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Makita

A Guide To Chainsaw Maintenance

DC Vickers

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Contents

Acknowledgements

I have been wanting to write this book for years, after writing the course notes for the forestry and arboriculture short courses whilst I was at Sparsholt College. I lost count of the number of times I sat down to start writing this book but family life, work or some other issue stopped me from making any headway into it.

So, the fact that this first edition has now been written is thanks in large part to the people at Makita who have been extremely generous in loaning me various chainsaws to photograph and use - with special thanks to Kevin Brannigan (Marketing Manager) and Stuart McCrudden of JB Media. A huge debt of thanks also go to Sean Rayment and his wife Dawn, from SR Forestry, for pouring over the pages and providing constructive feedback to improve the book yet further - I know it took you both several hours to go through and I am hugely grateful. Naturally, any errors or omissions are entirely my own fault.

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About The Book

Who Is The Book For?

The book has been written for those people that have little or no experience with chainsaws - but it is targeted towards those in industry rather than private individuals using a chainsaw at home. That said, the information surrounding chainsaw maintenance is as valid for private users as it is industry users, although those working in the industry and attempting the industry standard chainsaw maintenance assessments will find the additional information on legislation and health & safety useful.

Why Write This Book?

I originally had the idea to write a book on chainsaw maintenance about 8 or 9 years ago; at the time I was working at an agricultural college and I started to write it. However, I never really finished it and what started out as a book ended up as a 30-odd page booklet on maintenance and cross-cutting to accompany the courses I was teaching back then.

Since then, I've thought about writing this book and prompted by Makita, whose chainsaws I have used for years, we agreed on a deadline and I duly cleared a space in my diary. Now, 131 pages later, this is the result.

I hope you find it useful and please feel free to contact me at training@drivelinktraining.co.uk if you have any comments or would like to see something in version 2.0.

Usage

The book has been written to appeal to those starting out with chainsaws, but also to provide trainers with something to use. If you would like to use sections, pages or images from this book for educational purposes, then feel free - but please credit the material that you use to “DC Vickers, Drivelink Training”.

This book is not intended to be a replacement of proper training, guidance and supervision. The book does not try to deal with all makes and models of chainsaw, but instead aims to provide you with enough of a foundation to tackle most modern saws.

This book must not be resold, or passed off as your own work.

For any commercial usage please contact the author directly at training@drivelinktraining.co.uk

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Legislation

Health & Safety At Work Act

Introduction

The Health & Safety At Work Act is designed to secure the *health, safety and welfare of persons at work* and *for protecting others against risks to health and safety in connection with the activities of persons at work*[1]. Part 1 of this 1974 Act has a number of objectives that, put simply, aim to…

1. secure the health, safety and welfare of those at work;
2. secure the health, safety and welfare of other people who may be affected by the activities of those at work;
3. control the keeping and use of explosive or highly flammable or otherwise dangerous substances, and;
4. control the emission into the atmosphere of noxious or offensive substances.

An important feature of the Health & Safety At Work Act is that both employers and employees have a set of general duties under it.

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1 http://www.legislation.gov.uk/ukpga/1974/37

General Duties For Employers

Under the Act, it is the *duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees*; but before exploring a little deeper into what those duties actually cover, it may be worth asking the question, "What is meant by *reasonably practicable*?".

The Health & Safety Executive's website[2] gives a fairly concise answer, stating that *reasonably practicable* means **balancing the level of risk against the measures needed to control the real risk in terms of money, time or trouble. However, you do not need to take action if it would be grossly disproportionate to the level of risk**.

The Act goes on to list a range of duties, such as…

1. the ensuring that plant and machinery are provided and safe to use;
2. ensuring safe handling, use and storage of substances;
3. the provision of information, instruction, training and supervision to ensure health and safety at work;
4. maintaining safe access to, and egress from, the work site;
5. the provision and maintenance of welfare facilities for employees.

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2 http://www.hse.gov.uk/risk/faq.htm

General Duties For Employees

As well as employers having duties, under Section 7 of the Act employees also have their duties stated; although it is fair to say that these duties largely support those duties of the employer…

1. employees must take care of the health and safety of themselves and any other person who may be affected by their work activities, and;
2. co-operate with their employer to ensure that the duties imposed on them are met.

Provision & Use of Work Equipment Regulations

Introduction

The Provision & Use of Work Equipment Regulations[3], more commonly known as PUWER, came into force in December 1998 and aims to ensure that equipment is fit for purpose and used by operators who are trained to use that equipment. However, the Regulations do have repercussions on people other than those who are actually using the equipment; for this reason it's worth looking at PUWER in a little more detail.

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3 http://www.legislation.gov.uk/uksi/1998/2306/contents/made

Who's Responsible Under PUWER?

Under the Health & Safety At Work Act, we've already seen that both employers and employees have duties to ensure that plant and machinery are safe to use, but PUWER expands on these requirements quite a lot further. There are many areas of PUWER that do not concern the tree work industry, especially those areas dealing with shipping for example(!), but it does specifically mention employers, employees and the self-employed which could be highly relevant as many people working in the tree industry are either small businesses or individuals that get sub-contracted by large companies.

As stated in PUWER Regulation 3, it applies to any employer providing work equipment for use or used by an employee of theirs at work; this includes the self-employed, as well as to any person *who has control to any extent* of the equipment being used, or how the work equipment is used, or someone in the workplace who uses, supervises or manages the use of that work equipment.

Work Equipment

PUWER goes into specifics regarding the work equipment, and it is often said that any work equipment must be suitable for the task at hand, and fit-for-purpose… but what does that really mean? Are we allowed to adapt machinery, or use machinery that has been adapted?

Part II, Regulation 4 is where we can find out some of the answers and reasoning to common statements, let's start with the fact that work equipment must be "suitable". This key word is defined in the Regulations and is stated as "*suitable in any respect which it is reasonably foreseeable will affect the health or safety of any person*", thereby covering any action taken by an operator that could have been foreseen. Taking a practical example, when dealing with hung-up trees it was common practice to use a turning strap in conjunction with a long pole to roll the tree out, these days it's

common to see and hear people using an endless sling to achieve the same thing; this isn't the originally intended use for the sling as it would more usually be used when winching a tree but it's use in place of a turning strap could be foreseen.

Every employer should also ensure that the work equipment is only used for operations for which it is suitable, and that the work equipment is *constructed or adapted as to be suitable for the purpose for which it is used*.

Part II, Regulation 5 covers the maintenance aspects of work equipment, stating that it is *maintained in an efficient state, in efficient working order and in good repair*.

Part II, Regulation 6 covers inspection of work equipment, and tells us that any work equipment that is *exposed to conditions causing deterioration which is liable to result in dangerous situations* must be inspected at suitable intervals. This could apply to winching equipment which can be subjected to overload conditions, as well as harsh environmental factors; however it should also be noted that climbing equipment is **not** covered by this regulation: paragraph 5 states that this regulation does not apply to *work equipment for lifting loads including persons*.

Part II, Regulation 7 mentions specific risks relating to work equipment, although it does not define what a 'specific risk' is, the use of a chainsaw would almost certainly be covered by this regulation where there are very clear, specific risks to health and safety (such as kickback). In this case the employer must ensure that the use of such equipment is *restricted to those persons given the task of using it*.

Training

Under Part II, Regulation 9 of PUWER there is a clear requirement for operators of work equipment and managers / supervisors to receive adequate training…

Every employer shall ensure that all persons who use work equipment, or any employees who supervise or manage the use of work equipment, have received adequate training for purposes of health and safety, including training in the methods which may be adopted when using the work equipment, and any risks which such use may entail and precautions to be taken.[4]

Best Practice

HSE INDG317

The Health & Safety Executive produce what can be considered as an overarching document regarding the use of chainsaws in the workplace; called *Chainsaws At Work*, it covers a wide range of topics from safe use to training ratios, from lone working to timber tools to aid working. At just 16 pages in it's current form, it is a concise guide to using a saw safely.

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[4] PUWER, Part II, Regulation 9: http://www.legislation.gov.uk/uksi/1998/2306/regulation/9/made

FISA & AFAG

There are two industry related groups, the Forest Industry Safety Accord (FISA) and the Arboriculture & Forestry Advisory Group (AFAG), both of which provide guidance leaflets on industry best practice. Prior to 2012, AFAG produced all the leaflets concerning forestry and arboriculture but that has since changed and now FISA provides safety bulletins and industry best practice leaflets for ground-based operations, and AFAG produces documents for aerial operations.

The FISA website allows operators to download the best practice leaflets covering a wide range of operations from using petrol-driven chainsaws to working near to electrical powerlines, and from manually fed wood chippers to dealing with windblown trees. FISA was created from a group of forestry companies such as Tilhill, Euroforest and the Forestry Commission; and in order to work on sites managed by them operators must have up-to-date **FISA** refresher tickets, or have upskilled their qualifications in the last 5 years. FISA accredited courses are run by several training providers - search on the FISA website to find a local trainer / assessor if you need to gain your FISA refresher.

AFAG seems to have moved away from the double-sided sheet of A4 listing best practices, and have now produced a series of very useful booklets dealing with aerial operations including AFAG401 (tree climbing operations), AFAG402 (aerial rescue) and AFAG403 (aerial cutting).

Chainsaw Safety

Risk Assessments

Working safely on a day-to-day, job-to-job, site-to-site basis is critical; forestry and arboriculture are dangerous industries to be working in. Although chainsaws are relatively safe if used properly, when something goes wrong, it tends to go wrong in a big way. Injuries tend to be more common when rushing, particularly at the end of the day; I'm sure we can picture the scene, you've turned up to start a new job at 8:30 in the morning and by 18:00 it's not quite finished, it's started to rain, it's getting dark and you're booked in to start the next job tomorrow morning. You're tired after a days work and the pressure is on to complete this task *now*!

It's a recipe for disaster, attempting to complete the job in a hasty manner is not good; but accidents can happen for all manner of reasons – it might be as simple as putting a new chain on the saw and not wearing gloves when you do it, or tripping over a tree stump, or lifting heavy timber on to a timber stack.

Whilst you can't necessarily write down every single thing that might happen, there are a number of common hazards to identify whenever, and wherever, you are using a chainsaw. In this section, we'll take a look at assessing the risk.

It's not all about you…

Risk assessments are created to ensure that everyone knows about the potential for hazards to cause an accident, and how they should be dealt with. Risk assessments are not just about assessing the risk for the operator, they should also include members of the public, property and the

environment.

Risk assessments are not ‘set in stone’, but documents that can be amended as necessary – but that does not mean that you need to create a new risk assessment from scratch for each job!

Creating and maintaining a risk consists of five steps:

1. Identifying the **hazards**.
2. Calculating the **risk**.
3. Implementing **control procedures**.
4. **Communicating** and **recording** the risk assessment.
5. **Re-assessing** the hazards, and implement any changes as a result of that review.

Ideally, a note is taken of each of these steps, so let’s have a look at each step in the sequence and then see how this is done in reality, based on a practical example.

Identifying the hazards

There are a number of common hazards when maintaining and using a chainsaw, why not try to write down five hazards that you can think of, then we’ll consider hazards in more detail…

List five hazards that relate to using a chainsaw:

1. …
2. …
3. …
4. …
5. …

When looking into identifying most of the hazards, there are four areas of consideration, these are:

1. the **Machine** (for example, the chainsaw);
2. the Operator;
3. the **Site**;
4. the **Task**.

…or **MOST** (Machine, Operator, Site, Task).

Remembering this abbreviation will help you to identify relevant hazards, so let's use this to begin creating some examples for our risk assessment.

Complete the list of hazards relating to the **machine**:

1. e.g. Kickback.
2. …
3. …

Having completed some of the options for the machine, consider the remaining three areas:

Complete the list of hazards relating to the **operator**:

1. e.g. Inexperience.
2. …
3. …

Complete the list of hazards relating to the **site:**

1. e.g. Sloping ground.
2. …
3. …

Complete the list of hazards relating to the **task:**

1. e.g. Lifting heavy timber.
2. …
3. …

By now you have already created quite a list of hazards in accordance with MOST, and you may also notice that many, if not all, of these are true no matter where you are working. Remember that, as it will help us to generate a generic risk assessment that we can just copy whenever we need to use it.

Calculating the risk

Having listed a number of hazards we now need to work out what the risk is, i.e. just how much of a danger does a specific hazard present? Calculating the risk is simple, and although different people and companies will do it slightly differently, it is all founded on one easy to remember formula…

severity x likelihood = risk

All we need to do is assign an individual value to *severity* and *likelihood* respectively and then multiply them together. In order to keep it as simple as possible, we will use values of ‘1’, ‘2’ or ‘3’ to indicate how severe, or how likely, something is.

If we believe that any injury from a hazard could cause a **minor injury**, we will assign the *severity* a value of '**1**'; if it has the potential to cause a **major injury** (or end up in time off work) then we could assign it the value of '**2**'; finally, if we think there is the potential for a **severe injury or a fatality**, then it would be classed as a '**3**'.

Now go through the same exercise for the *likelihood*; a value of '**1**' would denote something as being **unlikely** to happen, '**2**' would assume that something might happen **sometimes**, and '**3**' would suggest **often** or **always**.

The story so far…

Let's start going through a worked example for a hazard to summarise what we have so far. We've identified a number of hazards that relate to the equipment we're using, the operator, where we are working and what we are doing (based on **MOST**).

Our scenario

We are working out in the woods, and a team of foresters have been felling a number of trees, which now need to be cross-cut according to specification. We're going to be cutting lengths of timber that vary between 2.1 metres and 3.6 metres (as that is what our notional specification tells us), resulting in some fairly heavy pieces of timber that will need to be moved.

There are a number of hazards that could be drawn out from even this minimal scenario, but for the purposes of this quick summary, our hazard will be "lifting heavy timber".

Having defined our hazard, we need to calculate the potential risk. Consider what might happen trying to lift heavy pieces of timber… back injury has to be a fairly high concern, but is that a minor injury? A major injury, or something that results in time away from work? Or a severe injury? You should make up your mind about this, but to me, I would assign this a value of '**2**' (major injury).

How likely is that injury to occur when we attempt to manhandle large pieces of timber? Unlikely? Sometimes? Or often? Again, to my mind I'd assign this a value of '**3**'.

