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Safe working methods with top-handled chainsaws

Prepared by **Treevolution**
for the Health and Safety Executive

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This report presents the results a of research project carried out to identify safe working methods for use with top-handled chainsaws. These chainsaws are fundamentally different from conventional chainsaws in that they can be operated with one hand. This report identifies safe working methods for using them in all situations in which an arborist may expect to operate. In the exceptional circumstances in which one-handed operation is desirable, the methods and techniques described in this report will enable the operations to be carried out with the minimum of risk of injury to the operator.

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1. INTRODUCTION

For the past ten years the HSE has had concerns over the safety of the use of top-handled chainsaws. These chainsaws are of a fundamentally different design to conventional chainsaws in that the rear handle is positioned on the top of the machine. This allows the chainsaw to be used one-handed. It is the expressed opinion of the HSE that this design ignores one of the fundamental design aspects of conventional chainsaws, namely that they should be held with both hands when being operated. One-handed use can result in the operator having less control over the chainsaw. In one-handed use the saw may skate, bounce or kick back on contact with the material being cut, or may come into contact with the operator's free hand/arm if used incorrectly.

Until now, the policy of the HSE has been to:

- make an input into the safe design of top-handled chainsaws through the standard set out in ISO EN Standard 11681-2 (1998).
- restrict the use of top-handled chainsaws to competent, trained operators.
- confine the use of top-handled chainsaws to off-ground work.

The arboricultural and forestry industries have been active in promoting specific training in the correct use of top-handled chainsaws and have produced operational guidance in the form of FASTCo *Safety Guides*.

However, despite these efforts, the number of accidents to trained, competent operators has remained unacceptably high. Of greatest concern have been two recent accidents where the operators had top-handled chainsaw contact with their necks, narrowly missing vital blood vessels.

The HSE's concerns about these chainsaws are shared with other EU member states, and particularly Denmark. The Danish authorities have for some years banned the sale of top-handled chainsaws in Denmark, and when ISO EN 11681-2 was published as a harmonised standard they launched a formal safeguard action against the standard. This safeguard action led CEN to seek an early revision of the standard with a view to improving the safety of top-handled chainsaws. However, technical improvements may be reaching their limits and, without change to their fundamental design (i.e. their ability to be used one-handed), they will always require the operator to use appropriate safe working methods.

While ISO EN 11681-2 sets out instructions to the operators of top-handled chainsaws, it does not deal with how operators need to position themselves when working from a rope and harness in order to maintain maximum control over the saw and minimise the risk of injury. Better guidance on appropriate working techniques would also be beneficial to trainers who run courses on the use of the chainsaw from a rope and harness.

Accordingly, research was needed in order to establish and promote safe working methods when using top-handled chainsaw. A contract was duly granted to *Treevolution* to carry out the research during November/December 2000. This report presents the results of this research.

2. AIMS AND OBJECTIVES

The aim of this research project was to determine safe working methods that minimise the risk of injury when using top-handled chainsaws.

The research carried out was concerned with:

- determining general safe working practices for top-handled chainsaws.
- determining the work positioning techniques to be adopted by arborists when working from a rope and harness in order to:
  - allow, where possible, the operator to hold the saw with both hands.
  - allow the saw to be safely used one-handed where it is not possible for it to be held with both hands.
- recording the required work practices and techniques in a report which includes all relevant photographs and diagrams.

3. METHODS USED

The research involved a step-by-step analysis of work with a top-handled chainsaw. The work on general safe working practices included:

- checking and starting the chainsaw.
- getting the chainsaw to the operator in the tree.
- procedures for keeping the chainsaw away from climbing lines and other arborist equipment.
- actions necessary for dealing with problems that might arise (e.g. a trapped saw).

Work positioning considerations were made of a variety of tasks in a variety of tree species. Amongst other aspects, the research covered consideration of crown reduction and crown thinning in trees with a variety of branching habits (e.g. open, close, coniferous etc.)

The research studies looked at the efficient and safe work positioning required to maintain control of the chainsaw in both two-handed and one-handed operation, and sought to define where two-handed and one-handed use are respectively appropriate. Particular attention was paid to the methods required to enable one-handed use to be undertaken with minimum risk of injury to the operator.

Appropriate photographs were taken by a photographer competent to climb alongside the research worker. Where appropriate these photographs were worked into line drawings that demonstrated clearly the relevant techniques and methods.

4. GENERAL SAFE WORKING PRACTICES

Before a top-handled saw is put to work in the canopy of a tree, steps should be undertaken in the field at ground level to ensure that the chainsaw is fit for use.

The Forestry & Arboriculture Safety & Training Council (FASTCo), in their Safety Guide (SG) 308 entitled *Top-Handled Chainsaws*, advises operators to undertake adequate pre-start checks, appropriate fuelling and starting procedures, and adequate pre-work checks. These may be undertaken by the climber (competent in top-handled chainsaw use) before leaving the ground, by a ground worker (competent in basic chainsaw techniques and maintenance), or by a trainee under the supervision of a competent chainsaw operator.

Appropriate Personal Protective Equipment (PPE) should be worn by the climber and ground person(s) likely to start the chainsaw on the ground. Guidance is given for appropriate PPE for the climber in FASTCo SG 401 *Tree Climbing Operations* and for ground workers in FASTCo SG 301 *Petrol Driven Chainsaws*.

Operators of both rear-handled and top-handled chainsaws must be competent under the *Provision and Use of Work Equipment Regulations 1998* (PUWER 98) as demonstrated by the achievement of an appropriate national competence award. They should also be familiar with industry best practice as advised by FASTCo in the following Safety Guides:

- SG 402 *Aerial Rescue*
- SG 403 *Mobile Elevating Work Platforms*
- SG 801 *Noise and Hearing Conservation*
- SG 802 *Emergency Planning and First Aid*
- SG 804 *Electricity at Work: Forestry & Arboriculture*

5. PRE-START CHECKS

The chainsaw should have certain safety features as advised by the Health and Safety Executive (HSE) in their booklet *Chainsaws at Work* and by FASTCo in SG 308. For top-handled chainsaws these features are:

- A clearly marked positive on/off switch.
- A front hand guard that incorporates a chain brake mechanism.
- A chain catcher.
- Anti-vibration mounts in good condition.
- A throttle interlock (also known as a dead man's handle) that will not allow the throttle to be squeezed unless depressed.
- A suitable means for attaching a strop (a short length of rope or webbing) to the rear of the saw.
- An exhaust silencer in good order.
- Properly fitting fuel and oil caps and seals.

In addition to adequate and intact safety features, the chainsaw should be checked over to ensure that the casings are assembled properly and the fixing screws and nuts are adequately tensioned. The saw chain should be sharpened and correctly tensioned, and should run freely along the bar for its entire length. The bar and chain should not show signs of excessive wear or overheating, and the starter cord should be properly tensioned and in good condition.

Before the saw is started from cold, it should be checked to ensure that it has a full tank of petrol/ 2-stroke oil mix and a full tank of chain oil.

6. FUELLING, STARTING PROCEDURES AND PRE-WORK CHECKS

The saw should be fuelled and lubricated appropriately on the ground at least four metres away from the work/starting zone (FASTCo SG 308). Whenever the saw is fuelled with petrol / 2-stroke oil mix it should also be filled with appropriate oil for chain lubrication. Care should be taken to ensure that the fuel and oil caps are tightened properly and not so excessively as to damage the cap, threads and seals.

