario with a tiny stopwatch: Depressing the nose to the work before pulling the trigger readies the chip for single fire. The chip then allows the user two seconds to dispense a single fastener. Depressing the trigger first readies the chip for bump fire. The user must then dispense a fastener every second or the tool will temporarily time itself out. The temporary time-out is easy to reset by depressing the nose or pulling the trigger. Doing so tells the chip which firing mode to use.

## **DISCUSSION:**

Injuries occur due to accidental contact/firing of nails. Staff believes that there are several options for preventing accidental depression of the trigger that range from a trigger guard to a lock out setting on the trigger or a double action trigger. The simplest deterrent is a physical barrier such as a trigger guard, that allows a place for the finger to grasp the nailer around its center of gravity without actuating the trigger. Product A and D use a switch to set the trigger selection, and one of those settings is a trigger lock out. While this allows the trigger to be held, it requires conscious effort on the user's part to correctly set the trigger switch. A double action trigger that resets to the locked position upon release would better ensure that a finger can rest on the trigger without actuation. Concepts similar to the aforementioned could address accidental depression of the trigger.

Nailers with the touch trip triggers were susceptible to double firing, especially when trying to accurately place the nailer against the work piece during toe-nailing. In awkward positions the user is less likely to hold the nailer firmly enough to counter the nailer's recoil. The recoil and firing of the second nail occurs well before the trigger can be released. The top heavy coil nailers exhibited significant recoil and double fire tendencies. Both coil nailers (Product A and B) and one stick framing nailer (Product C) exhibited significant recoil and double firing during trigger force testing. Further testing of the recoil forces and characteristics of nailers would be required to fully evaluate this hazard potential. Factors such as contact force, nailer weight, and trigger sensitivity in conjunction with the effects of recoil should be investigated. Further testing would require the design of a test apparatus that constrains the movement of the nailer to one plane, while measuring the acceleration of the recoil.

Sensitive triggers in conjunction with nailer recoil can also lead to the inadvertent firing of an additional nail. This second nail can ricochet off the first nail and cause injury, or miss the work piece entirely to strike a body part or victim. Three of the nine nailers tested exhibited significant recoil during operation. Each of these nailers exhibited excessive double firing of nails during the trigger force test measurements.