Here's how our risk assessment is shaping up so far; try to add another hazard and its associated severity, likelihood and risk in the empty line beneath it (ignore the greyed out boxes as we will be using those in a minute)…

Hazard	**Severity**	**Likelihood**		**Risk**	
Heavy lifting	2	3		6	

With a risk level of 6, out of a possible maximum value of 9 that would be achieved if both the severity and likelihood had each been given a value of 3, we are above what could be considered a medium level of risk. In practice what this means is that we need to take some course of action to reduce the risk to a lower level; in this example, a *risk* value of between 1 and 3 would be considered to be acceptable.

Implementing control measures

Having calculated our level of risk for manually moving and lifting heavy timber as being too high, we need to do something to reduce that risk to what could be considered a safe level. That plan of action to make it safer is called a ***control measure*** and it is the third step in managing risk…

1. Identify the ***hazards***.
2. Calculate the ***risk***.
3. Implement control measures.

When considering what control measures should be put into force, do not just limit your thinking to ‘what would keep me safe?’ – there are wider issues at stake. Planning your control measures is not only about you as the operator, but should include:

- the environment;
- other people on the site such as the general public, co-workers, etc.;
- livestock and other animals that may be present such as horses being ridden, or dogs being walked;
- tools and equipment.

Returning to our scenario regarding moving or lifting heavy timber, what control measures can you think of in an attempt to make it safer?

Complete a list of control measures relating to moving or lifting potentially heavy timbers:


RISKZONE 20 M

1. e.g. use a forwarder grab.
2. …
3. …

Things like the use of timber tongs and winches, or rolling the timber rather than lifting it are all well and good, but one of the options has to be to just leave it. Or at least wait until you can use more suitable lifting gear – hence the reason why the example given above was to use a forwarder grab instead.

Each hazard that you consider, should have one, or more, appropriate control measures showing how to mitigate the risk resulting from that hazard. With the control measure decided upon, the risk can be re-calculated and if it now appears to be a low risk then you have theoretically minimised the chances of harm. If it isn't, then it is back to square one and you will need to reconsider the control measures.

Once all this analysis is complete, we can now update our example risk assessment; note the changes to the values in severity, likelihood and risk, which now take account of the control measures (also listed) as well as who this element of the risk assessment applies to.

Hazard	Severity	Likelihood	Control measure	Risk	Affects?
Heavy lifting	1	1	Use forwarder grab to lift / move timber.	1	Operator

Talk to each other…

The fourth step in managing risks is to ***communicate*** with your colleagues, the public and anyone else who might have an interest in the site where you are working, or the work you are undertaking. It is important that everyone understands the hazards, the level of risk involved and how to mitigate that risk.

With a small team, the easiest way is to talk the risk assessment through with your co-workers and ask each person to read and sign the risk assessment to say that they understand it; this gives a chance for anyone to question the assessment or suggest amendments and additions.

Don't stop assessing the risk…

The fifth and final step in the creation of our risk assessment is to ***re-assess***. This does not necessarily mean that everyone downs tools every half-hour to discuss the finer points of the risk assessment strategy, but that everyone maintains vigilance for additional hazards or hazards resulting from a change in circumstance.

If there are any changes, then it is a good idea to update the risk assessment and inform others of the amendment.

Emergency Planning

Whilst we have dealt with risk assessments, there is another important, and related, document to consider – the ***emergency plan***. This document lists important information that might be required in the event of an accident happening.

One of the main things to note down is your location; this can be defined in a number of ways such as using the grid reference for the work site, or the address and postcode, or by specifying a nearby landmark.

However, the reality of the type of work that you might be undertaking means that you could be working off the beaten track, and knowing the grid reference of the location where you are working does not mean that it is accessible. In this case, you may want to also specify a meeting point – (access point, locked gates, tracks, etc.) – where you will meet the emergency services if needed.

If you are working away from a good track you should ask yourself the question of whether the emergency services would actually reach you with a standard vehicle… you may need to be specific about requesting an off-road ambulance or an air ambulance, for example. Remember that if you are likely to require an air ambulance, you should find out where a potentially suitable landing zone might be.

For many people working within the forestry and arboriculture industry, they often finding themselves at different sites, at different times; from the perspective of having to deal with an accident, this may have some ramifications. Naturally, one can call the emergency services, although you might opt to take the casualty direct to the nearest A&E hospital – but do you know where it is, and how to get to it? You can visit the NHS website and use their search facility (http://www.nhs.uk).

Note that the European standard emergency number is 112.

As well as being aware of contact details for the local hospital, what about useful contact details? This could be anything from your supervisor, the land-owner, utility companies and next-of-kin details for operators. One way of managing next-of-kin details is for each operator to have “ICE” entries in their mobile phones – “ICE” is *In Case of Emergency* and simply means putting the phrase “ICE” next to the person that they would want to be contacted in the event of an accident.

You should also be aware of medical alerts (“medi-alerts”) for each operator – knowing that an individual suffers severe allergic reactions to wasp stings is worth knowing in advance; if they go into anaphylactic shock you need to react swiftly. As they say “forewarned, is fore-armed”.

Personal Protective Equipment

The European Union has issued a number of Directives that are aimed at improving the health and safety at work. The PPE *Directive 89/686/EEC* covers the manufacture and marketing of personal protective equipment and the CE mark provides evidence that the PPE meets the required standard. However, as of April 21st 2018 this will be repealed and a new Regulation comes into force - the *Regulation (EU) 2016/425*.[5][6]

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[5] *Source:* http://ec.europa.eu/growth/sectors/mechanical-engineering/personal-protective-equipment/index_en.htm

[6] What’s the difference between a Directive and a Regulation? A Directive is a legislative act that sets out an objective that all EU countries must achieve by a given date. However, it is up to the individual countries to decide how this is done. In contrast a Regulation is a binding legislative act, and it must be applied in its entirety across the EU without the need for separate national legislation. *Source:* http://www.bsigroup.com/Documents/BSI-PPE-Whitepaper-UK-EN.pdf

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As well as the directive / regulation that specify the testing required to ensure PPE meets a defined standard, the other important piece of legislation is the *Personal Protective Equipment at Work Regulations*. [Note that hearing and respiratory protection is not covered by this Regulation].

The PPE at Work Regulations stipulate that an employer must provide PPE to a worker where the risks cannot be controlled to an acceptable level using other means, in essence, using PPE is the last line of defence to lower the risk. That said, it is expected that anyone using a chainsaw will wear relevant PPE such as chainsaw protective trousers, chainsaw protective boots, chainsaw gloves, helmet, ear protection and face protection.

For maintenance tasks we should wear safety boots and gloves when handling the chain and guide bar, or dealing with fuel and oil. You might also consider wearing safety glasses when dealing with fuel filters, and definitely if you are using an air-line to clean components. Once we begin to use the saw we require a whole new level of protection, and not just from the chain; with the saw running we are subject to vibration, noise, wood chips flying around, fumes and a number of other hazards.

- Helmet;
- Face protection;
- Ear protection;
- Chainsaw trousers;
- Chainsaw boots;
- Gloves;

- First aid kit;
- Outer clothing: high visibility / non-snag.
- Whistle.

Helmet

There are essentially two types of protective hat, designed for either forestry or arboriculture. There are differences within these two disciplines that mean the helmets are modified slightly to improve the safety of the wearer based on the conditions they are likely to find themselves in – the most obvious difference being that the arboriculture helmet is fitted with a chin strap, unlike the forestry one.

There has been much talk about the use of 'arb' helmets when carrying out forestry work, especially as the two styles of helmet appear to conform to different standards. The requirement is that protective helmets must conform to EN 397 standard; however, arboriculture helmets are often built to the EN 12492 standard – leading to a certain amount of confusion between the two 'competing' standards.

The bottom line is that *helmets built to meet the EN 12492 standard exceed the requirements of the EN 397 standard*, which can be seen in the table. Those helmets built to meet EN 12492 can withstand twice the force from a load dropped from directly above the hat, and must withstand two penetration tests from a conical object (rather than one for the EN 397 standard). Also, these helmets are subjected to impacts from front, side and rear of the helmet, whereas side impact tests are an optional component of the EN397 standard.

In order to seek further clarification regarding the suitability of helmets, we can refer to the various industry guidance documents produced by the Arboriculture & Forestry Advisory Group (AFAG), the Forest Industry Safety Accord (FISA) and the Health and Safety Executive.

For climbers who wish to use a chainsaw, we should refer to the AFAG guide, AFAG401: Tree Climbing Operations, which states “when climbing, chainsaw users should wear… a safety helmet (the HSE Arboriculture and Forestry Advisory Group (AFAG) recommends a mountaineering-style helmet complying with BS EN 12492)”. This statement is actually quite confusing as it uses the word “recommends”, rather than “must” – the minimum requirement then, is to use “a safety helmet”, with the recommendation that it should meet EN 12492 (and it would be considered best practice to do so).

But what does “*a safety helmet*” have to conform to? We can find that out in the HSE’s *INDG317: Chainsaws at work* document, which states the relevant PPE standard that applies is “*safety helmet to EN 397*”.

For forest workers, working on the ground, we can either refer directly to *Chainsaws at work*, or to the FISA safety guide *301: Using petrol-driven chainsaws* where the guidance clearly states that helmets must be “*complying with EN 397*”.

Table 1 shows the comparison between the EN397 and EN 12492 standards

Standards	**EN397**	**EN12492**
Shock Absorbtion		
Form and mass	Spherical mass = 5kg	Spherical mass = 5kg

Standards	EN397	EN12492
Height and angle of fall	Height = 1m, vertical fall	Height = 2m, vertical fall
Requirement	Maximum force 5kN	Maximum force 10kN
Resistance to penetration		
Form and mass	Conical (60º), mass = 3kg	Conical (60º), mass = 3kg
Height and angle of fall	Height = 1m, vertical fall	Height = 1m, vertical fall
Number of falls	One	Two
Requirement	No contact between mass and head	No contact between mass and head
Absorbtion of lateral impacts		
Form and mass		Flat, mass = 5kg
Height and impact angle		Height = 0.5m, impact from front, side and rear.
Requirement		Maximum force 10kN

What can we conclude from all these standards, tables, and guidance documents? When using a chainsaw, the operator must wear a helmet that meets the EN 397 standard as a minimum.

If you are working towards your arboriculture assessment, then you may want to use a helmet that meets BS EN 12492 (as that is the recommendation). However, *whichever helmet you choose you must abide by the manufacturers guidelines on suitable usage*.

Helmets are often fitted with ear and eye protection, but you could purchase separate items – helmet, ear defenders and safety glasses (however, under current tax rules that could cost you more as individual components would be subject to VAT, whereas a complete unit is not)[7].

Example PPE: Petzl Vertex Vent helmet, often used by arborists, meets EN 12492.

Eye Protection

Eye protection is achieved through mesh visors or safety glasses… or both. I've lost count of the times that I have been cutting timber, or felling trees, and had chips of wood come around my visor and land in my eye – how they get around the full face visor I have no idea! Whatever you use though, make sure that you do protect your eyesight by using a mesh visor that meets the EN 1731:2006 standard, or safety glasses that meet EN 166.

Both mesh visors and safety glasses should carry the CE logo, but also an impact resistance rating (both standards use the same rating as defined in EN 166). Impact ratings are tested using a steel ball, with Grade 'S' being the least impact resistant, resisting a 43g 22mm steel ball dropped on to the

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7 HMRC guidance states that "if you fit accessories such as visors or ear protectors as an integral part of a qualifying helmet, you can zero-rate the supply of the complete helmet. But accessories supplied on their own are standard-rated", http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageLibrary_ShowContent&propertyType=document&id=HMCE_CL_000107#P34_1936, accessed 31/01/2014.

lens from a height of 15” / 38cm. Grades ‘F’, ‘B’ and ‘A’ are much more resistant and involve a ballistics test, with ‘A’ being the most resistant to impact; this test involves firing a 6mm, 0.86g steel ball at 190m/s into the lens (that’s 425mph!).

Table 1: impact resistance for eye protection.

Grade	Use	Impact
S	Basic	Increased robustness
F	High speed particles	Low energy
B		Medium energy
A		High energy

Example PPE: Petzl Vizir; this item fits on to the Petzl Vertex Vent helmet and is a clear protective face shield that meets EN 166 and has an impact rating of ‘B’ which means it is resistant against medium energy impacts (tested by firing a 6mm, 0.86g steel ball at the lens at 120m/s, or 286mph).

Hearing Protection

Under the Control of Noise at Work Regulations 2005, employers must provide adequate hearing protection when operatives are working in noisy environments; which is classed as any situation where the noise level is greater than 80dB(A). This legislation applies across Europe, where it is deemed that continued exposure to noise levels greater than 80dB(A) can result in permanent hearing damage.

The standard for hearing protectors is EN 352, and there are a number of 'sections' such as EN 352-1 for ear-muffs, EN 352-2 for ear-plugs, and EN 352-3 for ear-muffs on a safety helmet; there are more sections, but these cover the most likely options for our use. Although the vast majority of operators will use helmet mounted ear-muffs, it is interesting to note that in the HSE's industry guidance document *Chainsaws at work*, the relevant PPE standard is for "*hearing protection to EN 352-1*", whereas the AFAG and FISA guidance states merely that it should "*comply with EN 352*".

If using [helmet mounted] ear-muffs, our ear protection must conform to EN 352-3, you will find that protectors are also listed with a series of other figures "SNR30 H39 M28 L21" for example. This seemingly random collection of letters and numbers is important, and the higher the number, the greater the level of attenuation. Note that not all ear defenders are created equal, and you should ensure that you use the correct ear protection to meet your application; but how do you know what you need?

3M produce a very useful catalogue[8] of hearing protectors that sets out the legislation, and how it applies to enable you to choose the correct product. So how do you choose?