Photograph 1
Cold start on the ground

After fuelling, the person starting the chainsaw should move at least four metres from the working or fuelling areas to some clear ground. The following procedure should then be carried out when starting the saw from cold, after undertaking the pre-start checks:

- The saw should be placed on the ground with the bar nose pointing away from any nearby objects, and with the chain clear of the ground.
- The left hand should be placed on the top of the front handle and the right knee should be dropped on to the rear of the top handle.
- The starter handle should be held with the right hand.
- The chain brake may be applied, depending upon the manufacturer's recommendations.
- Once started, the half-throttle lock should be disengaged and the saw warmed up **on the ground**. With the saw still on the ground, it should be accelerated to full revs and the chain brake applied, momentarily keeping the saw under full revs in order to ensure that the chain brake does not slip under load (refer to specific manufacturers' recommendations). The saw must not be used if the chain brake is ineffective.

- The operator, holding the saw, should then stand up with the chain brake on, roll the saw from side to side and swing it gently from side to side by its strop in order to ensure that it ticks over properly whilst hanging upside down as it would from a climber's harness (minor adjustments to the carburettor may be required).
- Holding the saw with both hands, the chain brake should be released and the saw allowed to tick over. The chain must not creep at tick-over speed. If it does, the chain may be loose, the clutch springs may be worn, or minor carburettor adjustments may be required. No attempt should be made to touch and/or re-tension the chain until the saw has been switched off and the chain cooled down.
- The saw should then be switched off. If the stop switch is found to be ineffective, the chain brake should be applied and the saw flooded (in order to stop it) by activating the choke. The saw must then not be used until the stop switch has been **positively** repaired.
- With the engine switched off, the saw should be checked to see if it is oiling properly by visually checking for a film of oil on the chain. (Modern oil pumps and some chain designs are low consumption and, consequently, looking for oil flung onto a light coloured surface may not be sufficient to determine adequate oil flow.)
- Also with the engine switched off, the chain should be checked to see if it is either too tight or too slack, and it should be re-tensioned if this is required.

If conditions prevent a ground start (e.g. deep snow or 'brash'), the saw can be started from cold by holding the body of the saw between the knees. However, care must be taken if the exhaust is mounted to the side / rear of the saw, as revving such a top-handled saw in the knee-start position may melt some designs of chainsaw protective trousers! Alternatively, the saw can be started by applying the chain brake and thrusting the saw away from the body with the **left** hand whilst pulling hard on the starter cord with the right hand.

Photograph 2
Warm start on the ground

When starting the saw in the standing position, the same pre-work check and starting routine must be followed as for cold starts on the ground, but with the saw held in a comfortable and safe position around the top of the thighs (but **not** with the saw held at arms length or with the left hand on the top handle).

7. SENDING THE SAW TO THE CLIMBER

Four different methods of sending the saw to the climber were investigated, namely:

Method A
The most common method of sending a saw aloft is by attaching it to the saw's strop at chest height using a marlin-spike hitch tied in the climber's lifeline. Care should be taken not to tie a slipped-hitch as this can pull through, either by the weight of the saw or through the saw becoming jammed in branches, particularly if the knot is tied close to the end of the rope. Alternatively, the saw can be tied on to the climber's lifeline via its front or top handle with a double figure-of-eight knot (see **photograph 6** overleaf). (NB When a top-handled saw is suspended from its top handle, the saw rests in a horizontal position, making it more prone to becoming caught when being hauled up.)

Photograph 3
Lanyard attached to saw with connector and additional eye

Photograph 4
Marlin-spike hitch

Photograph 5
Slipped hitch

Whenever a saw is to be sent to a climber, **the saw should be switched off** with the chain brake applied. A snap or karabiner on the saw's strop is then clipped into the loop and the saw is hoisted up by the climber. Karabiners with a self-locking gate are less likely to open and it is not possible for the locking operation to be overlooked. A plain gate can easily twist off the harness, whilst screw gates have a tendency to unscrew with vibration. Plain-gate *swivel*-type snaps are less likely to twist off the tool ring, but if they are used for this application they should have a stiff gate action.

Photograph 6
Figure-of-8 knot to top handle

Photograph 7
Friction hitch with micro-pulley and saw clipped between

Method B

It may not be possible for the climber to hoist the chainsaw along the route that has been used for ascending or work positioning. Closely juxtaposed branches and /or a pull from a hard side angle may cause the saw to jam between branches. In such situations, the climber's line will need to be re-directed before retrieval of the saw is possible. A fast, ergonomic and safe technique can be applied as follows, using any friction hitch incorporating a micro-pulley:

- Once the climber has reached the chosen work position / final anchor point, slack is pulled from a point between the friction hitch and the pulley. This sends a loop of slack directly to the ground.
- The ground worker then clips the saw directly into the loop via its strop without tying a knot. The ground worker then pulls on the climber's line, thereby sending the saw up to the climber via the climber's micro-pulley whilst the climber's line is automatically re-directed to its original position.
- When the saw reaches the climber, it can be attached to the harness with a lower risk of dropping the saw (as in chapter **8**, below).

Method C

If the climber attains a suitable anchor point from the ground by means of a throw-line followed by the installation of a friction saver and 'footlocking' to the desired work height, the saw can be sent to the climber by the following method:

- The climber ties into the tree with a lanyard and loosens (but does not remove) the 'footlock' friction hitch. This latter action prevents the lifeline drifting out of reach before it is tied in to the work system. The use of double ascenders in place of a footlock friction hitch would enable the saw to be pulled up totally secured from a fall (alternatively, similar security can be achieved by removing the footlock system and tying the work positioning friction hitch to the lifeline).
- The ground worker then clips the saw into the dead end of the lifeline (using an approved knot, eye splice or karabiner) and hauls the saw up to the climber.

- When the saw reaches the climber, it is secured to the harness (as in chapter **8**). The climber then clips into both the end termination of the lifeline and the friction hitch and resumes work.

Method D

The saw can be hauled up directly by the climber after first clipping the friction hitch, at arms length, into the lifeline using a marlin-spike hitch. This technique requires momentarily transferring weight to a supplementary anchor while re-positioning the friction hitch. It is therefore only recommended where the supplementary anchor can safely support the climber's weight and therefore **not** at the tips of branches. This method works well in a tall tree where the climber does not have sufficient rope to allow re-direction of the lifeline so that the ground worker can haul up the saw. It automatically redirects the line to its original position and is far more ergonomic than method A.

Photograph 8
Saw clipped into end of line

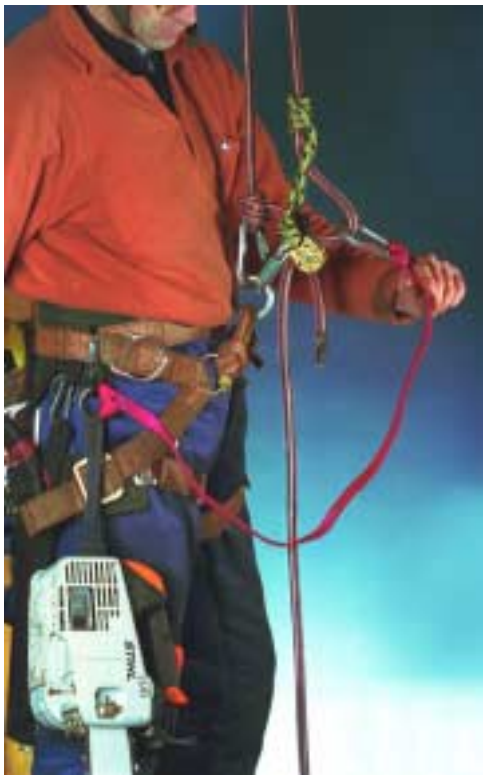
Photograph 9
Friction hitch and micro-pulley for self-hauling of chainsaw

8. SECURING THE SAW TO THE HARNESS

The method of securing the chainsaw onto the harness can provide an opportunity for accidentally dropping the chainsaw. For this reason, persons should not stand directly under the climber until the saw is safely attached to the harness. Using a chainsaw strop with an additional eye or karabiner can reduce the chances of this happening. This allows the strop to be attached to the harness while holding the saw and before it is released from the climbing line. These types of strop also allow the saw to be clipped directly and/or closer into the harness whilst not in use. This prevents the saw from whipping over a branch and striking the climber should there be a slip or swing whilst branch walking – it also eases climbing by keeping the saw out of the way of obstructions. The saw should be switched off when clipped directly into the harness, in order to prevent injury if the chain brake becomes accidentally disengaged.

