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American National Standard

for Power Tools -

Gasoline-Powered Chain Saws - Safety Requirements

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B175.1-2000
Revision of
ANSI B175.1-1991

American National Standard
For Power Tools –

Gasoline-Powered Chain Saws - Safety Requirements

Secretariat
Portable Power Equipment Manufacturers Association

Approved October 27, 2000
American National Standards Institute, Inc.

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Foreword (This foreword is not part of American National Standard B175.1-2000.)

This standard sets forth the minimum safety requirements for gasoline-powered chain saws. These requirements have resulted from several years of standards development effort by the ANSI B175 Accredited Standards Committee. The original standard was approved in 1979 and revised in 1983, 1985, and 1991.

The changes in this revision include: addition of the requirement for a chain catcher; increased tank filler opening sizes; a revision to the method of measuring front hand guard clearances; changes to vibration and chain brake performance requirements; refinements to test procedures for sound, vibration and kickback; an update of the programming language used for calculation of Computed Kickback Angle; and revision of requirements for instruction manuals.

This standard contains eleven annexes, ten of which are informative and are not considered part of this standard. Annex C, Safety precautions for chain saw users, is normative and is considered part of this standard.

Suggestions for improvement of this standard are welcome. They should be sent to the Secretariat, ASC B175 Committee, 4340 East West Highway, Suite 912, Bethesda, MD 20814.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee B175. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the B175 Committee had the following members:

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American National Standard for Power Tools — Gasoline-Powered Chain Saws — Safety Requirements

1 Scope and purpose

1.1 Scope

The requirements of this standard apply to portable, hand-held, gasoline-powered chain saws for use primarily in cutting wood.

NOTE — Metric units are included for information only.

1.2 Purpose

The purpose of this standard is to establish minimum safety requirements with respect to the manufacture of portable, hand-held, gasoline-powered chain saws.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI S1.4-1983 and its supplement ANSI S1.4A-1985, *Specification for sound level meters*

ANSI S2.11-1969 (R1986), *Methods for specifying the characteristics of auxiliary equipment for shock and vibration measurement*

ANSI/SAE J184-FEB87, *Qualifying a sound data acquisition system*

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ISO 10012-1:1992 *Quality assurance requirement for measuring equipment – Part 1: Metrological confirmation system for measuring equipment* [1)]

IEC 651(1993), *Sound level meters* [1)]

ISO 5349:1999 *Part 1 and 2, Mechanical Vibration — Measurement and evaluation of human exposure to hand-transmitted vibration* [1)]

SAE J335-JUN95 *Recommended Practice — Multiposition small engine exhaust system fire ignition suppression* [2)]

3 Definitions [3)]

3.1 bar tip guard: A shield that prevents contact with the chain at the tip of the guide bar and that may be removable and replaceable.

3.2 bow guide: A narrow rail structure with a large open center that supports and guides the saw chain.

3.3 bucking: The process of cross-cutting a felled tree, or log, into lengths.

3.4 chain brake: A device used to stop the saw chain.

3.5 chain catcher: Device for restraining the saw chain if it breaks or degrooves.

3.6 chain saw powerhead: A chain saw without the saw chain and guide bar.

3.7 choke control: A control that is used to enrich the carburetor fuel/air mixture.

3.8 clutch: A mechanism for connecting and disconnecting a driven member to and from a rotating source of power.

3.9 drive sprocket: The toothed part that drives the saw chain.

3.10 felling: The process of cutting down a tree.

3.11 felling back cut: The final cut in a tree-felling operation made on the opposite side of the tree from the notching undercut.

3.12 front hand guard: A structural barrier between the front handle of a chain saw and the guide bar, typically located close to the hand position on the front handle and sometimes employed as an activating lever for a chain brake.

[1)] Electronic versions of IEC and ISO documents are available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, http://webstore/ansi.org; requests for hard copies of standards should be directed to Global Engineering Documents at 800-854-7179, http://global.ihs.com.

[2)] Available from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

[3)] For additional nomenclature, see Annex B.

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3.13 front handle: The support handle located at or toward the front of the chain saw.

3.14 guide bar: A solid railed structure that supports and guides the saw chain.

3.15 guide bar effective length: The length of cut a guide bar and chain will make when the guide bar adjustment is at the halfway point. The chain used for measurement will be the one normally intended to be used with the bar. Measurement shall be made from (a) the bumper plate (where no spikes are provided or the spikes are removable) or (b) the root of the spikes (where the spikes are a permanent part of the saw) to the top of the chain cutters at the tip end of the bar. Capacity shall be expressed in terms of the nearest whole unit of measure (in/cm).

3.16 kickback

3.16.1 pinch kickback: The rapid pushback of the saw chain that can occur when the wood closes in and pinches the moving saw chain in the cut along the top of the guide bar.

3.16.2 rotational kickback: The rapid upward and backward motion of the saw that can occur when the moving saw chain near the upper portion of the tip of the guide bar contacts an object such as a log or branch.

3.17 low-kickback saw chain: A saw chain that has been demonstrated to meet the requirements of 5.11.2.4.

3.18 may: The term that indicates a permissive requirement.

3.19 muffler: A device to reduce engine exhaust noise and direct the exhaust gases.

3.20 normal cutting positions: Those positions assumed in performing the bucking and felling cuts.

3.21 notching undercut: A notch cut in a tree to direct the tree's fall.

3.22 oiler control: A system for oiling the guide bar and saw chain.

3.23 on/off or stop control: A control that allows the engine to run or causes the engine to stop.

3.24 primer control: A control for supplying extra fuel for engine starting.

3.25 rear handle: The support handle located at or toward the rear of the saw.

3.26 reduced-kickback guide bar: A guide bar that has been demonstrated to reduce kickback significantly.

3.27 reduced-kickback saw chain: A saw chain that has been demonstrated to reduce kickback significantly, but that does not meet the requirements of 5.11.2.4.

3.28 saw chain: A loop of chain that has cutting teeth for cutting wood and is driven by the engine and supported by the guide bar.

3.29 shall: The term that indicates a mandatory requirement.

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3.30 spiked bumper (spike): The pointed tooth or teeth used when felling or bucking to pivot the saw and maintain position while sawing.

3.31 starter: The mechanism that rotates the engine to start it.

3.32 throttle control system: The complete system including the throttle control trigger, throttle control linkage, and, in some cases, a throttle control latch or a throttle control lockout, or both.

3.32.1 throttle control latch: A device to temporarily set the throttle control valve in a partially open position to aid the operator in starting the engine.

3.32.2 throttle control linkage: The mechanism that transmits motion from the throttle control trigger to the throttle control valve.

3.32.3 throttle control lockout: A movable stop that prevents the accidental opening of the throttle control valve until manually released.

3.32.4 throttle control trigger: The part of the saw, usually a lever, activated by the operator's hand or finger, which in turn controls the throttle control valve.

3.32.5 throttle control valve: A control that adjusts the volume of fuel and air mixture delivered to the combustion chamber of an internal combustion engine.

4 Responsibility

It shall be the responsibility of the chain saw manufacturer to design and construct his chain saws in accordance with section 5. It shall be the responsibility of the owner to maintain the chain saw in accordance with the instructions in the instruction manual(s).

Chain saws shall be used in accordance with the operating instructions and safety precautions listed in the instruction manual(s). It shall be the responsibility of the owner to see that such instructions and precautions are given to every operator who uses the saw.

5 General specifications

5.1 Throttle control system

The chain saw shall be equipped with a continuous-pressure throttle control system that will shut off the power to the saw chain after the pressure is released.

5.1.1 Throttle control trigger

There shall be a guard completely around the trigger in the plane of trigger motion. A continuous loop formed by the handle and body of the chain saw will satisfy this requirement. The trigger shall be located so that it may be actuated and released while both hands are gripping the chain saw handle(s).

5.1.2 Throttle control lockout

If a throttle control lockout is provided, it shall be constructed so that it must be actuated before the throttle control valve can be opened. When the throttle control system is locked out, the throttle control valve shall be locked in the idle position. The throttle control lockout shall not prevent the engine from returning to idle speed.

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5.1.3 Throttle control latch

If a throttle control latch is provided for starting, it shall be self-releasing when the throttle control trigger is depressed. In the starting mode the saw chain may be powered.

The throttle control latch shall be constructed so that two or more independent motions are required to engage the latch. A one-motion throttle latch is acceptable, provided that it does not cause the chain to be powered.

5.1.4 Throttle control linkage(s)

The throttle control linkage(s) shall either be enclosed or confined in a space defined by the vertical projection of the handle containing the throttle control trigger with the saw in an upright position and with the bar centerline horizontal.

The throttle control linkage(s) shall be constructed so that a force in the amount of three times the empty weight of the chain saw (without guide bar and saw chain), applied in any direction on the rear handle, shall not increase engine speed to a point at which the clutch engages and chain movement begins.

5.1.5 Throttle control valve(s)

The throttle control valve(s) shall return to the idle position if the throttle control linkage(s) becomes disconnected, regardless of the attitude of the chain saw.

5.2 Handles

All chain saws shall be designed and constructed with a handle, or handles, enabling the operator to operate the chain saw with two hands.

5.2.1 Handle strength

The chain saw handles shall not break when subjected to the static test loads separately applied in each of six directions as specified in figure 1. The chain saw may be supported at the guide bar mounting pad when the test loads are applied. The load shall be applied in the normal hand grip area of not more than 3.5 in (90 mm). For this test, the grip area for the front handle is defined as that area closest to the center of balance for the saw when in the bucking or crosscutting position.

5.2.2 Handle vibration isolation system

If a handle vibration isolation system is used, the chain saw shall be constructed so that a failure of one or more of the vibration isolators shall not result in the loss of ability of the operator to control the chain saw.

5.2.3 Handle sizes

5.2.3.1 General

The handle clearances and the handle sizes shall be at least the minimum values specified in figure 2.

5.2.3.2 Handle clearance

If a fixed hand guard that meets the requirements of 5.8.4 and figure 5 is provided, then the requirements of dimension B, figure 2, shall not apply. When a saw is provided with a hand

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guard that can be pivoted toward the handle, the construction shall comply with dimension B, figure 2.

5.3 Controls

5.3.1 On/off or stop controls

5.3.1.1 Applicability. All units shall be equipped with an engine stopping device which brings it to a complete stop and does not depend on sustained manual effort for its operation.

5.3.1.2 Identification. The purpose and method of operation of the device shall be clearly and durably marked. The color of the control shall contrast to the background.

5.3.1.3 Location. The control for this device shall be so positioned that it can be operated while the machine is being held with both hands.

5.3.2 Oiler control

If the chain saw is equipped with a manual saw chain oiler control, it shall be located so that it can be operated while maintaining a grip on the handle, or handles, with both hands.

5.3.3 Choke control

If a manual choke control is provided, it shall be clearly and durably identified.

5.3.4 Primer Control

If a manual primer control is provided, it shall be clearly and durably identified.

5.4 Fuel tanks and oil tanks

5.4.1 Tank filler location and identification

The fuel tank and oil tank filler openings shall be located so that they will not be unduly obstructed by the chain saw components. Each cap or opening shall be clearly and durably identified. If only the caps are identified, they shall not be interchangeable.

5.4.2 Tank filler openings

The minimum diameter of the fuel tank filler hole shall be 0.79 in (20mm). The minimum diameter of the oil tank filler hole shall be 0.75 in. (19mm).

5.4.3 Fuel line

The fuel line shall be routed so that it is not subject to abrasion where the line is outside the fuel tank.

5.5 Exhaust system

5.5.1 Exhaust direction

The exhaust flow shall be away from the chain saw and away from the operator when operating the chain saw in the normal cutting positions.

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5.5.2 Muffler location

The muffler shall be located or guarded so that the operator will not inadvertently contact any hot muffler surface when starting the saw or when operating the chain saw in the normal cutting positions.

5.5.3 Spark-arresting mufflers

All saws shall have spark-arresting mufflers meeting the specifications and performance requirements given in SAE J335-JUN95.

5.6 Saw chain tensioning

The chain saw shall be manufactured with provisions for adjusting the guide bar to obtain proper saw chain tension.

5.7 Bars

5.7.1 Guide bars

No opening with a dimension greater than 0.40 in (10 mm) shall be in the cutting area of the guide bar.

5.7.2 Bow guides

In accordance with 5.15, the following wording shall be placed on the bow guide:

> **WARNING:** A bow guide increases the risk of severe kickback and serious injury. Do not use the bow guide unless you have experience and/or specialized training. Do not remove guard(s) and/or spur(s) provided by the manufacturer.

This warning may be suitably paraphrased.

5.8 Guards

5.8.1 Rotating part guards

All power-driven shafts, gears, flywheels, and starter pulleys, except drive sprockets and clutches, shall be positioned or otherwise guarded to prevent contact by a probe having a hemispherical end and a diameter of 0.50 in (13 mm).

5.8.2 Drive sprocket and clutch guards

The clutch and drive sprocket shall be guarded on the top, sides, and rear so as to conform with the accessibility noted in 5.8.1. If the chain saw is equipped with a wraparound front handle, the drive sprocket guard shall fully cover the chain to the rear of the handle and extend forward of the handle a distance of 1 in (25 mm) or greater. For this protected area, the drive sprocket guard may be open on the bottom, but shall extend at least 0.50 in (13 mm) below the saw chain cutter teeth.

5.8.3 Bow guide guard(s) and spike(s)

5.8.3.1 Chain guards that cover the saw chain on the upper and lower portion of the bow guide, near the powerhead, shall be provided. The guards shall cover a minimum of 4 in (102 mm) of exposed chain in each area. To allow for assembly, a maximum of 0.5 in (13 mm) gap is allowed between guards and the powerhead when a new, unused chain is installed.

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5.8.3.2 A bow guide shall also be equipped with spike(s), dog(s), or spur(s), as illustrated in figure 3.

5.8.3.3 The saw chain shall be replaceable without removing the chain guard(s) or spike(s).

5.8.4 Front hand guard

5.8.4.1 General

All chain saws shall be equipped with a front hand guard, meeting the strength requirements of 5.8.4.9 and the dimensional requirements specified in 5.8.4.2.through 5.8.4.8. The hand guard may be designed to also function as a chain brake actuator.

5.8.4.2 Front hand guard dimensions

Dimensions and clearances of the front hand guard shall be met in relation to the intended position of the left hand on the front handle during vertical cutting (bucking) and are specified by the use of gauges defined in Table 1.

Table 1-Front Handguard Gauge Specifications

Gauge type	Diameter +/- 0.020 in. (± 0.5 (mm))	Length +/- 0.020 in. (± 0.5 (mm))	Corner radius max in. (± 0.5 (mm))
A	1.38 (35 mm)	3.94 (100 mm)	0.2 (5 mm)
B	2.75 (70 mm)	3.94 (100 mm)	0.02 (0.5 mm)
C	2.20 (56 mm)	3.25 (82 mm)	0.02 (0.5 mm)

Unless otherwise specified the following applies when determining the dimensions and clearances:

a) the chain saw shall be kept in upright position

b) forces applied to the gauges shall not exceed 2.2 lbs. (10 N)

c) if the front hand guard also activates the chain brake, the measurements shall be made:

with the front hand guard in the non-activated position

with a force of max 2.2 lbs. (10 N) applied, at 45° in a forward and downward direction relative to the guidebar centerline and 50 mm to the left of X_0 when viewed from the rear, projected on the top edge of the guard.

5.8.4.3 Determination of Reference Point X_0

The reference point X_0 is determined, when viewed from the rear, with the gauge type A kept furthest to the right side of the front handle, parallel to and directly below the centerline of the front handle, and in contact with both the handle and the top of the housing, see figure 4-1.

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When the machine design is such that the gauge type A with 4 inches (100 mm) length can not be inserted between the handle and the housing as required above, the gauge length shall be shortened or its diameter reduced to no less than 1 in. (25mm) but not more than needed. See figure 4-1c.

With this modified gauge, the reference point X_0 shall be determined as stated above.

5.8.4.4 Front hand guard width

The front hand guard width, W_1, is the distance from X_0 to the point where the requirement for H_1 (see 5.8.4.5) is not fulfilled. When viewed from the rear, the front hand guard width shall at least cover the front handle from X_0 to 4 inches (100 mm) to the left of X_0. See Figure 4-2a.

Any part of the area defined by the outer contour of the front hand guard and the housing shall be intersected by the line from X_0 to the rearmost, upper unprotected part of the saw chain on the guide bar, see figure 4-2b.

5.8.4.5 Front hand guard height over front handle (H_1)

The measurement of the vertical height (H_1) of the front hand guard shall be made in a plane parallel to the guide bar plane and perpendicular to the guide bar centerline, as illustrated in Figure 4-3.

Any free play in the guide bar mounting shall be taken up by tightening the guide bar to the saw body with the bar tip in its uppermost position.

H_1 shall be at least 0.79 inch (20mm) above the upper surface at each point on the front handle over the length of W_1 as defined in figure 4-2a.

When the front hand guard activates the chain brake, the height shall be at least 0 inch with the front hand guard in the actuated position (see H_{1a} in figure 4-3).

5.8.4.6 Front hand guard openings (H_3)

The front hand guard may have openings. Such openings shall be limited in size so that a gauge type C, applied in any direction, cannot pass through when pushed perpendicularly to the face of the opening. See Figure 4-4.

Note: The gauge may be applied from either front or rear.

5.8.4.7 Front hand guard clearance with the saw body (H_2)

The clearance (H_2) between the lower edge of the front hand guard and any component of the saw body shall be limited so that a gauge type C, held parallel to the front hand guard, cannot pass through. See Figure 4-4.

This limitation of the clearance applies over W_1 as defined in figure 4-1.

Note: If necessary, the gauge may be applied from the front. If so, means may be needed to hold the hand guard in its nominal position.

5.8.4.8 Front hand guard clearance to front handle (R_1 and R_2)

There shall be a clearance between any part of the front hand guard and the front handle starting from X_0 to the left when viewed from behind so that a gauge:

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- type A can pass the clearance without contact to the guard (R_1).

If the front hand guard also activates the chain brake, there shall be a clearance (R_2) between any part of the non-activated front hand guard and the front handle starting from X_0 so that a gauge

- type B can not pass the clearance such that any part of the gauge centerline will come lower than any part of the center line of the front handle. See Figure 4-5.

5.8.4.9 Front hand guard impact strength requirement

The guard shall not break when struck one time by the pendulum shown in figure 5 at the midpoint of the dimension W_1 of figure 4-2a. This test shall be conducted at the temperature of –13°F ± 4.0°F (–25°C ± 2°C). For this test, the chain saw shall not be running. If the hand guard can actuate a chain brake, this test shall be carried out with the chain brake in the actuated position.

5.8.5 Chain brakes

5.8.5.1 General

If a chain brake is provided, it shall stop the saw chain within 0.15 second, maximum, and 0.12 second, average, after actuation, when tested in accordance with 5.8.5.2.

If a chain saw is equipped with a hand-guard-actuated chain brake, the actuating lever shall meet the requirements in 5.8.4 and the requirements specified in figures 4-1 through 4-5.

When tested in accordance with 5.8.5.2, the static release force shall be not less than 4.4 lbf nor more than 15.4 lbf (20-70 N).

5.8.5.2 Hand-guard-actuated chain brake test requirements

The following requirements shall be met when testing hand-guard-actuated chain brakes:

a) During the test, the chain saw shall be rigidly mounted by the bar pad or the handles.

b) Initially, the brake's friction surface shall be in a dry and unlubricated condition.

c) The engine shall be run-in before the test, and the chain saw adjusted and operated according to the manufacturer's instructions.

d) Only new brakes shall be tested.

e) No adjustment to the brake shall be permitted during the test.

f) The test temperature shall be 68°F ± 9°F (20°C ± 5°C).

g) The chain brake shall be activated in accordance with the test sequence set forth in figure 5. The brake shall be activated by the pendulum, having a mass of at least 1.5 lb (0.7 kg) and a length of 27.5 in (700 mm).

h) Once racing speed has been reached, the pendulum shall strike the top edge of the handguard as shown in figure 5, 2 in. (50 mm) to the left of X_0 as defined in figure 4-1. The drop height shall be 8 in (200 mm) as shown in figure 5. The throttle shall be kept in a fixed position at racing speed during the test. Racing speed is defined as the

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manufacturer's rated engine speed for maximum power plus 33%, or full throttle, whichever is less. When the chain has stopped after braking, the throttle shall be returned to the idle position and the brake reset. The braking time is defined as the interval from the instant the pendulum hits the chain brake actuator to the instant the saw chain stops.

i) The static force needed to release the chain brake actuator shall be measured in the direction of 45° forward and downward in relation to the guide bar centerline at the top edge of the handguard 2 in. (50 mm) to the left of X_0 as defined in figure 4-1. The force shall be applied at a uniform rate with the engine not running.

5.8.6 Rear handle

The rear handle shall be designed or positioned so that the operator's hand is protected if the chain breaks or comes off the guide bar. If a rear handle is designed so that any portion of the operator's hand is in line with the guide bar centerline, then a hand guard shall be provided.

Where a handle offset from the plane of the guide bar is used, guarding shall extend from the right side of the handle a distance sufficient to intersect the plane of the bar and chain, but need not extend more than 1.2 in (30 mm). This protection shall be provided as measured from the right outer surface of the handle and shall extend over that length defined by the projection of the trigger finger and hand (dimensions F & H), shown in figure 2, in a direction perpendicular to the surface of the handle top and down to the guarding.

5.9 Chip discharge

The chain saw shall be designed so that the main stream of wood chips and sawdust shall not be directed any higher than the centerline of the guide bar when tested in the horizontal bucking position.

5.10 Sound levels

The chain saw sound level shall not exceed 108 dB(A) at the chain saw operator's ear and 84 dB(A) at distance of 50 ft (15 m) from the chain saw location. The sound levels shall be measured in accordance with section 6. The instruction manual(s) shall provide instructions for the use of hearing protection. Powerheads shall be marked using either text or symbols indicating that operators should always use hearing protection.

5.11 Chain saw kickback

5.11.1 Scope

Permissible limits of computed kickback angle (see figure 6) for chain saws that are below 3.8 cubic inch displacement (c.i.d.) are established in 5.11.2. (The application of computed kickback angle limits to saws that are 3.8 c.i.d. and larger is under investigation.) In addition, in accordance with 5.11.2, all saws shall have devices to reduce the hazard of kickback. Performance requirements for replacement chain are also included in 5.11.2. There are no specific performance requirements for guide bars in the standard. However, some guidelines for selecting replacement bars are provided in 5.11.2.

In accordance with 5.11.3, kickback warning labels shall be placed on all chain saw powerheads, and warning labels shall be used on replacement saw chains.

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Accredited Standards Committee (ASC) B175 recognizes that there is a limited group of users whose extraordinary needs may not be satisfied by bar-and-chain combinations that comply with the 45° acceptance criteria of the standard. In such cases, it is appropriate that other bar-and-chain combinations be available at the user's request. The original equipment recommended for sale by the manufacturer, for a chain saw below 3.8 c.i.d., shall result in the chain saw meeting the performance requirements of the standard. Any user choosing different cutting attachments shall do so knowingly in the face of clear and strong warnings.

Other clauses dealing with kickback are 5.14, which requires instructions regarding kickback to be in the instruction manual(s), and section 8, which establishes the test equipment and procedures for determining the computed kickback angle.

5.11.2 Acceptance criteria

5.11.2.1 Chain saws below 3.8 c.i.d.

The following applies to chain saws below 3.8 c.i.d.:

a) When evaluated in accordance with section 8, either the chain saw shall not exceed a 45° computed kickback angle, or the moving chain shall be stopped before the chain saw exceeds a 45° computed kickback angle;

b) The chain saw shall have at least two separate features to reduce the risk of injury from kickback, such as a bar tip guard, a chain brake, a low- or reduced-kickback saw chain, a reduced-kickback guide bar, or other feature demonstrated to reduce significantly the risk of injury from kickback. This requirement is in addition to the requirement for a front hand guard contained in 5.8.4.

5.11.2.2 Chain saws 3.8 c.i.d. and above

The following applies to chain saws 3.8 c.i.d. and above:

a) Chain saws 3.8 c.i.d. and above may meet the acceptance criteria of 5.11.2.1;

b) Chain saws 3.8 c.i.d. and above that do not meet the acceptance criteria of 5.11.2.1 shall be equipped to reduce the risk of injury from kickback through the use of a feature such as a bar tip guard, a chain brake, a reduced-kickback guide bar, a low- or reduced-kickback saw chain, or other feature demonstrated to reduce significantly the risk of injury from kickback. This requirement is in addition to the requirement for a front hand guard contained in 5.8.4.

5.11.2.3 Replacement saw chain

The following applies to replacement saw chain:

a) Saw chain sold as replacement equipment for a specific chain saw model originally certified in accordance with the criteria of 5.11.2.1.(a) shall, when evaluated with that chain saw model, enable that chain saw model to meet the acceptance criteria of 5.11.2.1(a); or

b) It shall conform to the requirements for low-kickback saw chain in accordance with 5.11.2.4.

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5.11.2.4 Low-kickback saw chain

Chain may be designated "low-kickback" saw chain if, when evaluated using the chain saws listed in table 2, the computed kickback angle does not exceed 45° for any saw.

Table 2— Replacement saw chain test sample

Manufacturer	c.i.d.	Model	Bar Size (in.)	Bar Tooth	Pitch
Poulan	2.0	2000	14	7	3/8 MINI
	2.3	2300 AV	16	7	3/8 MINI
	3.4	3400	18	9	3/8
	2.3	Sears 71-35507	16	7 Top Sharp	3/8 MINI
	3.7	Sears 71-35610	18	9 Top Sharp	3/8
Echo	1.7	280E	12	7	3/8 MINI
	2.04	302S	16	7	3/8 MINI
Homelite	1.6	XL 10	10	H-Tip	3/8 MINI
	2.4	240	16	9	3/8 MINI
	3.3	330	16	11	3/8
	3.5	SXL	20	11	3/8
Husqvarna	2.7	44	18	12	325
	3.11	50	16	11	325
	3.75	61	24	11	3/8
McCulloch	2.0	MAC 130	14	9 Top Sharp	3/8 MINI
	2.1	PM 310	14	9	3/8 MINI
	3.7	PM 610	16	11	3/8 MINI
	3.5	PM 1010	20	11	3/8
	2.0	MAC 130	14	9 Top Sharp	3/8 MINI
	2.1	PM 310	16	9 Top Sharp	3/8 MINI
	2.3	Titan 35	16	9 Top Sharp	3/8 MINI
Stihl	2.3	009 EQ	14	9	3/8 MINI
	2.5	011 AVEQ	16	9	3/8 MINI
	2.6	024 AVEQ	16	11	325
	2.9	028 WB	16	11	325
	3.75	034 AVSEQ	20	10	3/8

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The chain saws listed in the table represent a baseline for qualification of replacement chain for chain saws under 3.8 c.i.d. New saw chain shall be tested on each model in the sample that will accommodate the chain. Modified versions of previously designated low-kickback saw chains shall be evaluated on the two models on which the low-kickback chain exhibited the highest computed kickback angle in previous tests.