Let's take an example chainsaw – the Makita DCS5121, which has a noise level of 102dB LpA (which is the sound pressure level at the operator position). Above a level of 85db(A), hearing protection is compulsory and at a level of 102dB, serious damage to hearing could be done to the operator even if they used the saw for just a short time; using the 3M Hearing Product catalogue, we can see that between levels of 94dB-105dB(A),

8 Hearing Product Catalogue, UK & Ireland, available at http://solutions.3m.co.uk/wps/portal/3M/en_GB/PPE_SafetySolutions_EU/Safety/Products/Product-Catalog-PoW/?PC_Z7_U00M8B1A0OP590IB369UJT2UU4000000_nid=K9PKQNNJ54beN8MT32R3VMgl

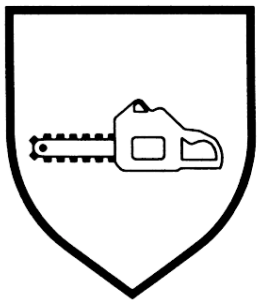
the Peltor Optime II ear-muff should be selected (as it comes in form allowing attachment to a helmet). If you want to choose another manufacturer, look at the SNR figure for the Optime II (SNR30) and compare this value to your chosen manufacturer.

Note that if you regularly use a wood chipper, you should up-rate your ear protection; even the popular Timberwolf TW150DHB 6" chipper has a "*guaranteed sound power of 120db(A)*"

Chainsaw Trousers

Chainsaw trousers must be worn, and there are many different types, classes, styles and prices to contend with when choosing a pair – so how do you know what you are paying for?

As with most things in life, you get what you pay for… more expensive chainsaw trousers probably fit better, will be lighter in weight, cooler to wear in the summer and incorporate a stretchy, flexible material to aid comfort when working.



With anything that purports to be chainsaw protective clothing, trousers must display the CE logo, the 'chainsaw shield' and state the protection class.

Chainsaw trousers are commonly available in two different types, A and C; although the relevant standard actually sets out designs for three types, A, B and C:

•Type A provides front-only protection.

•Type C provides all-round protection.

Chainsaw trousers must comply with the EN381-5 standard, which sets out the designs, protective material, protective coverage, speed rating protection (or *class* rating), as well as other specifications. The specifications[9] stipulate that the trousers must be "durably marked" with:

- The name or trademark of the manufacturer, or legally responsible company;
- Designation or style number (this is the company's design identifier);
- Design (type 'A', 'B' or 'C');
- Serial number / batch number;
- Date of manufacture;
- The number "EN 381-5";
- Size;
- Speed classification (Class rating). This is to be shown outside of the 'chainsaw shield';
- The wording "If the protective material is damaged, the garment is to be discarded";
- Washing / cleaning instructions.

Protection Classes:

There are four classes of protection available:

Class 0 protects against a chain running at 16m/s.

Class 1 protects against a chain running at 20m/s.

Class 2 protects against a chain running at 24m/s.

Class 3 protects against a chain running at 28m/s.

9 BSI EN 381-5: 1995, Protective clothing for users of hand-held chainsaws. Part 5: Requirements for leg protectors.

Chainsaw protection for the legs can also be achieved through the use of *chaps*, essentially leggings that fit over an existing pair of trousers, which can be easily removed. Whilst these may suit occasional users, for professional use a ‘proper’ pair of chainsaw trousers should be worn.

Chainsaw Boots

Chainsaw boots are available in two distinct styles – welly and lace-up, but whatever the style of boot you use, it must conform to the EN381-3 standard and display the ‘chainsaw shield’, the class rating and the CE logo / EN number.

Boots that meet this requirement, will provide protection to the toes, the instep and the vamp (described as “the front part of the shoe, starting behind the toe, extending around the eyelets and tongue and towards back part of the shoe”

Chainsaw Gloves

Under normal conditions, chainsaw gloves should be worn by operators of a chainsaw. There are however, some instances where wearing them can be more dangerous than not wearing them, and your risk assessment should reflect this situation; typically this is when using a chainsaw in the rain – once the gloves get wet they also get slippery and proper grip is hard to maintain.

For all other occasions, chainsaw gloves should be worn when working on the ground (climbers do not need to wear gloves when operating a saw in the tree). Chainsaw gloves provide a protective pad to the back of the left hand, and some also provide the same protection to the back of the right hand.

Chainsaw gloves are typically rated as **Class 0** protection, and they should display the 'chainsaw shield' to denote they are proper chainsaw gloves… as well as the CE logo. As you might expect, chainsaw gloves must met a specific standard and in this case, it is a separate part of EN381 that we have already come across for chainsaw trousers.

Although EN381-7 sets out the requirements of the gloves, such as design, performance and markings, EN381-4 lays out the testing methods to be used to ensure the glove meets the standard. Chainsaw gloves are placed on a fake hand and a chainsaw running at a set speed is dropped on to the glove – clearly the glove must resist the chain cutting through it before the chain comes to a stop.

High Visibility Clothing

There are different options for high visibility clothing and certain situations require specific hi-viz clothing. Although not all high visibility clothing meets a recognised standard, a standard does exist regarding this clothing: *EN20471: 2013*.

The standard specifies three different classes of hi-viz clothing, with requirements for the amount of background material and reflective material, the performance of the reflective tape and any fluorescent material after a series of washing and drying cycles, water permeability and rip characteristics.

- Class 3 is the highest level of protection and is required to be worn by anyone working on or near motorways or dual-carriageways. It must incorporate a minimum of 0.8m^2 of background material and 0.2m^2 of reflective material. Class 3 tops will have sleeves.
- Class 2 provides medium level of protection and is required for anyone working on or near A / B roads. These will have 0.5m^2 of background material and 0.13m^2 of reflective tape. Class 2 tops are generally of sleeveless design.

- Class 1 provides the least protection and has 0.14m^2 of background material and 0.10m^2 of reflective material.

First Aid Kit

Working with chainsaws is a potentially high-risk activity and a suitable first aid kit should be available, but what do the regulations say about first aid? The *Health & Safety (First Aid) Regulations 1981* stipulate that an employer must "provide adequate and appropriate first-aid equipment, facilities and people so employees can be given immediate help if they are injured or taken ill at work".

The minimum requirement is for a 'suitably stocked first-aid kit', an appointed person to take charge of first aid arrangements, and information for employees on first aid arrangements. A self-employed person must also take charge of their own first aid requirements.

The first aid kit must be sized appropriately for the number of members in the team, and there is **no mandatory list of items that should be in a first aid box**. Although there will be basic items such as non-allergenic plasters, the first aid kit should contain those items that cover the likely hazards in the workplace - for chainsaw use that is likely to include eye-wash and large wound dressings.

More information can be be in the HSE's INDG214(rev2) First Aid At Work leaflet.

Signs

As part of your risk assessment you will inevitably come across the situation where you will need to consider the general public, other third parties, or traffic. A common control measure to deal with these would include the use of a banksman, or to create an exclusion zone by the use of barriers or

Make sure you carry a personal first aid kit. There should also be a first aid kit sized for the number of operators on site. These kits should be inspected regularly and updated as required.

barrier-tape; but frequently signs are used to show potential dangers and act as a warning to others.

The Health and Safety (Safety Signs and Signals) Regulations 1996 sets out the requirements for signs, and you should be aware that the colours of the signs do have a specific meaning. This is known in the regulations as a *safety colour*.

- *Red*: used on prohibition signs to inform of dangerous behaviour.
- *Yellow*: used on warning signs to denote that care should be taken.
- *Blue*: used on mandatory signs to show that a certain behaviour is required.

The regulations also stipulate the various types of sign, and of relevance to us as chainsaw users, and where other people are likely to be present within the vicinity whilst we are using the chainsaw, are:

- *Mandatory signs*: these signs prescribe a required behaviour.
- *Prohibition signs*: these signs prohibit any behaviour that is likely to cause a risk to health or safety.
- *Warning sign*: this is a sign that warns of a risk to health or safety.
- *Safety sign*: this means a "sign referring to a specific object, activity or situation and providing information or instruction about health or safety at work".

On the HSE website, concerning public safety, it stipulates that "on all reasonably foreseeable approaches to the worksite, erect warning and prohibition signs conforming to the Health and Safety (Safety Signs and Signals)

Regulations 1996 , indicating a hazardous worksite and that unauthorised access is prohibited”

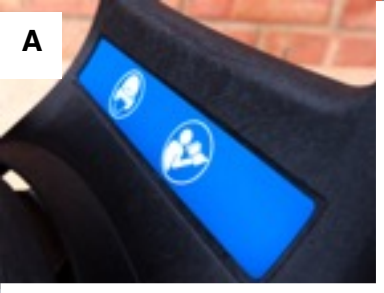
Chainsaw Safety Features

Modern chainsaws are fitted with a number of features designed to improve the safety of the machine whilst it is being operated, and whilst you might just still come across old chainsaws that don’t have chain brakes, or that allow the operator to lock them in full throttle, these days safety is taken much more seriously so let’s take a look at the main safety features of a modern saw.

Chain Brake

The chain brake (I) is possibly the most important safety feature of them all and it’s purpose is to stop the chain rotating quickly in the event of the chainsaw kicking back towards the operator during cutting, or to allow the operator to apply the brake when moving with the saw when the engine is still idling. The chain brake operates in two ways - although the result is the same, and that is to apply a brake band around the drive sprocket to stop it moving. This action can either be manually initiated (i.e. the operator applies the brake) or through inertia (i.e. the force of the kickback is sufficiently strong for the brake to come on automatically).

There are some subtle differences between makes and models of chainsaws, which relate to how to the clutch systems are made (inboard clutch or outboard clutch) but we’ll be looking at clutch systems and the chain brake in more detail later in this book.



A

B

C

D

E

F

G

H

I

J

On / Off Switch

The on / off switch (B) is a fairly obvious safety feature and it should be positively marked… but do make sure that you understand how to operate it on your chainsaw as there are, yet again, some subtle differences in how they work, which way they need to be slid to switch the saw off and how the choke function operates. To find out how your saw works consult the manufacturers user guide for it.

Chain Catcher

This small item is found at the bottom of the saw, in-line with the chain, and it's purpose is exactly as it's name suggests - it catches the chain should it become derailed or snapped. On the majority of saws the chain catcher (D) is a small piece of sacrificial aluminium that can be easily replaced by simply unscrewing it and bolting in the new one; but on some smaller capacity saws the chain catcher may be plastic and moulded into the side panel casing.

Be warned though that if the chain snaps, the chain catcher will take out most of the energy of the chain coming back towards the operator but will still leave a short section that is unchecked… which leads us on to the next safety feature…

Rear Hand Guard

Found at the back of the ground based chainsaw, the handle has a wide bottom 'plate' that many people use to stabilise the saw whilst starting it (by putting their heel or foot on it when pulling the starter cord), but that wider plate also provides protection for your right hand should the chain snap; as

mentioned above in *Chain Catcher*, should a chain snap the chain catcher catches most of the chain but there is likely to be a short length still flying towards the operator… the rear hand guard (G) is there to protect you in this instance.

Safety Throttle

Often mistakenly called a *Dead Man's Handle*, the safety throttle (E) will not allow you rev the engine unless the safety latch has been pressed down first. It's a simple interlock system that is designed to ensure that, under normal operation, you are holding the saw correctly when cutting. When you release the safety throttle the engine does not cut-out… that's the difference between a safety throttle and a *dead man's handle*.

Safety Stickers

The safety stickers (A) are a legal requirement on all chainsaws and include the CE logo[10] to show that the machine conforms to European standards, the noise level[11] of the machine in decibels (dB), a warning symbol denoting that this is potentially dangerous equipment, a PPE symbol to remind you

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[10] Any equipment sold in the UK must have a CE stamp to show that it has undergone a series of tests to confirm that it is safe to use. This is part of the Machinery Directive.

[11] Petrol powered chainsaws are quite loud in use, and the noise level is given in dB. Any equipment under 80dB does not require ear protection to be worn. Between 80dB and 85dB, it is up to the person concerned whether they would prefer to wear ear protection, but above 85dB ear protection must be worn.

that appropriate PPE must be worn when using it, and the book symbol telling you to read the manufacturer's instructions. Some chainsaws also show a kickback warning symbol too.

Scabbard

Also known as the *chain guard*, the scabbard (F) fits over the chain and guide bar to provide protection to the cutting edges of the chain, the operator and anything else which the saw may come into contact with when moving it around. The scabbard should be fitted correctly and the correct length to provide proper protection. These will need to be replaced over time, as the action of constantly removing them and putting them back on will eventually tear the edges.

Exhaust

The exhaust (H) is considered a safety primarily because it is designed to direct fumes away from the operator; on a ground-based saw this will be forward-facing, and on a climbing (top-handled) saw it will be side-facing.

However, exhausts may also have safety features built-in, such as a spark arrester.

Anti-Vibration Mounts

With the increasing awareness of Hand-Arm Vibration Syndrome (*HAVS*) and ‘whitefinger’, manufacturers try hard to ensure that any vibrations from using the equipment are kept to an absolute minimum to the operator through anti-vibration mounts (C), and they must provide figures to show the levels of vibration for all new equipment by law.

In order to keep vibration levels low, manufacturers rely on either rubber fixings, or metal springs, to isolate the engine unit from the handles.

Chain Type

Although the chain (J) is the sharp end of the tool, it is still designed with safety in mind and has been built to reduce the chance of kickback and reduce vibration.

Reducing the likelihood of kickback is achieved by ensuring a smooth transition to the cutting edge, especially at the tip of the guide bar where there is highest chance of kickback occurring. This transitional element is built into the chain in two ways and depends upon who manufactured the chain… either the leading edge of the cutter will be shaped, or another link called the *Guard Link* will be fitted in front of the cutter.

The combination of correct PPE, correct chain type incorporating low kickback features, and the correct stance when using the chainsaw will provide some level of protection against kickback… but what is kickback?

Kickback

Knowing what causes kickback means that you can use the saw in a safe manner to eliminate it, but this is not always easy to achieve when carrying out forestry and arboricultural operations. Looking at the saw from the drive side, the chain is driven in a clockwise direction… understanding this fact helps us to understand how the saw reacts to certain types of cuts.

Under normal circumstances we would use the underside of the bar and chain to cut with; at this point the chain is moving back towards the engine unit and we call this the *pulling* chain because the timber being cut is being pulled into the wood (conversely the chainsaw is being pulled into the timber). Keeping the saw close to the timber and making use of the spiked bumpers can really help with efficient cutting and improving safety as it drastically reduces smaller lengths of timber rolling around.

There are plenty of occasions however, that we cut using the top of the bar and chain. This side is the *pushing* chain as the saw and the timber are being pushed apart; in this case maintain a good grip on the saw as it will be pushing back towards you and keep the timber away from the spiked bumpers as they are pointing up slightly and will constantly dig into the wood.