The saw may be attached to the harness on the back strap at the centre of the harness (if a purpose designed attachment point is provided), or to one of the sides. In general, the saw should only be clipped to recommended attachment points, particularly as these may incorporate breakaway designs (refer to manufacturers' specific requirements). Whilst sitting in the harness, the saw may be hung from the lifeline attachment points in order to take weight off the hips. However, at times this can make branch walking difficult.

Photograph 10
Attachment of saw strop to harness



Photograph 11
Saw clipped high

Whichever method of attachment is used, keeping the saw on the opposite side of the harness from the adjustable lanyard will prevent entanglement and damage to the lanyard from the saw chain. Clipping the saw to the centre of the back will achieve the same effect, with the added benefit of aligning the weight of the saw centrally down the spine.

Where pruning of branch tips only involves the use of a handsaw, the chainsaw may be detached and hung in the tree. The saw can then be picked up on return to the trunk before re-positioning. When detaching a chainsaw care must always be taken to prevent accidental dropping. This can be achieved safely by setting a sling around a branch and clipping the saw into it whilst it is still attached to the harness. Alternatively, the chainsaw strop can be chokered around the branch directly. Awareness of activity below must always be maintained when detaching the chainsaw.

9. SECURING THE WORK POSITION

The climber will normally proceed to the work position before starting the saw. Before starting the saw safely, the climber must be securely positioned. When working closer in along branches with good overhead line angles the climber may feel that good footing is all that is required to secure a work position. Very shallow overhead line angles may require additional support from an adjustable lanyard secured to the branch, from a re-direct, or from a second climbing line system (which can be arranged either with the other end of the lifeline or with a completely separate lifeline). This will help prevent a swing or a cutting accident should the climber lose footing, especially whilst using the chainsaw.

Photograph 12
Work positioning lanyard

Photograph 13
Re-direct

It may also be necessary to fashion a foot stirrup from an endless sling (see **photograph 15** overleaf) in order to assist in holding a position. A supplementary anchor point should also be applied whenever there is a risk of severing the primary lifeline (e.g. when working close against the stem). These work positioning techniques are in keeping with industry best practice as advised in the Arboricultural Association and FASTCo booklet *A Guide to Good Climbing Practice.*

If the work positioning lanyard is being used to prevent a pendulum swing, it may be clipped to any of the work positioning D-rings or attachment points on the harness as they will not be supporting most of the climber's weight. If the lanyard is being used to prevent a fall in the event of a lifeline being severed, it should be attached to both side D-rings to support the climber adequately. It was found that the lanyard hindered the cutting operation in some situations when used from side 'D' to side 'D'. This was overcome relatively easily, however, by chokering the lanyard to a suitable branch and attaching to a central harness attachment.

Photo 14
Supplementary anchor using end of climbing line

Photograph 15
Endless sling as foot stirrup

Photograph 16
Cutting in close proximity to lifeline - lanyard attached D to D

Photograph 17
Cutting in close proximity to lifeline - lanyard to front D and chokered to tree

Photograph 18
Endless sling chokered to tree with lanyard attached

Photograph 19
Correct chokering of karabiner against tree

When chokering with a karabiner, it is important to avoid side loading the spine, especially on small diameter wood. If the lanyard cannot be safely chokered to a branch, an endless sling or a running bowline tied in to the end of the lifeline can first be slung and then clipped into. This technique also supports the climber properly in the event of the primary lifeline being severed. Appropriate equipment for work positioning should be used as advised in FASTCo SG 401 and *A Guide to Good Climbing Practice*.

10. STARTING THE SAW IN THE TREE

Once the work position has been reached and secured, the climber must decide on the best way to start the saw. This is normally dictated by the way(s) in which the tree's form and the work position will allow the saw to be started, as much as by safety and ergonomic considerations. The saw may be started either to the right side or to the left side of the climber. The chain brake should be applied and the saw thrust with either the left or right hand (see note below) whilst engaging the starter mechanism (FASTCo 308). The saw was found to be more stable when held with the right hand, and in this position the throttle could be activated easily. When the saw was held with the left hand, it tended to rotate toward the climber when the starter mechanism was engaged. Both methods have their dangers, especially when starting the saw with half-throttle from cold. However, these dangers are greatly mitigated by the **chain brake being engaged** and the saw being thrust away from, and quite often below, the body.

What *was* found to be uncomfortable and of higher risk of injury was starting the saw on the right-hand side of the body whilst holding the saw with the left hand and vice versa. This technique places the saw too close to the body to allow the saw to be started safely.

Photograph 20
Starting the saw –
right hand on top handle

Photograph 21
Starting the saw –
left hand on front handle

It is of interest to note that industry best practice currently dictates that:

- **In training**, the technique taught should be to hold the front handle with the left hand and the starter handle with the right hand.
- **At assessment** (and therefore in general use), it is acceptable for a candidate to hold the top handle with the right hand and the starter handle with the left hand (with the chainbrake applied).

Starting a top-handled saw tends to be easier than with most rear-handled saws due to the lower weight and compression and the compact size of the top-handled saw. Care must always be taken to ensure that the saw is started away from any climbing and rigging equipment, the body and parts of the tree.

The chain brake should always be engaged before lowering a running saw onto its strop, as otherwise the chain may creep and damage the lifeline.

11. FREEING A TRAPPED SAW

From time to time it is likely that an operative will have to contend with a trapped saw. Industry best practice (NPTC Chainsaw Scheme: *Performance criteria and standard questions and answers*) advises that the saw should be released by the following procedure:

- Switch off the saw and attach it to the tree inboard of the cut or to a separate tool line.
- Pull the saw from the kerf whilst lifting the branch as necessary (this is easier with the chainbrake off).
- If necessary, use a second saw to release the trapped saw by cutting a minimum of twelve inches away from the trapped saw.

The third stage in this process relates to the use of a second chainsaw and the need to prevent a clash of blades resulting in kickback. In some species prone to splitting, an additional undercut may also be required when cutting twelve inches (30cm) along from the original. However, before resorting to hauling up a second chainsaw, consideration should be made of using the handsaw, which should always be carried for completing small cuts, self rescue and freeing a trapped saw (this is regarded as industry best practice).

Photograph 22
Freeing a trapped saw with a chainsaw (also showing the trapped saw clipped to lifeline)

Photograph 23
Freeing a trapped saw with a handsaw

It was found that if the chainsaw was trapped while completing an undercut on a smaller section (of the order of 15cm or less), the saw could be easily and safely freed by the following procedure (depending on the size of the handsaw):

- Switch off and secure the chainsaw inboard of the cut (toward the branch union).
- With the handsaw, place an outboard (toward the branch tip) top cut at a suitable distance away from the under cut (approximately 10cm). This completes a step cut using the kerf in which the saw is trapped. The branch breaks free leaving behind the saw (which may drop clear).

It was found to be unnecessary to cut as far away as 12 inches from the original undercut, as a handsaw could be safely used in closer proximity without the risk of striking the bar of the chainsaw (i.e. no risk of kickback). Cutting in closer proximity also allowed the undercut formed by the trapped saw to be utilised rather than wasting energy cutting a new undercut with the handsaw.