NOTE —For those chain saws equipped with a chain brake, the computed kickback angle shall be determined with the chain brake operative and the moving chain shall stop before the chain saw exceeds a 45° kickback angle.

5.11.2.5 Replacement guide bars

Because of differences in replacement guide bars, the following guidelines shall be considered to determine kickback energy:

a) Sprocket nose guide bars with the same effective length, the same number of sprocket nose teeth, and the same pitch may be considered to have equivalent kickback energy;

b) A hard-nose guide bar having the same effective bar length, and the same or smaller nose radius as a sprocket-nose bar, may be considered to have equivalent or less kickback energy than the sprocket nose-bar. (See figure 7 for definition of bar nose radius.);

c) Kickback energy of all guide bar types may be considered to be less for smaller nose radius sizes.

5.11.3 Kickback labels

5.11.3.1 Labels — All chain saw powerheads

All chain saw powerheads shall be clearly and durably marked in a lasting manner with the following verbatim or suitably paraphrased statements (pictorial or graphic illustrations may be used in lieu of or in addition to written statements):

Contact of the guide bar tip with any object should be avoided.

Tip contact may cause the guide bar to move suddenly upward and backward, which may cause serious injury.

Both of the operator's hands must be used to operate the chain saw.

5.11.3.2 Labels — Chain saw powerheads below 3.8 c.i.d

Chain saw powerheads below 3.8 c.i.d. shall be clearly and durably marked in a lasting manner to identify at least one replacement bar-and-chain combination that has been evaluated with that chain saw powerhead and that will provide performance conforming to 5.11.2.1(a), and shall state that there may be other replacement components for achieving kickback protection.

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5.11.3.3 Labels — Chain saw powerheads 3.8 c.i.d. and above

a) Chain saw powerheads 3.8 c.i.d. and above that have been evaluated and found to meet the acceptance criteria of 5.11.2.1 may be labeled in accordance with 5.11.3.2.

b) Chain saw powerheads 3.8 c.i.d. and above that are not labeled in accordance with 5.11.3.2 shall be clearly and durably marked in a lasting manner with the following verbatim or suitably paraphrased warning:

WARNING: This chain saw is capable of severe kickback that could result in serious injury to the user. Do not operate this chain saw unless you have extraordinary cutting needs and experience and specialized training for dealing with kickback. Chain saws with significantly reduced kickback potential are available.

5.11.3.4 Labels — Replacement saw chain

All saw chain packaging shall be clearly labeled in accordance with (a), (b), or (c) below, as appropriate. The labels may be suitably paraphrased or combined, or both, as appropriate. The label or labels must be clearly visible without opening the package.

a) *Saw chain that is sold for specific chain saw models and meets the requirements of 5.11.2.3(a):*

This saw chain met the kickback performance requirements of ANSI B175.1 (current revision of standard) when tested with [list specific chain saw model(s) and guide bar combinations, or refer to manufacturer's literature]. It may not meet the ANSI B175.1-(current revision of standard) performance requirements when used on other chain saws or guide bars.

b) *Saw chain that meets the requirements of 5.11.2.4:*

This saw chain met the kickback performance requirements of ANSI B175.1-(current revision of standard) when tested on a representative sample of chain saws.

c) *Saw chain not meeting the requirements of 5.11.2.3 or 5.11.2.4:*

WARNING: This saw chain may be capable of severe kickback that could result in serious injury to the user. Do not use this saw chain unless you have experience and specialized training for dealing with kickback. Saw chain with reduced-kickback potential is available.

5.12 Balance

5.12.1 When tested in accordance with 5.12.2, the centerline of the guide bar shall not be at an angle greater than 15° above or 30° below the horizontal. For chain saws with an engine displacement of more than 5 in^3 (82 cm^3), the guide bar shall not contact the horizontal plane defined by the base of the chain saw when placed in the upright position.

5.12.2 The test procedure is as follows:

a) The chain saw fuel and chain oil tanks shall be filled to at least one-half their respective capacities.

b) The chain saw shall be fitted with the type of guide bar and chain recommended by the manufacturer. The length of the guide bar shall be in accordance with table 3.

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c) For chain saws with an engine displacement up to 5 in^3 (82 cm^3), the chain saw shall be suspended by the front handle gripping area with the crankshaft in the horizontal position.

d) For chain saws with an engine displacement more than 5 in^3 (82 cm^3), the chain saw may be supported on a horizontal plane.

Table 3- Balance

Engine displacement		Guide bar test length	
cubic in	cubic cm [1)]	in (± 2 in)	cm [1)] (± 5 cm)
Through 2.0	through 33	12	30
> 2.0 to 2.5	> 33 to 41	14	35
> 2.5 to 4.0	>41 to 66	16	40
>4.0 to 5.0	> 66 to 82	20	50
>5.0 to 6.0	>82 to 98	24	60
>6.0	>98	32	80
[1)] Metric conversions are not exact. The numbers are rounded and reflect commonly used metric bar lengths.			

5.13 Vibration

Vibration of all chain saw powerheads with manufacturer recommended saw chains, except those intended for the occasional user shall meet the following requirement. When tested in accordance with section 7, the front and rear handles shall be constructed so that the root mean square (rms) value of the weighted acceleration sum (WAS) from 3 orthogonal axes for each handle shall not exceed 12.5 m/sec/sec for engines less than 3.7 in^3 (60 cm^3) and 15 m/sec/sec for engines of 3.7 in^3 (60 cm^3) or more.

5.14 Safety instructions

5.14.1 Chain saw

All chain saw powerheads shall be clearly and durably marked with the following verbatim or suitably paraphrased statement:

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WARNING: Read and follow all safety precautions in the instruction manual(s). Failure to follow instructions could result in serious personal injury.

5.14.2 Instruction manual(s)

An Instruction manual(s) shall be provided with each chain saw or powerhead and shall include the following information:

a) The instruction manual(s) shall provide the safety precautions listed in annex C, verbatim or suitably paraphrased. These shall be of a form readily legible and with a letter size of not less than 5/64 in (2.0 mm);

b) The instruction manual(s) shall include an explanation of the kickback safety features that the chain saw incorporates as part of the original-equipment safety system or that are recommended by the manufacturer. This shall include discussion of chain saw features such as bar tip radius and type, bar length, bar tip guard, saw chain, chain brake, front hand guard, or other appropriate feature. The instruction manual(s) shall also provide sufficient information to enable the user to maintain the safety system throughout the life of the product and shall explain the consequences of improper maintenance, use of nonconforming replacement components, or the removal of safety devices. The user shall also be informed about the possible effects of normal use and maintenance on the kickback safety performance of the equipment;

c) The instruction manual(s) shall include instructions for starting and stopping the chain saw;

d) The instruction manual(s) shall provide instructions for properly installing and adjusting the guide bar and saw chain;

e) The instruction manual(s) shall explain the proper techniques for making the basic felling, limbing, and bucking cuts with the chain saw;

f) For chain saws that are labeled as meeting the kickback performance requirements of 5.11.2.1, the instruction manual(s) shall caution the user not to use replacement saw chain unless it has been designated as meeting the ANSI B175.1- (current revision of standard) kickback performance requirements on that specific powerhead, or has been designated as low-kickback saw chain in accordance with ANSI B175.1- (current revision of standard);

g) For chain saws that are labeled as meeting the kickback performance requirements of 5.11.2.1, the instruction manual(s) shall contain the following statement:

Low-kickback saw chain is chain that has met the kickback performance requirements of ANSI B175.1- (current revision of standard) (American National Standard for Power Tools—Gasoline-Powered Chain Saws—Safety Requirements) when tested on the representative sample of chain saws below 3.8 c.i.d. specified in ANSI B175.1- (current revision of standard).

h) For chain saws 3.8 c.i.d. and above that do not meet the kickback performance requirements of 5.11.2.1, the instruction manual(s) shall contain the warning set forth in 5.11.3.3(b);

i) The instruction manual(s) shall provide instructions for the use of hearing protection.

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j) A unit intended for occasional use shall be so identified in the instruction manual(s).

5.15 Marking and identification

The marking may be accomplished by silk screening, embossing, casting, molding, or affixing a pressure-sensitive label.

The marking used shall form a durable bond with the base material and shall show no appreciable loss of adhesion during weathering exposure. The marking shall be weather resistant and following normal cleaning procedures shall show no appreciable fading, discoloration, cracking, crazing, blistering, or dimensional change. The marking shall not be affected by spilled gasoline or oil.

6 Chain saw sound level test procedures

6.1 Scope

This test procedure establishes the instrumentation, test site, saw operation, and measurements for determining the sound level of chain saws.

6.2 Instrumentation

The following instrumentation shall be used:

— A precision sound level meter that meets the Type-I requirements of ANSI S1.4 and S1.4A;

— As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder, a graphic level recorder, or an indicating meter, provided the system meets the requirements of ANSI/SAE J184;

— A sound level calibrator (see 6.6.2.4).

The microphone shall be used with a foam windscreen. The windscreen shall not affect the overall reading by more than ± 0.5 dB(A) for the sound source that is being measured.

6.3 Test site

6.3.1 Measurement of noise in free field

The test area shall be a flat, open space with ground cover not exceeding 3 in (8 cm) in height and free of any large reflecting surfaces such as signboards or buildings for a minimum distance of 100 ft (30 m) from the chain saw and microphone.

The ambient sound level at the point of measurement (including wind effects) coming from sources other than the chain saw being tested shall be at least 10 dB lower than the sound level of the chain saw.

Measurements shall be made only when wind gusts are below 12 mi/hr (5.4 m/s).

6.3.2 Measurement of noise in sound room (alternate method)

An anechoic or semi-anechoic chamber may be used for conducting noise tests, provided that they don't vary more than ±1 dB(A) from the free field test results.

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The correction between the sound room measurement and free field noise measurement shall be applied to the result obtained from the sound room. Sound levels for distances exceeding the dimensions of the chamber may be calculated from measurements taken in the chamber provided that sufficient data is available to substantiate such calculations.

6.4 Chain saw operation

The chain saw shall be adjusted for best cutting performance in accordance with the chain saw manufacturer's recommendations.

The chain saw shall be operated in an upright position, as shown in figure 8 at a minimum distance of 24 in (610 mm) above ground. The chain saw tested shall be equipped with the shortest guide bar recommended by the manufacturer. The log diameter shall be approximately 75% of the guide bar effective length ± 1 in (± 25 mm).

All readings shall be taken with the chain saw at wide-open throttle and best cutting speed while cutting a test log. The best cutting speed shall be determined by a cutting speed test. The cutting speed shall not vary more than ± 5 percent during the sound level test cut.

The log, microphone, and chain saw shall be so oriented as to produce the maximum sound level at the microphone. The cut shall be made within 2 in (5 cm) of the end of the log.

6.5 Measurements

The sound level meter shall be set for slow response and the A-weighting network.

Measurements shall be taken with the microphone 50 ft (15 m) from the chain saw and 4 ft (1.2 m) above ground.

Measurements shall be taken at the operator's ear. The microphone shall be located in the plane of the guide bar 27.5 in (700 mm) from the centerline of the front handle and within 30° from the vertical toward the operator. The observer reading the meter shall be at least 8 ft (2.4 m) from the microphone.

The reported sound level shall be the average of three recorded sound levels that are within 2 dB of each other rounded to the nearest whole decibel.

6.6 General comments

6.6.1 Recommendations

It is recommended that technically trained personnel select the equipment and that the test be conducted only by persons trained in the current techniques of sound measurements and chain saw operation.

6.6.2 Precautions

Proper use of all test instrumentation is essential to obtain valid measurements. Operating manuals and other literature furnished by the instrument manufacturer should be referred to both for recommended operation of the instruments and for precautions to be observed. Specific items to be considered are described in 6.6.2.1 through 6.6.2.5.

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6.6.2.1 Instrumentation

The type of microphone and its orientation relative to the source of noise should be considered.

6.6.2.2 Weather

The effects of ambient weather conditions on the performance of all instruments (temperature, humidity, and barometric pressure) should be taken into consideration.

6.6.2.3 Equipment installation

Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems should be checked.

6.6.2.4 Calibration

Proper acoustical calibration procedures should be observed, including the influence of extension cables, etc. Field calibration shall be made immediately before and after each test sequence. Either an external calibrator or internal calibration means is acceptable for field use, provided that external calibration is accomplished immediately before and after field use. All test results shall be considered invalid should the recheck by external calibration not be within 0.5 dB of the initial calibration.

6.6.2.5 Other influences

Because bystanders may have an appreciable influence on meter response when they are in the vicinity of the chain saw or the microphone, not more than one person other than the observer reading the meter and the operator shall be within 50 ft (15 m) of the chain saw or microphone, and that person shall be directly behind the observer reading the meter, on a line through the microphone and the observer.

6.7 Test data to be recorded

The recorded test data should include the following:

— geographical location;

— date and time;

— names of chain saw operator, sound level meter reader, and observers;

— weather conditions, including ambient temperature, wind velocity, and barometric pressure;

— make, type, and serial number of sound level meter;

— make, model, and serial number of chain saw being tested;

— type of guide bar, saw chain, and sprocket being used;

— wood species and size;

— all meter readings taken;

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— engine speed (rpm);

— sketch or photograph of microphone, log, and chain saw orientation.

7 Vibration level test procedure

7.1 Scope

This test procedure establishes the instrumentation, test site, saw operation, and measurements for determining handle vibration levels.

7.2 Instrumentation

7.2.1 General

Trained personnel shall select the equipment and the tests shall be conducted only by qualified persons trained in the current techniques for vibration measurement and chain saw operation.

Since proper use of all test instrumentation is essential to obtain valid measurements, operating manuals and other literature furnished by the instrument manufacturer shall be consulted both for recommended operation of the instruments and for precautions to be observed. The specific items described in 7.2.1.1 through 7.2.1.3 shall be considered.

7.2.1.1 Calibration

All vibration-measuring equipment shall be calibrated properly. Field calibration shall be made immediately before and after each test sequence.

7.2.1.2 Frequency response

The instrumentation for the measurement shall have a uniform frequency response (±2 dB) in terms of acceleration over the whole frequency range of 8 to 1500 Hz. At the reference frequency, 31.5 Hz, the tolerance range shall be ±1 dB. The readings shall be taken using the "slow" response in accordance with IEC 651.

7.2.1.3 Handle covering

When a resilient handle covering lies between the hand and vibrating member, the readings of the solid handle system shall be recorded. Measurements may be made over the handle covering if it can be demonstrated that comparable readings may be obtained.

7.2.2 Hardware

The test instrumentation used shall meet the requirements described in 7.2.2.1 through 7.2.2.5.

7.2.2.1 Accelerometer

For each test location, the weight of the accelerometer(s) shall not exceed 25 g, including mounting hardware but excluding the cables. Each accelerometer shall meet the requirements outlined in ANSI S2.11. The cross-axis sensitivity shall be no more than 10 percent of the sensitivity in the axis to be measured. The mounting of the accelerometer(s) shall be such that the transfer function is flat up to 1500 Hz in the direction(s) to be measured.

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7.2.2.2 Amplifier

The amplifying device and amplitude or level indicator employed shall meet the requirements outlined in ANSI S2.11-1969 (R1986).

7.2.2.3 Measurement

As an alternative to making direct measurements, a magnetic tape recorder, a graphic level recorder, or indicating meter may be used. An alternate measurement technique can be to use a sampling network to record the continuous measurements as a discrete time series, with appropriate anti-alias filtering. Processing of measurements should be conducted using signal analysis provided that it meets the requirements outlined in ANSI/SAE J184.

7.2.2.4 Tachometer

A tachometer shall be used to measure the engine speed, in revolutions per minute, accurate to within ±3 percent of the reading.

7.2.2.5 Filter

A frequency filter used to weight the overall vibration level in each axis is defined in figure 9. Table 4 gives the attenuation factors for 1/3-octave-band center frequencies. For other frequency spectral techniques, filter weighting frequencies that comply with the guidelines in the table are acceptable.

7.2.3 Accelerometer location and mounting

The accelerometer(s) shall be rigidly mounted such that the center of gravity is less than 0.8 in (20 mm) from the outside of the handle bar contour and shall be located so as to permit a normal hand grip. The accelerometer(s) shall be located as close to the hand as practical. Care shall be taken that the size, shape, and mounting of the accelerometer(s) or the special accelerometer support do not significantly alter the operator's grip on the handles. The accelerometer(s) should not be in contact with the operator's hand during testing.

7.2.4 Vibration

The vibration level shall be measured in the appropriate directions of an orthogonal coordinate system, as shown in figure 10(a). Where this procedure cannot be followed, the positions of the accelerometer(s) relative to the hand coordinates shall be reported.

7.3 Chain saw operation

The chain saw and new saw chain shall be adjusted for best cutting performance in accordance with the manufacturer's recommendations.

The chain saw shall be operated in an upright position in accordance with figure 8 and equipped with the guide bar listed in table 3.

The chain saw shall be operated with a wide-open throttle, and the best cutting speed while making at least 5 cuts in a test log. The best cutting speed shall not vary more than ±250 rpm while recording data. The test log shall be squared timber of normal local usage, solid

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Table 4— Attenuation factors for 1/3 octave band center frequencies

Central Frequency 1/3 octave Hz	Linear gain	Gain dB
< 8	0	-
8	1	0
10	1	0
12.5	1	0
16	1	0
20	0.8	-2
25	0.63	-4
31.5	0.5	-6
40	0.4	-8
50	0.315	-10
63	0.25	-12
80	0.2	-14
100	0.156	-16
125	0.125	-18
160	0.1	-20
200	0.078	-22
250	0.0625	-24
315	0.05	-26
400	0.039	-28
500	0.03125	-30
630	0.025	-32
800	0.02	-34
1000	0.0156	-36
>1000	0	-

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or laminated vertically. Slices shall be cut perpendicular to the longitudinal axis of the timber. The width of the cut shall be 75% of the guide bar effective length ±1 in (±25 mm). No part of the powerhead shall contact the test log during the test.

The chain saw shall be tested with the fuel and oil tanks containing between 1/4 and 3/4 of maximum capacity.

A relaxed grip on the handles sufficient to maintain proper control shall be employed, consistent with day-long use of the chain saw.

7.4 Measurements

7.4.1 Measured quantity

The acceleration in the three orthogonal directions according to figure 10(a) shall be measured by accelerometers and processed to form an overall vibration value, the weighted acceleration sum (WAS) according to figure 10(b). Mathematically, the WAS is the sum of the root mean square (rms) of the weighted signals from each axis.

The WAS can be calculated from a frequency spectra of 1/3 octave or 1/1 octave with the weighting factors for the mid-frequencies calculated as described in ISO 5349. Alternatively, WAS can be calculated from higher-resolution FFT Spectra whose weighting complies with ISO 5349.

The three different acceleration directions may be measured at different times.

7.4.2 Results

The results reported shall be the arithmetic average obtained from a minimum of 5 cuts.

7.5 Test data to be recorded

The following test data shall be recorded:

— geographical location;

— date and time;

— names of chain saw operator, technicians, meter readers, and observers;

— make, model, and serial number of the chain saw being tested;

— wood species and size;

— all vibration levels;

— all meter readings taken;

— engine speeds (rpm) at which readings were taken;

— sketch or photograph of the location and attachment means of the accelerometers;

— pitch size, type, and gauge of saw chain;

— guide bar type and length;

— drive sprocket type and size;

— test equipment.

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8 Kickback test procedure

8.1 Scope

For chain saws required to meet acceptance criteria based on the computed kickback angle, measure the energy using the kickback test machine and measure the saw characteristics. Compute the kickback angle utilizing the analytical model.

8.2 Equipment

The following equipment and materials shall be used to determine the computed kickback angle:

a) Computer kickback program (see section 9) to compute the kickback angle using measured inputs;

b) The chain saw kickback machine for energy level measurements[4)];

c) Instrumentation

1) Tachometer with an accuracy of ±1.5 per cent of the measured value;

2) Carriage velocity timing device, including probes with an accuracy of ±1 ms;

3) Timer control switch box;

4) Chain brake timing device, including probes having an accuracy of ±3 ms;

d) Test samples 1.5 in. x 1.5 in[5)] x 10 in (38 mm x 38 mm x 250 mm) consisting of medium-density fiberboard (MDF) with density of 46 lb/ft^3 ± 2 lb/ft^3 (740 kg/m^3 ± 32 kg/m^3). The sample shall be oriented with rough side (end grain) facing bar tip.

e) Chain brake actuating apparatus.

8.3 Physical measurements

8.3.1 Scope

This subsection specifies the chain saw physical measurements that shall be made in order to position the saw correctly in the kickback machine and to compute the kickback angle.

8.3.2 Measurements

The following measurements are to be made with the bar and chain attached in proper working position and with oil and fuel tanks full. The saw chain shall be prepared in accordance with 8.4.3 prior to taking measurements

a) Chain saw weight (lb). An accuracy of ±0.1 lb is acceptable for this measurement;

[4)] The bill of materials and engineering drawings describing the kickback test machine are available from the Portable Power Equipment Manufacturers Association, 4340 East West Highway, Suite 912, Bethesda, MD 20814

[5)] Or 3 inches when necessary to prevent splitting.

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b) Location of the center of gravity (to be marked on the saw body). Representative methods for making this measurement are given in annex D. An accuracy of ± 0.25 in is acceptable for this measurement;

c) Chain-saw moment of inertia about an axis through the center of gravity and perpendicular to the plane of the guide bar (in-lbf-sec^2). Representative methods for making this measurement are given in annex D;

d) Chain saw bar tip location relative to the center of gravity, expressed as x, y coordinates (in). An accuracy of ±0.12 in is acceptable for this measurement. See figure 11;

e) Chain saw front-handle location relative to the center of gravity, expressed as x, y coordinates (in). An accuracy of ±0.12 in is acceptable for this measurement. See figure 11;

f) Chain saw rear-handle location relative to the center of gravity, expressed as x, y coordinates (in). An accuracy of ±0.12 in is acceptable for this measurement. See figure 11.

8.3.3 Measurement of chain saw coordinates

The bar tip and handle coordinates shall be measured as follows (see figure 11):

a) Position the chain saw on a level surface so that the centerline of the guide bar is level. Locate guide bar tip, point *B*, at the intersection of a horizontal line through the nose radius and the outermost element of the saw chain.

NOTE — For nonsymmetrical bars, this point will not lie on the centerline of the guide bar. The saw chain should be rotated to the greatest horizontal displacement.

Measure and record *BTX*, the horizontal displacement (in inches) from the center of gravity to point *B*. Measure and record *BTY*, the vertical displacement;

b) Locate the front handle, point *F*, at the center of the front handle in the midpoint of the hand-grip segment. Measure and record *FHX*, the horizontal displacement, and *FHY*, the vertical displacement;

c) Locate the rear handle, point *R*, by determining the intersection of a 1-in radius arc and the lower portion of the rear handle. The arc originates at the lowest point the chain saw throttle control trigger intersects the saw casing. Measure and record *RHX*, the horizontal displacement, and *RHY*, the vertical displacement.

8.4 Chain saw preparation

8.4.1 Scope

This subsection establishes the method to be used to prepare the chain saw and saw chain for the kickback energy test.

8.4.2 Saw preparation

a) The chain saw shall be in functionally new condition;

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b) The saw shall be run-in according to the manufacturer's recommendation.

8.4.3 Saw chain preparation

a) The saw chain shall be new and shall be prepared for the test by cutting clean or debarked wood for approximately five minutes;

b) Saw chain tension shall be set to provide a maximum clearance between the chain and the bar of 0.017 in per in (0.4 mm per mm) of rated bar-cutting capacity. This clearance is measured with a 2-lb (0.9-kg) weight suspended from the chain at the midpoint of the guide-bar length. The chain shall be positioned to achieve the tightest condition for this measurement. See figure 12. The chain should move freely on the bar.

8.5 Kickback test — Chain saw operation

8.5.1 Scope

This subsection establishes the procedure for operation of the chain saw, measuring and recording of data, and the computation of kickback energy .

8.5.2 Preparation

The chain saw shall be installed and balanced in the kickback machine and frictional levels measured to ensure that standard conditions are met.

8.5.2.1 If the saw weighs less than the standard carriage, the standard carriage may be replaced with the lightweight carriage.

8.5.2.2 If necessary, add weight to the carriage until the carriage weight (including Medium Density Fiberboard (MDF)) is equal to the weight of the saw (±0.25 lbf).

8.5.2.3 If the saw is equipped with a removable bar tip guard, remove the bar tip guard for testing.

8.5.2.4 If the saw is equipped with a chain brake, disable the mechanism if necessary to prevent brake activation.

8.5.2.5 Chain saw and bracket assembly shall be installed as follows:

a) Remove the front handle grip cover in the area where the saw handle clamp will be attached and construct a clamp insert to fit the saw handle. Attach the saw handle clamp so that it is level and as nearly parallel to the guide bar as possible;

b) Install the saw and cradle assembly in the kickback machine in accordance with figure 13 and align the guide bar with the centerline of the MDF specimen;

c) Adjust the chain saw, clamp, and cradle so that the saw center of gravity is aligned to within ± 0.12 in with the rotary axis. Make this adjustment by rotating the clamp where it attaches to the cradle and by sliding the cradle in the support blocks;

NOTE — Do not rotate the clamp where it attaches to the saw handle. This was adjusted in (a), above.

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d) Attach the brace (EX 4444-D) [4] to either leg of the cradle as near as possible to the rotary axis. The brace attachment may be located on either side of the rotary axis. A second brace may be installed as needed to restrict side motion.

8.5.2.6 The chain saw shall be balanced as follows:

a) Fuel tanks and oil tanks shall be filled;

NOTE — External fuel and oil supplies to maintain full tanks are acceptable.

b) The system shall be balanced using the minimum amount of mass located as close to the rotary axis as possible;

c) Acceptable initial balance is achieved when the cradle will not rotate at the "horizontal" or "vertical" position or when a 0.13-lb (60-g) weight hung from the rotary pulley will counter any observed rotation. If the center of gravity of the saw shifts due to soft isolators, a compromise between the horizontal and vertical positions is permissible.

8.5.2.7 Horizontal friction shall be measured prior to and after kickback energy tests using procedures in annex F or equivalent. The average of the horizontal friction measurement in the direction of travel away from the powerhead shall not exceed 0.5 lb (0.23 kg).