Both of the above two scenarios - cutting with the bottom of the

bar, and the top of the bar - are perfectly normal, but the problems really start when using the tip of the bar or, more specifically, the top quarter of the tip of the bar. At this point the chain is moving downwards and moving at around 50mph[12] which means that the reaction forces are no longer acting towards or away from the operator, but acting to throw the end of the chainsaw up into the air. This is an area called the *kickback zone*.

The use of a safety chain that smoothes the transition to the cutting edge and/or using low height cutters, will minimise the chance of kickback. The other option is to use a guide bar with a much nose sprocket that has a much tighter radius, as the larger the radius at the end of the bar, the greater the kickback zone.

[12] Actual speed will vary greatly depending on the saw, bar length and engine revs, but the 50mph figure is based on a chain running at around 22 - 24m/s.


OIL

Understanding The Chain

Introduction

Although there are several basic maintenance tasks that the chainsaw operator should carry out, keeping the chain sharp and correctly set has to be one of the most important. However, to do it correctly requires a little understanding of the chain components, what their function is, and how to identify one chain from another - not only will this information help you to look after the chain correctly, it will also ensure that you fit the correct chain for your saw and the right type of chain for the intended use.

Chains are made up of either three or four key components and we'll take a look at each of them here.

The Cutter

As the name would suggest, this component actually does the cutting - but the amount that is cut each time it enters into the timber is set by the *depth gauge* at the front edge of the cutter. The depth gauge will need to be checked and adjusted as part of the chain maintenance regime.

If you look closely at the chainsaw chain, you'll see that there are cutters on both sides of the chain, and the cutting edge is angled such that the outside corner of the cutting edge is pointed; this angle is dependent upon the type of chain and it's intended use[13]. The manufacturers recommended angle is based on the action required to either sever or chip the fibres away, and is a compromise between safety, strength and cutting efficiency.

Not all chains are the same as we not only have to consider whether we want a chain for crosscutting or ripping, but if it's for crosscutting then we have additional choices based on the timber that we are likely to cut. There are three basic types of cutter:

1. *Chisel* cutter - this is used when primarily cutting softwood.
2. *Semi-chisel* cutter - this is a general-purpose cutter used when cutting a mixture of hardwood and softwood.
3. *Chipper* cutter - this is designed to be used when primarily cutting hardwood.

The chisel cutter can be identified by looking at the top plate… because the top plate and side plate essentially meet at a right angle, the top plate extends for the full width of the cutter and the working corner has a very definite sharp point. The sharp point ensures that the wood fibres are severed very efficiently and this is the fastest cutting profile of the three. However, whilst it may provide the fastest cut, if it is used in hardwood the point will blunt quickly and so this profile is also the least durable of the three types.

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[13] There are two types of chain - *crosscut* chain and *ripping* chain. Chains designed for crosscutting could be considered as 'normal' chains used to cut firewood for example, where the cut is made across the fibres of the wood (the fibres essentially run from the bottom of the tree to the top). If we wanted to cut along the fibres then a slightly different cutting action is required and we would a ripping chain for this purpose (i.e. planking).

Both the semi-chisel and chisel profiles have top plates that do not extend the full width of the cutter as the top of the side plate is rounded. Because these types of cutter profile are not as pointed as the chisel, they are better suited for dealing with hardwood. The chipper profile is much more rounded than the semi-chisel, and it is the chipper that is ideally suited for crosscutting hardwood. The semi-chisel can be thought of as an 'all-rounder' and is ideal for day-to-day operations if you are not sure what you'll be cutting.

Whatever the type of cutter, you must ensure that you sharpen it to the correct angle and that the depth gauge is set correctly; this will be covered in more detail in the section *Sharpening The Chain* later.

The Tie-Strap and Rivets

The tie-strap and rivets combined look somewhat like a piece of bicycle chain and they are designed to provide flexibility to the chain and to hold all the relevant components together. When you purchase a ready-made chain it is already in a loop so you can fit it to your saw, but you can also make your own chains which can be effective if you run a number of saws that require the same chain but in different lengths. Either way, when the chain is taken straight off the reel it will need to have the ends joined to form the required loop, and a tie-strap (plus rivets) is inserted into the two ends of the chain and secured using a *rivet spinner*.

Because of the way crosscut chains are made with a cutter fitted on each side alternately, adding in this extra tie-strap to form the loop may cause two cutters to be next to each other on the same side - this is not important and will not affect the performance of the saw.


makita®

The Drive Link

The drive link goes largely un-noticed, sitting along the middle of the chain with the bottom part of it sitting in the groove in the guide bar. For all that it is unseen, it does fulfil a number of important roles, perhaps the most important of these is that it forms part of the system to drive the chain around the bar.

There are a number of stages in driving the chain from the petrol engine, or hydraulic motor (in the case of underwater chainsaws) or electric motor in the case of mains-powered / battery saws. However the power is derived, a sprocket is rotated into which the bottom of the drive link sits. As the *drive sprocket* is turned the *drive links* will be engaged and the chain pulled around.

As the drive link moves along the groove in the bar, the *tang* at the bottom of the link clears out debris from the base of the groove whilst cutting, but the lower part of the drive link also performs another important task in assisting with lubrication.

Chain oil is pumped from the chain oil tank when the chain is being driven (the chain oil pump is essentially driven by the drive sprocket), and this is fed via a small slot in the casing of the chainsaw through a small hole in the guide bar and into the bar groove. As the drive link passes this small hole in the guide bar it carries it around the bar and passes some of it up to lubricate the rivets; some chains have small holes drilled into the drive links to act as an oil reservoir.

Chains come in various sizes and ‘weights’ depending upon the saw they are to fit - a lightweight chainsaw or telescopic pole pruner will use a much lighter weight chain than a 90cc chainsaw designed for heavy duty workloads. A heavier duty chainsaw will utilise a physically larger and crucially,

wider, guide bar… therefore the drive link needs to be sized appropriately for the width of the bar groove. The width of the bar groove must match the width of the drive link, and this measurement is called the ***gauge***.

The Guard Link

In order to reduce the chance of kickback and to ensure a smoother cut, some chains utilise a fourth component called the *guard link*. As we saw earlier in the section on *kickback*, not all chains use this component but on those that do, you'll find it right in front and partly overlapping the front edge of the depth gauge on the cutter.

Buying A New Chain

As tempting as it is to just walk into a garden machinery store and ask for a chain to fit your particular make and model of saw, if you want to make sure that you get exactly what you need then you need to know some important facts about the setup of your saw. We've already come across one of these important measurements when we discussed the *gauge*, but there are another two things to consider to ensure the chain will fit your saw, as well as an optional extra to make sure you get the chain you want.

Chain Gauge

This was discussed in the section dealing with the *drive link*, so just to re-iterate that the gauge is the measurement that ensures the width of the drive link is the same as the width of the groove in the guide bar. There are industry standard sizes and these are 1.1, 1.3, 1.5, 1.6, 1.8 and 2.0mm.

Chain Length

Asking for a chain to fit an 18” bar is very common, but it’s possible to come unstuck as not all machines use the same length of chain for the same *effective length* of the guide bar. To make absolutely certain you get the right length (or if you are making your own chain), the length of a chain is measured in the number of drive links.

Chain Pitch

The pitch of a chain is important as the spacing between the drive links must match the spacing between the teeth of the drive sprocket.

Cutter Profile

This is the optional piece of information; we mentioned it whilst discussing the cutter earlier in the book. For crosscutting chains there are three basic profiles depending on whether you will be working primarily in hardwood, softwood or a unknown mixture of both.

- Hardwoods: choose a *chipper* profile (Stihl also refer to this as a “standard” cutter).
- Softwoods: choose a *chisel* profile (this goes under several different names depending on the manufacturer, for instance Oregon refer to this as a “round ground chisel” and Stihl call it a “super” profile).
- Mixture / general purpose: choose a *semi-chisel* profile (again, depending upon the manufacturer this may be called a “micro-chisel” (Oregon) or just a “micro” profile (Stihl)).


MAKITA PP
.325"
64
1.5mm/.058"
445.038.631

Where To Find Chain Information

There are a number of places to find out this information should you need to; the most obvious is to look in the operators guide supplied by the chainsaw manufacturer. However, many manufacturers (but not all) put all the useful information on the guide bar although this does tend to suffer from the problem that the time when you need to use this information is when the chain / bar has worn out and you can no longer read it! Despite this, it's definitely worth checking the guide bar to find out if the data is still there, although different manufacturers put the information in slightly different places and use slightly different icons / terminology.

Makita / Dolmar, Oregon, Husqvarna Chains

All of these manufacturers use the same underlying method of finding out the information required to sharpen the chain, which is to stamp a model number directly on to the drive link that can then be referred to in a filing chart or user manual. This method is used by other manufacturers too such as Windsor (owned by Blount International who also own Oregon), Tigar and Carlton (also owned by Blount International).

Makita / Dolmar Chains

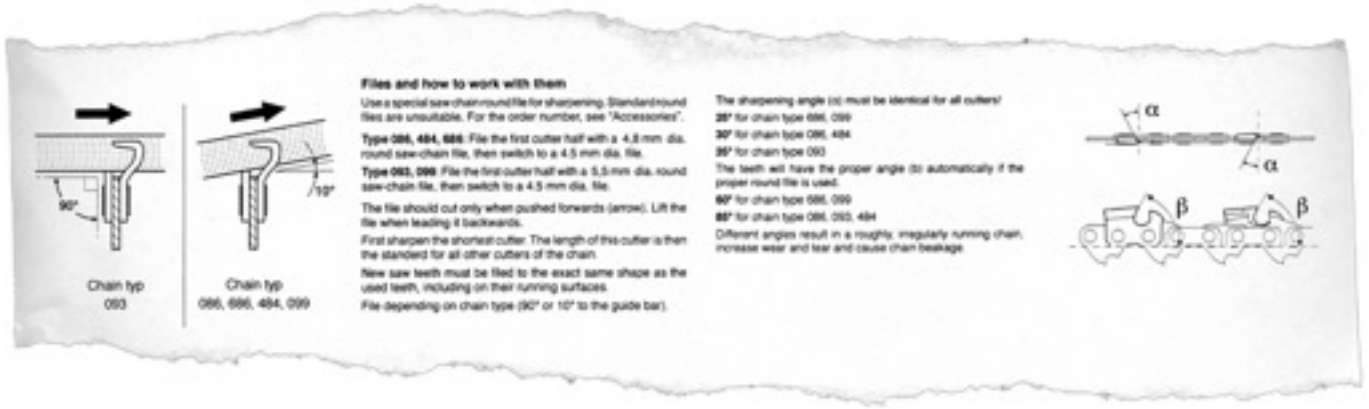
These chains are marked to make it simple to find the information - all you need is the model number from the drive link and the user guide or appropriate filing table; by referencing the model number against the table provided all the data you need is presented.

Makita Filing Tables / Information

The image to the right shows the Makita filing table found on the back of the box that comes with a new chain. This concise guide provides all the basic information needed to file the chain, and also shows the cutter profile.

Underneath this image is some of the filing information provided in the user manual for the Makita chainsaw.

Type							
xxx **466** xxx	4,0 mm	4,0 mm	0,65 mm / .025"	10°	30°	85°	7
xxx **290** xxx	4,5 mm	4,0 mm	0,65 mm / .025"	90°	30°	75°	
xxx **092** xxx	4,0 mm	4,0 mm	0,65 mm / .025"	90°	30°	80°	
xxx **093** xxx	5,5 mm 5,2 mm	4,8 mm 5,2 mm	0,65 mm / .025"	90°	35°	85°	
xxx **484** xxx	4,8 mm	4,5 mm	0,65 mm / .025"	10°	30°	80°	
xxx **086** xxx	4,8 mm	4,5 mm	0,65 mm / .025"	10°	30°	85°	
xxx **099** xxx	5,5 mm 5,2 mm	4,8 mm 5,2 mm	0,65 mm / .025"	10°	25°	60°	7
xxx **686** xxx	4,8 mm	4,5 mm	0,65 mm / .025"	10°	25°	60°	



Oregon Chains

Oregon chains use a similar system to Makita / Dolmar and Husqvarna, but with a slight twist. After obtaining the model number from the drive link on the chain and cross-referencing it against the table, you may find that there is more than one chain with the same model number, and several model numbers may appear on the same line in the filing table.

This may seem to be confusing at first glance, but it is fairly straightforward - perhaps not quite a straightforward as the Makita system, but you very quickly get the information you need. A common, mid-range saw might use an Oregon 21 or 22 chain for example, and on the filing table you'll find two lines that both show these model numbers - but the filing angles will be different.

The key to understanding this situation is to know that if you have more than one line with the same model *number*, the separate lines will appear under different cutter profiles. Any model numbers appearing on the same line, will be of the same cutter profile and filed using the same information (the only difference between the model numbers in this case reflects the differing chain gauges, for example, an Oregon 21 chain has a gauge of 1.5mm, but an Oregon 22 chain has a 1.6mm chain gauge).

On the other hand, an Oregon 21BP (*micro chisel* profile) is filed to a different angle to an Oregon 21LP (*round ground chisel* profile) chain.

Husqvarna Chains

Husqvarna chains are much more similar to Makita / Dolmar chains - the number that appears on the drive link appears on the filing table, albeit preceded with the letter **H**. So, if you find the number **30** on the drive link, on the table this will be referenced as **H30** and you can read across the line to gain all the required information.

Finding Out About Stihl Chains

Most chain manufacturers mark their chains with a model number, normally on the drive link, which you can then refer to a filing table to get the relevant information such as file size, filing angle and depth gauge setting. Stihl do it slightly differently. At it's most basic, Stihl put a number on the cutter and another number on the drive link; you then put these two numbers together to make the model number. Be aware that older Stihl chains mark the depth gauge with the actual pitch, rather than part of the model number - in this case, you will have to convert the pitch to the relevant number (which can be found using the table in the following section on *Pitch & File Size*.

However, the power of the Stihl system is that with a little bit more knowledge we can work out a lot more about this chain, so let's take a closer look at those numbers and what they actually mean.

Stihl Pitch & File Size

Using the number on the cutter, we can determine the pitch of the chain (useful to ensure it will fit the nose and drive sprockets), and the file size.