Whether a handsaw or a chainsaw is used to free a trapped saw, the release cuts should always be outboard (toward the tips of the branch), in order to prevent the trapped saw being taken with the section and further complicating the situation.

Where a cut section is too large or too weak to secure the strop to, it was found that the trapped saw could be clipped to the primary lifeline below the anchor point on the harness, rather than to a separate tool line (see **photograph 22** on the previous page). By this method, the lifeline (which has more than adequate safety reserves) is able to absorb the minor shock of the falling saw instead of the climber absorbing it. However, if the climber were to *incorrectly* cut inboard of the stuck saw, there is a possibility that the section could take the saw with it and thereby overload the anchor point! Hence, this should only be done as a last resort and with extreme caution. Depending on the situation, it may be hazardous to both the climber and others to spend time requesting and hauling a tool line.

If the saw becomes trapped whilst cutting an easily-handled section (sometimes done deliberately, see chapter **13**), it was found to be far more efficient and controlled to adopt the following procedure:

- Switch off the saw.
- With one hand, hold the chainsaw strop close to the saw.
- With the other hand, lift the end of the section slightly to release the saw.
- Lower the saw onto its strop by allowing the strop to slide through the hand.
- Lower the section slowly to allow the kerf to close gently.

The removal of upright sections may present another opportunity for a saw to become trapped. If the section can not be easily manhandled, has no positive lean, or there are windy conditions, before cutting commences a pull line must be attached in order to provide control. Industry best practice (NPTC *Chainsaw Assessment Schedule: Performance criteria - unit 41*) requires the use of a pull line for free-fall and roped sections. If a section sits back without a pull line attached **the situation becomes hazardous.** The following procedure should be adopted:

- Switch off the saw, disconnect the saw from the harness and secure it to the stem or side branch below the cuts. If the saw cannot be attached to the stem (because the stem is too large), the saw can be clipped to a marlin-spike hitch in the lifeline below the friction hitch. (If there is no overhead anchor point both the lifeline and the lanyard should be attached to the stem.)

- Push the section sufficiently to enable the trapped saw to be pulled free. If the saw cannot be freed because the section is too heavy, a pull line must be set. Throughout this procedure the climber must be wary, as the section may break over backward or sideways without warning.
- If a throw-line and/or pull line can be installed **without climbing above the cuts**, these can be applied and utilised by the ground crew to pull the section over. If it is not possible to do this without climbing above the cuts, a second saw should be used to redirect the face cut 30 cm above the trapped saw.

Unless the saw is equipped with a breakaway ring for the strop / lanyard attachment, a lanyard with a low breaking strength will offer the climber some protection should the saw be taken with a large tree section. However, some breakaway designs have been found to be insufficiently robust in general use. Industry best practice dictates that the saw should normally be disconnected from the harness if there is a high risk of it being taken with a heavy (i.e. not easily manhandled) cut section.

12. RE-FUELLING THE CHAINSAW

Fuel levels must be known before undertaking critical cuts.

The chainsaw may be equipped with a transparent fuel tank. This will enable a quick visual check to be made on fuel levels before commencing a critical cut. The alternative check would be to undo the fuel cap and look into the tank if it is expected that the saw may be low on fuel and a critical cut is to be made. However, it takes some experience to be able to estimate fuel levels depending upon the type of cutting involved (e.g. occasional small pruning cuts or larger diameter dismantling sections). In addition, it may be difficult to undo a fuel cap or prevent spillage whilst sitting in some positions with a rope and harness.

If it is suspected that the saw is low on fuel, the climber should return the saw to the ground and request it to be refuelled. To prevent the chain running dry, the oil tank should always be topped up at the same time as the fuel, even with low consumption oil pumps and attachments.

When the saw does need to be refuelled, it may be returned to the ground by first clipping it onto the climbing line below the friction hitch, and then lowering it by feeding the line hand over hand. An alternative and more efficient technique can be used as in chapter **7**, **method B**. If the climbing line is not long enough to allow the ground worker to haul back the saw to the climber, then **method A** might be used, or **method D** if the situation allows. The climber can then safely reconnect the saw to the harness (as in chapter **8**).

Photograph 24
Returning the saw to the ground hand over hand on lifeline

Photograph 25
Friction hitch with micro-pulley – as in chapter 7, method B

13. CUTTING TECHNIQUES

It is important that two hands are kept on the saw at all times, except where covered under one-handed chainsaw use (chapter **15** below). A variety of techniques can be used by a competent operator in order to maintain control and prevent damage to self, tree or persons and property on the ground.

Whatever cutting techniques are used, the climber should be positioned so as to gain support from the harness, with a supplementary anchor if appropriate.

On horizontal sections, the saw should be **held at hip level** to the left, right or in front of the climber. Although it is more natural to hold the saw on the right-hand side of the body, it may be necessary to hold it to the left side if the work position is so dictated by the form of the tree.

It was found that a top-handled saw could be held comfortably and stably on the left-hand side of the body with the right hand still on the top handle. Such a situation is therefore not an excuse to use the saw one-handed. By comparison, a rear-handled saw would have to be used left-handed in such a situation in order to maintain adequate control. To minimise the risk of kickback, the saw chain must come to a stop before the saw is moved from one cut to the next, and when withdrawing the saw from a cut.

Photograph 26
Work positioning with saw on left-hand side of body

On vertical sections, the climber will normally cut with the chainsaw at solar plexus level (see **photograph 27** overleaf) in order to avoid waist level anchorage. However, there can be a temptation to use the chainsaw above shoulder height if the climber cannot find a suitable branch to stand on. In the latter situation the climber should use an endless sling (or slings) chokered around the stem as foothold(s) in order to gain height. An exception to this was found to be when working in branch tips having insufficient strength to permit climbing higher.

Photograph 27
Cutting a vertical section with slings as footholds

Photograph 28
Hand-held step cut

However, when working in branch tips the material being cut is likely to be small enough to allow the effective use of a handsaw or pole pruner (or possibly a chainsaw). If the tree or the entire section is to be removed, the use of climbing spurs may facilitate the best work positioning.

13.1 HAND-HELD SECTIONS (GENERAL)

For **all** hand-held sections the chainsaw must be held with two hands.

When undertaking both pruning and dismantling operations, there will be occasions when it will be preferred to manhandle and cast sections (rather than apply a rope or allow them to free-fall). On some species, the sides of the hinge or holding wood may require to be nicked into the sapwood in order to reduce the risk of the section tearing along the cambium layer and possibly causing loss of control and/or injury to the climber. Hand-held sections should be cut in easily manageable sizes. The major differences in technique come between horizontal and vertical sections. Leaning sections may be dealt with as vertical sections or horizontal sections depending upon the severity of lean.

13.2 HAND-HELD STEP CUT (OUTBOARD UNDERCUT)

The sequence of operations for an outboard hand-held step cut is as follows:

- The first cut is made from the top down, to one third to one half of the branch diameter.
- An undercut is then made at least one inch outboard (toward the tip) of the section, and parallel to the first cut. The amount of holding wood left will depend on the thickness of the branch, but the two cuts must slightly overlap.
- At this point the saw may normally be withdrawn without being pinched in the kerf. The chain brake is applied (or the saw is switched off) and the saw is lowered onto its strop. If the saw does become pinched, the guidance given in chapter **11** should be followed.
- The section can then be lifted upwards to snap the holding wood, with the butt resting on the step to maintain control before casting.