8.5.2.8 Rotary friction shall be measured prior to and after kickback energy tests using procedures in annex G or equivalent. The average of the rotary friction measurement shall not exceed 0.5 lb (0.23 kg).

8.5.2.9 The MDF angle shall be set to 30°. Move the carriage so that the MDF contacts the saw chain. Adjust the position of the rack/horizontal restraining assembly so that the cable from the carriage to the pulley is vertical. See figure 14.

8.5.2.10 With the guide-bar centerline in horizontal position, adjust the location of the cable attachment pin and adjust the mechanism to bring the 2-lb (0.9-kg) weight to the zero position. See figure 15.

8.5.2.11 Adjust the carriage release point to achieve impact velocity of 30 in/s ± 0.5 in/s. See annex H for more information.

8.5.2.12 Adjust the MDF angle to the initial conditions specified in 8.6.2.

8.5.2.13 At the start of the test and after every twelve impacts, the centrifugal clutch shall be burned as follows:

a) Clamp the saw chain to the guide bar and run the saw 5 seconds with full throttle. Measure and record the slip speed (rpm);

b) If the slip speed varies more than 500 rpm during the test, replace the clutch.

8.5.2.14 Saw chain tension shall be set initially and adjusted during the test in accordance with 8.4.3(b).

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8.5.3 Procedure

a) With the barrier bar in position, start the chain saw. Adjust the engine speed and MDF angle to the required test conditions;

b) Raise the barrier bar and stand clear of the kickback machine;

c) Release the carriage, observing the engine speed at impact;

d) Turn off the chain saw.

8.5.4 Measurements

a) Record the lift in inches (centimeters) of vertical displacement of the horizontal restraining weight and the inches (centimeters) of horizontal displacement of the carriage;

b) Record the lifts in inches (centimeters) of displacement of the upper and the lower rotary restraining weights.

NOTE — The horizontal and rotary restraining systems may have alternate calibrations to permit direct readings.

8.5.5 Additional testing requirements

a) The MDF sample shall be clamped in the carriage with the rough side (end grain) facing the bar tip;

b) The chain saw shall be inspected for unusual conditions and reset for next impact conditions. Do not operate a damaged chain saw;

c) On occasion, balance of unit may change. Check and reset balance if imbalance exceeds 0.25 lbf. (See annex E.) If imbalance of more than 0.25 lbf occurs, previous impact data is invalid;

d) The MDF sample should be examined and exchanged. The orientation of the sample shall be adjusted to preclude vertical runout. Sample splitting may be overcome by addition of a C-clamp. If a C-clamp is used to prevent splitting, the carriage weight shall be compensated;

e) Make only two impacts per specimen (one on each face). All saw penetrations shall start within the middle inch on the face of the specimen. If any penetration track runs off the specimen, do not use the energy readings in the computations. Repeat the test on another specimen;

f) Horizontal and rotary friction levels are to be measured upon the completion of the test using methods specified in annexes F and G, or equivalent methods. The greater measured level is to be used for energy computations. If friction at the end of the test program exceeds specifications, the test shall be repeated.

8.5.6 Kickback energy computation

a) Compute the horizontal energy for each impact as follows:

Horizontal energy = $(W)\ (D_w) + (f_h)\ (D_c)$

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where

W is the horizontal restraining weight (lbf);

f_h is the horizontal axis friction (lbf). See annex F;

D_w is the displacement of horizontal restraining weight (inches);

D_c is the displacement of carriage (inches).

b) Compute the rotary energy for each impact, as follows:

Rotary Energy = $(W_u + F_r)(D_u) + (W_l)(D_l)$

where

W_u is the upper weight (lbf);

W_l is the lower weight (lbf);

D_u is the displacement of upper weight (inches);

D_l is the displacement of lower weight (inches);

f_r is the rotary friction force (lbf).

NOTE — For the horizontal system, see annex F. For the rotary system, see annex G.

8.6 Kickback test program

8.6.1 Scope

This subsection establishes the test conditions at which impacts are to be performed and the method of analyzing the data to determine kickback energy.

8.6.2 Kickback energy determination

Using the test procedures specified in 8.5, perform impacts at the test conditions specified in tables 5 or 6 and determine kickback energy in accordance with 8.6.3. For saws that cannot be tested as slow as 9000 rpm, the saw may be tested at 9500 or 10000 rpm, whichever is the saw's lowest stable operating speed.

8.6.3 Data analysis

8.6.3.1 Measurements and calculations

Kickback shall be measured as follows:

a) For each set of conditions in the test sequence, perform three impacts and measure the rotary and horizontal energy for each impact;

b) Compute the average of the three rotary energy measurements and the average of the three horizontal energy measurements;

c) If the rotary energy measurements are each within 10 percent of the average rotary value, use the average of the three measurements;

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d) If any of the rotary energy measurements are not within 10 percent of the average, perform three additional impacts and use the average of all six rotary energy measurements. Similarly, use the average of the six horizontal energy measurements.

8.6.3.2 Termination of test sequence

Either test sequence may be discontinued if, at each rpm:

a) there is a 50 percent reduction in average rotary energy between measurements at two consecutive contact angles; or

b) there is a decrease in average rotary energy for two consecutive contact angles.

8.7 Chain brake test procedure

8.7.1 Scope

This subsection establishes the test procedure for saws equipped with a chain brake and where the calculated kickback angle exceeds 45° without the chain brake.

If a chain saw is equipped with a chain brake, it will be necessary to determine (a) the rotary kickback energy with the chain brake actuated, (b) the actuation angle, and (c) the chain stopping time as specified in this section.

8.7.2 Chain brake energy measurement procedure

NOTE — At the discretion of the manufacturer, 8.7.2(a) through 8.7.2(c) may be omitted.

a) At the conclusion of the test sequence specified in 8.6, remove means used to prevent the chain brake from actuating and perform three additional impacts at peak rotary energy conditions. If the rotary energy values are not within 10 percent of the average, perform three additional impacts and compute the average of all six impacts;

b) Record the energy measurements and note if the chain brake actuates each time;

c) If the chain brake actuates each time, *R4*, the energy value that is input into the computer model as rotary energy with chain brake actuated, equals the average of the rotary energy values. If a brake is designed to activate by means other than manual force, an additional mass (not exceeding 200 grams) may be added to the center of the front hand guard. Balance of the saw should be rechecked and adjusted if necessary. If the chain brake does not actuate each time, proceed to 8.7.2(d);

d) Mount the chain brake actuator on the left side of the mainframe column of the kickback machine;

e) Set the spring-loaded lever so that the lever and the hand guard impact at or immediately past the point the saw exits the test specimen. Refer to 8.7.3(a);

f) Set the spring-loaded lever of the chain brake actuator in set position so that its centerline intersects the saw center of gravity as shown in figure 16;

g) Adjust the position of the spring-loaded lever so that the contact point of the chain brake lever (hand guard) in the set position on the spring-loaded lever is 3.54 in (90 mm) from the pivot point of the spring-loaded lever. See figure 16;

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Table 5— Test sequence

Data set no.	Contact Angle degrees	Impact Velocity		Saw speed (±200 rpm) rpm
		in/s	m/s	
1A	0	30	0.76	11,000 (maximum or highest attainable)
1B	0	30	0.76	9,000
2A	5	30	0.76	11,000
2B	5	30	0.76	9,000
3A	10	30	0.76	11,000
3B	10	30	0.76	9,000
4A	15	30	0.76	11,000
4B	15	30	0.76	9,000
5A	20	30	0.76	11,000
5B	20	30	0.76	9,000
6A	25	30	0.76	11,000
6B	25	30	0.76	9,000
7A	30	30	0.76	11,000
7B	30	30	0.76	9,000

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Table 6 — Optional test sequence

Data set no.	Contact Angle Degrees	Impact velocity		Saw speed (± 200 rpm) rpm
		in/s	m/s	
1A	0	30	0.76	11 000 (maximum or highest attainable)
2A	5	30	0.76	11 000
3A	10	30	0.76	11 000
4A	15	30	0.76	11 000
5A	20	30	0.76	11 000
6A	25	30	0.76	11 000
7A	30	30	0.76	11 000
1B	0	30	0.76	9 000 (or maximum minus 2000 rpm)
2B	5	30	0.76	9 000
3B	10	30	0.76	9 000
4B	15	30	0.76	9 000
5B	20	30	0.76	9 000
6B	25	30	0.76	9 000
7B	30	30	0.76	9 000

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h) Recheck steps 8.7.2(e), 8.7.2(f), and 8.7.2(g). Readjust if necessary;

i) Measure and record the chain brake release force (lbf) with the engine not running. The brake release force shall be measured with a spring scale accurate to 0.25 lbf. The force shall be applied at a uniform rate at the center of the top part of the brake lever. The force shall be measured in a direction that is normal to the centerline of the spring-loaded lever when the saw is in the contact position shown in figure 16 and the spring-loaded lever is set as shown in figure 16;

j) Adjust the release force of the spring-loaded lever to the chain brake release force plus 2.2 lbf. Measure the release force of the spring-loaded lever by placing a spring scale at the point 3.54 in from the pivot point of the spring-loaded lever and pulling normal to the centerline of the lever. Record this information on the data sheet shown in annex J;

k) Position the chain saw so that the guide bar is horizontal, and set the contact angle and engine speed at the settings determined to give the highest average rotary energy in the test program detailed in 8.6.

All tests performed under 8.7.2(l) and 8.7.2(m) shall be conducted at the contact angle and engine speed determined to give the highest average rotary energy;

l) Conduct the chain brake actuation test to determine kickback machine *rotary energy* with operating chain brake actuator and operating chain brake. Using the procedures detailed in 8.5, conduct the kickback test with the actuator and the chain brake operating, and record data. Reset the actuator and repeat for a total of three impacts. If the rotary energy values are not within 10 percent of average, perform three additional impacts and use the average of the six values. If the chain brake activates on each impact, *R3* equals the average of the rotary values. If the brake does not activate on each impact, compute the kickback angle using values calculated in accordance with 8.6;

NOTE — If the brake activates but does not trip the lever, record that the lever did not trip and continue calculations and test as though the lever did trip.

m) Conduct the kickback test to determine *R2*, rotary energy with operating chain brake actuator but with chain brake not actuated.

By a suitable means, such as taping or wiring the chain brake handle to the saw handle, disable the chain brake so that it will not actuate on impact. Using the procedures detailed in 7.5, conduct the kickback test with the chain brake actuator operating and the chain brake disabled, and record data.

Reset the actuator and repeat for a total of three impacts. If the rotary energy values are not within 10 percent of the average, perform three additional impacts and use the average of the six values. *R2* equals the average of the rotary energy values;

n) *R1* is the peak rotary energy determined in accordance with 8.6, that is, the average of the rotary energy values at the conditions that produced the highest average rotary energy during the test sequence. The test program of 8.6 is conducted without the actuator and with the chain brake disabled.

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Calculate the energy absorbed by the chain brake actuator, *EA*, in accordance with 8.7.5:

$EA = R1 - R2$.

Calculate the rotary energy with the chain brake actuated, *R4*. This is the energy value that is input to the computer model:

$R4 = R3 + EA$.

8.7.3 Chain brake actuation angle procedure

a) Measure the angles where the bar tip exits the MDF specimen under peak rotary conditions as determined in 8.6, and compute the average. This is the MDF exit angle. See figure 17;

b) If the rotary energy, *R4*, was determined in accordance with 8.7.2(c), then the actuation angle is one-half of the MDF exit angle. Record this as the chain brake actuation angle (*A2*) on the data sheet, figure J.1, and in the computer program;

c) If the rotary energy, *R4*, was determined in accordance with 8.7.2(n), the chain brake actuation angle is equal to the MDF exit angle. Record this as chain brake actuation angle (*A2*) on the data sheet, figure J.1, and in the computer program.

8.7.4 Chain brake stopping time measurement procedure

8.7.4.1 Scope

The chain brake stopping time test shall be conducted at the rpm setting of the peak rotary energy condition determined in 8.6. Use the pendulum test technique specified in 5.8.5.2. This test may be conducted subsequent to the procedure specified in 5.8.5.

8.7.4.2 Test conditions

a) Chain saws shall be adjusted for best cutting performance in accordance with the chain saw manufacturer's recommendations;

b) Chain saws shall be solidly mounted during the test;

c) No adjustment of brakes shall be permitted during the test;

d) Initially, brakes shall be in a dry and unlubricated condition.

8.7.4.3 Taking measurements

The chain brake shall be activated ten times without recording data. Then actuate the brake three times and record the average stopping time. Refer to 5.8.5 for test apparatus details and test technique.

8.7.5 Chain brake energy calculations

ΔE = energy absorbed by chain brake

Calculations:

$EA = R1 - R2$

$R4 = R3 + EA$

$\Delta E = R1 - R4 = R2 - R3$

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where

R1 is the peak rotary energy measured without the chain brake actuator: average of the rotary energy values determined in accordance with 8.6 at the condition that produced the highest rotary energy;

R2 is the rotary energy measured with operating chain brake actuator, but with the chain brake not actuated: average of values;

R3 is the rotary energy measured with operating chain brake and with operating chain brake actuator: average of values.

Calculated Values:

R4 is the rotary energy with chain brake actuated only;

EA is the energy absorbed by chain brake actuator.

8.8 Computed kickback angle computation

8.8.1 Scope

This subsection establishes the computations for determining the computed kickback angle of the chain saw.

8.8.2 Computed kickback angle

The computed kickback angle is an angle, defined as shown in figure 6, used as a measure of the reaction of a hand-held chain saw when subjected under simulated conditions to a rotational kickback impulse.

8.8.3 Values

Values for the following measurements shall be used as input for the computer program .

a) Chain saw weight (lb) in accordance with 8.3;

b) Chain saw moment of inertia (in-lb-sec^2) in accordance with 8.3;

c) Bar tip and handle locations (in) in accordance with 8.3;

d) Energy levels established at the peak rotary conditions in accordance with 8.6

   1) Horizontal energy (in-lb);

   2) Rotary energy (in-lb).

NOTE — For saws without chain brakes, if the average rotary energies measured at other sets of conditions are within 10 percent of the peak rotary value, calculate the computed kickback angle for each set of conditions and use the highest computed kickback angle.

e) Chain brake data in accordance with 8.7

   1) Rotary energy (in-lb), *R4*;

   2) Actuation angle (degrees);

   3) Saw chain stopping time (seconds).

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8.8.4 Computation

The computed kickback angle shall be determined in accordance with the mathematical model in the flowchart and the computer program in section 9.

9 Mathematical simulation of kickback

9.1 Introduction

The computed kickback angle is determined through a mathematical simulation of the motion of the chain saw during kickback. This simulation is contained in a computer program.[6)]

The computer program contains equations that represent the reaction forces exerted by the operator on the saw during kickback. These equations are based on analysis of high-speed films of simulated kickback tests. A summary of the steps that went into the formulation of these equations is provided in "Overview of the KICKBACK Computer Program—Contents and Development." [7)]

The computer program uses standard engineering force-motion equations to predict the path of the saw based on the kickback energy and saw characteristics input data from 8.8.3 and the simulated operator reaction forces. The computed kickback angle as illustrated in figure 6 is calculated from this predicted path.

The following documents contain background information used in the development of the standard.

- "Overview of the KICKBACK Computer Program — Contents and Development."
- Excerpt from Draft Proposed Kickback Standard, Section III, "Explanation of the Proposed Standard," December 1981.
- "CSMA High Speed Film Test on Hand Held Kickback," CSMA, October 1981.
- Santelli, Lynda, "Sensitivity Study of the CSMA KICKBACK Computer Program (01/25/82 Version)," Consumer Product Safety Commission, June 1982.
- Santelli, Lynda, "Study of the Simulation Time Increment Used in the Kickback Computer Program (10/27/82 Version)," Consumer Product Safety Commission, January, 1983.

[6)] Copies of the Kickback Computer Program are available on CD-ROM for purchase from the Portable Power Equipment Manufacturers Association. For information on obtaining a copy of the program, contact PPEMA at 301-652-0774.

[7)] Available from PPEMA.

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- "Medium Density Fiberboard suppliers for kickback testing" , a study of alternative sources for kickback test material, October 29, 1999 [7]

9.2 Energy terminology

The kickback energy is measured on the kickback machine in two parts, "horizontal" and "rotary" (see 8.5.6). The energy determined from the kickback machine measurements is divided within the "KICKBACK" computer program into horizontal, vertical, and rotational parts.

The "horizontal" energy within the computer program is the same as the "horizontal" energy determined from the kickback machine measurements, 8.5.6(a), also referred to as kickback machine "linear" energy in 9.3. The kickback machine "rotary" energy, 8.5.6(b), is divided into "vertical" energy and "rotational" energy within the computer program. Thus, the term "rotary" energy is used to refer to the energy determined from the kickback machine rotary system measurements. The term "rotational" energy is used to refer to that portion of the kickback machine rotary energy that is determined to be rotational (as opposed to vertical or horizontal) within the computer program.

Thus:

"Horizontal Energy" (Computer Program) = "Horizontal Energy" (Kickback Machine)

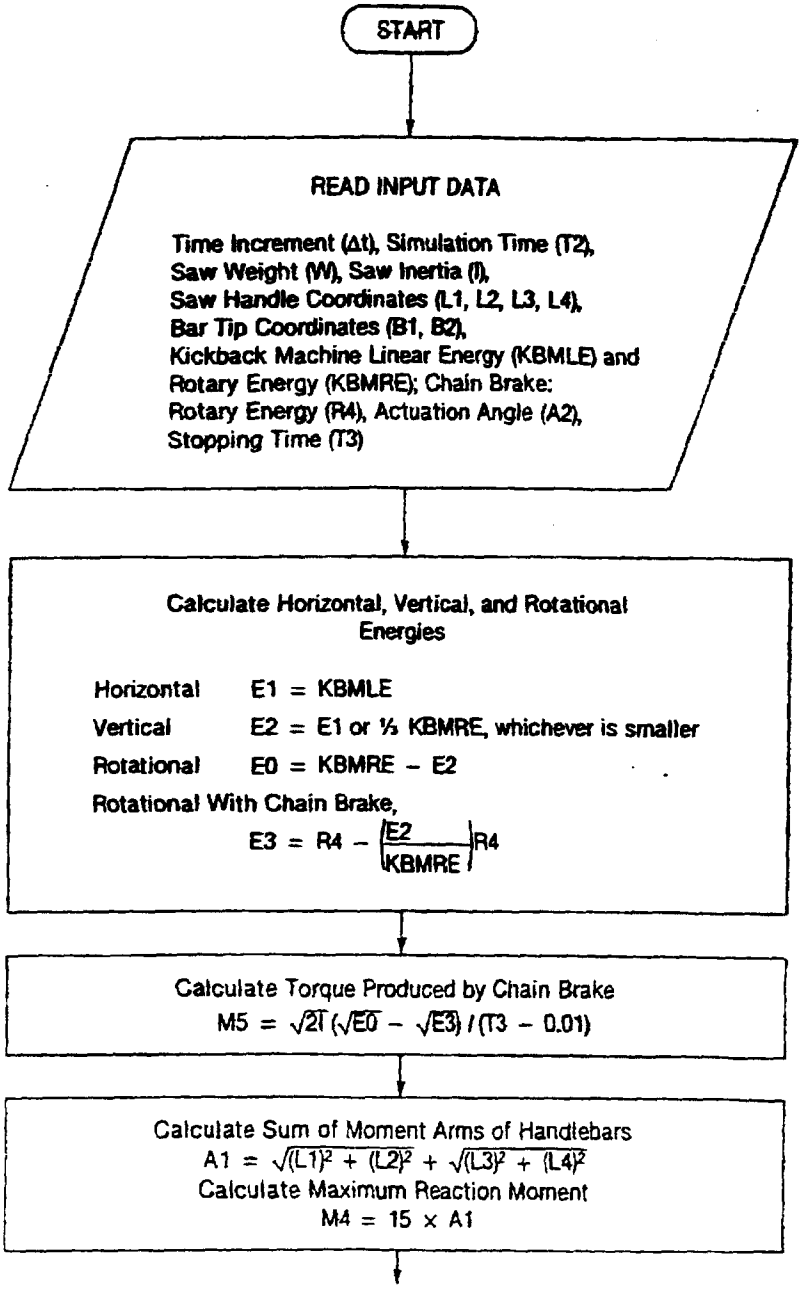
and:

"Vertical Energy" (Computer Program) + "Rotational Energy" (Computer Program) = "Rotary Energy" (Kickback Machine)

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9.3 Computer program flowchart

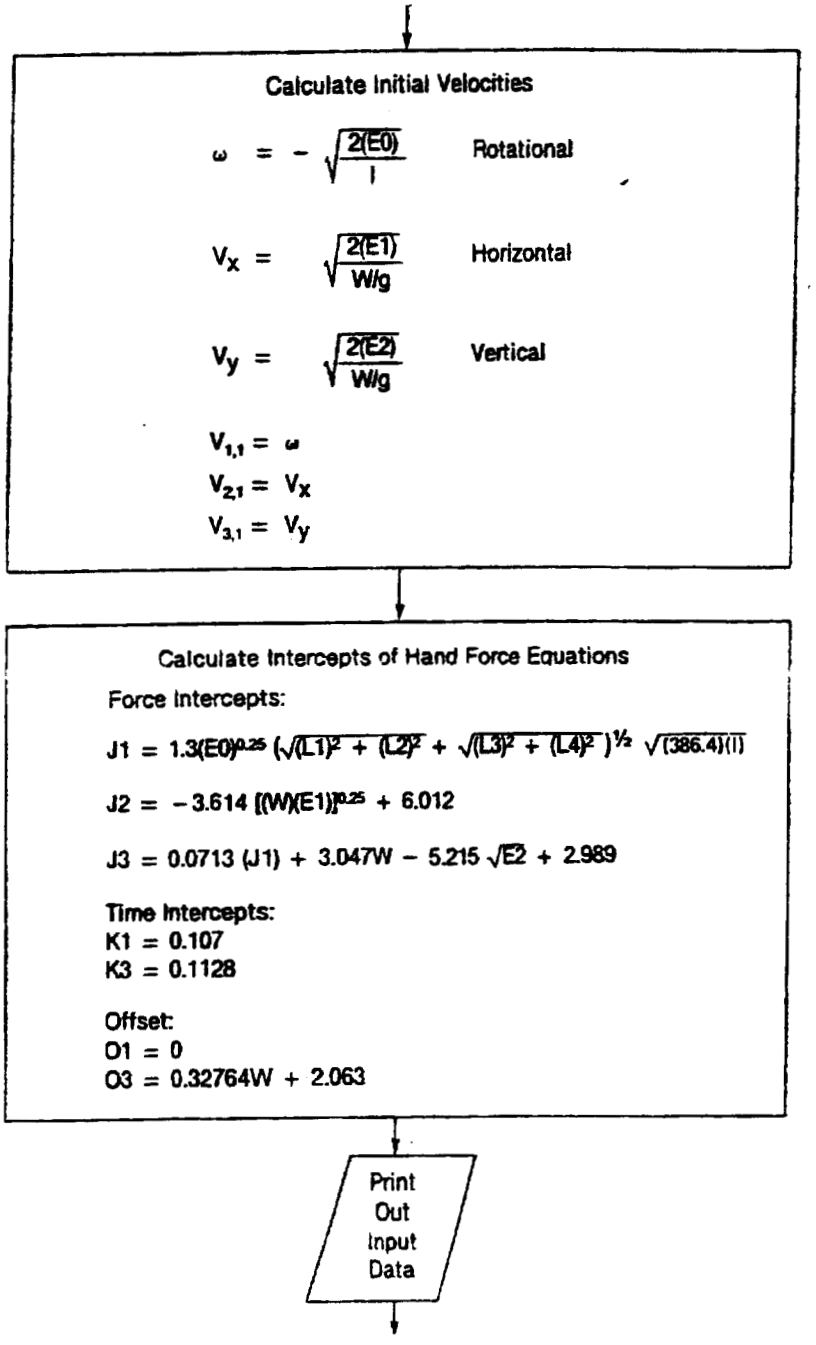
NOTE: This chart illustrates the flow for only the analysis portion of the program. (It does not include that portion associated with the report formats.)