STIHL

Cutter Number	Pitch	File Size
1	1/4”	4.0mm
2	0.325”	4.8mm
3	3/8”	5.2mm
4	0.404”	5.5mm
5	1/2”	-
6	3/8”P	4.0mm
7	1/4"P	3.2mm

Using an example where there is a number ‘3’ on the cutter equates to a chain with a pitch of 3/8”; and because Stihl standardise the file sizes in relation to the chain pitch, we can see that any [non-Picco] chain with a pitch of 3/8” uses a file of 5.2mm.

Under the older system, the chain in the above example would be marked with “3/8” on the depth gauge (see photo). This would have to be converted to the number “3” to provide the first number of the model identifier.

Looking at a Stihl filing table, you will see that any chain with a model number starting with a ‘3’ has a file size of 5.2mm; any chain with a model number starting with ‘2’ has a file size of 4.8mm, and so on.

It’s probably worth noting that Stihl make two basic types of chain: Rapid and Picco. Both 6x and 7x chains are Picco chains, meaning that they are classed as ‘low profile’ chains.

Chains that are ‘Rapid’ use the designator “R” after the model number, those that are ‘Picco’ use the letter ‘P’.

Stihl Chain Gauge

The number on the drive link determines the gauge of the chain; remember that the chain gauge must match the gauge of the guide bar.

Stihl have pre-determined sizes for chain gauge, as shown in the table below. Note that the number stamped on the drive link is the same as the number *after* the decimal point in the chain gauge column.

Returning to our example on the first page, the drive link had the number ‘6’ stamped into it, so this is a 1.6mm gauge chain.

Stihl Chain Profile

The model number shown in the filing table consists of two numbers, followed by a series of letters. We’ve already seen that if the letter after the number is a ‘R’, it is a Rapid chain, and if it’s a ‘P’, it’s a Picco chain.

The next letter describes the chain profile…

The profile of the chain also provides us with a clue to the filing angle… although it’s really not that complicated as cross-cutting chains are filed at 30^0!

Determining Chain Gauge

Drive link Number	Chain Gauge
1	1.1mm
3	1.3mm
5	1.5mm
6	1.6mm
0	2.0mm

Chain Profile

S	Super (full chisel)
M	Micro (semi-chisel)
C	Standard (chipper)

Maintaining The Chainsaw

Introduction

Maintaining the chainsaw is a part of ownership and important to ensure the saw remains safe to use, cuts effectively and efficiently, and so that any repairs or potential problems can be sorted out at the earliest opportunity. You'll find machine specific maintenance tasks in the operators handbook provided by the manufacturer of the chainsaw; if you don't have it, they can often be downloaded from the website of the manufacturer.

Whilst there will be subtle differences between makes and models of saws, the basic maintenance tasks remain fairly consistent amongst all saws. In this section we'll be going through the maintenance activities based on a selection of Makita chainsaws and then noting where you may find any important differences with other makes, or models, of chainsaw.

Summary Of Maintenance Tasks

In this section we will be discussing the following maintenance activities, how to tackle them and what to look out for.

- Sharpening the chain.
- Maintaining the guide bar.
- Checking the drive train which includes the clutch system and drive sprocket.
- Checking the chain brake system.

- Cleaning the cooling system.
- Checking the recoil starter system and replacing the starter cord.
- Checking and cleaning the air filter.
- Checking and adjusting the spark plug.
- Miscellaneous items.

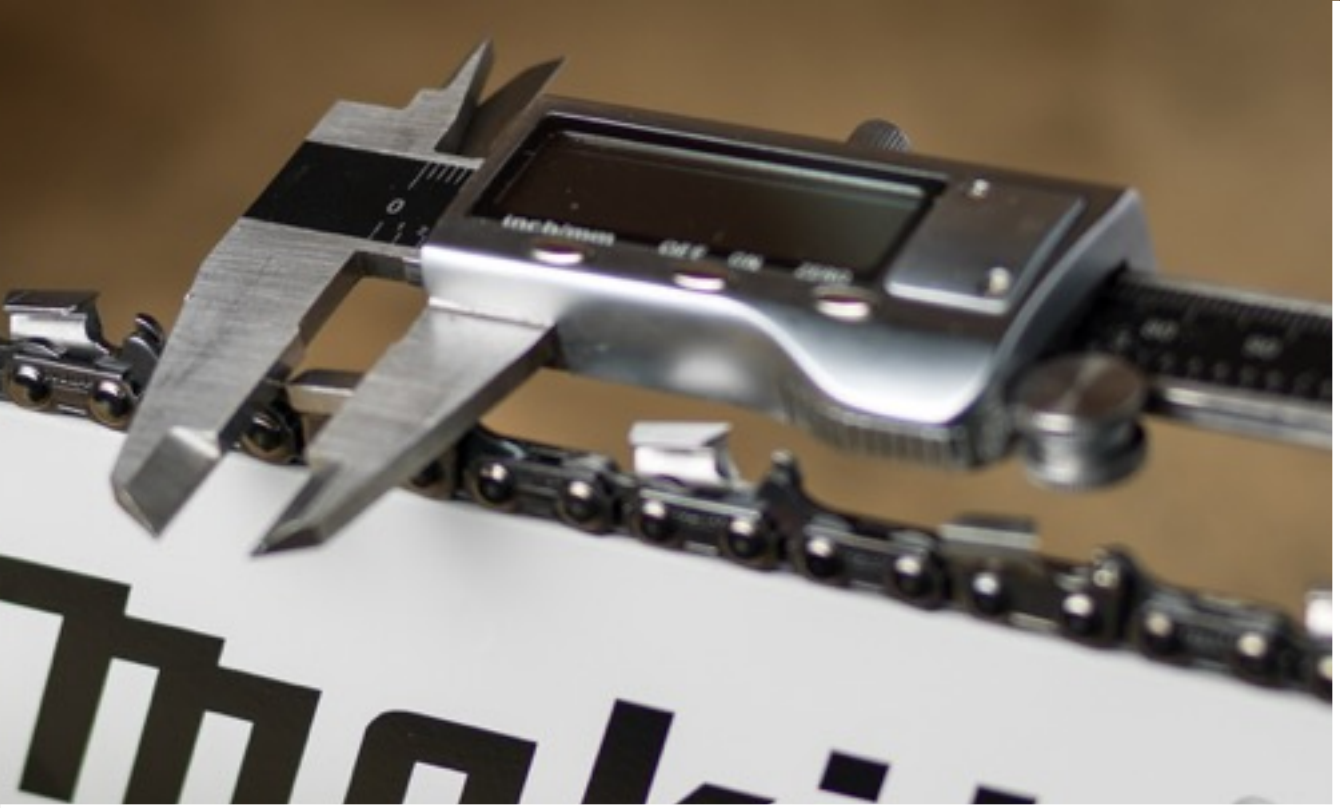
Sharpening The Chain

Sharpening the chain is a fundamental maintenance activity that is right at the heart of keeping the saw cutting effectively and efficiently. We have seen how to find the key information required to sharpen the chain (file size, filing angle and depth gauge setting) from the section on *Understanding The Chain*, but now we will use this information to work through a real example.

Basic Steps To Sharpening

Manually sharpening the chain follows seven basic steps:

1. Identify the chain and obtain the correct filing information from the manufacturers data.
2. Find the shortest cutter. It may be that some cutters are heavily damaged due to hitting stones, in which case these should be dealt with first of all, but you must identify which cutter is the shortest as this will be the reference for all the other cutters - we want all cutters to be the same length

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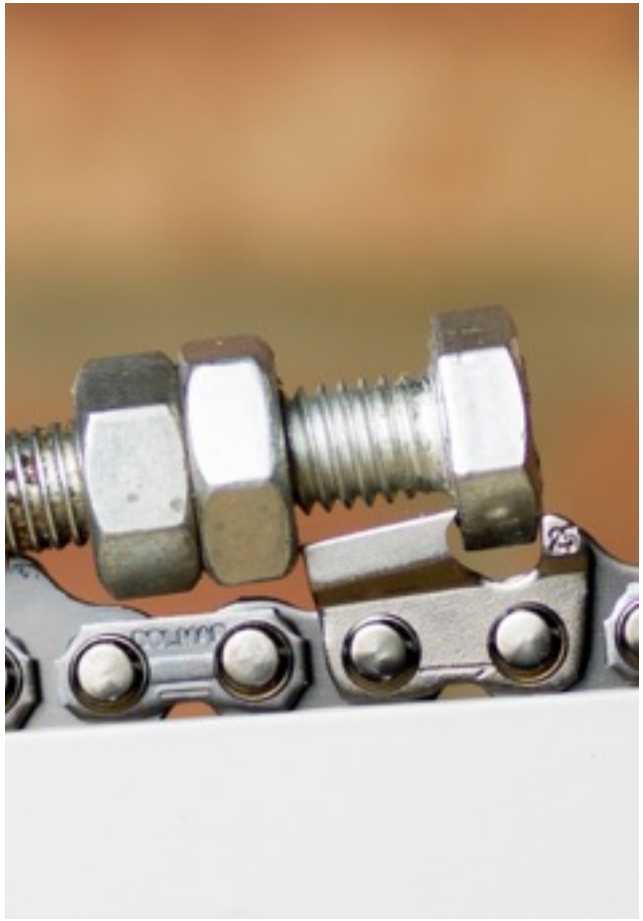
once sharpening has been completed.

3. Using the correct size file, file the shortest cutter at the correct angle, until any signs of damage have been removed and the cutting edge is clean and straight.
4. Mark this cutter with a permanent marker; this is so we know when we have filed all the cutters as we will return to this one - if it's not marked it is easy to end up filing it again!
5. Measure the cutter length, ideally using a set of vernier callipers to get an accurate measurement (the actual measurement does not need to be read, but once set the distance between the external jaws of the calliper must not be altered). If callipers are not available then a bolt fitted with two nuts can be used instead - place the head of the bolt at the front of the cutter (on the cutting edge) so that the thread runs alongside the cutter, then adjust the first nut so that it touches the back of the cutter and then tighten the second nut up to it to act as a locknut.
6. Tackling one side at a time, sharpen each cutter and regularly check the length of the cutter against that set on the calliper (or bolt) - if the cutter does not fit into the distance between the jaws then continue filing. Sharpen each cutter on the first side, then turn the saw around and continue sharpening the remaining side until all cutters have been sharpened and are the



same length.

7. Using a depth gauge tool, check each depth gauge and adjust any that are too high.

Sharpening

The first step is to identify the chain by finding out who made it… in this case, *Dolmar*. The next thing is to find the model number, which is stamped on to the drive link… here the number is *686*. Armed with this information refer to the manufacturers data sheet or user manual to find the angles and sizes appropriate to this chain:

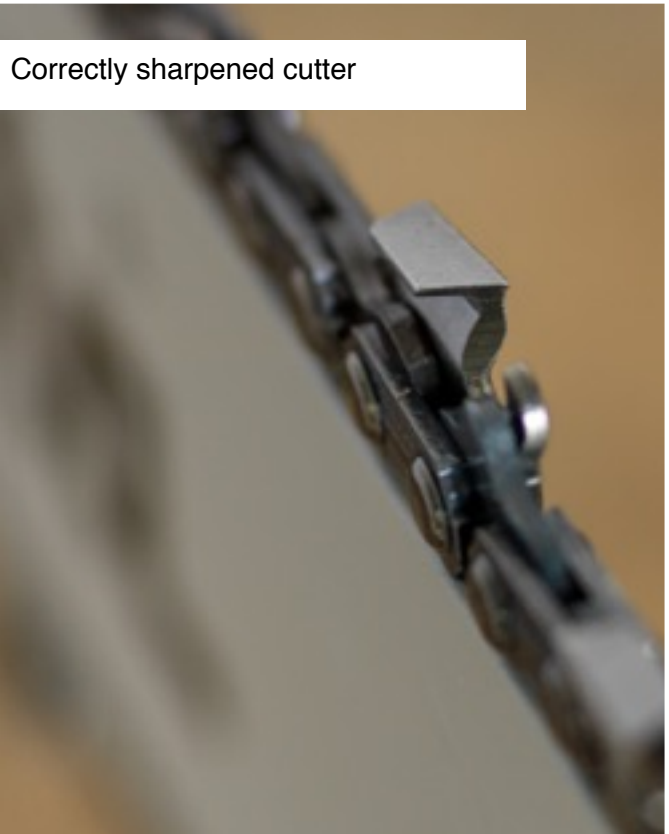
- File size: 4.8mm for the first half of the cutter, then switch to a 4.5mm file. Use a proper saw chain round file for this task.
- Filing angles: 25º filing angle with the handle held down at 10º.
- Depth gauge setting: 0.64mm (0.025”).

Now we need to ascertain the state of the cutters and find the shortest one, but in this particular example the cutters are heavily damaged and will need to have most of the major damage removed first. Once this has been done, then we can return to find the shortest cutter and sharpen it properly before marking it with a permanent marker pen.

When sharpening the file should only be cutting when pushed forwards as pulling it backwards across the metal of the cutters will ruin the teeth on the file. After pushing forward to create the cutting stroke, lift the file off the cutter to return to the starting position; this will protect the file and make it last

Seriously damaged cutter

Correctly sharpened cutter



much longer.

The file should be set into a *file guide*, which will have a series of filing angles etched into it. The file guide will help you to set the correct filing angles, but also keep the file at the correct height - an often overlooked point. File guides are not created equally and you just select the relevant file guide for your size of file, as placing a 4.0mm file into a file guide designed for a 5.5mm file places the file at the wrong height, even though it might look as if it fits the guide. **Select the correct file guide for the file size you are using**. You are also unlikely to get a decent, straight, cutting edge at the appropriate angles if you do not use a file guide.

Having the cutters filed to the correct angle will make sure that the saw cuts in the most efficient manner; if the filing angle is too sharp, the result will be a chain that tends to snatch at the timber as well as damaging the *working corner* - effectively blunting the chain. If the angle is too flat, then whilst the cutters will not blunt as quickly, neither will they sever the fibres of the wood efficiently. Either way, the result is a less effective chain and increased risk of vibration and kickback.

The leading edge of the cutter should be straight and looking at the cutter from the side should reveal a nice ‘hook’ to the side plate - if it appears to be leaning back then either the file is too large or the file guide is not being held correctly. One side of the file guide should rest on the depth gauge, with the other side resting on the top of the cutter; it should not be tilted such that the file guide is only resting on the top of the cutter.