The reason for a hand-held outboard step cut is to enable control to be maintained. If the undercut is run in too deep the weight of the section will trap the saw before it has the chance to go too far with subsequent loss of the section. With the saw trapped, control can then be maintained by applying the method described in chapter **11**.

13.3 HAND-HELD STEP CUT (VERTICAL SIDE CUTS)

On horizontal sections, an alternative technique to using an outboard step cut involves the use of a step cut with a vertical strip of holding wood:

- A cut is made at right angles to the traditional undercut, using the side of the chainsaw bar, continuing to one third to one half of the diameter of the section.
- A second cut is then made parallel to the first cut but with the side of the bar slightly toward the tip of the section (at least one inch out, depending upon the size of section). The cuts must over lap each other.
- At this point the saw may normally be withdrawn without being pinched in the kerf. The chain brake is applied (or the saw is switched off) and the saw is lowered onto its strop. If the saw does become pinched, the guidance given in chapter **11** should be followed.
- The section can then be pulled toward the climber, snapping the holding wood and resting the section in the climber's lap before casting it clear.

13.4 HAND-HELD SINK CUT

For heavier sections, another technique is to place an open notch on the top side and facing the climber (as per FASTCo SG 302). Then a back cut is placed to the rear, leaving a parallel hinge as in normal felling techniques. (An open notch of between 45° and 90° may provide even more control.) This enables the climber to pull the section forwards before breaking the hinge.

However, when using this technique it is difficult to judge the right amount of hinge to leave. In practice it was found to be better to leave the hinge a little stronger than necessary, and to then complete the cut using the handsaw one-handed whilst holding the section with the other hand. When the section starts to move the cutting should be halted and the section pulled into the climber's lap. If the hinge does not break clean, it should be severed with the handsaw.

Photograph 29
Hand-held sink cut

Photograph 30
Sink cut using endless sling

13.5 ENDLESS SLINGS AND HAND HELD SECTIONS

The hand-held techniques are especially effective when used in conjunction with an endless sling. The endless sling is choked around the end of the section and left until the climber has completed the cuts, engaged the chain brake and lowered the saw onto its strop. The sling is then used to gain purchase on the section and provide a better hand grip until the section has been pulled into the climber's lap. The sling is then either removed before casting, or may be left on to assist in swinging the section clear.

13.6 VERTICAL HEND-HELD SECTIONS

The main difference between cutting vertical & horizontal/leaning sections lies in the way in which the chainsaw is positioned in relation to the body and work positioning equipment. Horizontal and leaning sections can be dealt with by holding the saw from the side of the body, a position in which there is a reduced risk of injury from kickback. Vertical sections, however, require the saw to be turned on to its side. This is not especially dangerous provided the body is positioned to the side of and out of line of the kickback arc.

On some species, the sides of the hinge or holding wood may require to be nicked into the sapwood in order to reduce the risk of the section tearing along the cambium layer and possibly causing loss of control and/or injury. When the step cut is completed, the climber can step into the required position to break the section toward the body.

The incorrect stance illustrated below in **photograph 31** would allow the saw to cut into the stomach area if the saw kicks back or the operator loses footing.

Photograph 31
Incorrect stance for cutting a vertical section

Photograph 32
Lifeline used for additional support from an overhead angle whilst cutting a face on a pole

13.7 WORK POSITIONING ON A POLE WHILST CUTTING A 'FACE'

When cutting the face on a pole it is possible to gain the advantage of an overhead anchor point. The lifeline is chokered and the climber descends on a single line (the friction hitch may need additional wraps to compensate for the increased body weight being applied).

The climber can descend to the work position by differentially distributing weight through the feet where possible. A descending device should be used (e.g. figure-of-eight), below the friction hitch for adequate control. Once the work position is reached, the climber should tie in with the lanyard and proceed to cut the face from a comfortable position. This technique should not be used if the strength of the section could be significantly compromised by cutting the face.

The climber must remember to untie the overhead anchor point and retie below the lanyard before commencing with the back cut. Industry best practice (FASTCo & Arboricultural Association booklet *A Guide to Good Climbing Practice*) advises that the climber should be tied in below the cutting level with both the climbing line **and** a supplementary anchor (typically the adjustable lanyard).

The lifeline can also be chokered around the stem and set to offer support from the rear side of the stem (see **photograph 33**). This latter precaution also minimises slippage down the stem if the climber loses footing, provides an overhead anchor for cutting the face on the next section (as described at the beginning of this sub-section), and enables the climber to descend to the ground in the event of an accident (if backed up with a descender).

Photograph 33
Lifeline chokered around stem to offer support whilst removing a section on a pole

Photograph 34
Lifeline chokered for retrieval from a distance (also see photograph 24)

13.8 REMOVING SMALL SIDE BRANCHES ON FIRST ASCENT OF A CONIFER

When *dismantling* conifers with small side branches, climbers save energy by removing branches on the way up the stem as an overhead anchor is not essentially required for holding position. However, a supplementary anchor point is often required because of the close proximity to the lanyard when cutting with the chainsaw. Even though the lanyard may have a steel core, it will not be designed to withstand a chainsaw cut, and it is bad practice to rely solely on this as a life line whilst cutting with a chainsaw on a pole.

The following technique was found to be effective when climbing with spikes in this situation:

- The climber ascends approximately four metres (at the climber's discretion) above the first whorl of branches while being secured at all times.

Photograph 35
Removing small side branches on first ascent of a conifer

- The climbing line is then set (with a friction saver) around a suitable side branch or the main stem. Care must be taken on sloping branches (e.g. *Sequoiadendron spp.*) to prevent the lifeline slipping off/along the branch. The friction saver can be choked around a suitable side branch to prevent this happening. If the stem is too thick and the side branches too small, the lifeline can be choked around the trunk and used as a single line with extra wraps in the friction hitch.
- The climber then spikes down to the first whorl of branches and slings the lanyard around the stem at knee height; it can also be chokered if preferred.
- The climber can then remove the branches on the way back up to the lifeline anchor without having to frequently unclip the lifeline. There is also a low risk of cutting either the lifeline or the lanyard.
- The climber can ascend in the conventional sense, using the spikes and flipline and taking up the slack in the lifeline with one hand and the aid of a micro-pulley. If the spikes kick out while using the saw, the climber will not drop and the risk of a pressure cut from the chainsaw will be greatly reduced.

13.9 TOP-HANDLED CHAINSAW USE IN CONIFEROUS HEDGES

Working in this type of environment is normally very difficult due to the cramped working space. Most coniferous hedges can be easily dealt with by using a sharp handsaw and long handled pruners / secateurs. Taller and larger coniferous hedges requiring the use of a chainsaw can be dealt with effectively in the following way:

- The climber ascends to a suitable final anchor point while being secured to the tree at all times. The climber ties in with a friction saver. The use of a friction saver eases movement and reduces sap build up on the rope. The method as a whole may allow several smaller tops to be used together for appropriate support.
- The climber then descends to the point of work and sets the height of the hedge by removing side branches. The climber may be able to use the high anchor point to walk across the topped hedge with good support, cutting sections as previously described.

The climber should always have two hands on the saw. The extremities should be clipped with long-handled pruners or a hedge cutter. One-handed saw use was found to be hazardous due because of insecure footing. Reaching out with one hand and cutting at extremities can lead to kickback whilst using a pushing chain, or cause the body to fall onto the saw if a foot breaks through the hedge, or increase the risk of falling into the hedge.

The best defence against an injury is to have adequate support from the harness rather than relying on the feet.

Where a hedge has been previously pruned and multiple dense stems can only be practically cut with a chainsaw, good footing and work positioning are essential. Where thin stems need to be cut at the extremities, a number of new hedge-cutting attachments are now available.