See 9.3
A

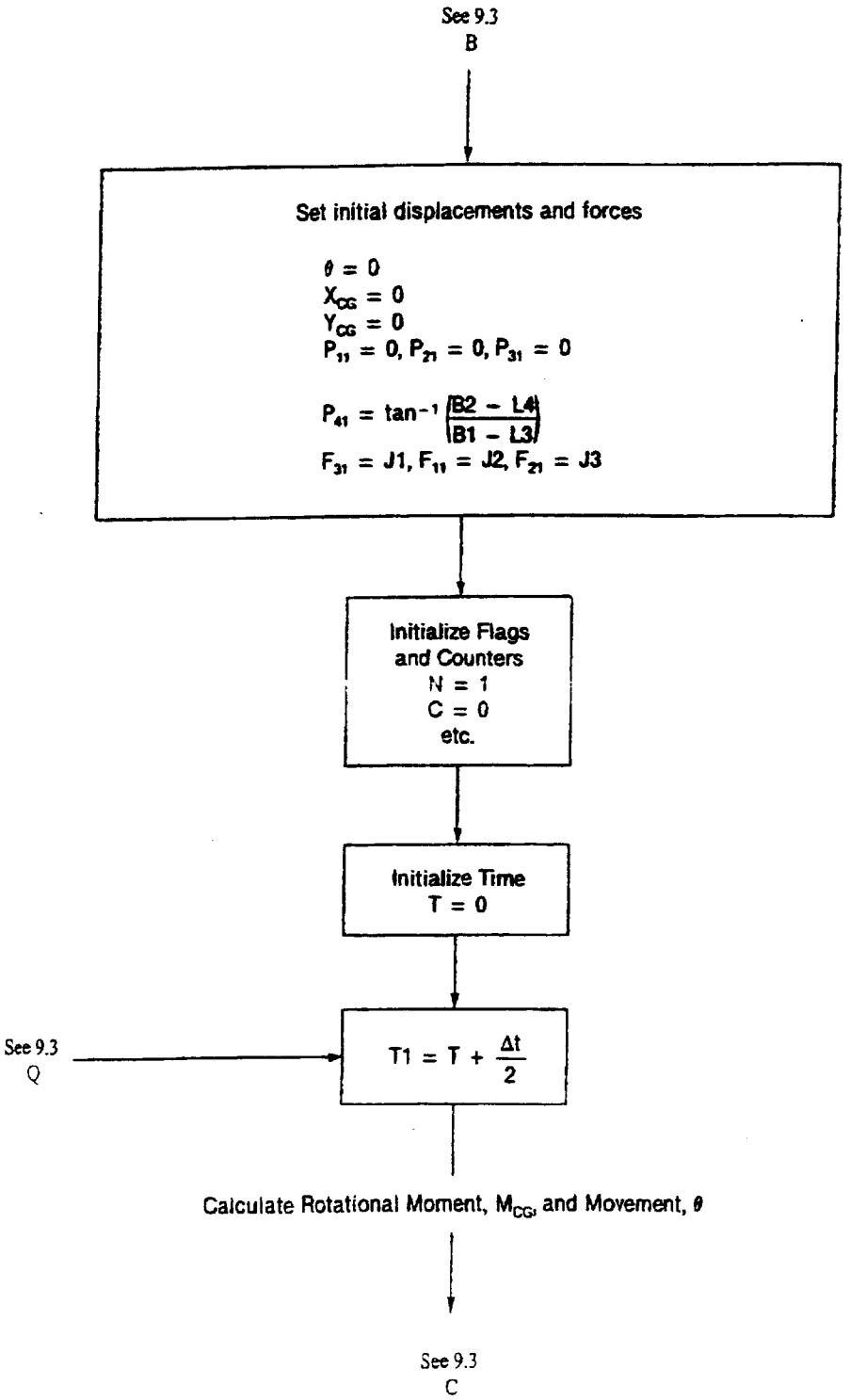
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See 9.3
A

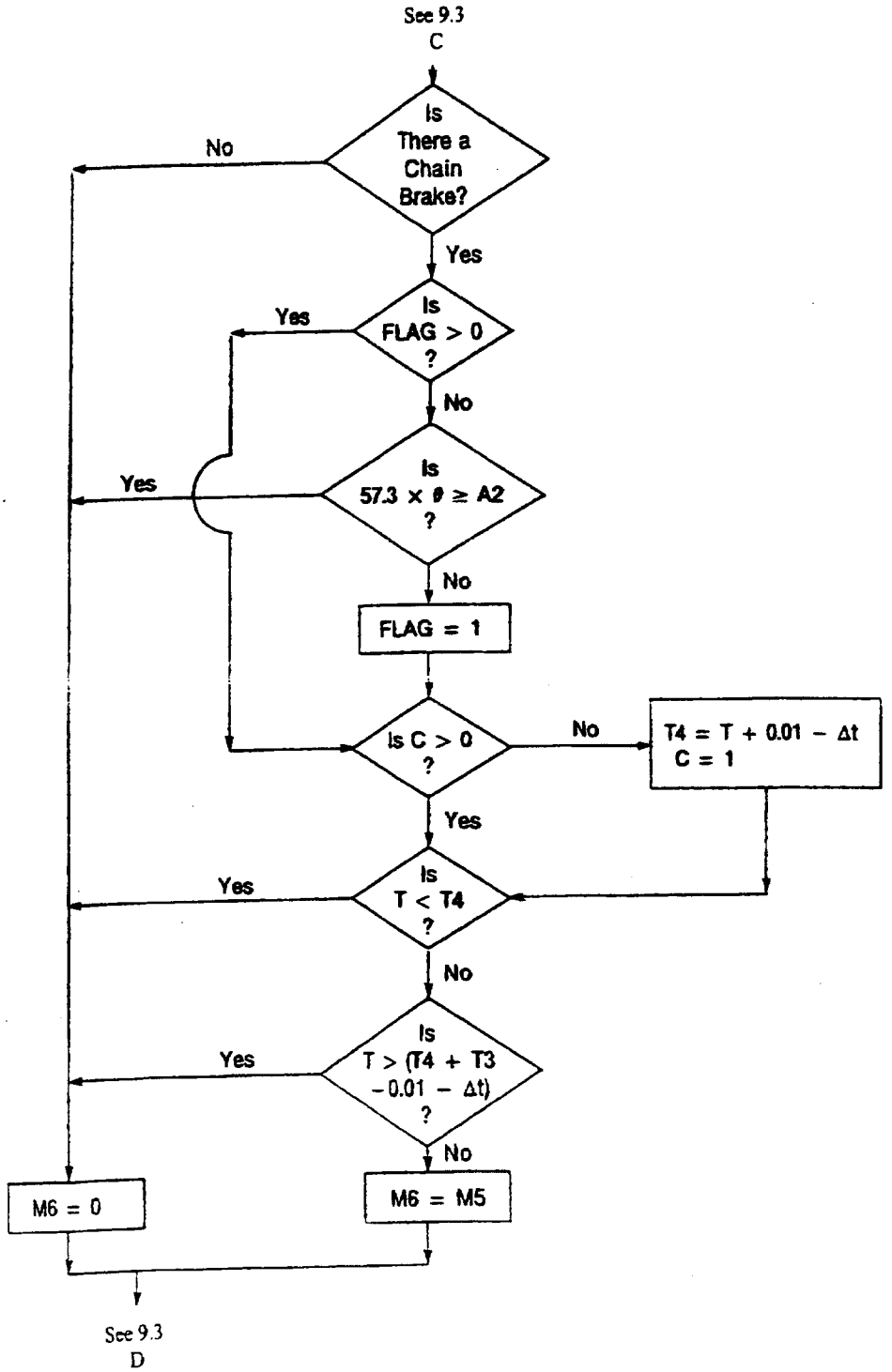


See 9.3
B

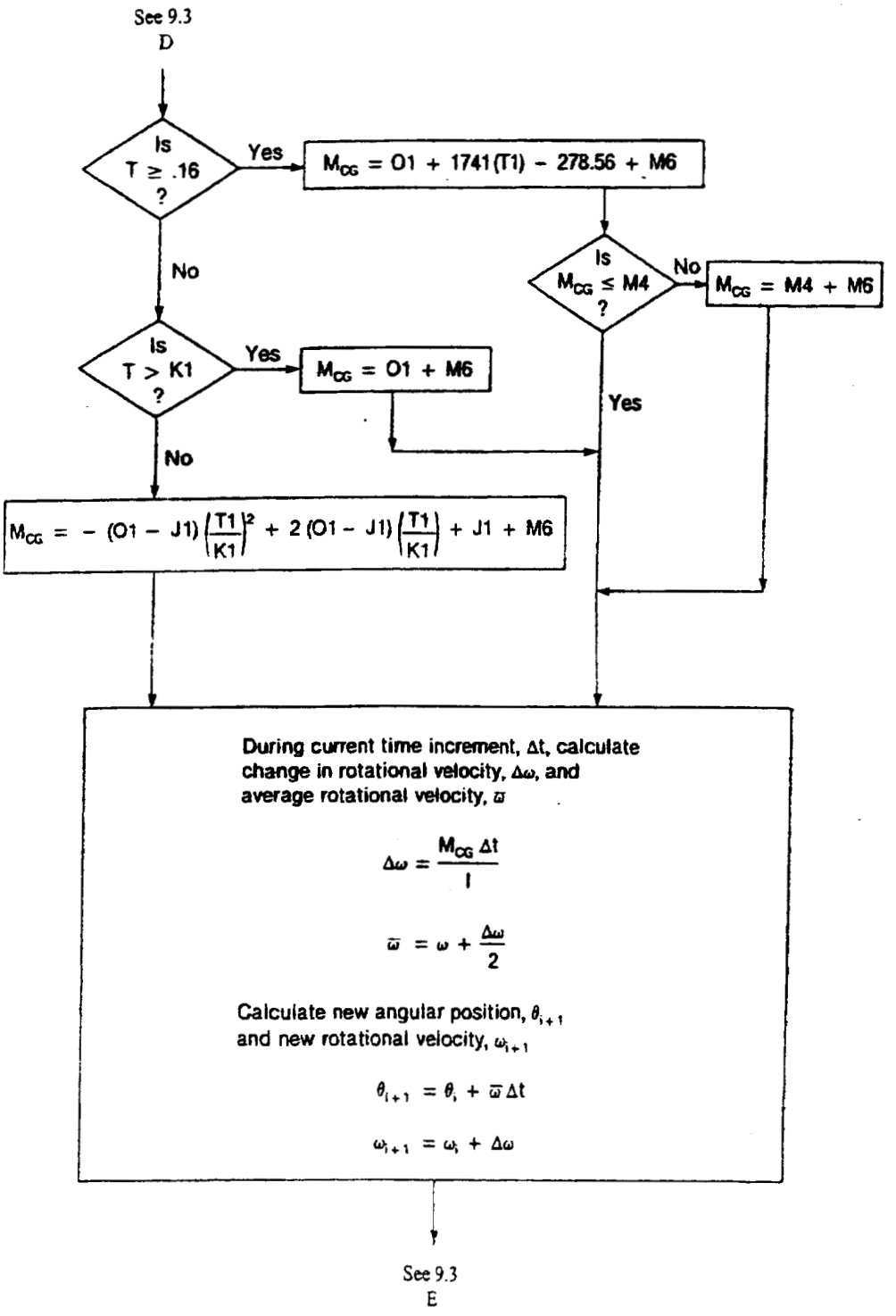
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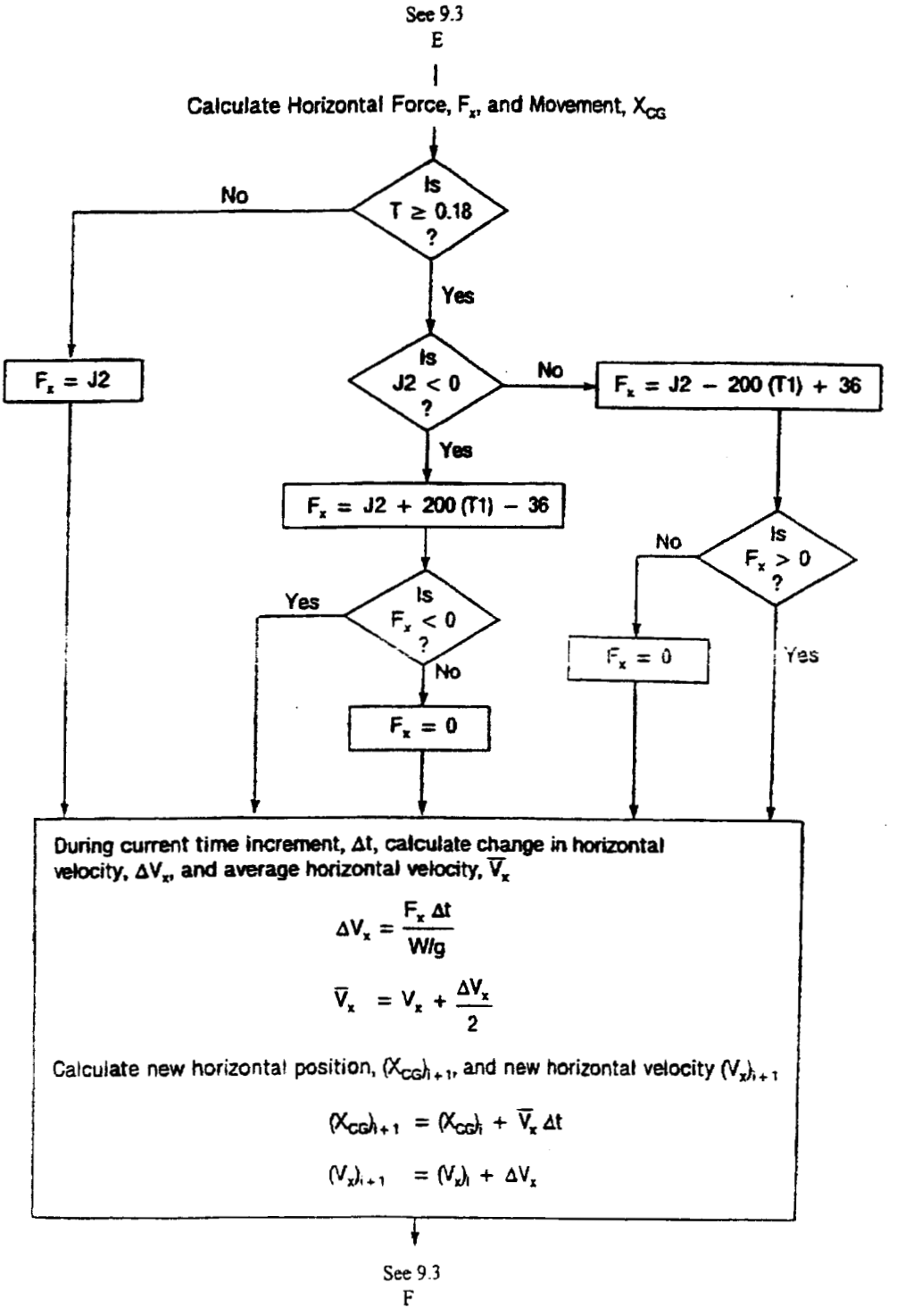
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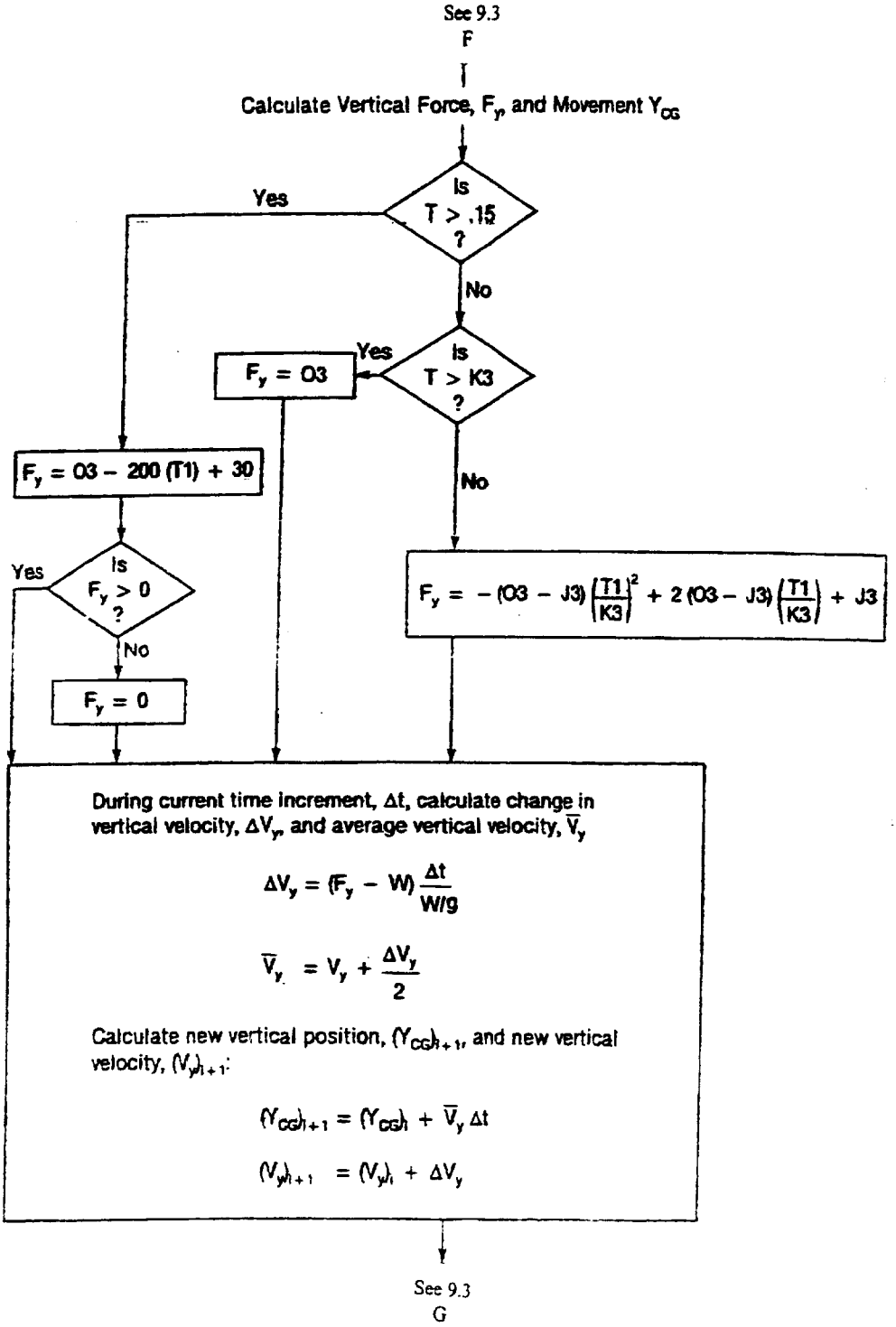
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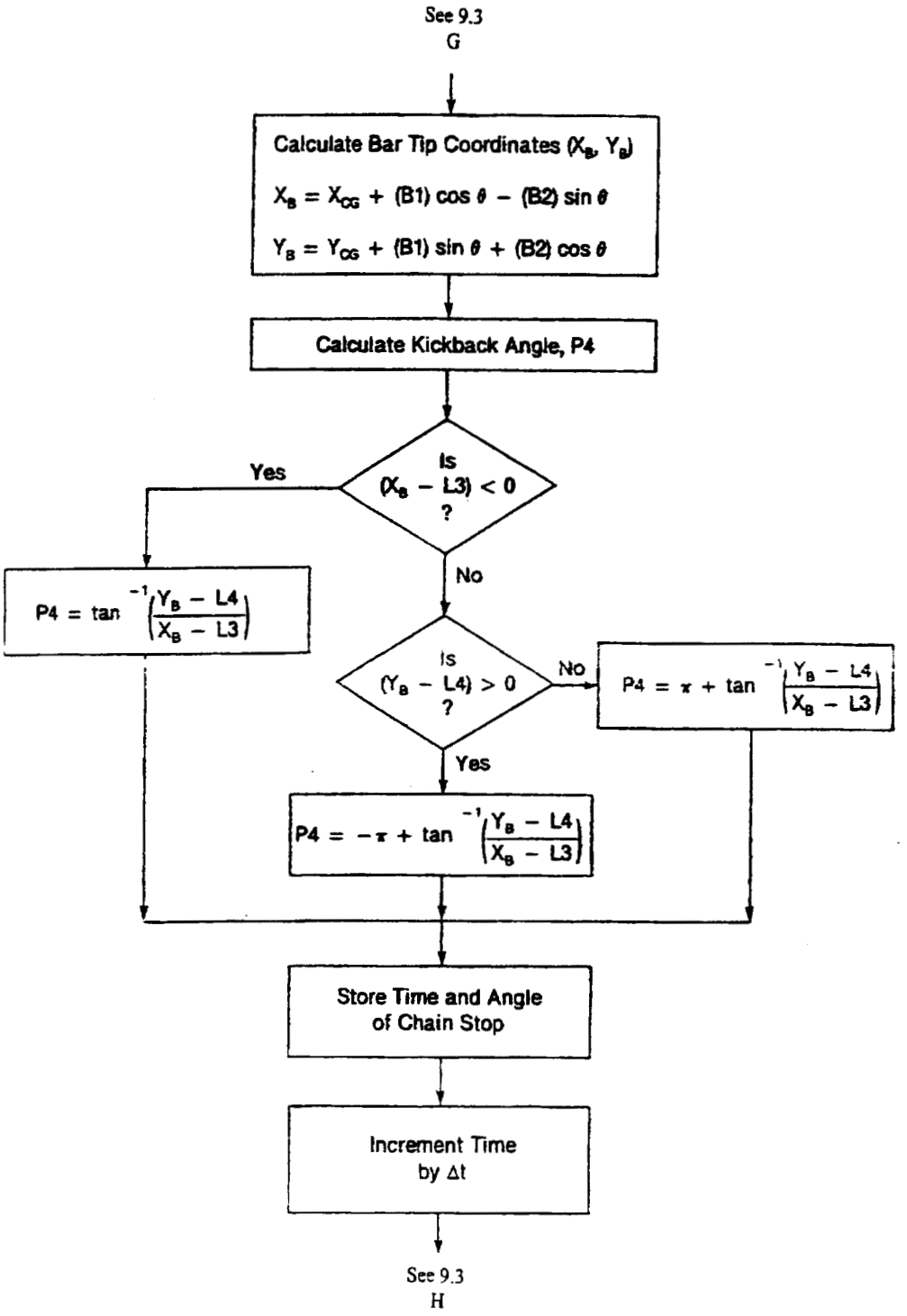
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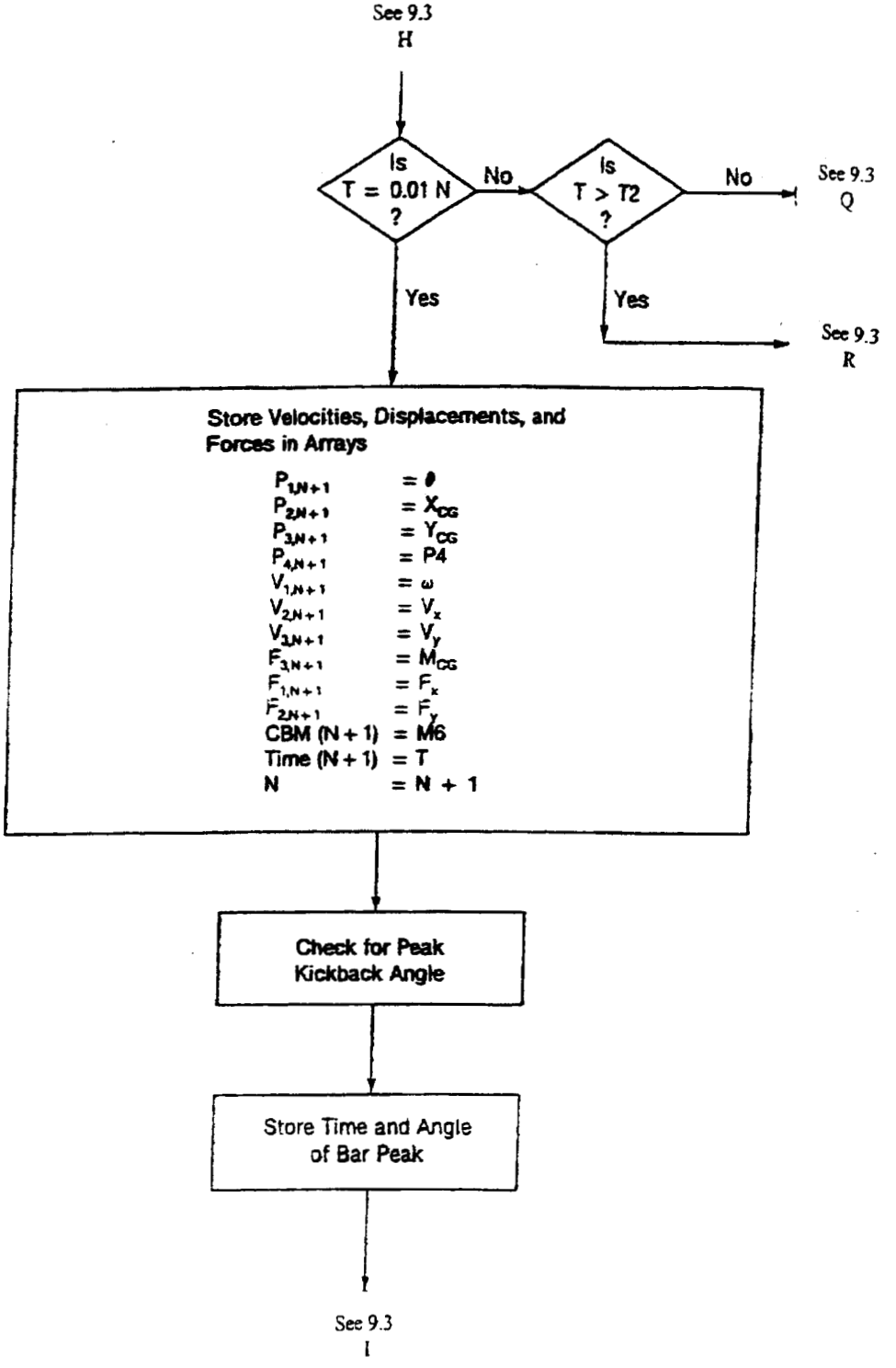
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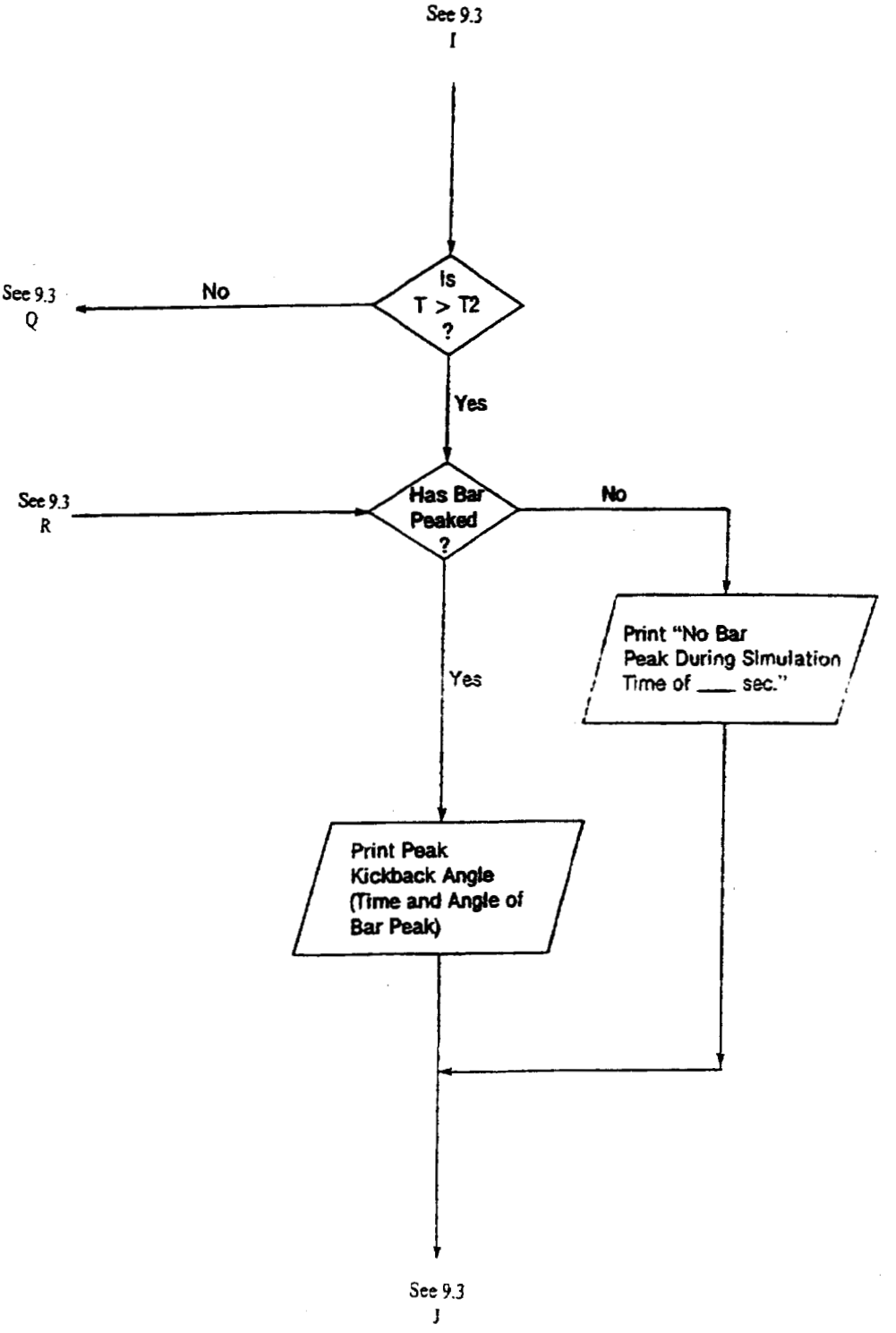
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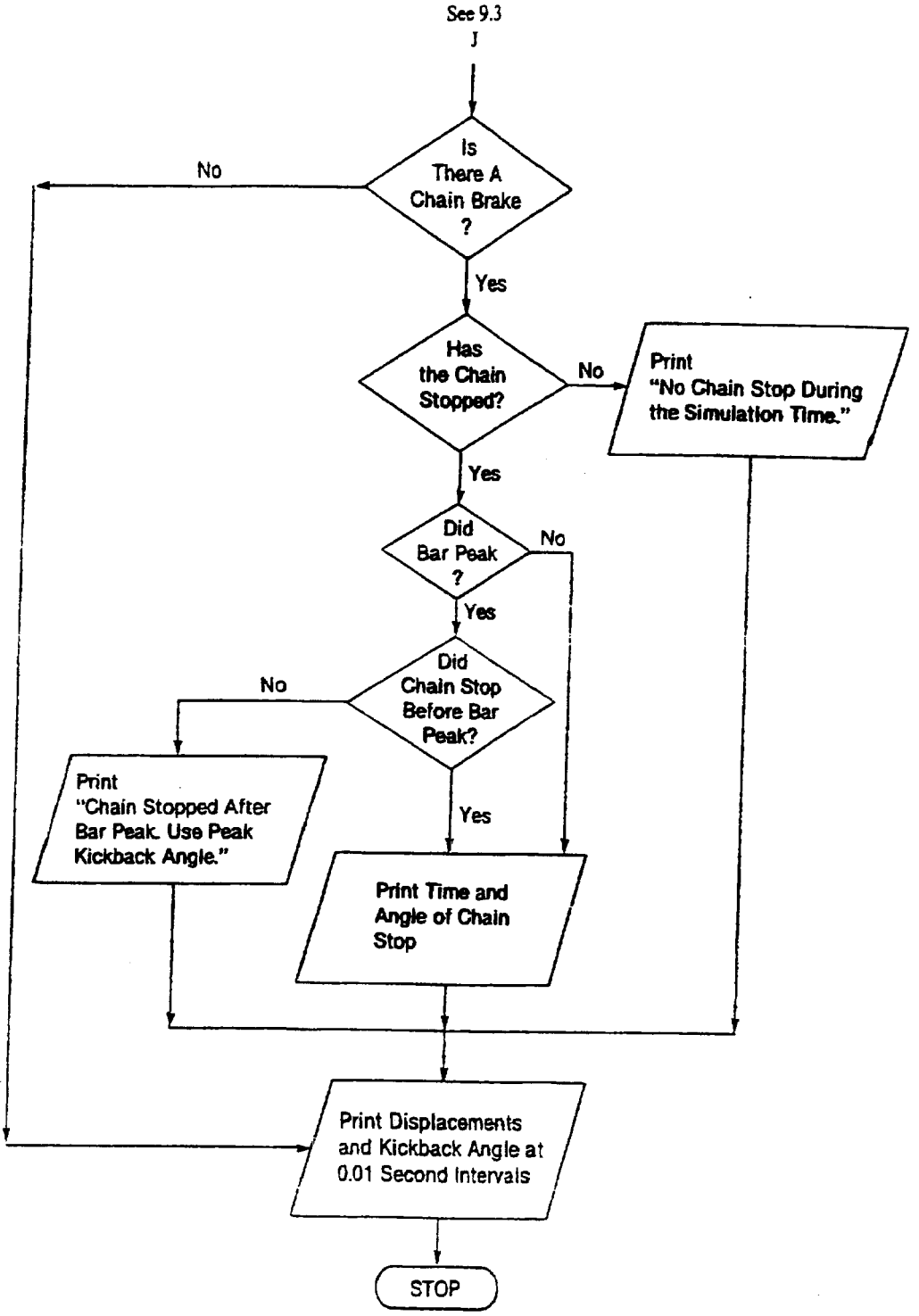
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Model: CHECKOUT #1 W/O BRAKE