One very common issue when sharpening is not using the whole length of the file, leading to a short worn section half way along the file! Try to push the file forward in a controlled manner; with a sharp file you will not require a lot of force to sharpen the cutter. Files are not expensive so if your file is worn, do yourself a favour, throw it away and use a new one.

With the first cutter now sharpened properly, checked and marked with the pen, we can measure the length of this cutter so it can be used as a reference for all the other cutters on the chain (irrespective of which side they are on). Maintaining all the cutters to the correct length will make sure that the chainsaw cuts in a straight line and does not veer off to one side.

We can turn our attentions to the next cutter on the same side. Cutters are arranged so that they alternate sides as you move along the chain (if you happen to find two on the same side, then this is where the chain was cut and joined together to form the loop). Pull the chain away from the power unit as this ensures that you are not pushing your fingers on to the sharpened cutting edges - you should also be wearing gloves when handling / sharpening the chain. Sharpen this cutter and once any damage has been removed check the length of the cutter against the vernier callipers (or nut & bolt), continue filing if the callipers do not fit on to the cutter. Move on to the next cutter… and so on until the entire chain has been filed.

Once you have completed one side, you'll probably need to turn the saw around to complete the other side; remember that you will need to switch angles on the file guide as the cutting edges run in the opposite direction.

At this stage you might want to remove any burrs that have formed on the cutting edge, this can be achieved by running a piece of wood up the chain (against the cutting edges). This does not require a lot of force, the idea is to just take any wire edges off that have formed due to the action of the file, as there is a chance that if you begin cutting the burrs can tear some of the hard coating on the cutters leading quickly to damaged edges.

With all the cutters sharpened at the correct angle, and all the same length, attention can be turned to dealing with the depth gauges. Setting the depth gauges is an important step in ensuring cutting efficiency as if left too high, the saw will not be cutting as much as it could do and might lead to an increase in the chance that the chain will skate across the surface of the timber; too low and the cutters will try taking out too much with each cut,

this will make the saw snag the timber much more and become much more aggressive. There is also a very real increase in the danger of kickback when the depth gauges have been lowered too much, and vibration levels will increase.

Setting the depth gauges is accomplished by using a depth gauge tool, which is held over the cutters and allows you to check the difference in height between the top of the depth gauge and the cutter. There are several different types of tool available, but perhaps the most commonly available one is shown in the photos; if the top of the depth gauge is higher than the tool setting then it must be filed down but it is a good move to lift the back of the tool up to protect the tool from being filed as well. In this position not only will you protect the tool, but you will protect the leading edge of the cutter that you have just sharpened.

These steps for sharpening the chain are to be followed when you need to do a ‘proper’ sharpening; on a daily basis you wouldn’t want to go through all of these stages, so the daily sharpen is generally much quicker and involves giving each cutter a quick file (just a few swipes) in order to maintain a sharp cutting edge, although if you strike a stone or a nail in the timber then you’ll be back to the full sharpening regime!

Removing The Chain

After sharpening the chain, the next step will be to move on to the guide bar, but this will require you to remove the bar and chain. There are a couple of subtle differences on how to remove the chain depending on whether the saw is fitted with an inboard- or outboard- clutch system, or a spur sprocket / rim & spline sprocket.

Before removing the chain you'll obviously have to remove the side panel (chain brake off if the machine uses an outboard clutch) and it's worth loosening off the side panel nuts (or quick release system) and de-tensioning the chain, before taking off the side panel. The tension adjuster can be found in various places depending on the machine that you are working on; side plate adjusters are common and much easier to work with than the older adjuster that sits between the guide bar and the spiked bumpers (you will find the side plate adjusters next to the side panel nut(s)).

On machines fitted with a quick tension system, just roll the adjuster at the top of the side plate in an anti-clockwise direction. You will see the end of the bar drop and the chain will hang down under the guide bar… at this point you can remove the panel and you are ready to remove the bar and chain. De-tensioning the chain before removing it will make it easier to take off, and more importantly, much easier to deal with when putting it back on again.

If your saw is fitted with a spur sprocket on an inboard clutch, then the bar and chain will likely just fall off when you take the side panel off - what could be easier! However, if it is fitted with a rim and spline sprocket, then you may find that you will have to pull the bar sideways a little so that it detaches from the adjuster pin, push it back towards the sprocket and then you will be able to lift the bar and chain off. This is because the drive links sit in the rim of the sprocket, making it ever so slightly more awkward to take off.

Now, if your saw is fitted with an outboard clutch (either type of sprocket) then you will not be able to just lift of the bar and chain, as the chain will not fit over the clutch system. In this case, you will have to pull the bar sideways a little so that it detaches from the adjuster pin, push it back towards the sprocket and then pull the chain off of the guide bar. Slide the guide bar, then remove the chain from around the sprocket.

Using A Grinding Machine

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Using A Grinder

1. Set the required angle on the grinder, and lock it off so it doesn't change.
2. Set the back of the cutter against the back stop and clamp the chain in place.
3. Bring the cutter down on to the chain (do not switch on) and adjust so that the grinding wheel just touches the bottom of the gullet.
4. Set the back stop so the grinding wheel will remove any damage. You will need to loosen the chain clamp to do this, then retighten.
5. Grind the first cutter.
6. Once completed, unclamp the chain and move it forward so the next cutter on the same side is in place. Set the back stop in position the clamp. Grind the cutter.

Refitting The Chain

Refitting the chain is largely a reversal of removal but there are a few things to look out for to ensure that it is installed correctly.

- Make sure the chain is on the right way around! It is surprisingly common for people to put the chain on back-to-front… the cutting edges of the cutters on the top of the bar should face the nose sprocket end of the guide bar.
- Make sure that the drive links are properly seated into the bar groove along the top edge of the bar and also on the underside of the bar near the drive sprocket. If the saw is fitted with a rim and spline sprocket then check that the drive links are also correctly fitted into the slots of the rim.
- Make sure that the guide bar is pressed flat against the side of the power unit, often if the bar is not flush against the casing it is because either the adjuster pin is not correctly located into the adjuster hole in the bar, or the bar is not seated correctly on the side plate studs (this is quite common with Stihl saws as the studs have a wider base to them).

Many people refit the bar and chain with the chainsaw on its side, but it's often easier to leave the saw sitting normally on its base; with the saw on its side the tip of the bar tends to hang down which lifts the other end resulting in the chain not sitting in the drive sprocket properly. With the saw sitting normally, you should be able to fit the bar and chain and (as long as you de-tensioned the chain) it will sit there quite happily whilst you refit the side panel. Once the side panel is fitted, screw the side plate nuts up only loosely - just enough to keep the panel in place - and you can then tension the chain.


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Re-tensioning The Chain

If you have just replaced the chain and put the side panel on, with the side plate nuts done up loosely then the next step is to tension the chain. The side panel nuts must be slightly loose as the bar will not be able to move freely if they are tight; if you are just re-tensioning the chain after use then you will need to loosen the side plate nuts first. The problem is that the side plate nuts do more than just hold the side plate on, they allow the side panel to apply pressure to one side of the bar, resulting in it being clamped to the saw.

There are many ways of tensioning the chain, and you're likely to get as many ways of achieving the correct tension as the number of people you ask how to do it! The problem is that when you are new to tensioning the chain how do you know what it is supposed to feel like? The chain should be tensioned so that it will rotate, with a little friction, as you pull it around. It if doesn't move then either you have the chain brake on still(!), or there is too much tension. If the chain rotates very freely then it's too loose; a certain amount of friction is required so that when the saw is at idle speed, the chain does not move.

Many people tension the chain and then pull it upwards to see how tight it is… but how hard do you pull it? Some people try putting a penny under the drive link when they pull it up… no. Just no. Not least because this is easier to do with a long bar than a short bar, there's no consistency. So, here is the Drivelink Training take on chain tensioning for those new to chainsaws.

In fact, before we tension the chain, see if you can try this experiment as it works with many (but not all) saws…

- Make sure the side plate nuts are loosened. Adjust the tensioner to increase the chain tension so that the chain on the underside of the bar *just* touches the bar.


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- Now lift the nose of the bar upwards. You'll probably find that the chain is now loose again, i.e. it has fallen away slightly from the underside of the bar.

Remember that we need to tension the chain with the side plate nuts loose and holding the nose of the bar up. Here's one method of tensioning the chain:

- Holding the nose of the bar up, tension the chain so that the tie-straps just touch the underside of the guide bar.
- Now, increase the tension by a small amount - unfortunately this will ultimately depend on your saw - but start with increasing the tension by 1/8th - 1/4 of a turn.
- With the chain brake off, pull the chain around. You should feel that the chain rotates but there is definitely a little friction. If it moves too easily, increase the tension; if it doesn't move, release the tension a fraction.
- With the tension set, tighten up the side panel nuts… then check the chain tension once more by pulling the chain around to make sure that clamping the bar up hasn't altered the setting.

If you have fitted a new chain to the saw, you can expect it to stretch quite quickly and this means that you'll have to keep an eye on the tension during usage and adjust it as required.

Maintaining The Guide Bar

The guide bar forms an integral part of the cutting system as the chain runs around the edge on the *bar rails*, whilst the drive link sits in the *bar groove*. Both of these need will need maintaining to ensure peak performance.

At one end of the bar, you will find the *nose sprocket* which may also require some maintenance, and on some larger guide bars this section can also be replaced.

So, with the bar rails, bar groove and nose sprocket all needing some amount of work to be carried out to them, let's take a look at why the bar needs to be maintained and what maintenance we need to do to it.

The guide bar provides the support for the chain, but with a metal chain running over a metal bar at around 50mph, a lot of heat and friction are produced, so the main tasks are related to ensuring smooth running surfaces and maintaining a constant supply of oil. Wear is inevitable and checking the bar for burrs is important.

Cleaning The Bar Groove

The drive link sits in the bar groove and takes up chain oil being fed through the guide bar for lubrication, and it is important to keep the groove as free from dirt as possible. To accomplish this, we use a *bar scraper* that fits into the groove and is dragged along it to remove all the debris - always start at the nose sprocket end and work away from the sprocket.

Whilst cleaning out the bar groove, often the small oil hole becomes clogged, and you must make a conscious effort to clean this out as a blocked oil hole will prevent any lubrication of the bar and chain, leading to overheating.

Using an air-line makes this task considerably easier - always start at the nose sprocket end and work away from the sprocket.

Maintaining The Bar Rails

The bar rails have a hard life - with the feet of the tie-straps and cutters running along the top of the rails combined with the pressure created during cutting, wear on them is going to occur. Initially this takes the form of burring which should be filed off using a flat file (it is particularly noticeable near the nose sprocket), and the rails should be returned to the correct profile.

Maintaining The Nose Sprocket

The teeth on the nose sprocket will become worn over time, and on larger guide bars this would replacement of the entire bar at considerable expense. For this reason, the highest wearing part can be replaced can often be replaced but you will need to check with the manufacture for full details on how to achieve this properly.

For the vast majority of general purpose chainsaws, one cannot replace the nose section, so we just need to check the teeth for wear, and grease the sprocket bearings if applicable. The sprocket teeth should have a slightly rounded profile - if they are very definitely pointed and sharp then they should be considered worn and the bar replaced. The nose sprocket runs on a series of bearings and these may need to be greased regularly using a special grease gun with a pointed nozzle; you can find out if this needs to be done by looking at the nose sprocket rivets that fix the sprocket

assembly into the bat, if there is a small hole near these, then you will need to grease them on a daily basis.

Due to the increased wear that happens on the underside of the bar rails, just behind the nose sprocket, the guide bar should be turned over at regular intervals in an attempt to even out this wear.

Clutch & Drive Sprockets

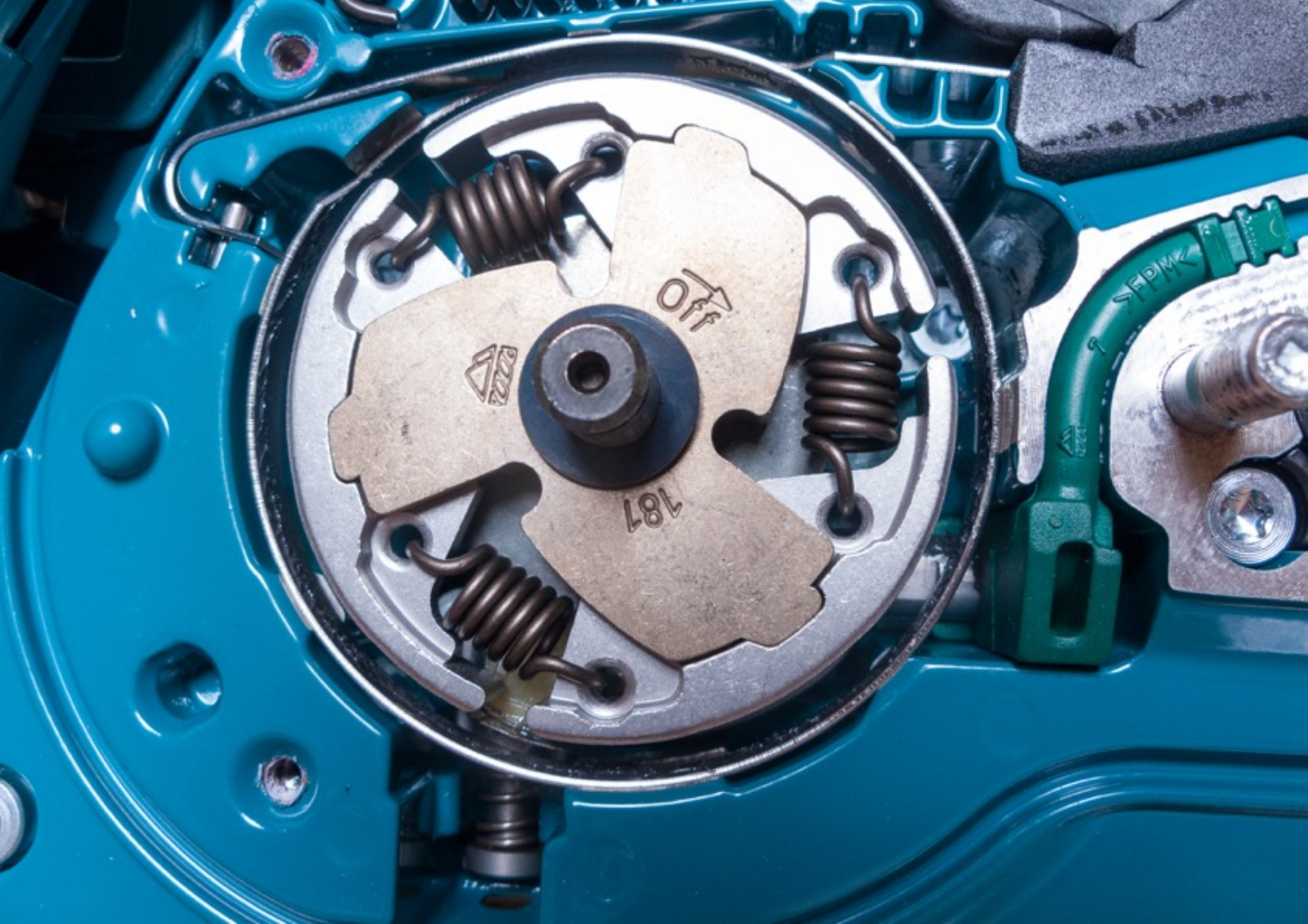
The drive train to the chain consists of a number of interlinked components, from the crankshaft which is connected to the clutch, and the drive sprocket that meshes with the drive links on the chain to drive it around.