13.10 SAW USE AND WORK POSITIONING ON LEANING STEMS WITH NO OVERHEAD ANCHOR

The most difficult aspect of saw control and work positioning comes when working on a leaning stem without an overhead anchor point. Depending upon the severity of lean, the use of a pushing chain was found to be the easiest and most accurate technique for cutting the face ('Humboldt' style – see **photograph 41** on page 41) on the right-hand side (underside of lean). An overhead anchor was not found to be beneficial, hindering the cutting of the face and introducing a high risk of cutting the lifeline. The lifeline can be chokered around the stem and set to offer support from the rear side of the lean.

13.11 VERTICAL HAND-HELD STEP CUT

With vertical hand-held step cuts, the holding wood principle is the same as for horizontal step cuts. At least one inch must be left between cuts, depending on the size of the section, and the cuts must overlap with an even parallel strip of holding wood. The step cut can be made with either a pushing or pulling chain, each with their particular advantages:

- Using a pushing chain directs the saw chips away from the operator. Cutting from the left enables the crankcase of the chainsaw to be uppermost, thus allowing the thumb to operate the throttle and the saw to be handled more ergonomically.

Photograph 36
Pushing chain – crankcase uppermost

Photograph 37
Pushing chain – crankcase down

Photograph 38
Pulling chain from the left – crankcase down

Photograph 39
Pulling chain from the right – crankcase uppermost

- Using a pushing chain from the right places the crankcase down. This enables the operator to have a good view of the progress of the cut and throws the chips away from the operator. However, holding any saw in this position places additional strain on the wrist whilst twisting the saw into the horizontal position in order to start the cut. The use of a pushing chain inherently requires more force to hold the saw in the cut.

- Using a pulling chain from the left has the same advantages and disadvantages as using the pushing chain from the right, except that the saw pulls itself into the cut without being pushed.
- Using a pulling chain from the right gives the same advantages as using a pushing chain from the left, but the saw pulls itself into the cut without being pushed.

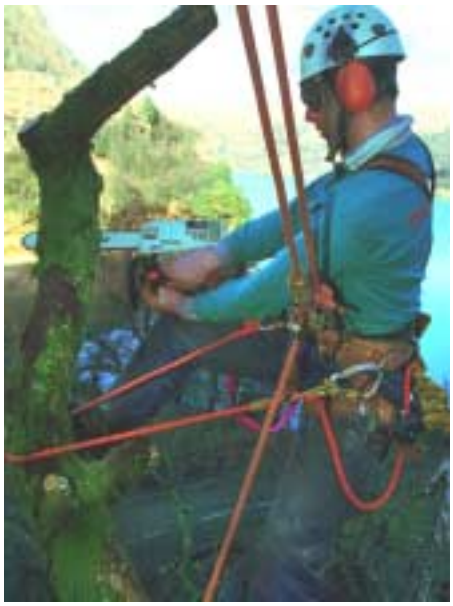
Generally it was found that using a pushing chain from the left (with the crankcase uppermost) or a pulling chain from the right (also with the crankcase uppermost) provided the best ergonomics. The bar of the saw could be pulled out momentarily to check the progress of the cut.

13.12 VERTICAL HAND-HELD SINK CUT

For a vertical hand-held sink cut the stance should be the same as for vertical hand-held step cuts. The face cuts should be made as per industry best practice (FASTCo SG 302). Face cuts of from 45° to 90° may be necessary, depending on the level of control required. However, the method of using a top-handled saw when placing the sink cut on a vertical section to the right differs ergonomically from the method when using a rear- handled saw.

The difficulty arises whilst using the saw to place the sink with a pushing chain from the right. In order to come down to meet the undercut (as in a normal felling cut), the saw must be twisted greatly by the right hand. This was found to place excessive strain on the tendons on the back of the right hand and wrist.

The situation can be remedied either by bringing the sink cut up to meet the undercut or by using a pulling chain to set the sink from the top down. The undercut can be made with a pulling chain from the right. It was found that the face cuts can be made to the left by using a pulling chain for the sink and a pushing chain for the undercut.



Photograph 40
Conventional sink cut using pushing chain

In all instances, it was found that greater accuracy could be achieved by placing the sink before the undercut in order to avoid cutting through the hinge. The weight of the wedge was not sufficient to trap the saw (various species up to 14 inches in diameter) before completing the cut. If trapping of the saw is likely to be a problem, the undercut can be cut slightly lower than the sink cut. Using the sink as a sight line, the undercut can be set and the saw then reintroduced into the sink cut in order to complete the cuts without trapping the saw. Alternatively, a Humboldt face may be cut.

Photograph 41
Humboldt-style sink cut

Photograph 42
Conventional sink cut using pulling chain

13.13 FREE-FALL CUTTING TECHNIQUES

The only difference with free-fall as compared to hand-held sections lies in the sequence of cuts on a horizontal step cut. There are two types of free-fall step cuts, inboard and outboard:

- **Outboard step cut**
  The sequence of operations for an outboard step cut is as follows (see **photograph 43** overleaf):
  - First an undercut is placed, no more than one third the diameter of the section, from underneath.
  - The top cut is then made at least one inch in front of (toward the tip of) the section and parallel to the undercut until the section falls.

  This cut allows the section to break sooner and therefore more horizontally compared to the inboard step cut. The disadvantage, however, is that the top cut is made in the section which is about to leave the tree, and therefore the saw may be taken with the section as it falls. The risk of this happening can be reduced by removing end weight from the section first, by cutting smaller sections and by matching the top and bottom cuts.

Photograph 43
Outboard step cut – free fall

Photograph 44
Inboard step cut – free fall

- **Inboard step cut**
  If a heavy section needs to be cut, the following technique can be applied:
  - First an undercut is placed no more than one third the diameter of the section from underneath and parallel with the ground.
  - The top cut is then made at least one inch behind (toward the butt of) the section and parallel to the undercut until the section falls.

  Because the final cut is made toward the butt, the section cannot take the saw. However, this technique allows the tips to drop first and this may not be desirable. If the outboard step cut is preferred for cutting a heavy horizontal section, the saw should be disconnected from the climber and attached to the tree. The sides of the cut may require nicking on some species to help prevent the section tearing along the cambium layer and possibly causing loss of control.

14. HAZARD CONDITIONS ARISING WITH HAND-HELD SECTIONS

Hazard conditions occur with hand-held sections when the climber:

- attempts to hold the section whilst cutting with a chainsaw with one hand;
- cuts too heavy a section causing loss of control and/or injury;
- makes incorrect cuts and reaches over the running chain in an attempt to control the section when it breaks free.

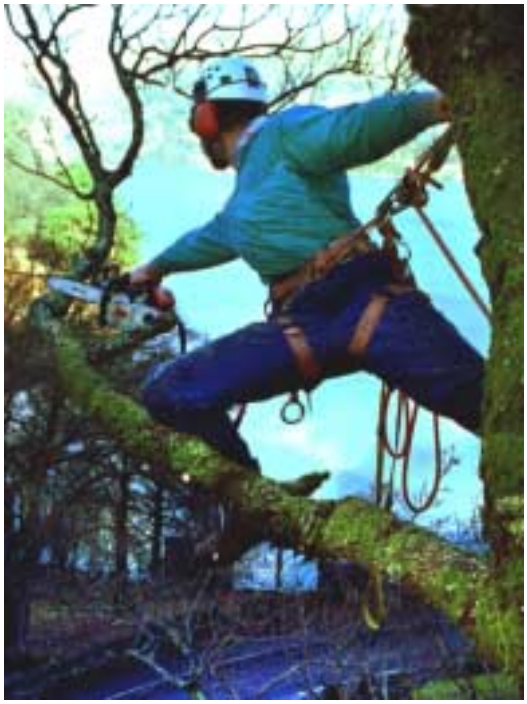
These situations are considered to be bad practice and avoidable. If they occur during an NPTC competency assessment of CS Unit 39, the candidate should be referred for further training or consolidation of skills before reassessment.