Date: 99/10/26

Physical characteristics of saw

Weight [lb]:		12.79
Inertia [in-lb-sec²]:		.839
Coordinates [in]:		
Front handle	FHX: -.44	FHY: 4.31
Rear handle	RHX: 3.75	FHY: 2.31
Bar tip	BTX: -15.62	BTY: -.94

KBM Energy measurements

Horizontal [in-lb]:	7
Rotary [in-lb]:	63

Energy components [in-lb]	Horizontal	Vertical	Rotational
	7	7	56

Kickback results

Computed kickback angle [deg]:	51.6
at time [sec]:	.22

Time	Horizontal		Vertical		Rotational		
	Vel.	Disp.	Vel.	Disp.	Vel.	Disp.	KB angle
sec	in/sec	in	in/sec	in	deg/sec	deg	deg
0	20.566	0	20.566	0	662.038	0	-9.525
.01	19.024	.198	28.367	.246	544.484	6.014	-4.062
.02	17.481	.38	34.439	.562	448.833	10.963	.907
.03	15.939	.548	38.951	.93	372.827	15.056	5.454
.04	14.397	.699	42.072	1.336	314.206	18.478	9.639
.05	12.855	.836	43.968	1.767	270.715	21.391	13.515
.06	11.313	.956	44.809	2.212	240.094	23.935	17.132
.07	9.77	1.062	44.761	2.66	220.085	26.228	20.532
.08	8.228	1.152	43.995	3.105	208.431	28.365	23.752
.09	6.686	1.226	42.677	3.538	202.874	30.417	26.818
.1	5.144	1.285	40.975	3.957	201.155	32.435	29.749
.11	3.601	1.329	39.058	4.357	201.026	34.446	32.551
.12	2.059	1.358	37.084	4.733	201.026	36.456	35.223
.13	.517	1.37	35.11	5.099	201.026	38.466	37.761
.14	-1.025	1.368	33.135	5.44	201.026	40.477	40.167
.15	-2.567	1.35	31.16	5.761	201.026	42.487	42.441
.16	-4.11	1.316	28.886	6.062	201.026	44.497	44.586
.17	-5.652	1.268	26.005	6.337	195.081	46.487	46.58
.18	-7.194	1.203	22.52	6.58	177.246	48.359	48.344
.19	-8.434	1.125	18.66	6.786	147.52	49.992	49.791
.2	-9.07	1.037	14.796	6.953	105.904	51.269	50.856
.21	-9.162	.945	10.932	7.082	52.398	52.071	51.478
.22	-9.162	.854	7.068	7.172	-12.999	52.278	51.588
.23	-9.162	.762	3.204	7.224	-90.285	51.771	51.11

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Model: CHECKOUT #1 WITH BRAKE

Date: 99/10/26

Physical characteristics of saw

Weight [lb]:	12.79	
Inertia [in-lb-sec²]:	.839	
Coordinates [in]:		
Front handle	FHX:-.44	FHY: 4.31
Rear handle	RHX: 3.75	FHY: 2.31
Bar tip	BTX:-15.62	BTY:-.94

Chain brake characteristics

Actuation angle [deg]:	20
Stopping time [sec]:	.1

KBM Energy measurements

Horizontal [in-lb]:	7
Rotary w/o chain brake [in-lb]:	63
Rotary with chain brake [in-lb]:	45

Energy components [in-lb]	**Horizontal**	**Vertical**	**Rotational**
with out chain brake:	7	7	56
with chain brake:	7	5	40

Kickback results

Computed kickback angle [deg]:	43.2
at time [sec]:	.2
Chain stop angle [deg]:	37.8
at time [sec]:	.146

Time	Horizontal Vel.	Horizontal Disp.	Vertical Vel.	Vertical Disp.	Rotational Vel.	Rotational Disp.	KB angle
sec	in/sec	in	in/sec	in	deg/sec	deg	deg
0	20.566	0	20.566	0	662.038	0	-9.525
.01	19.024	.198	28.367	.246	544.484	6.014	-4.062
.02	17.481	.38	34.439	.562	448.833	10.963	.907
.03	15.939	.548	38.951	.93	372.827	15.056	5.454
.04	14.397	.699	42.072	1.336	314.206	18.478	9.639
.05	12.855	.836	43.968	1.767	270.715	21.391	13.515
.06	11.313	.956	44.709	2.212	234.399	23.921	17.12
.07	9.77	1.062	44.761	2.66	203	26.1	20.423
.08	8.228	1.152	43.995	3.105	179.955	28.009	23.448
.09	6.686	1.226	42.677	3.538	163.007	29.72	26.227
.1	5.144	1.285	40.975	3.957	149.898	31.282	28.779
.11	3.601	1.329	39.058	4.357	138.379	32.723	31.116
.12	2.059	1.358	37.084	4.738	126.988	34.05	33.24
.13	.517	1.37	35.11	5.099	115.598	35.263	35.153
.14	-1.025	1.368	33.135	5.44	104.208	36.362	36.859
.15	-2.567	1.35	31.16	5.761	98.512	37.361	38.374
.16	-4.11	1.316	28.886	6.062	98.512	38.346	39.769
.17	-5.652	1.268	26.005	6.337	92.567	39.311	41.032
.18	-7.194	1.203	22.52	6.58	74.732	40.158	42.079
.19	-8.434	1.125	18.66	6.786	45.006	40.766	42.82
.2	-9.07	1.037	14.796	6.953	3.39	41.018	43.183
.21	-9.162	.945	10.932	7.082	-50.116	40.794	43.102

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Model: CHECKOUT #2 WITH BRAKE

Date: 99/10/26

Physical characteristics of saw

Weight [lb]:	13.52	
Inertia [in-lb-sec²]:	.895	
Coordinates [in]:		
Front handle	FHX: 1.38	FHY: 4.75
Rear handle	RHX: 6.69	FHY: 3
Bar tip	BTX:-18.5	BTY:-.12

Chain brake characteristics

Actuation angle [deg]:	15
Stopping time [sec]:	.1

KBM Energy measurements

Horizontal [in-lb]:	8.1
Rotary w/o chain brake [in-lb]:	43.3
Rotary with chain brake [in-lb]:	28.5

Energy components [in-lb]	**Horizontal**	**Vertical**	**Rotational**
with out chain brake:	8.1	8.1	35.2
with chain brake:	8.1	5.3	23.2

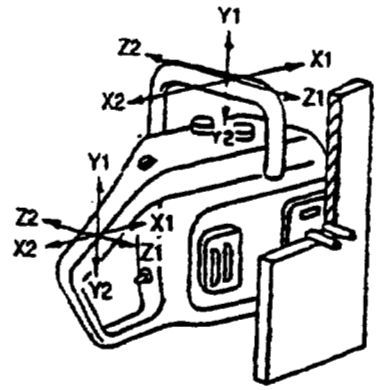
Kickback results

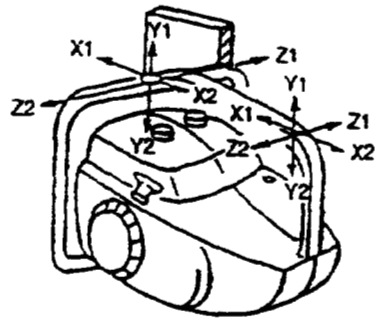
Computed kickback angle [deg]:	18.9
at time [sec]:	.17

Chain stopped after bar peak.

Time	Horizontal Vel.	Horizontal Disp.	Vertical Vel.	Vertical Disp.	Rotational Vel.	Rotational Disp.	KB angle
sec	in/sec	in	in/sec	in	deg/sec	deg	deg
0	21.517	0	21.517	0	508.194	0	-7.061
.01	19.894	.207	29.32	.256	388.054	4.462	-3.271
.02	18.271	.398	35.389	.581	290.299	7.836	-.038
.03	16.648	.572	39.891	.958	212.62	10.335	2.726
.04	15.025	.731	42.996	1.374	152.711	12.148	5.103
.05	13.402	.873	44.873	1.814	108.262	13.441	7.167
.06	11.779	.999	45.69	2.268	76.968	14.357	8.986
.07	10.156	1.109	45.617	2.725	56.519	15.017	10.619
.08	8.533	1.202	44.821	3.178	43.543	15.516	12.114
.09	6.91	1.279	43.471	3.619	27.208	15.865	13.459
.1	5.287	1.34	41.737	4.046	14.796	16.073	14.646
.11	3.664	1.385	39.787	4.453	4.009	16.167	15.687
.12	2.041	1.413	37.779	4.841	-6.647	16.153	16.583
.13	.417	1.426	35.771	5.209	-17.302	16.034	17.336
.14	-1.206	1.422	33.763	5.557	-27.958	15.807	17.944
.15	-2.829	1.402	31.754	5.884	-38.613	15.475	18.409
.16	-4.452	1.365	29.463	6.191	-49.269	15.035	18.731
.17	-6.075	1.313	26.597	6.472	-64.432	14.471	18.887
.18	-7.698	1.244	23.16	6.721	-81.151	13.752	18.847

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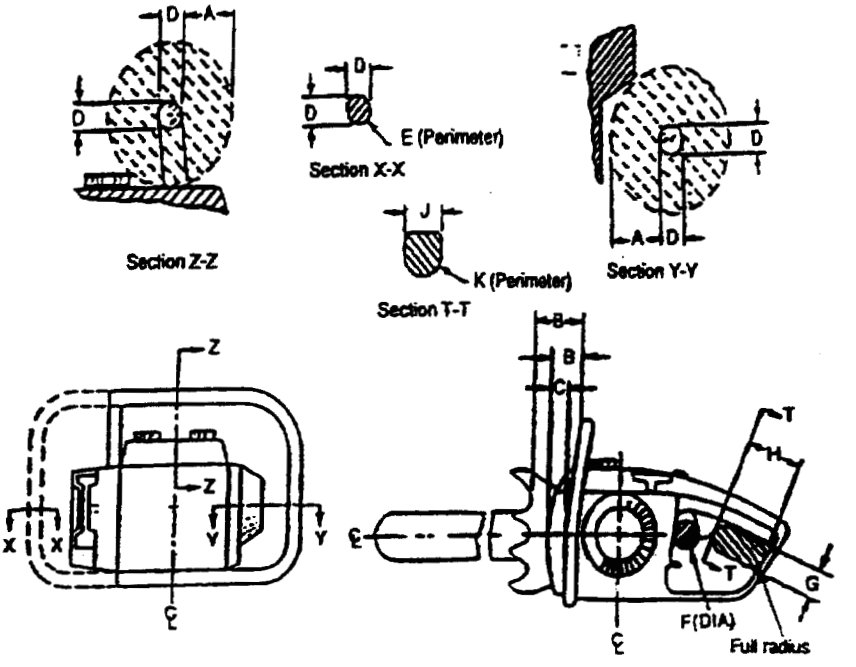




Chain saw engine Displacement		Handle strength test load (Applied at handle grip midpoint)					
		Front and rear X1 and X2		Up and down Y1 and Y2		Right and left Z1 and Z2	
cubic inches	cubic centimeters	pounds force	newtons	pounds force	newtons	pounds force	newtons
<3.05	< 50.0	150	670	150	670	75	335
≥3.05	≥ 50.0	300	1340	300	1340	150	670

Figure 1 – Handle strength test loads

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NOTE – Dimensions B and C shall be measured parallel to the centerline of the guide bar

Handle	Description	Dimension in fig. 2	Minimum size inches	mm
Front	Finger clearance in the handle grip area	A	1.00	25
	Clearance between the front of the chain saw body and the handle at the top. If the chain saw has an integral (nonremovable) bumper spike, then the measurement is to be made from the root of the bumper spike.	B	1.50	38
	Clearance between the front of the chain saw and the handle at the engine centerline	C	1.00	25
	Projected thickness	D	0.44	11
	Handle perimeter	E	2.35	60
Rear	Finger clearance at the released throttle control trigger	F	1.00	25
	Finger clearance behind the throttle control trigger	G	1.00	25
	Hand width clearance	H	2.50	64
	Projected thickness	J	0.70	19
	Handle perimeter	K	3.50	89

Figure 2 – Handle clearances and sizes

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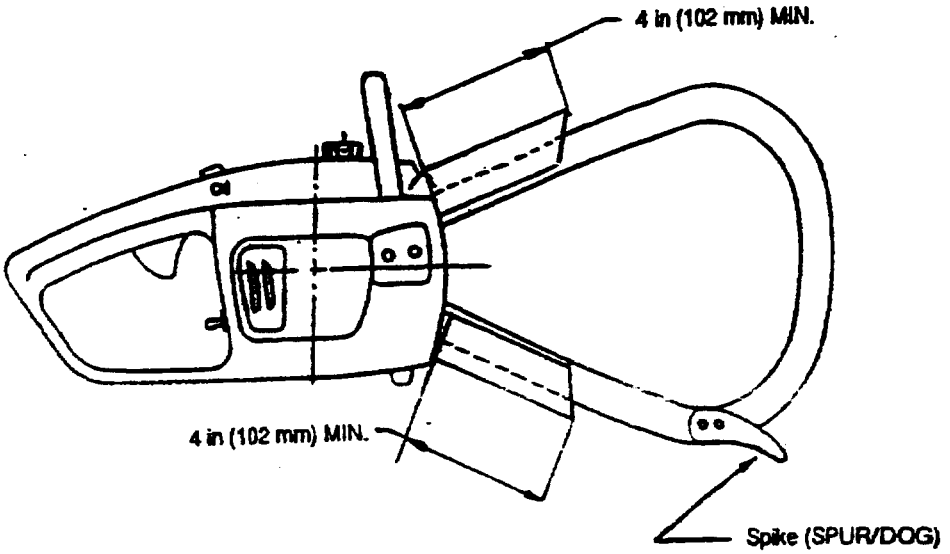
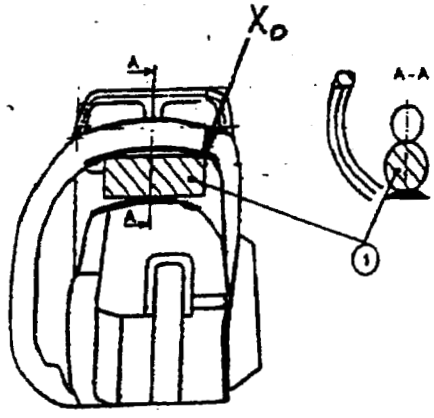
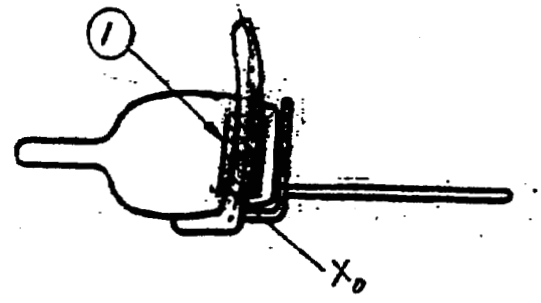


Figure 3 – Bow guide guard

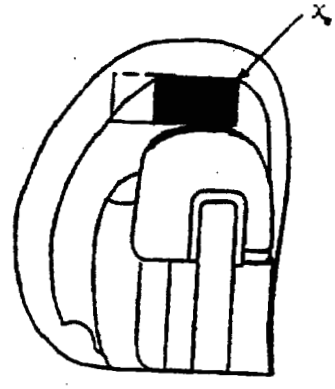
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4-1a Machine viewed from the rear
1 = Gauge type A



4-1b Machine viewed from the top



4-1c Special case with reduced gauge length
Machine viewed from the rear.

Figure 4-1 – Definition of reference point X_0

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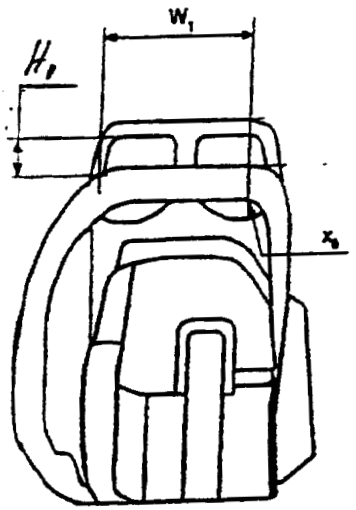
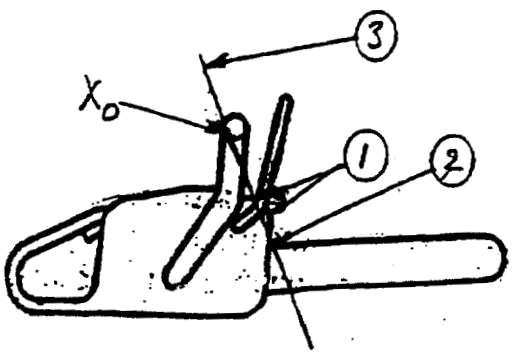


Figure 4-2a Front hand guard width (W_1)
Machine viewed from the rear.



1 = Points of intersection
2 = Rearmost, upper unprotected part of saw chain
3 = Line between X_0 and saw chain

Figure 4-2b Line between X_0 and rearmost part of the unprotected saw chain

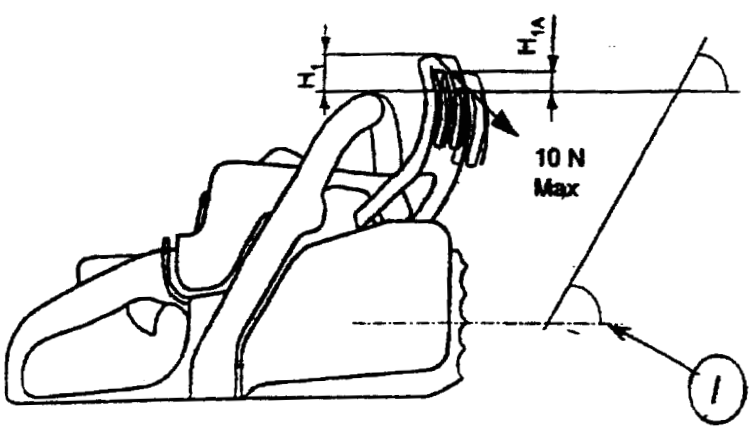
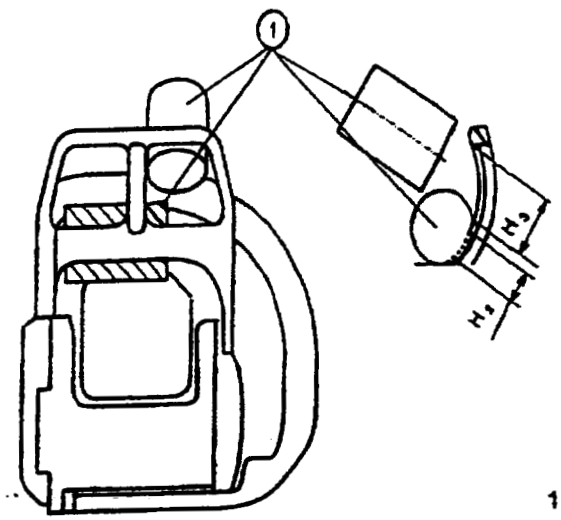


Figure 4-3 Front hand guard height over the front handle (H_1 and H_{1A})
(Machine viewed from the right side.)

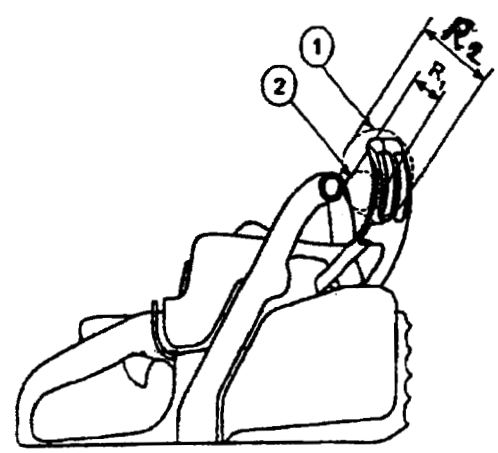
1 = Centreline of guide bar

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1 = Gauge type C

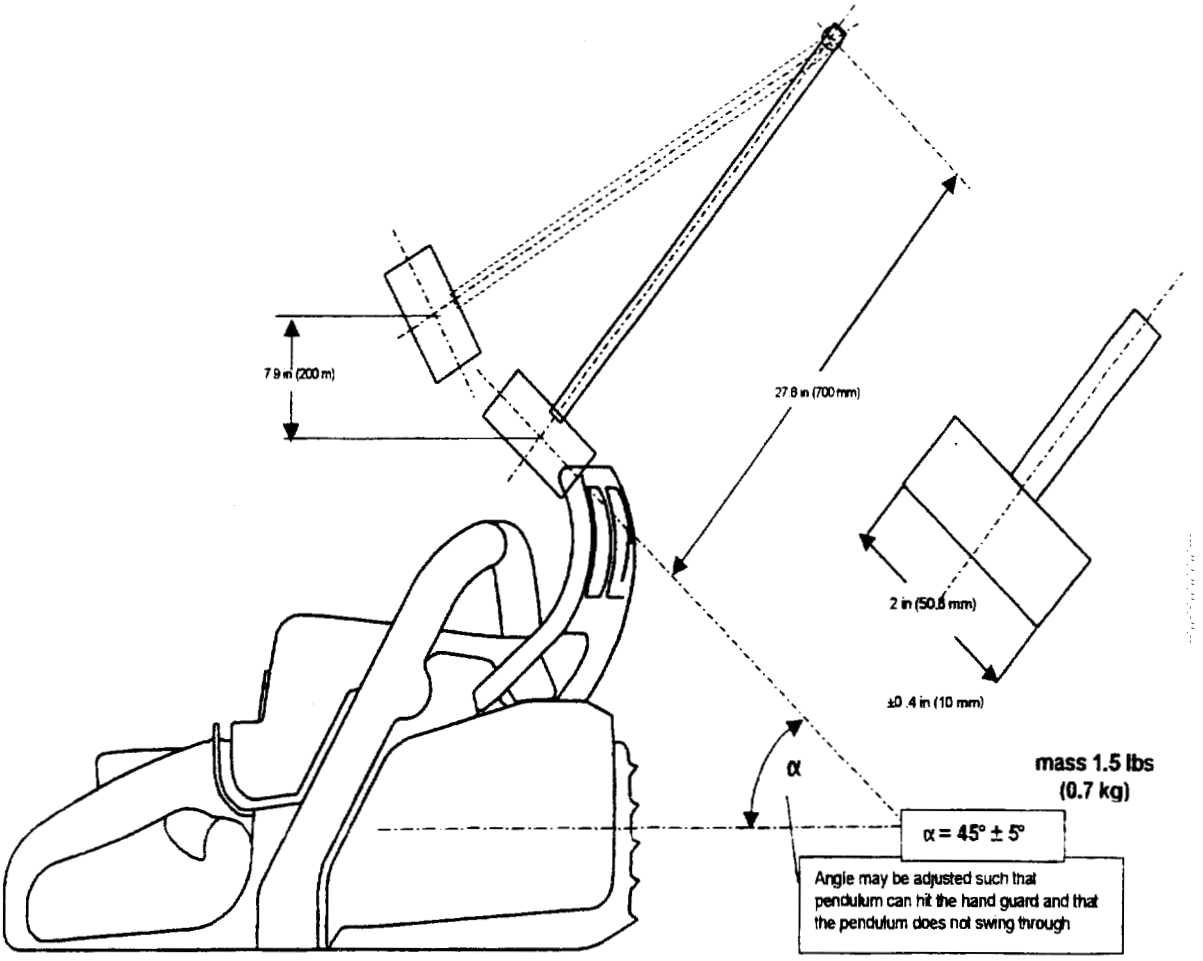
Figure 4-4 Clearance between the front hand guard and the saw body (H_2) and openings in the front hand guard (H_3) (Machine viewed from the front.)