Clutch Systems

On petrol powered chainsaws the engine is connected directly to the clutch, as the clutch is screwed on to the end of the crankshaft (on a reverse-thread). These chainsaws use a particular type of clutch called a *centrifugal clutch* that typically consists of two or three clutch weights that are held in place by the clutch springs; at normal idle speeds these springs pull the clutch weights in and they do not make contact with the drive sprocket.

However, once the throttle is revved, the engine speed increases and this creates a centrifugal force that throws the weights out against the drive sprocket, which will cause it drive the chain. Once the throttle is released the clutch springs can pull the weights back in again to remove the drive. It's a simple and effective system but there are two different ways of setting this clutch system up - the *inboard* clutch and the *outboard* clutch.

Knowing which clutch system your saw uses is important as it will affect how you replace the drive sprocket and even how you remove the side panel to get access to the chain / drive sprocket / chain brake mechanism / clutch system… and you can't really tell by looking at the outside of the machine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as to which system you have. The easiest thing to do is to **always let the chain brake off before removing the side panel**.

If you have an inboard clutch system then once the side panel has been removed you will see the drive sprocket; with an outboard clutch machine you will see the clutch weights sitting inside the drive sprocket.

As far as maintaining the clutch, there is not a lot for the operator to do but it's worth quickly checking the clutch springs are tight and secure (this is much easier on an outboard clutch machine, but with a inboard clutch machine this simple task can be completed when the drive sprocket is being replaced or removed for checking).

Battery operated saw and mains powered saws do not require a clutch system as they use a direct drive from the electrical motor.

Drive Sprockets

There are two types of drive sprocket commonly in use and these are the *spur* sprocket and the *rim & spline* sprocket (pictured). As a rough guide, the spur sprocket is used on smaller chainsaws, with the rim & spline being used on larger capacity / professional machines - but this is most definitely not a hard-and-fast rule and there is considerable overlap and personal preference.

The spur sprocket is a one-piece unit and once the teeth are worn, the entire drive sprocket must be replaced (and it may be worth replacing the needle roller bearing too at this time). The rim & spline consists of two pieces, not unsurprisingly, the rim (on to which the chain fits) and the spline (on to which the rim fits and is driven); with this unit when the rim becomes worn it can be replaced rather than having to change to whole unit.

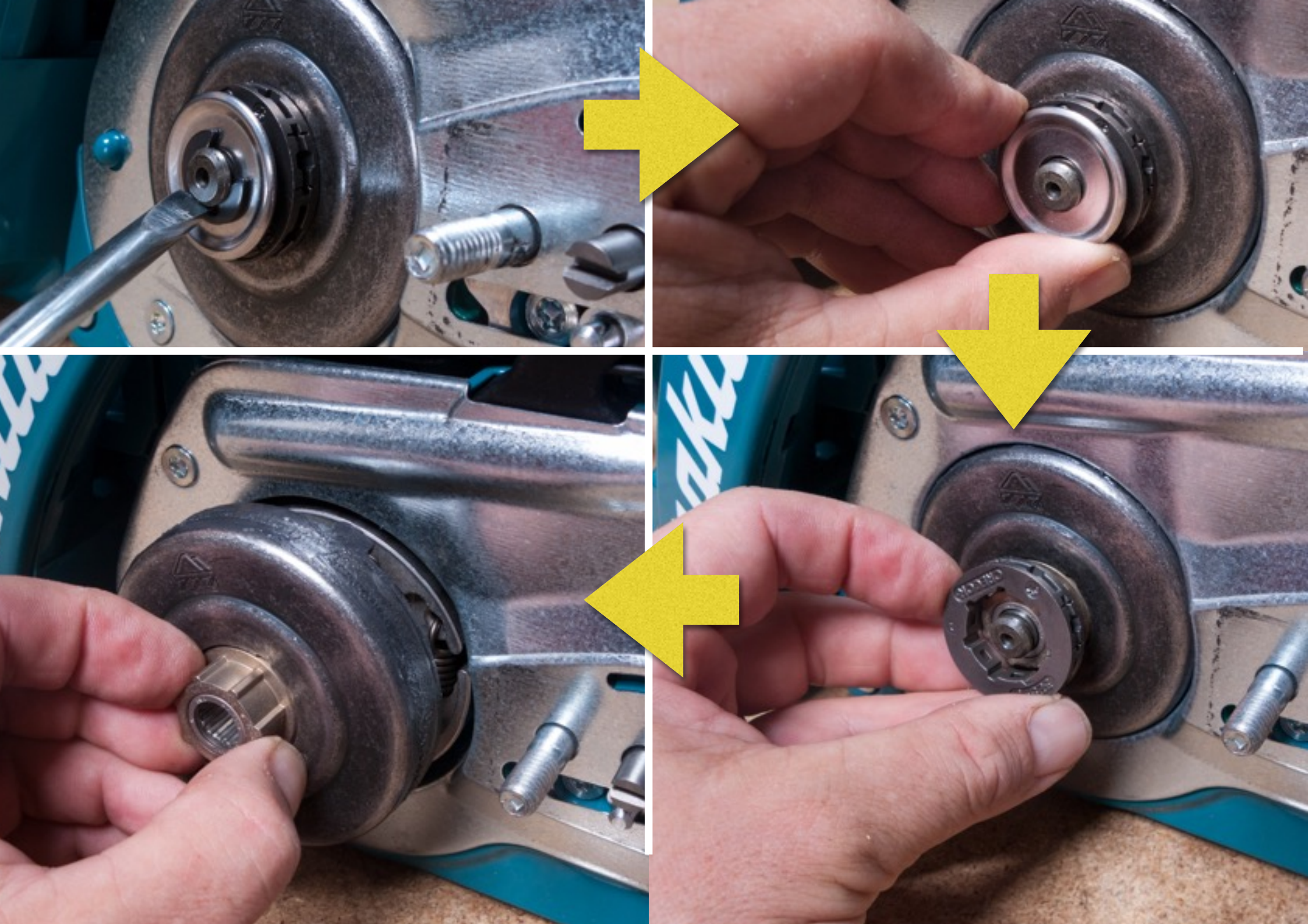
The general guidance is to replace the drive sprocket every two to three chains, and the maximum amount of wear on the teeth of the sprocket is 0.5mm.

When it is time to replace the drive sprocket, how you do so will depend upon the clutch system fitted to your chainsaw. If the saw uses an inboard clutch system then you will need to remove the retaining circlip first, followed by the washer (which is usually dished so take note of which way it should be fitted). Now, so long as the chain brake is off you will be able to remove the entire drive sprocket and access the needle roller bearing which sits between the crankshaft and sprocket. This needle roller bearing should be checked, replaced if necessary, and a **small** amount of grease applied to it before fitting the new sprocket.

If the saw uses an outboard clutch system then things are a little bit more difficult as you will need to remove the centrifugal clutch before gaining access to change the drive sprocket. You must remember that the clutch is screwed on to the end of the crankshaft using a reverse-thread and it is often very tight; you may need to remove the spark plug and use a *piston stop* tool in order to prevent the engine from turning whilst you drive the clutch off.

Chain Brake System

For petrol powered chainsaws, the chain brake system is simple to operate and easy to maintain. Whether your saw uses and outboard clutch, or an inboard clutch, the system basically consists of a brake band that sits around the edge of the drive sprocket, which is attached at one end to a strong spring. These two items are really the only user-changeable parts within the system, but let’s take a closer look at how the implementation of the chain brake system differs between chainsaws.



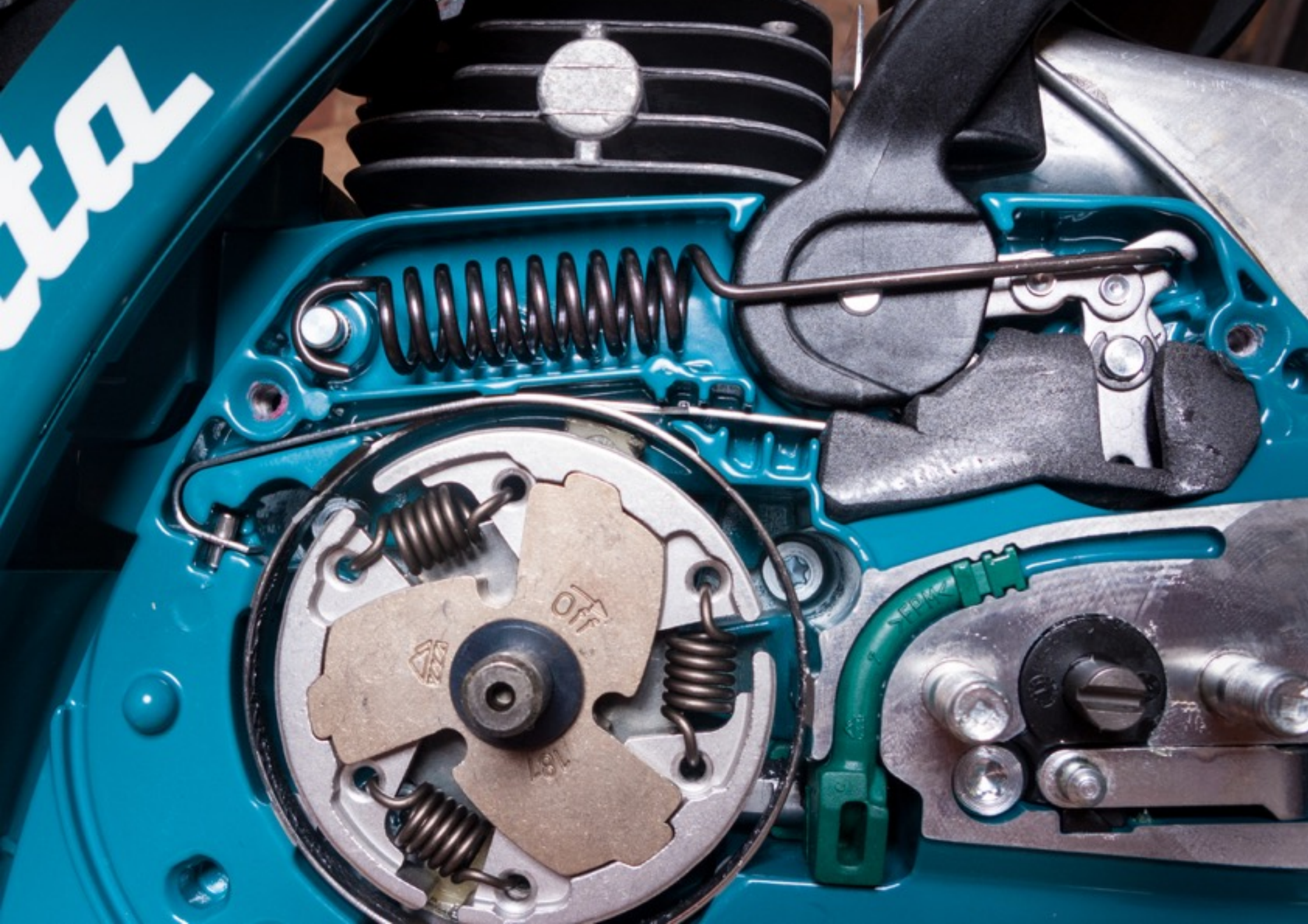
With a chainsaw that uses an inboard clutch, the chain brake system is fitted within the power unit; this is unlike those saws that utilise an outboard clutch where the chain brake spring and brake band are installed into the side panel. I find that the chain brake systems on inboard clutch machines tend to be a little weaker than those fitted to outboard clutch machines… specifically the chain brake spring.

In an outboard clutch machine, the brake spring is held compressed in a compartment in the side panel and because it is literally a straight spring, it does not come under the same forces that the spring on an inboard clutch machine does. Here, the spring has a hook at either end of it, one end fits around a fixed post, and the other end is connected to a cantilever arrangement that operates the brake band. It's not uncommon for the spring to snap at the fixed post end, especially if the chain brake is constantly being applied before the chain has stopped rotating.

It is very common for chainsaw operators to run the saw at full power to cut timber, but then apply the chain brake as soon as the cut is complete and whilst the chain is still rotating at full speed, i.e. using the chain brake to stop the chain. The problem is that this puts the chain brake system under huge strain - the engine is likely to be running at something in the region of 12,500rpm and the chain could be travelling at 20-24m/s (approximately 50mph). When you apply the chain brake it will stop the chain nearly instantaneously… that's 50mph to 0mph in fractions of a second. The forces generated are enormous and it's a sure-fire way to weaken the springs (or band) until they snap.

Any chainsaw that does not have a working chain brake should not be used.

If the disadvantage of the brake system fitted to the inboard clutch machine is that it is not as strong as the outboard clutch machine, this is more than made up for in ease of servicing! As long as you have a spare brake band / brake spring, it is a simple job to replace the brake components in the woods, reducing downtime due to failure. This is not to say that the other system could not also be done in the woods, but in my experience, the


off

inboard clutch system wins for sheer ease of maintenance over the outboard clutch - but, as they say, your mileage may vary.