It may be both safer and more efficient to ‘rope up’ a larger section so that fewer chainsaw cuts are required and more control can be maintained, rather than to undertake many hand-held sections.

15. ONE-HANDED CHAINSAW USE

Only in extreme situations should the chainsaw be used one-handed. Top-handled chainsaws should not be used one-handed either in place of poor work positioning or in preference to a handsaw whilst cutting smaller material at branch tips. In hard woods like Oak (*Quercus petrea/cerris* and *robur*) and Beech (*Fagus sylvatica*) it was found that branches of up to7cm diameter could be cut easily with a handsaw.

However, cutting any size of branch over 3cm diameter was found to be difficult if the handsaw had to be held at 90° in order to undercut a branch in extreme positions and at full stretch. In such situations, the chainsaw held one-handed was found to be a more suitable and efficient choice, as the cut could be completed more accurately, more quickly, and with less strain to the arm and shoulder. The risk of injury from kickback was greatly reduced because the saw would be thrown to the side of the body rather than towards it, and the branch also offered protection.



Photograph 45
One-handed chainsaw use avoiding injury

Photograph 46
One-handed chainsaw use at 90 °

Industry best practice dictates that top-handled saws must only be used one- handed where one hand is required to help hold a balanced stance or when material is situated out of reach of two-handed use - usually at the extremities of branches (FASTCo SG 308 & NPTC Chainsaw Assessment Schedule: *Standard questions and answers – Unit 39*). Care must be taken to place the body out of line of possible kickback. Use of the kickback zone of the saw (as marked in **photograph 47** overleaf) must be avoided.

Photograph 47
Kickback zone of chainsaw

16. SPECIES DIFFERENTIATION OF CUTTING TECHNIQUES

All broad-leaved and coniferous species commonly encountered in the UK can be dealt with using the techniques described above. Regardless of the type of operation (e.g. thinning or reducing), the only techniques that will require modification are the ones used on species that readily split or break (e.g. *Sophora japonica, Ailanthus altissima, Robinia pseudoacacia, Pinus strobus, Salix spp.* and *Populus spp.*). *Fagus* and *Fraxinus* also have a tendency to split under a lot of tension. Cutting the ends of the hinge (the sapwood) will help maintain control of sections which tear easily but do not have much tension in the heartwood. Heavy tops likely to split should have the hinge set first by boring before releasing. Alternatively, the heartwood may be bored out through the face before completing the back cut. In species with 'chewy' fibres (e.g. *Salix spp.*), a 30° face will encourage the section to break the hinge early. The climber's lanyard should also be clipped to the centre 'D' or 'Ds' in order to prevent crushing against the stem if it splits (additional caution is required when a split tail system is being used). Additionally, the body should be kept out of the danger area if a section is likely to split and 'barber chair' (i.e. directly behind the direction of fall).

17. CONCLUSIONS

Manufacturers have always stated that top-handled chainsaws are to be used with both hands. Tree climbers have tended to use them one-handed in some situations and accidents have occurred from time to time as a result of such usage.

As a result of recent advances in modern tree climbing techniques and equipment, more suitable work positioning is now possible, thereby enabling greater use of the top-handled chainsaw with both hands.

However, it is still in the nature of a climbing arborist to use a top-handled saw one-handed when working at the extremities of branches (enabling the other hand to be used to assist in maintaining balance). In such situations a top-handled chainsaw can be safer to use, and produce less strain on the arms, than a rear-handled chainsaw since the point of balance is over the main body of the saw. In such a situation a rear-handled chainsaw is not easy to control in the event of a kickback.

The advent of inertia chain brakes has reduced the risk of kickback injury compared to mechanical chain brakes as the inertia brake will operate in any position.

Top-handled chainsaws play an important role in aerial tree work due to their compact nature, balance and ease of starting.

This research project has identified safe working methods of using a top-handled chainsaw in all situations in which a climbing arborist may expect to operate. In the exceptional circumstances where one-handed operation is desirable, the methods and techniques described in this report will enable the operations to be carried out efficiently, ergonomically and with the minimum of risk of injury to the operator.

The answer to safe use of the top-handled chainsaw by operators, in all circumstances, is to ensure that comprehensive and up-to-date training, and subsequent updating, is provided to operatives by qualified and experienced instructors. This research paper demonstrates the methods and techniques that the trainers need to assimilate and pass on to their trainees.