1 = Gauge type B
2 = Gauge type A

Figure 4-5 Clearance between the front handle and the front hand guard (R_1 and R_2) (Machine viewed from the right side.)

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Chain brake pendulum test sequence

Step	Engine Speed	Time	Actuations	Remarks
1.1	Max power	4'45"	–	Warm up, no measurement
1.2	Racing	15"	1	Record stopping time
2.1	Idling	3'	–	Cooling down
2.2	Max power	1'45"	–	Heating up, no measurement
2.3	Racing	15"	1	Record stopping time
2.4	Idling	3'	–	Cooling down
2.5	Max power	1'45"	–	Heating up, no measurement
2.6	Racing	15"	1	Record stopping time
2.7	Idling	3'	–	Cooling down
2.8	Max power	1'45"	--	Heating up, no measurement
2.9	Racing	15"	1	Record stopping time
3.1	Racing	10"-30"	15	15 times wear-in, no measurement
3.2	Racing	10"-30"	5	Record stopping time

Report:
a) The average of the nine measured stopping times, in steps 1.2, 2.3, 2.6, 2.9 and 3.2;
b) The highest single measurement of recorded stopping times.

Figure 5 – Chain brake test pendulum and test sequence

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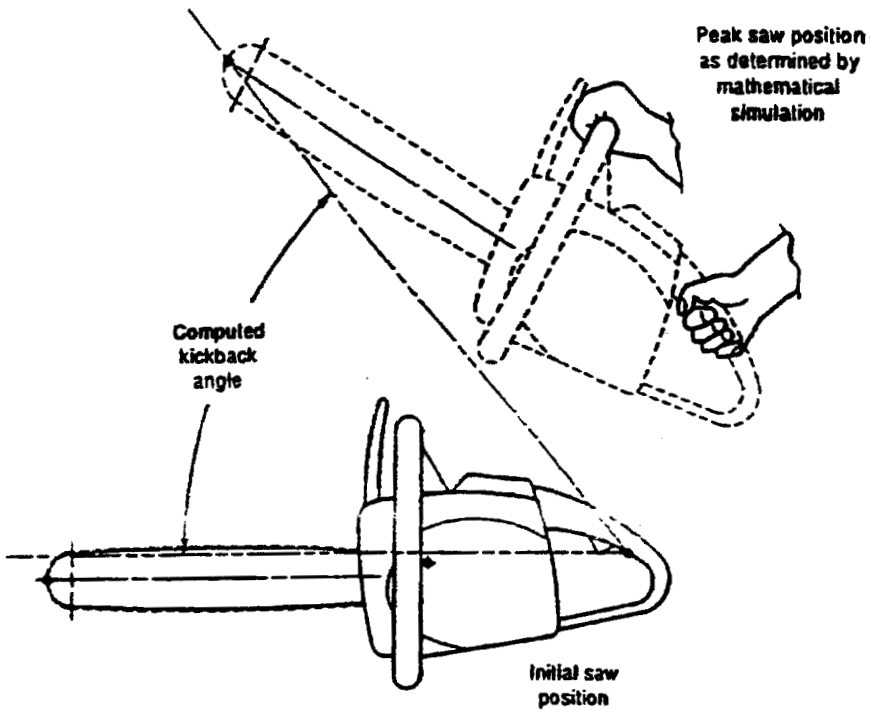


Figure 6 – Illustration of computed kickback angle

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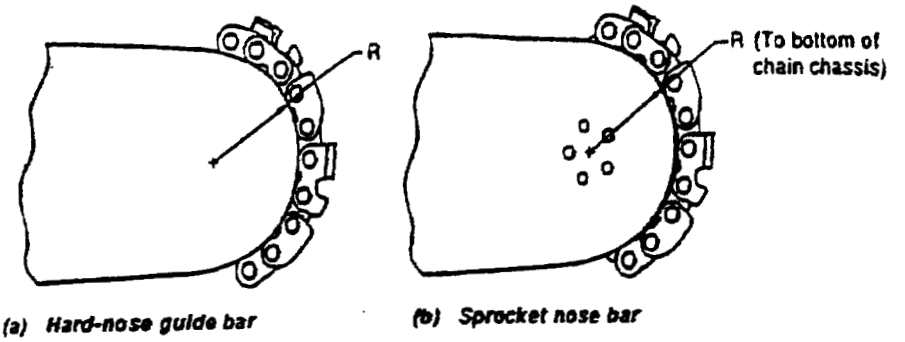


Figure 7 – Guide bar nose definition

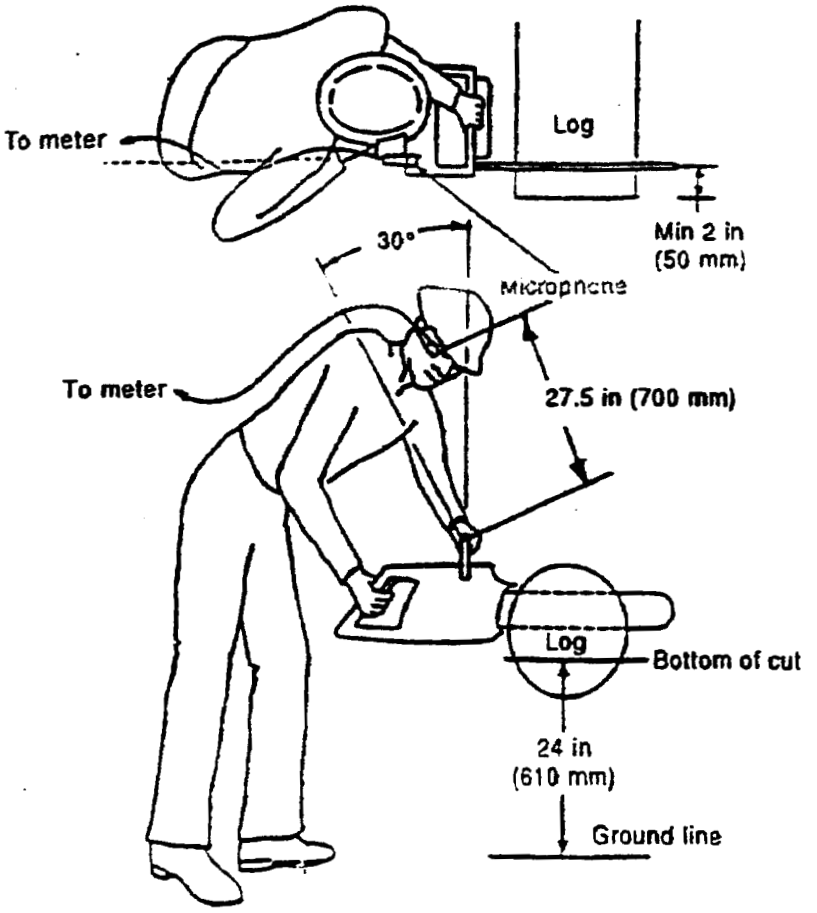


Figure 8 – Chain saw operation

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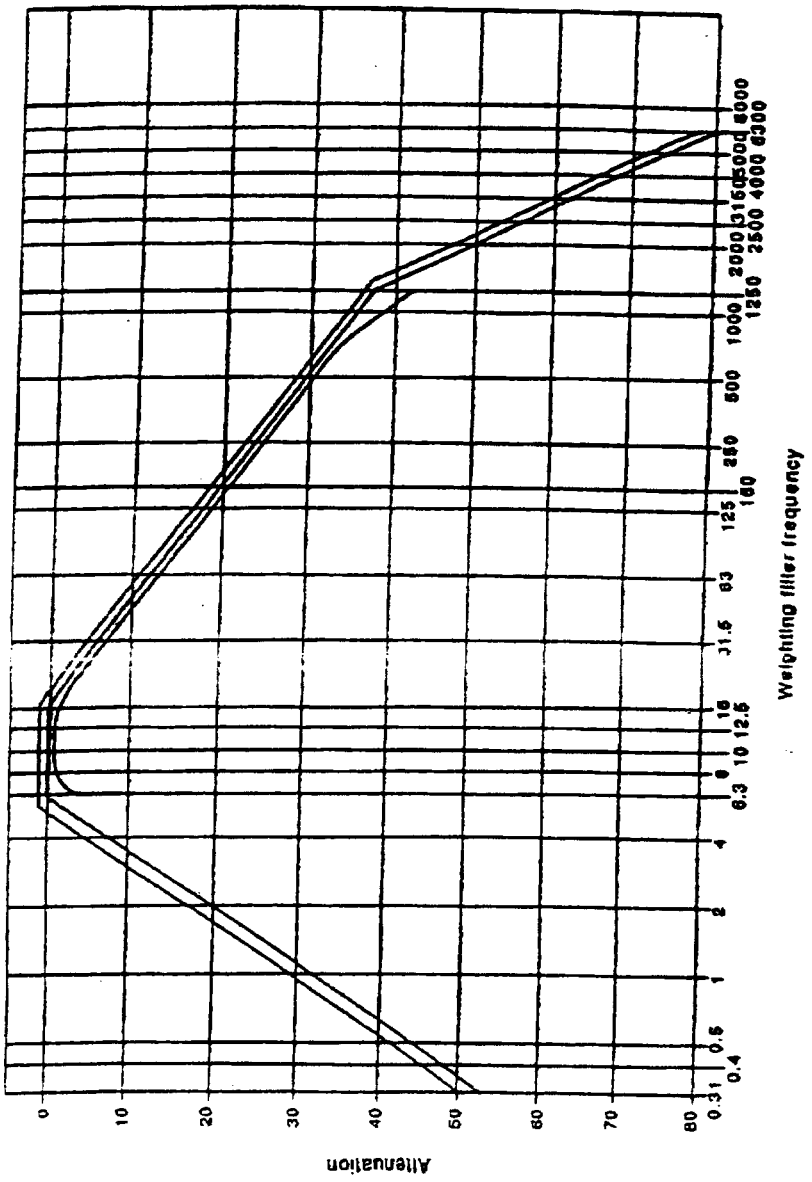
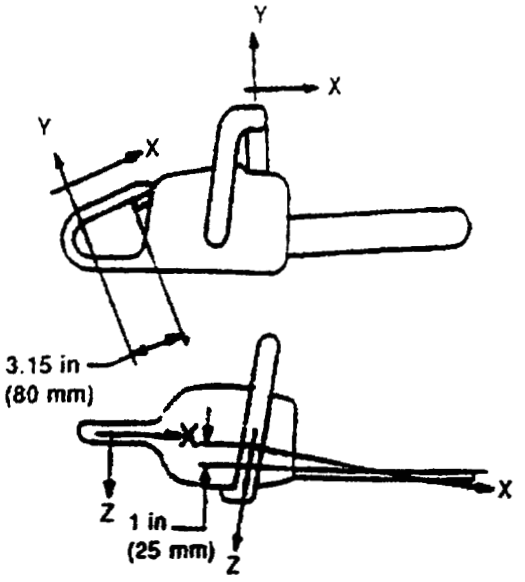
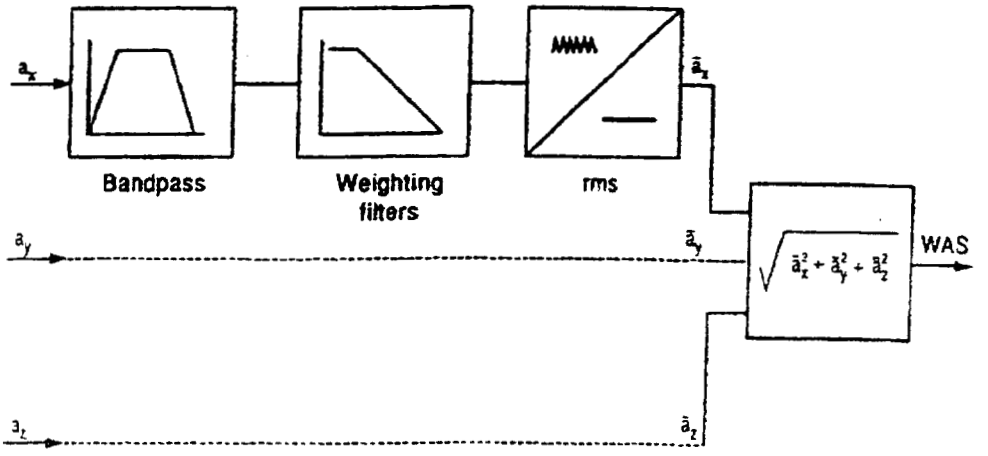


Figure 9 – Weighting filter frequency attenuation curve

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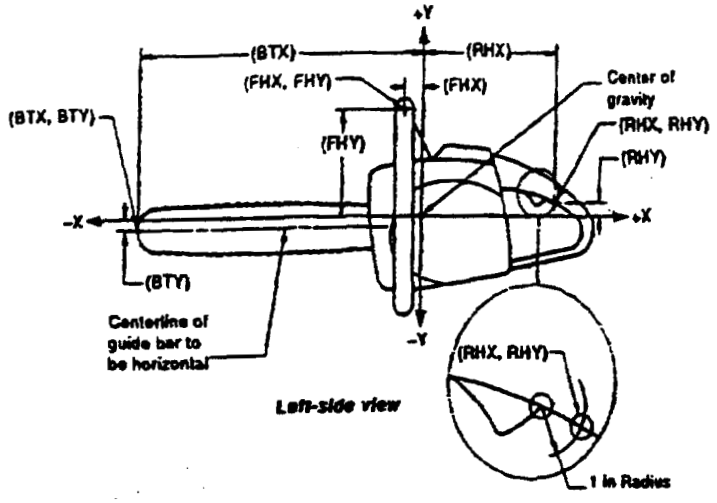
(a) Accelerator mounting locations



(b) Weighted acceleration sum (WAS)

Figure 10 – Accelerometer mounting locations and weighted acceleration sum (WAS)

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NOTES:

1 Observe sign convention carefully.

2 Chain saw bar tip and handle locations shall be measured from the center of gravity.

Key:

(BTX, BTY) are the bar tip coordinates, with the chain adjusted so that maximum *X* dimension is obtained, measured to the tip of the chain on the guide bar located along the projected centerline of the guide bar. For asymmetrical bars, they are located along a line through the center of the upper quadrant nose radius and parallel to the guide bar centerline.

(FHX, FHY) are the front handle coordinates, measured to the center of the front handle bar. NOTE - If the handle is angled in any plane or direction, use the midpoint of the grip area.

(RHX, RHY) are the rear handle coordinates, measured 1.0 inch behind the rear edge of the throttle trigger on the underside of the handle surface.

Figure 11 – Chain saw handle and bar tip coordinates

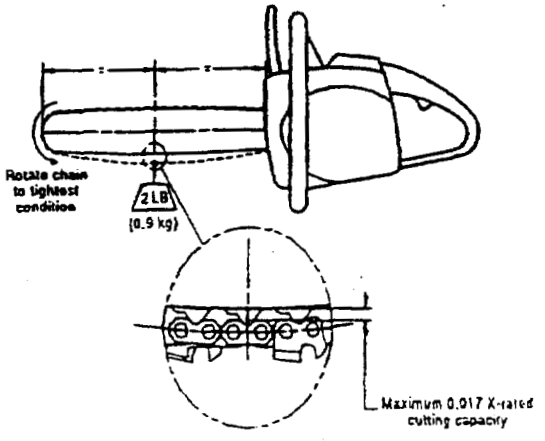


Figure 12 – Saw chain tension adjustment

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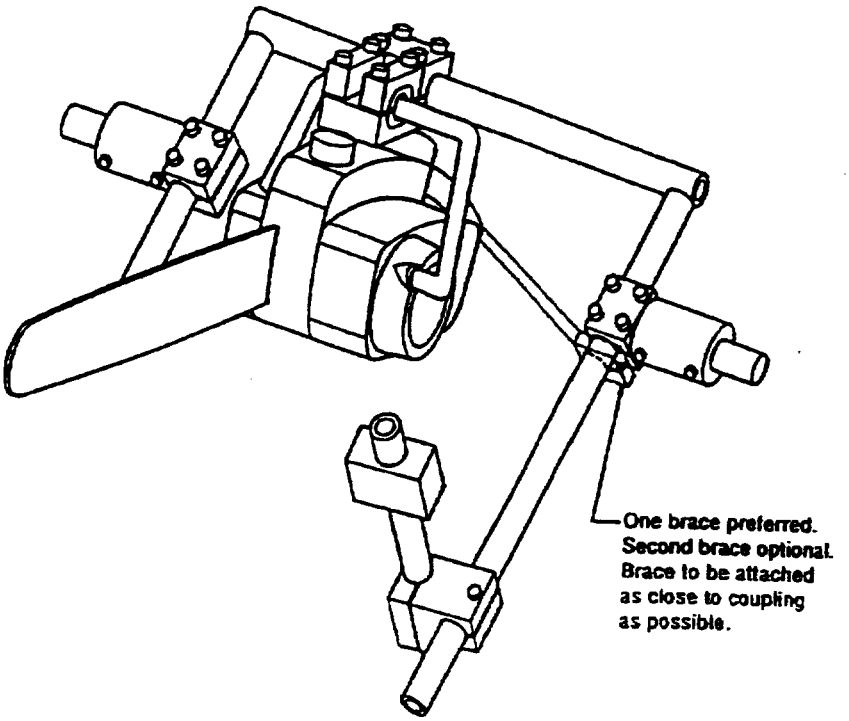
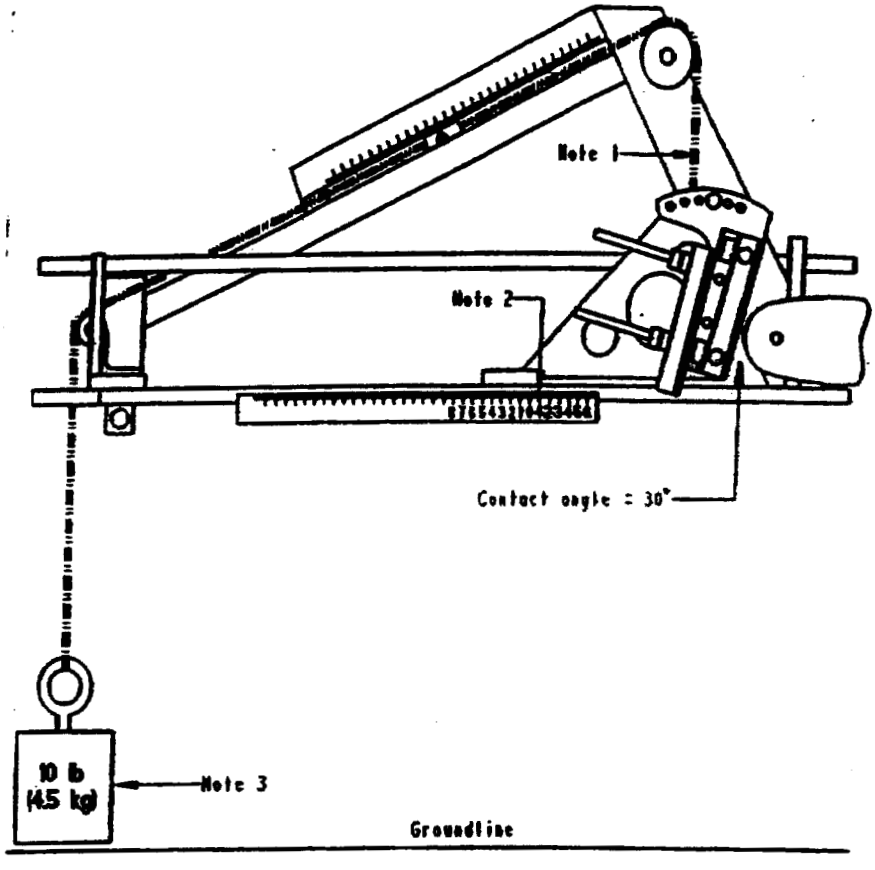


Figure 13 – Installation of saw and cradle assembly in kickback machine

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Notes

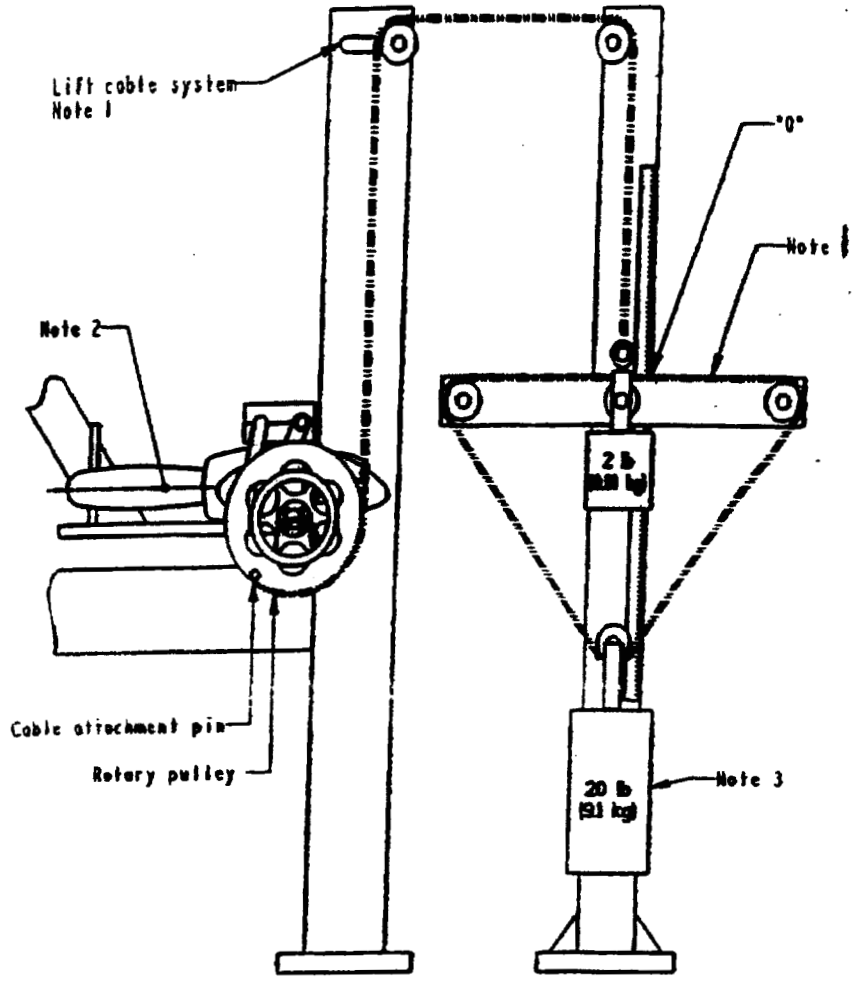
1 This section of cable is vertical.

2 The wood carriage is 1 to 2 inches to the right of the point at which the weight will lift.

3 The restraining weight will just swing free with the carriage pointer at "0." (A larger weight may be used only if necessary.)

Figure 14 – Location of rack/horizontal restraining system assembly.

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Notes

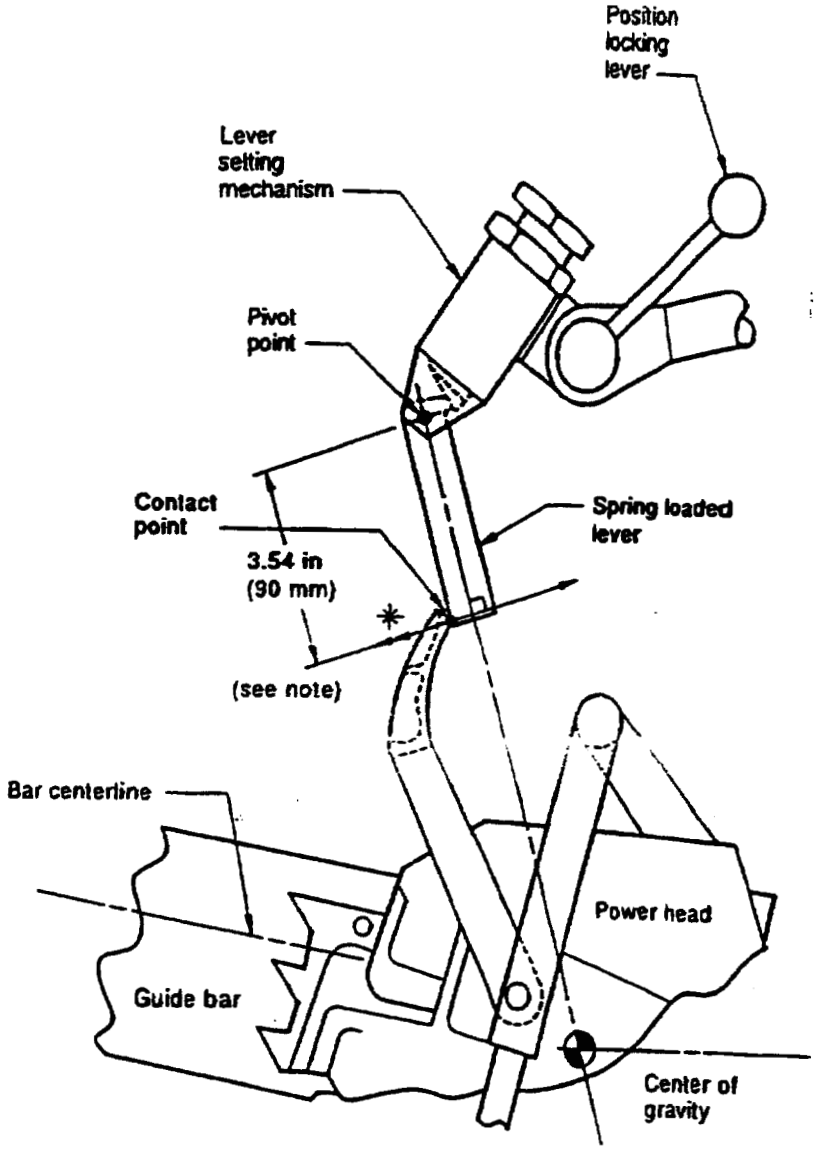
1 Adjust location of cable attachment pin in rotary pulley and adjust mechanism so that this section of cable is horizontal. (This is the "0" position of the 2-lb. Weight.)

2 Guide bar centerline is horizontal.

3 A larger weight may be used only if necessary

Figure 15—Adjustment of cable of rotary restraining assembly

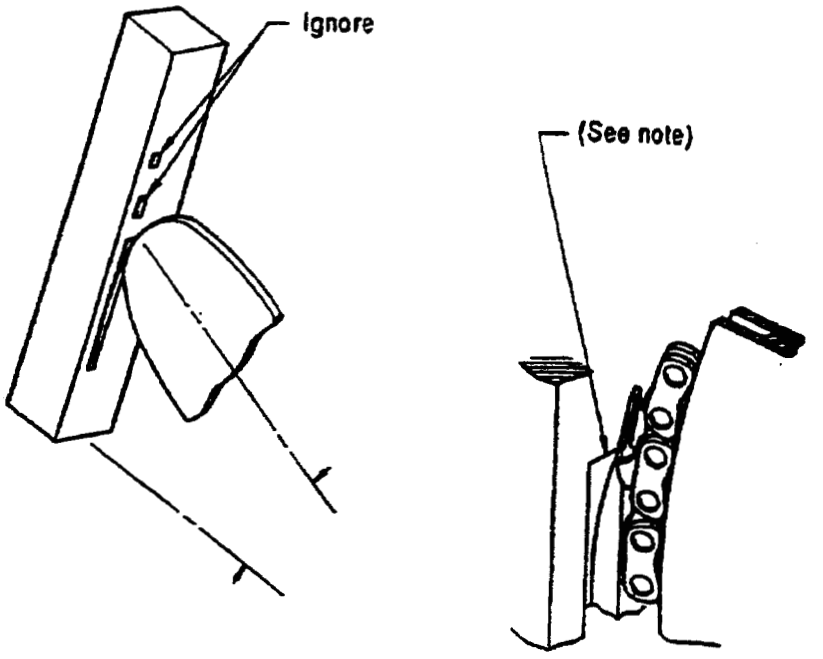
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NOTE – Measure brake release force in this direction.

Figure 16 – Chain brake actuation diagram

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NOTE – Measure angle with chain in contact at highest point in cut area. Ignore any following tracks where cutters may have hit.

Figure 17 – MDF exit angle measurement

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Annex A
(informative)

Rationale

This annex gives the rationale behind changes to the various requirements of this voluntary safety standard. The section and subsection numbers used in this annex correspond to those used in the body of the standard.

3.5 Chain catcher - This section, which provides for a device used to restrain a broken or degrooved saw chains, has been added for purpose of clarifying a term included in Annex B to the standard.

3.23 On/off stop control - The definition was modified to provide additional detail.

5.3 (old) Pull-type starter - This section was deleted. The test suffers from large variability, is difficult to perform, and because modern saws overcome limitations of the past through use of electronic ignition, risk to operators this provision is intended to control has been minimized.

5.3.1 On/off or stop controls - This section, which provides that all saws shall be equipped with on/off or stop controls, was subdivided into three separate sub-sections regarding Applicability, Identification, and Location. This modification was made to make the B175.1 standard consistent with analogous provisions of other B175 standards. These changes continue to permit use of an engine shut-off function that provides an automatic reset after a delay sufficient to ensure that the engine has come to a complete stop.

5.4.2 Tank filler openings - The minimum diameter of the fuel tank filler hole was modified to be consistent with ISO requirements. The minimum diameter of the oil tank filler hole was modified to be consistent with CSA requirements.

5.8.4 Front hand guard - This section has been modified to reflect the requirements of the ISO 6533 standard for handguard dimensions, thereby promoting international harmonization.

5.8.5.2 (h) Hand guard actuated chain brake test requirements - This subsection was modified to specify that the pendulum strike be consistent with international standards and to provide further consistency in the test procedure.

5.10 Sound levels - This section already provided that operator's manuals should include instructions on wearing hearing protection. To emphasize the importance of this, a sentence was added to this subsection to require that power heads be marked to inform the operator to always use hearing projection.

5.11.1 Chain saw kickback Scope - The last paragraph of Section 5.11.1 has been deleted because its reference to the kickback requirements for electric chainsaws is beyond the scope of this standard.

5.11.2.4 Low kickback saw chain - This section establishes testing requirements for saw chain that is designated "low kickback" and calls for testing on several different chain saw models. After several years of testing experience, it was determined that it was appropriate to establish independent testing requirements for new saw chain and for modified versions of previously designated "low kickback" saw chain. Whereas the testing requirements for new saw chain are unchanged, modified versions of previously-designated "low kickback" chain need be tested only on the two saws that produced the highest CKA's in prior testing. This modification to the test requirements recognizes that previously designated chain has

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already met extensive testing requirements that need not be fully duplicated simply because of a minor modification.

5.13 Vibration - This section, which establishes vibration requirements for chain saws not intended for the occasional user, has been modified to provide separate standards based upon engine displacement, i.e., for saws that use engines less than 3.7 in^3 (60 cm^3) displacement and those that use engines of 3.7 in^3 (60 cm^3) or more. This modification harmonizes the B175.1 standard with vibration levels adopted by other organizations. The section also was revised to clarify that these requirements apply to powerheads using the manufacturer's recommended saw chains.

5.14.2 Instruction manual(s) - This section was previously designated "Owner's manuals." It was changed to "instruction manuals" in recognition that the precautions and instructions contained in such manuals apply to all chain saw users and owners. This modification was made throughout the standard.

8.2 Equipment - Reference to the kickback test material has been changed in this section and throughout the standard from "Baraboard® Medium Density Fiberboard" to "Medium Density Fiberboard (MDF)." The Baraboard® Brand MDF is no longer available. Material from two alternative suppliers of MDF has been evaluated by the Committee and found to be acceptable alternatives. These are Hornitex (manufactured in Europe) and Veneer Products (manufactured in the U.S.). A Committee report entitled, "Study of Alternative Sources for Kickback Test Material" is available from PPEMA. A footnote to subsection (d) was added to permit use, when necessary to prevent splitting, of medium density fiberboard (MDF) specimens with three inch depth (the standard depth is one and one half inch).

8.7.2 Chain brake energy measurement procedure - Subsection (c) of this section was modified to allow the addition of extra mass, not to exceed 200 grams, to the center of the front handguard on saws that have chain brakes that can be demonstrated to activate by means other than manual force. This revision permits use of the kickback test procedure to evaluate saws that use non-manually operated chain brakes, which, because of the way the test machine restrains motion of the saw, was not always possible under prior versions of the standard.

Figure 3 (old) Pull-type starter test - This figure was referenced by section 5.3 of the B175.1-1991 standard, which section has been deleted. Accordingly, Figure 3 that was shown in prior versions of the standard is not included in the current version.

Annex C Safety precautions for chain saw users - This annex was redesignated "Normative" to be consistent with subsection 5.14.2(a) of the standard, which provides that the "instruction manual *shall* provide the safety precautions listed in annex C, verbatim or suitably paraphrased." (Emphasis added.) The note to this annex in prior versions of the standard has been moved to new subsection 5.14.2(j).

Annex K (old) Procedures for control and calibration of Baraboard® test material – Annex K (old) has been removed from the standard. It identified a procedure for control and calibration of Baraboard®, medium density fiberboard – the material used for bar nose kickback testing.

Since inception of the kickback test procedure first included in the 1985 version of the standard, the committee has gained extensive experience with the kickback test, involving consumption of large quantities of kickback test material. Annex K procedures have proven unworkable and unnecessary.

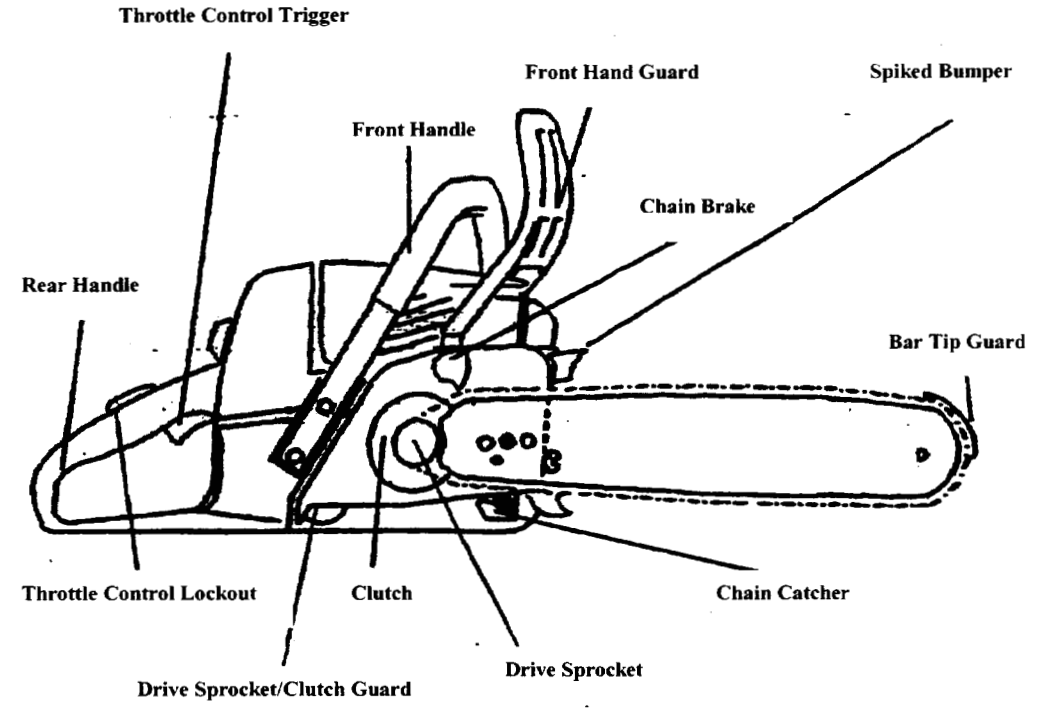
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Annex B
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Chain saw nomenclature

The commonly used nomenclature for chain saw parts is illustrated in figure B.1. (Note that the position of the parts shown may vary on different models of chain saws.)

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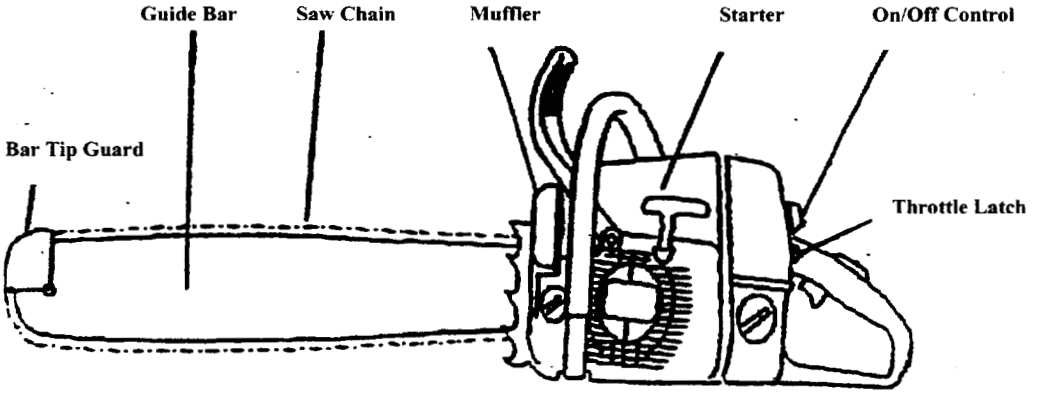


Figure B.1 – Chain saw diagram with nomenclature

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Annex C
(normative)

Safety precautions for chain saw users

C.1 Kickback safety precautions

WARNING!: Kickback may occur when the nose or tip of the guide bar touches an object, or when the wood closes in and pinches the saw chain in the cut. Tip contact in some cases may cause a lightning-fast reverse reaction, kicking the guide bar up and back toward the operator. Pinching the saw chain along the top of the guide bar may push the guide bar rapidly back toward the operator. Either of these reactions may cause you to lose control of the saw, which could result in serious personal injury. Do not rely exclusively upon the safety devices built into your saw. As a chain saw user, you should take several steps to keep your cutting jobs free from accident or injury.

a) With a basic understanding of kickback, you can reduce or eliminate the element of surprise. Sudden surprise contributes to accidents;

b) Keep a good firm grip on the saw with both hands, the right hand on the rear handle and the left hand on the front handle, when the engine is running. Use a firm grip with thumbs and fingers encircling the chain saw handles. A firm grip will help you reduce kickback and maintain control of the saw. Don't let go;

c) Make sure that the area in which you are cutting is free from obstructions. Do not let the nose of the guide bar contact a log, branch, or any other obstruction that could be hit while you are operating the saw;

d) Cut at high engine speeds;

e) Do not overreach or cut above shoulder height;

f) Follow the manufacturer's sharpening and maintenance instructions for the saw chain;

g) Only use replacement bars and chains specified by the manufacturer or the equivalent.

C.2 Other safety precautions

— Do not operate a chain saw with one hand! Serious injury to the operator, helpers, bystanders, or any combination of these persons may result from one-handed operation. A chain saw is intended for two-handed use.

— Do not operate a chain saw when you are fatigued;

— Use safety footwear; snug-fitting clothing; protective gloves; and eye, hearing, and head protection devices;

— Use caution when handling fuel. Move the chain saw at least 10 feet (3 m) from the fueling point before starting the engine;

— Do not allow other persons to be near the chain saw when starting or cutting with the chain saw. Keep bystanders and animals out of the work area;

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— Do not start cutting until you have a clear work area, secure footing, and a planned retreat path from the falling tree;

— Keep all parts of your body away from the saw chain when the engine is running;

— Before you start the engine, make sure that the saw chain is not contacting anything;

— Carry the chain saw with the engine stopped, the guide bar and saw chain to the rear, and the muffler away from your body;

— Do not operate a chain saw that is damaged, improperly adjusted, or not completely and securely assembled. Be sure that the saw chain stops moving when the throttle control trigger is released;

— Shut off the engine before setting the chain saw down;

— Use extreme caution when cutting small-size brush and saplings because slender material may catch the saw chain and be whipped toward you or pull you off balance;

— When cutting a limb that is under tension, be alert for springback so that you will not be struck when the tension in the wood fibers is released;

— Keep the handles dry, clean, and free of oil or fuel mixture;

— Operate the chain saw only in well-ventilated areas;

— Do not operate a chain saw in a tree unless you have been specifically trained to do so;

— All chain saw service, other than the items listed in the instruction manual(s) maintenance instructions, should be performed by competent chain saw service personnel. (For example, if improper tools are used to remove the flywheel or if an improper tool is used to hold the flywheel in order to remove the clutch, structural damage to the flywheel could occur and subsequently could cause the flywheel to burst.);

— When transporting your chain saw, use the appropriate guide-bar scabbard.

NOTE — This annex is intended primarily for the consumer or occasional user.

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Annex D
(informative)

Chain saw center of gravity and inertia measurements

D.1 Introduction

The center of gravity of the chain saw and the inertia of the chain saw about an axis passing through its center of gravity and perpendicular to the guide bar may be measured using the procedures in this annex, or equivalent. Measurements are to be taken with fuel tanks and oil tanks full.

NOTE—The following are examples only. Other technically adequate methods of making these measurements are acceptable.

D.2 Inertia measurement method A: Three-wire platform

D.2.1 Center of gravity

To determine the center of gravity, suspend the chain saw by the front handle and, dropping a plumb line from the point of suspension, mark a vertical line on the saw. Suspend the saw by the center of the rear handle and similarly mark a second line on the saw. The intersection of the two marked lines locates the center of gravity.

D.2.2 Taking measurements

Place the saw on the disc, drawing number EX4485C,[6] with the center of gravity aligned with the disc center as illustrated in figure D.1. The saw must be adjusted so that the guide bar is parallel and level to the platform. Rotate the platform through a 10° arc. Measure three time intervals of 20 cycles each. Compute average seconds per cycle for the 60-cycle sample.

D.2.3 Inertia computation

$$I_{chain\ saw} = K(W_1 + W_2)T^2 - I_t$$

where

$I_{chain\ saw}$ is the inertia of the chain saw (in-lb-sec^2)

I_t is the tare moment of inertia of the empty assembly (in-lb-sec^2). Refer to calibration procedure E.4;

W_1 is the weight of chain saw (lb);

W_2 is the weight of platform (lb);

T is the period of oscillation (sec/cycle);

K is the calibration constant.

D.3 Inertia measurement method B: Single-wire platform

D.3.1 Center of gravity

Place the saw in the single-wire facility as shown in figure D.2. The saw must be adjusted so that the guide is parallel to the platform. Rigid foam support blocks may be required under the guide bar to maintain the bar in a position parallel to the platform. Move the saw

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on two axes until the platform is leveled. When the saw is positioned so that the platform is level in all directions, locate the center of gravity of the saw by marking the saw through a centered hole located in the bottom of the platform.

D.3.2 Taking measurements

Rotate the platform through a large angle (90° - 180°) from the equilibrium position and release. Allow the assembly to rotate through six complete cycles. Measure the time interval to the nearest 0.1 second and compute the period of oscillation T(sec/cycle). Repeat the six-cycle measurement and compute the average of the two periods. Measure the length of the single support wire, L, in inches.

D.3.3 Inertia computation

$$I_{chain\ saw} = (KT^2/L) - I_t,$$

where L is the length of the support wire (in) and $I_{chain\ saw}$, I_t, T, and K are defined as in Method A (D.2.3).

D.4 Calibration of inertia platforms

To calibrate the inertia platform, place two calibration blocks equidistant from the center of the platform. Measure the period of oscillation, T, as described in D.3.2. Measure the distance, D, from the center of the platform to the center of gravity (CG) of the blocks. See figure D.3.

Repeat the above measurements for at least six different distances, D, with the blocks in positions ranging from near the center of the platform to near the outer edges of the platform. Repeat the period measurements without the blocks, that is, with the platform empty. Measure the weights of the blocks. Also, for the three-wire platform, measure the weight of the platform. For the single-wire platform, measure the length of the support wire with and without the blocks.

The two calibration blocks must be of the same size, weight, and shape. The blocks should be of a heavy material such as steel. The size and shape of the blocks should be selected so that, as nearly as possible, when the blocks are placed at various distances, the inertias of the blocks about a vertical axis through the center of the platform cover about the same range as the inertias of the chain saw to be measured.

When the calibration blocks are placed equidistant from the center of the platform as described above, the inertia equations can be written

$$(2W_bD^2/g) = KwT^2 - (I_t+2I_b)$$

three-wire platform,

$$(2W_bD^2/g) = (KT^2/L) - (I_t + 2I_b)$$

single-wire platform,

where

T is the period of oscillation (sec/cycle);

W_b is the weight of each calibration block;

I_b is the moment of inertia of the calibration block about its centroidal axis;

I_t is the tare moment of inertia of the empty assembly;

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D is the distance from the center of the platform to the CG of the calibration block;

L is the length of the support wire for the single-wire facility;

w is the weight of the platform plus the weights of the two blocks;

g is the acceleration due to gravity.

These equations are in the form of the straightline equation

$y = mx + b$,

where

$y=2W_bD^2$

and

x is the wT^2 for the three-wire platform;

x is the T^2/ L for the single-wire platform.

The calibration measurements described in this subclause are taken, and, for each placement of the blocks, the values of x and y are calculated. A least squares fit (linear regression) of this data will provide the slope, m, of the line. This is the value of the calibration constant K. Using this value of K and the period, T_0, measured with the empty platform, calculate the tare inertia of the facility, I_t

$I_t = KW_2T_0^2$ for the three-wire platform,

$l_t = KT_0^2/ L_0$ for the single-wire platform,

where

W_2 is the weight of the three-wire platform;

L_0 is the length of the support wire for the single-wire platform when empty;

T_0 is the period of oscillation with platform empty (sec/cycle).

An example of the calibration of the single-wire facility for measuring inertia follows.

Weight

Block 1 6.667 Ib

Block 2 6.666 Ib

Dimensions (inches)

Block 1 1.990 x 2.953 x 3.998

Block 2 1.988 x 2.952 x 3.997

Torsion Wire Length (L) with block 47-1/8 inches

Torsion Wire Length (L) without blocks 47-1/16 inches

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Approximate d (inches)	Measured d (inches)	TI (sec) (6 cycles)	T2 (sec) (6 cycles)	T (sec) (T1 + T2)/12
2	1.989	98.1	98.0	16.342
3	2.964	100.9	101.4	16.858
4	3.989	105.2	105.2	17.533
5	5.021	110.5	110.7	18.433
6	5.977	116.0	116.2	19.350
7	6.975	123.0	123.2	20.517
8	7.981	130.3	130.3	21.717
9	8.99	138.3	138.2	23.042
10	9.99	146.2	146.0	24.350
No Blocks		93.0	93.0	15.500

NOTE – d = 2D = distance between the centers of gravity of the two blocks.
D = d/2 = distance from the center of gravity of each block to the center of the platform.

Using the measured data, the values of x and y are calculated.

d = 2D	x (T^2/L)	y $(2W_bD^2/g)$ or $(W_bd^2/2g)$
1.989	5.668	0.03412
2.964	6.031	0.07578
3.989	6.524	0.13725
5.021	7.211	0.21746
5.977	7.946	0.30815
6.975	8.934	0.41965
7.981	10.009	0.54943
8.99	11.268	0.69714
9.99	12.583	0.86085

$y = Kx + b$

A least squares linear fit of this data gives a slope
$K = 0.1191$ in^2-lb (See figure E.4).

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The inertia equation becomes

$I = (0.1191\ T^2/L) - I_t$

Using the data measured without the blocks (empty platform)

$0 = (0.1191\ (15.50^2)^2/47.06) - I_t$

$I_t = 0.6080$ in-lb-sec^2.

The final equation for this facility becomes

$I_{chainsaw} = (0.1191\ T^2/L) - 0.6080$

where

T is in seconds;

L is in inches;

$I_{chain\ saw}$ is in in-lb-sec^2.