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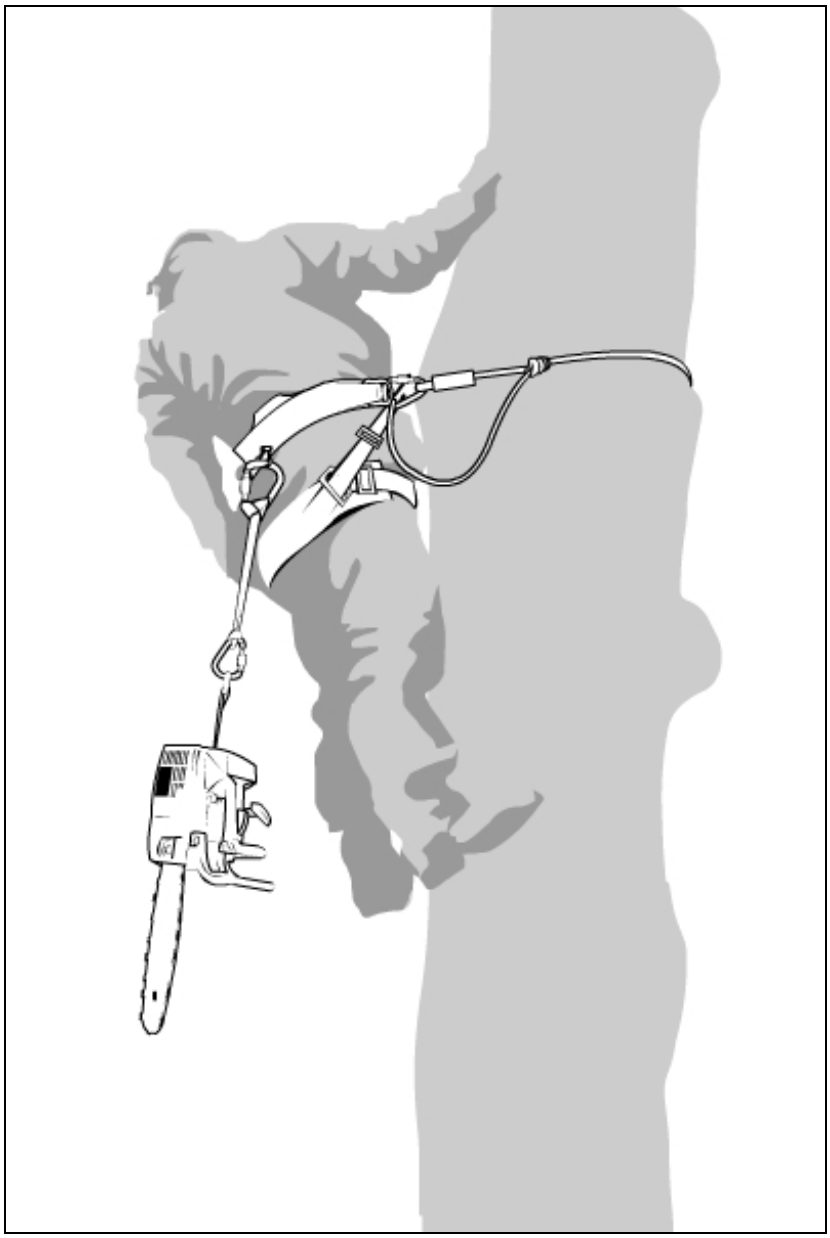
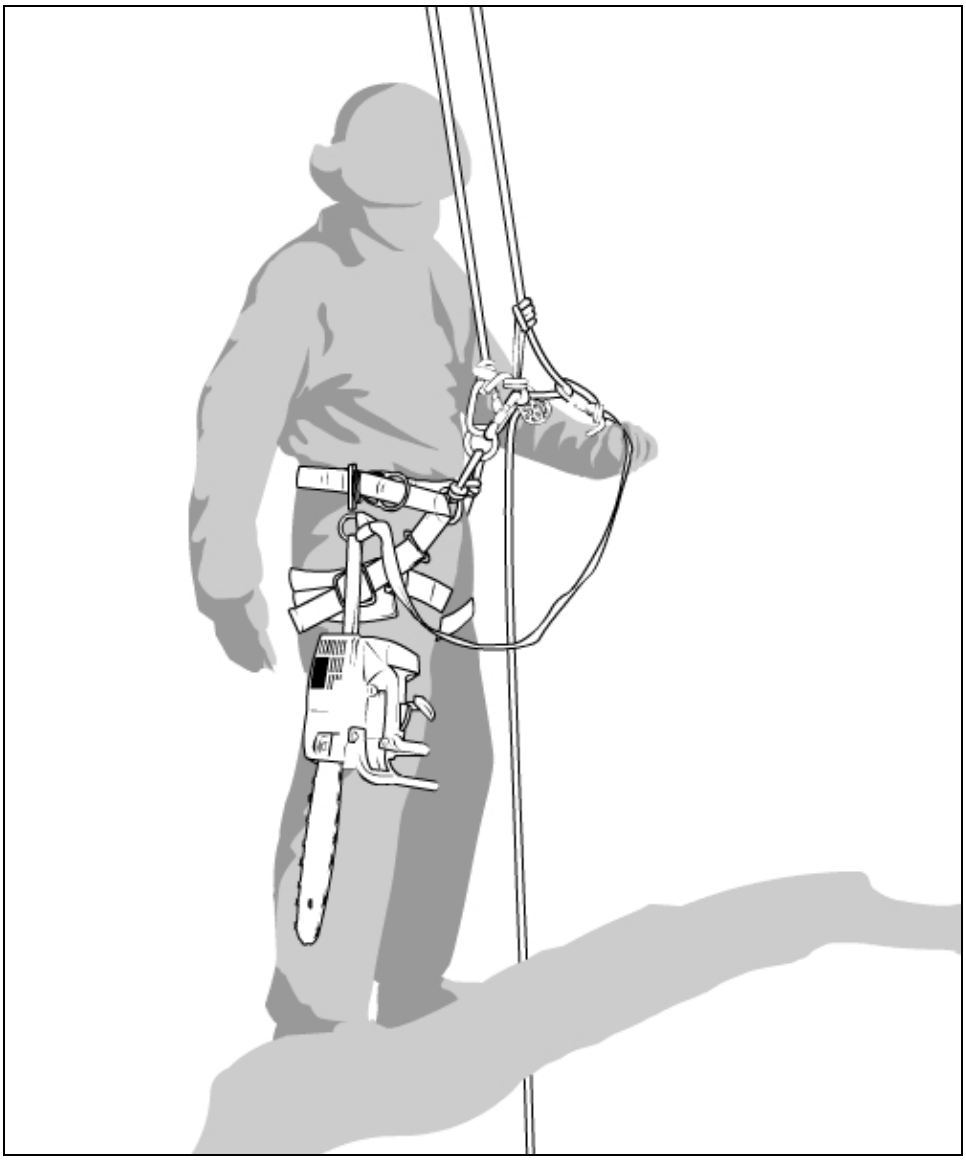
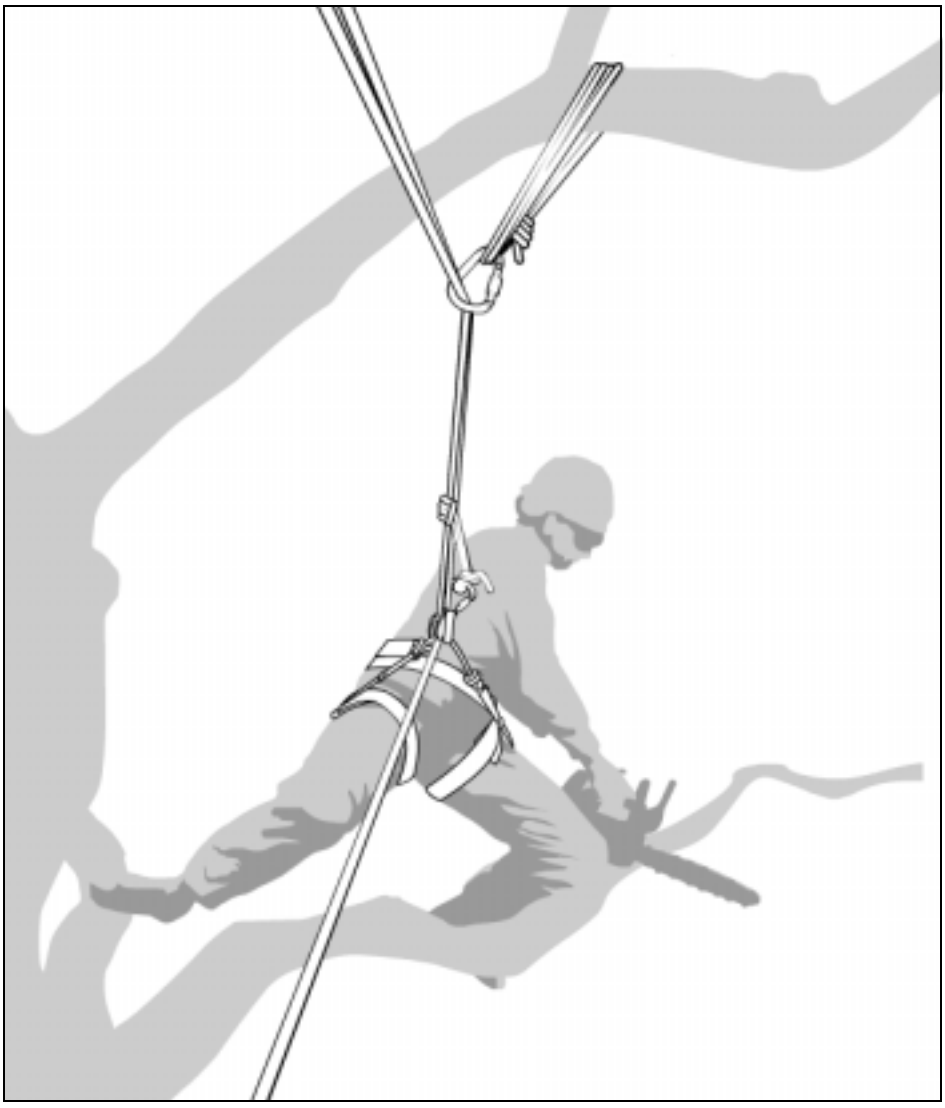
ANNEX OF LINE DRAWINGS



Drawing 1
Attachment of saw strop to harness



Drawing 2
Saw clipped high



Drawing 3
Re-direct

Drawing 4
Endless sling as foot stirrup

Drawing 5
One-handed chainsaw use avoiding injury

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