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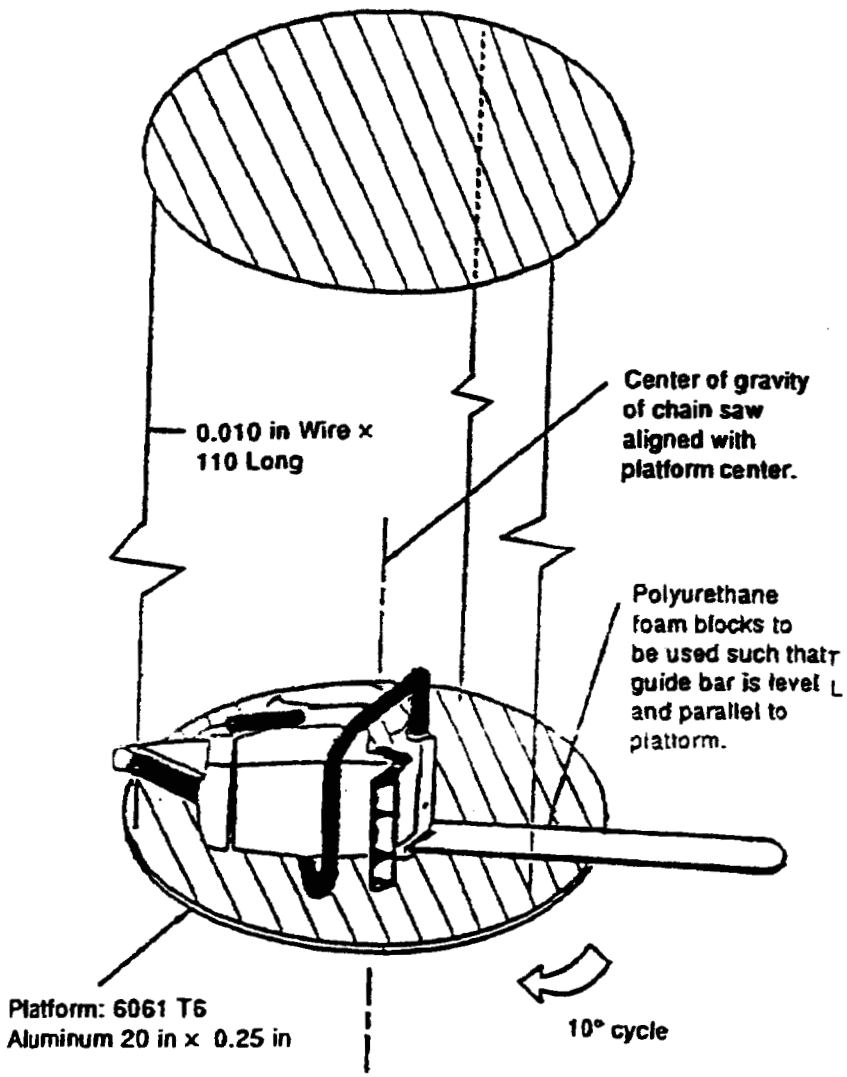


Figure D.1 – Three-wire facility for measuring inertia of the chain saw

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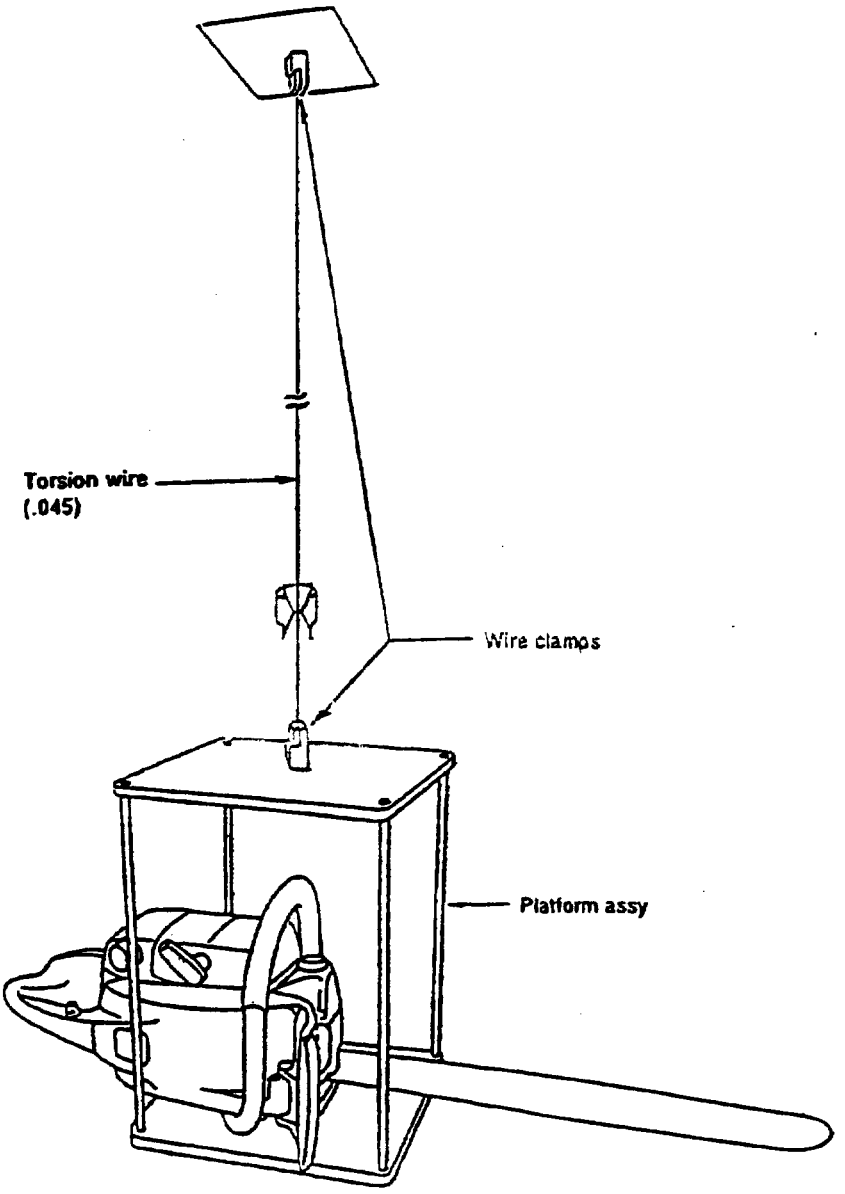


Figure D.2 – Single-wire facility for measuring inertia of the chain saw

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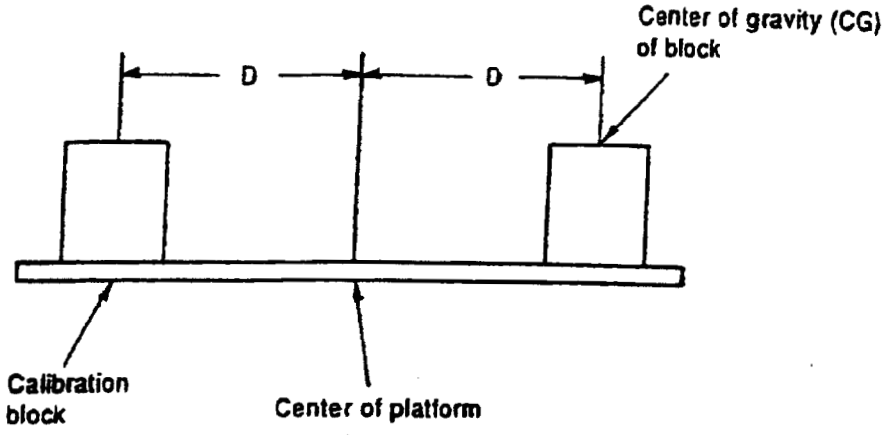


Figure D.3 – Calibration of inertia platform

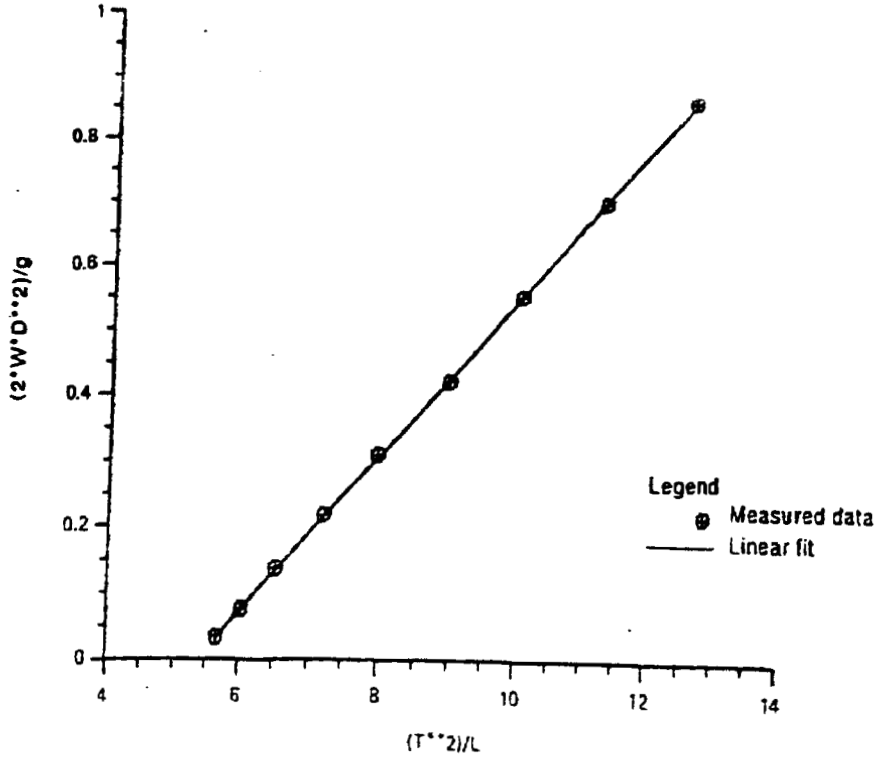


Figure D.4 – Calibration of single-wire device for measuring inertia of the chain saw

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Annex E
(informative)

Kickback machine — Chain saw balancing procedure

The following is a suggested procedure for balancing of the chain saw in the kickback machine.

NOTE — The terms "horizontal" and "vertical" used in the following refer to the orientation of the cradle. The "vertical" position of the cradle should be with the legs of the cradle pointing up, and the "horizontal" position with the legs pointing forward.

a) Locate the bracket (EX 4743)[4)] to achieve horizontal balance, being sure the bracket is oriented as shown in figure E.1. If horizontal balance cannot be achieved, then proceed to (b);

b) When additional mass is required to obtain balance, center the connection rod (EX 4742)[4)] in the bracket and locate the bracket to achieve horizontal balance, maintaining the orientation as shown in figure E.2. Attempt to achieve vertical balance by sliding the connection rod through the bracket. If balance cannot be achieved both horizontally and vertically, go to (c);

c) When additional mass is required:

1) Add the aluminum countermass (EX 5011)[4] to the connection rod in the orientation shown in figure E.3;

2) Move the bracket to achieve horizontal balance;

3) Locate the aluminum countermass along the connection rod to achieve vertical balance.

4) If balance cannot be obtained, repeat (1) through (3) using the steel countermass (EX 4744)[4)].

d) If any system cannot be balanced using this procedure, add suitable weights to achieve balance and document the added weight and its location on the data sheet. See figure J.2.

NOTE — When system balance is achieved, configuration may be recorded on Form J.2 in annex J. Documentation should include the location of the rear handle brace(s) on the cradle and notation of which countermass (aluminum or steel) was used.

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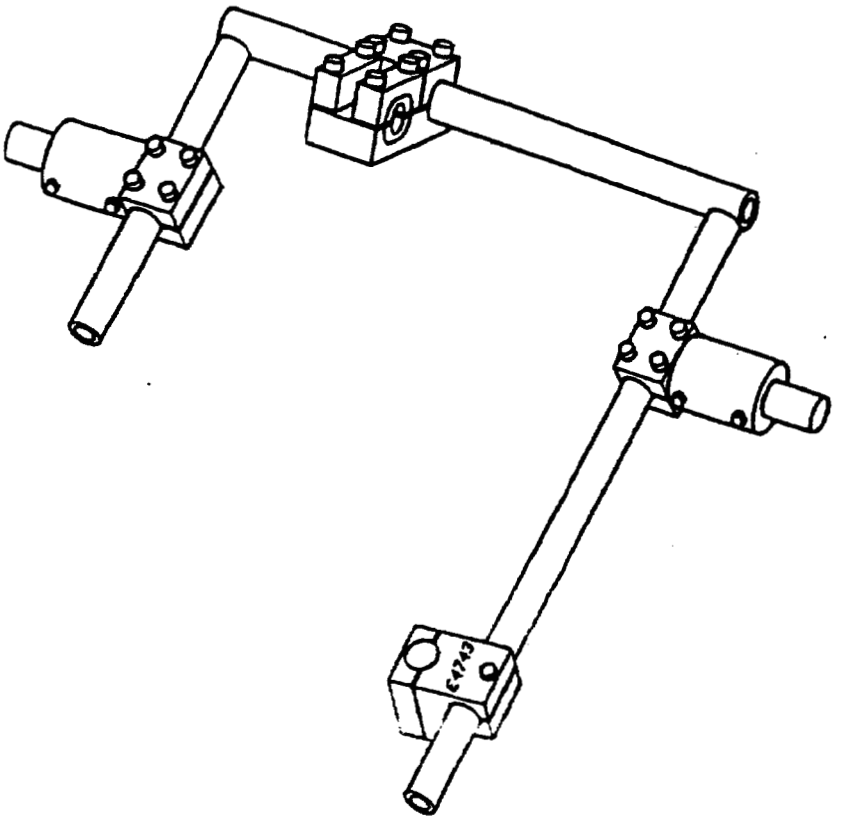


Figure E.1 – Balancing procedure – Addition of bracket

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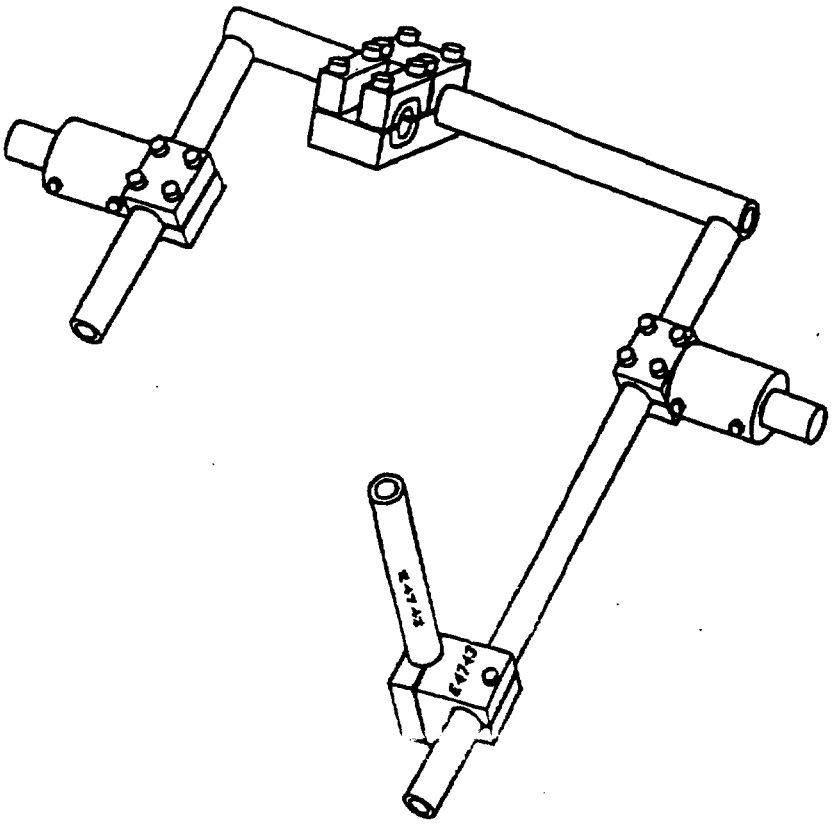


Figure E.2 - Balancing procedure – Addition of connection rod

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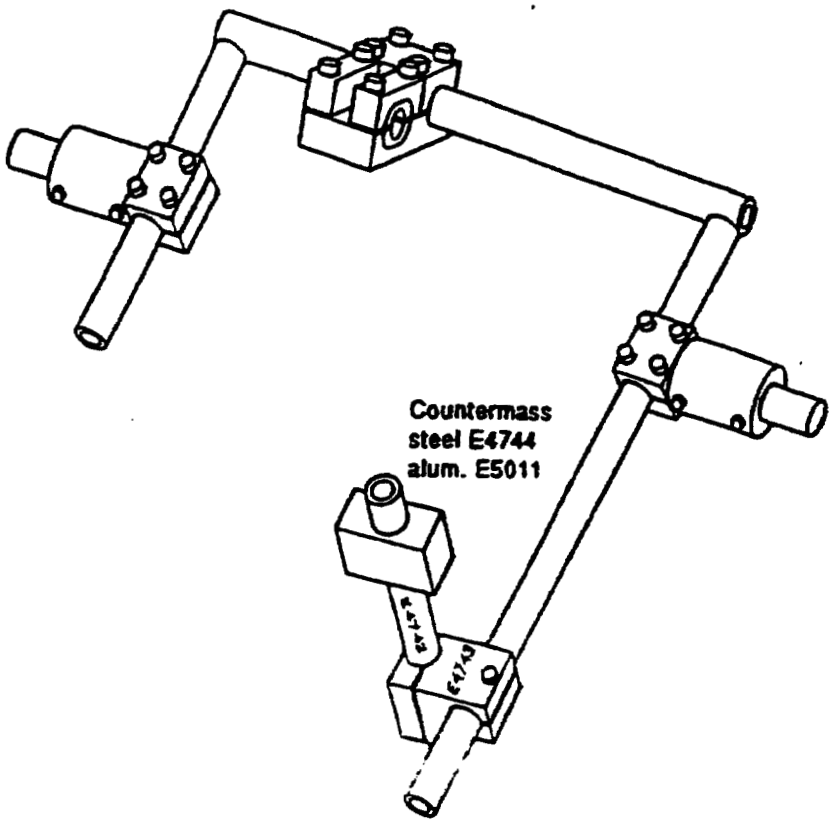


Figure E.3 - Balancing procedure – Addition of countermass

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Annex F
(informative)

Kickback machine — Horizontal system

F.1 Introduction

Carriage weight is to be in accordance with Drawing EX 4201 (with MDF_specimen)[4]. Horizontal friction must be measured prior to and after kickback energy tests using procedures in this annex, or equivalent. Pulleys for restraining weights system must spin freely. Alignment of the carriage bearings may be accomplished in accordance with procedure F.2.

F.2 Carriage bearing alignment

The average of the horizontal friction measurements in the direction of travel away from the powerhead must not exceed 0.5 lb (0.23 kg).

a) One bearing should be adjusted with the other one loose. After adjustment, note the position of the adjusting screw when the first bearing is aligned;

b) Loosen the first bearing, then adjust the second;

c) When loose, each bearing should be tightened until it starts to grip the shaft. The tightening should be stopped just before an increase in the force required to move the bearing is felt;

d) The first bearing is then returned to its proper setting.

F.3 Horizontal friction test method A

F.3.1 Preparation

Attach weights to the carriage, with MDF sample installed, to equal the weight of the chain saw.

F.3.2 Taking measurements

a) Connect the friction-measurement weight cup to the carriage;

b) Add sufficient weight to the cup assembly to cause the carriage to move at least 12 inches (with the ratchet in place). If friction exceeds 0.5 lb (0.23 kg), clean the bearings and adjust the machine as required to bring the friction level below 0.5 lb (0.23 kg).

F.3.3 Horizontal friction computation

Horizontal Axis Friction = $W_1 + W_2$,

where

W_1 is the weight of cup assembly (lb);

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W_2 is the added weight (lb).

F.4 Horizontal friction test method B

a) Attach a 0.5-lb (0.23-kg) weight and cable assembly to the carriage;

b) If the weight causes the carriage to travel at least 12 in (30.5 cm), the friction level is within tolerance;

c) Adjust the horizontal system to reduce frictional level if necessary.

NOTE — Horizontal kickback energies are to be computed with a frictional level of 0.5 lb (0.23 kg).

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Annex G
(informative)

Kickback machine — Rotary system (with saw in place)

G.1 Introduction

Rotary friction must be measured prior to and after kickback energy tests, using the procedures outlined below, or equivalent. Pulleys for restraining the weight system must spin freely. Alignment of the rotary bearings may be accomplished per procedure G.2.

G.2 Rotary bearing alignment

The average of the rotary friction measurement must not exceed 0.5 lb (0.23 kg), the rotary bearings should be checked for alignment and adjusted.

a) Remove the rotary machine parts and place a 1 inch X 44 inch (2.54 cm X 112 cm) alignment shaft through the rotary bearings;

b) Level the alignment shaft;

c) Adjust the pillow blocks and bearing plates so that the alignment passes easily through the bearings and rotates freely.

G.3 Rotary friction test method A

G.3.1 Preparation and measurement

a) Attach the friction-measurement weight cup (EX 5230)[6] to the rotary pulley with the cradle legs horizontal;

b) Add sufficient weight to the weight cup to cause a saw rotation of at least 180° with ratchet pawls in place;

c) If the rotary friction exceeds 0.5 lb (0.23 kg), clean and adjust the bearings to bring the friction level within tolerance.

G.3.2 Rotary friction computation

Rotary axis friction $=f_r = W_1 + W_2$,

where

W_1 is the weight of cup (lb);

W_2 is the weight added to cup (lb).

G.4 Rotary friction test method B

a) Attach a 0.5-lb (0.23-kg) weight and cable assembly to the rotary pulley, ratchet pawls in place.

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b) If the 0.5-lb (0.23-kg) weight causes the saw cradle assembly to rotate from horizontal (0°) through at least 180°, the friction level is within tolerance.

c) In rotary kickback energy computations, use 0.5-lb (0.23-kg) rotary friction.

NOTE — In saws with soft isolator systems, the center of gravity shifts as the saw and cradle rotate. If shifting of the center of gravity of the saw prevents accurate friction measurements, a substituted saw of approximately the same weight may be used for friction measurements.

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Annex H
(informative)

Velocity adjustment

H.1 Scope

This annex establishes a procedure for adjustment of the carriage velocity.

H.2 Preparation

a) Set the MDF angle to 30°. Move the carriage so that the MDF contacts the saw chain. Adjust the position of the rack/horizontal restraining assembly so that the cable section from the carriage to the pulleys is vertical. See Figure 15.

b) Measure and record the distance between the actuation points of the velocity probes. Be sure the probes are located in the free-travel range, that is, in the range before the restraining weight is lifted.

c) Reset the MDF sample to the initial test condition.

H.3 Adjustments

Release the carriage to locate the release point for test conditions of 30 in/s ± 0.5 in/s (0.76 m/s ± 0.013 m/s).

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Annex J
(informative)

Kickback fixture test record

The following test forms (figures J.1 and J.2) may be used to record the results of the kickback tests.

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KICKBACK FIXTURE TEST RECORD

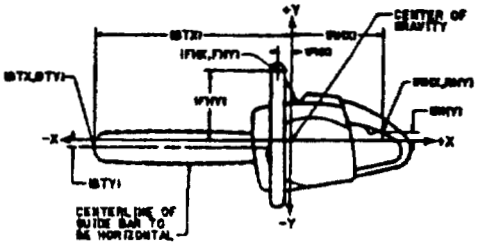
LABORATORY _____
DATE _____
TECHNICIAN _____
TEST NUMBER _____

TEST COMBINATION

SAW MODEL/MFG'R.		CHAIN TYPE/MFG'R.	O.L. COUNT
SERIAL NO.		CUTTER TYPE	
DISPLACEMENT		SEQUENCE	
SAW WEIGHT		CONDITION	D.G. SETTING
CARRIAGE WT.:	MATCHING WT.:	PITCH	GAUGE
INERTIA		GUIDE BAR	
ROTARY FRICTION		NOSE TYPE	GAUGE
HORIZONTAL FRICTION		BAR PART NO./MFG'R	
CLUTCH SLIP SPEED		DRIVE SPROCKET TYPE	TOOTH COUNT

CHAIN SAW HANDLE AND BAR TIP COORDINATES, LEFT SIDE VIEW

BTX		FHX		HRX	
BTY		FHY		HRY	



CHAIN BRAKE SUMMARY

RELEASE FORCE	LBS	R1:
LBS-2.2 LBS	LBS	R2:
ANGLE OF ACTUATION A2	DEGREES	R3:
CHAIN STOPPING TIME T3	SEC	R4:

DATA SUMMARY

DATA SET NO.	CONTACT ANGLE (°)	RPM X 10^3	AVG. HORIZONTAL ENERGY (IN-LBS)	AVG. ROTARY ENERGY (IN-LBS)	CKA (°)

DATA SET NO.	CONTACT ANGLE (°)	RPM X 10^3	AVG. HORIZONTAL ENERGY (IN-LBS)	AVG. ROTARY ENERGY (IN-LBS)	CKA (°)

PEAK AVG. ROTARY ENERGY _____ IN-LBS

AVG. ROTARY ENERGY AT PEAK CKA _____ IN-LBS

COMPUTED KICKBACK ANGLE

CKA WITHOUT BRAKE

_____ DEGREES

ENERGY SPLITS

HORIZONTAL	VERTICAL	ROTATIONAL

CKA WITH BRAKE

_____ DEGREES

CHAIN STOP ANGLE _____ DEGREES

ENERGY SPLITS

HORIZONTAL	VERTICAL	ROTATIONAL

COMMENTS _____

Figure J.1 – Kickback test record

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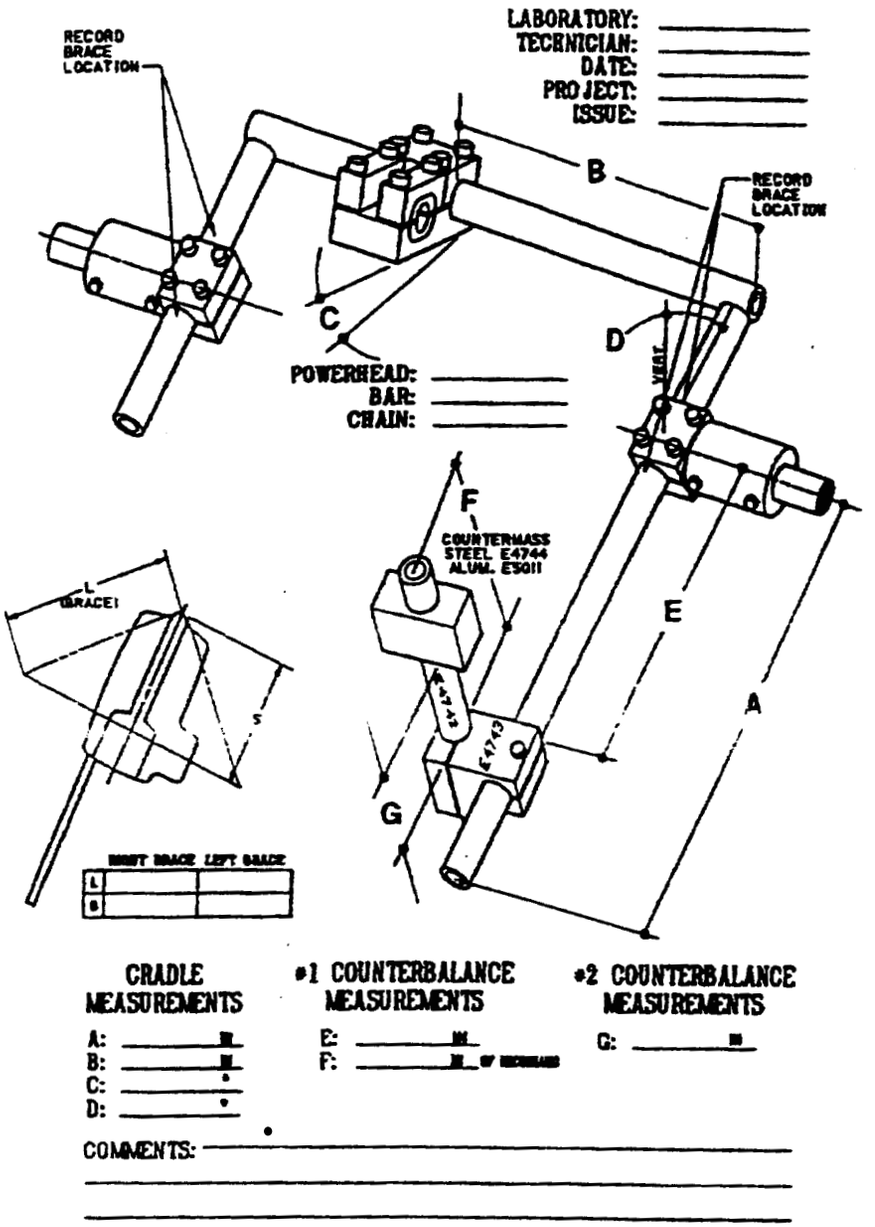


Figure J.2 – Chain saw installation and balancing test record

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Annex K
(informative)

Index to chain saw labeling requirements

Subsection

5.3.1.2 Engine "off" or "stop" control
5.3.3 Manual choke control
5.3.4 Primer control
5.4.1 Fuel tank and oil tank filler caps and openings
5.7.2 Bow guide warning
5.11.3.1 Kickback statements on powerheads
5.11.3.2 Replacement bar and chain on powerheads below 3.8 c.i.d.
5.11.3.3 Kickback warning on powerheads 3.8 c.i.d. and above
5.11.3.4 Replacement saw chain
5.14.1 Caution label Instruction manual(s) reference
5.15 Label durability requirements

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Annex L
(informative)

Bibliography

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ISO 6534: 1985, Forestry machinery — Portable chain saws — Front-hand guard — Determination of strength [1)]

ISO 6535: 1983, Forestry machinery — Portable chain saws — Chain brake — Performance [1)]

ISO 7182: 1984, Acoustics — Measurement at the operator's position of airborne noise emitted by chain saws [1)]

ISO 7505: 1986, Forestry machinery — Measurement of hand-transmitted vibration [1)]

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