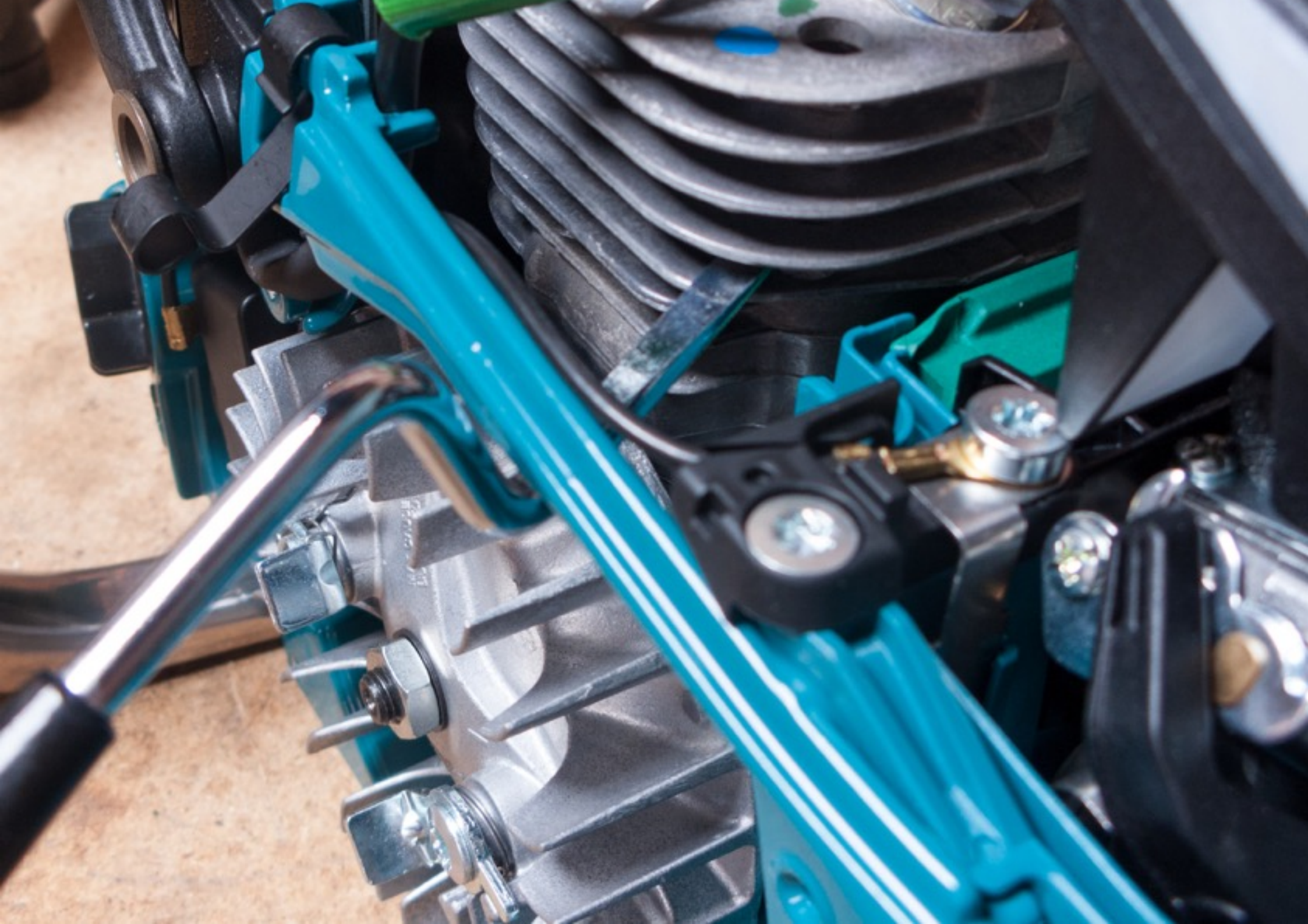
For battery powered and mains-powered saws the brake system is completely different, and there is no brake band and brake springs to maintain. These saws use the power of the electric motor to stop the chain, and the chain brake handle is there to cut the power to the motor.

Finally, once again, please remember that with a machine that uses an outboard clutch system, you will not be able to remove the side panel if the chain brake is on as the brake band is fitted into the side panel. You must let the chain brake off before removing the panel.

Cooling System

The chainsaw is air-cooled and the cooling system comprises five basic parts:

1. Air intake: the grill on the recoil starter panel is where air is sucked into the saw.
2. Air guiding plate / centrifugal cleaner: with the recoil starter panel removed, you'll find a plastic plate that appears to restrict the flow of air through the intake grill, but that plate is there to guide the air in and to separate out larger dirt particles which are thrown out by the air-flow across this plate. The centrifugal nature of the air-flow at this point, ensures that heavier particles are thrown to the edges of the panel - that's why this piece is often dirty.
3. Flywheel fan blades: the flywheel has a number of functions, but here we are interested in the fact that it is fitted with a number of fan blades that create the vortex to suck air in and blow it over the engine.



4. Cylinder fins: the engine barrel is fitted with a number of fins that act as a heatsink; as the engine heats up, that heat is transferred to those cooling fins, over which cold air is blown.
5. Cylinder cowling: the ‘top cover’ of the saw is designed to direct the cooling air over the engine.

The cooling system requires little in the way of maintenance, other than keeping the various airways clear, either using a stiff brush or an air-line. However, don’t neglect to do this simple task, as clogged airways can result in overheating of the engine with inevitable damage to the cylinder and piston.

Recoil Starter System

These days there are a number of recoil starter systems, and even amongst the simplest systems there are some very minor differences - however, the good news is that the basics of the recoil starter system are straightforward and armed with just some basic knowledge, it’s possible to apply that to just about all the different systems.

The recoil starter system comprises of the starter cord (and handle), which is wound around a pulley that sits inside the recoil starter panel. The pulley has a system that will engage with the flywheel when the cord is pulled, turning the engine over to start it. When the cord is released, a spring on the reverse side of the pulley causes the pulley to wind in the cord.

The only maintenance for the recoil starter system is to check the cord and replace it if it shows signs of wear, but this will require you to de-tension and re-tension the spring.

De-tensioning The Cord

Taking out the tension in the cord is easy enough, but you will have to look at the panel moulding around the pulley - many saws have a guard around the pulley to stop the cord from coming off - in this image [IMG_0034.CR2] you can see a series of pillars around the edge of the pulley. If this is the case, there will be a small notch in the pulley that will accept the cord, allowing you to turn the pulley to remove or add tension. To de-tension the starter assembly:

1. Remove the recoil starter panel from the saw; although there are differences it is quite common to find four screws holding the panel on, with one of the screws also holding the chain brake / left-hand guard. The screws are often Torx-head screws or allen screws (that may also be undone using a large flat-bladed screwdriver).
2. Remove the air guiding plate from the panel to gain access to the starter pulley.
3. Grab hold of the starter handle and pull approximately 6” - 12” (150 - 300mm) of cord out, then using your other hand (I use my thumb) press down hard on the pulley to stop it moving.
4. Let go of the handle (remember to keep the pressure on the pulley to stop it moving), and grab the cord between the pulley and the recoil panel. If you need to, ensure that the cord is fitted into the notch.
5. Hold your hand with the cord directly above the centre of the pulley… now release the pulley by removing the thumb that was holding it. The tension will be released quite quickly - just keep the bit of cord that you’re holding above the pulley.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DCS5030

6. If you are removing / replacing the cord, you can now unscrew the pulley and separate it from the panel. Replace the cord… remembering to feed the cord through the starter panel!

Re-tensioning The Cord

Once the cord has been replaced, you'll need to put the tension back into the recoil spring that sits underneath the pulley. Generally, this is just a reversal of de-tensioning the cord, but you will also need to check the tension to ensure that the spring is not under- or over-wound.

1. Fit the pulley with the new cord to the recoil starter panel. Make sure the cord has been fed through the starter panel too.
2. Fit the cord into the notch in the pulley (if required).
3. Holding the cord about 1.5" (40mm) away from the pulley, pull the pulley around - **clockwise** - for six turns. Then take out the cord from the notch and allow the pulley to slowly reel in the cord using the tension that you have just put into the recoil spring. This sounds fairly easy, but many operators new to chainsaws actually find this relatively hard to get right, as you really need three hands! The common mistakes are to turn the actual pulley, rather than pull the pulley around using the cord; to hold the cord to far away from the pulley which will increase the chance of it not winding on properly; and to just let go right at the end of this operation which will cause the pulley to snap the cord back quickly. Try to keep everything under control - if the tension builds up too quickly and you have difficulty putting six turns on in one go, then put three turns on, let the spring pull back some of the cord, then put another three turns on.
4. With the cord back on, the next step is to check the tension.

Checking The Recoil Tension

The recoil tension will need to be checked after replacing the starter cord - too loose and the handle will not be pulled firmly back into position once released, and if it is too tight you won't be able to pull the handle out all the way without the recoil spring binding, possibly damaging it.

Checking to see if the recoil spring is too loose is possibly the least taxing bit of maintenance that you'll do! With the recoil starter panel held upright (i.e. normal position), push the handle around so that it is laying flat against the side of the recoil panel… then let go. The handle should be pulled back into it's proper position and not just flop around.

If the recoil spring is under-wound (too loose, handle flops about) then you will need to add an extra turn on to the pulley. To do this…

1. Grab hold of the starter handle and pull approximately 6" - 12" (150 - 300mm) of cord out, then using your other hand (I use my thumb) press down hard on the pulley to stop it moving.
2. Let go of the handle (remember to keep the pressure on the pulley to stop it moving), and grab the cord between the pulley and the recoil panel. If you need to, ensure that the cord is fitted into the notch.
3. With the cord in the notch (if needed), hold the cord about 1.5" (40mm) away from the pulley, pull the pulley around - **clockwise** - for one turn. Then take out the cord from the notch and allow the pulley to slowly reel in the cord using the tension that you have just put into the recoil spring.
4. Check the tension again. Repeat if it is still too loose. You may want to de-tension the spring completely and shorten the length of the starter cord if you need to put too many additional turns on - a cord that is too long will not wind properly on to the pulley and can become jammed.

Checking to see if the recoil spring has been over-wound is a little more difficult, but only because you find yourself wanting an extra pair of hands. Here's how to check that the spring is not too tight…

1. Pull the handle out as far as you can, if you are right-handed then I would recommend holding the recoil panel in your left hand, and pulling the handle with your right. Have the starter pulley facing you.
2. Now, using the thumb on your left hand, push down on the pulley to stop it moving. There's quite a lot of tension in the spring now, so this can be quite hard, but we need to ensure that the pulley does not rewind.
3. Let go of the handle in your right hand, and then turn the pulley clockwise using your now free right hand (remember that at this point you will need to remove your left thumb from the pulley!).
4. You should be able to turn the pulley clockwise at least one-quarter of a turn.

If you have difficulty with step 2, you can pull the handle out as far as possible and capture it between your knees - just don't let the handle come loose as it will fly back to the recoil panel rather quickly!

If you find that you are unable to turn the pulley at all, then that is an indication that the spring is binding before you have completely pulled the handle all the way out, so we need to reduce the tension just a little.

1. Grab hold of the starter handle and pull approximately 6" - 12" (150 - 300mm) of cord out, then using your other hand (I use my thumb) press down hard on the pulley to stop it moving.

2. Let go of the handle (remember to keep the pressure on the pulley to stop it moving), and grab the cord between the pulley and the recoil panel. If you need to, ensure that the cord is fitted into the notch.
3. With the cord in the notch (if needed), hold the cord about 1.5” (40mm) away from the pulley, and let the pulley turn **anti-clockwise** for one turn. Then take out the cord from the notch and allow the pulley to slowly reel in the cord using the new tension that you have just set.
4. Check the tension again. Repeat if it is still too tight. You may want to de-tension the spring completely and replace the starter cord with one of the correct length if you need to release too many turns - a cord that is too short will constantly cause the spring to over-wind and may damage it.

Dealing With Easy-Start Systems

Several of the smaller saws have an ‘easy-start’ mechanism, which normally comprises of an additional spring that is tensioned when you pull on the starter cord. The energy stored in this spring is then released and turns the engine over, making starting much easier. If you are just replacing the starter cord, then all of the above instructions for de-tensioning and re-tensioning remain the same… except for removing the pulley, as you will need to remove the easy-start system too.

Different manufacturers implement their own version of the easy-start system, so here we will concentrate on the Makita version.

1. De-tension the recoil spring as above.
2. Undo and remove the central screw holding the easy-start spring and pulley in place.
3. Lift off the cover from the easy-start spring - note the hole in the top of this cover that holds one end of the spring.

4. The spring can now be removed by lifting it off of the pulley, and the pulley can be removed to replace the cord if needed.
5. The top of the pulley / bottom of the spring should be re-greased if needed.

Checking And Cleaning The Air Filter

There are several types of air filter materials available on chainsaws - fleece, polyamide (nylon mesh) and polyethylene - which all do slightly different jobs and work best in different environments. Keeping the air filter clean is an important task in keeping the chainsaw running efficiently, and a blocked air filter directly affects the engine performance.

Fuel is mixed with air in the carburettor, therefore any change in the amount of air reaching the carburettor has a direct impact on the running performance of the engine.

Before removing the filters for checking and cleaning, make sure that you clean around the area of the filter - try not to get sawdust and dirt falling into the carburettor as you remove the filter; it may be useful to engage the choke as this will prevent debris getting into the venturi.

Do not use petrol to clean air filters, and replace any filter that is too clogged up with dirt, or has a tear in the filter fabric.

Fleece Filters

Fleece style filters are ideal for working in dry, dusty environments as they are able to filter out very fine particles of dirt. Makita saws often use a coarse pre-filter to remove any larger dust particles, which helps to improve the longevity and efficiency of a fleece filter.

However they will need to be kept clean, despite the pre-filter, and this can be accomplished by using an air-line to blow dirt from the face(s) of the filter. To do this, you may need to split the filter in half first, then blow air through the filter *from the inside to the outside*. Blowing air in from the outside will just force the dirt further into the fleece. Bear in mind that you may need to reduce the pressure of the air-line to prevent damage to the filter.

Fleece filters can be washed in warm, soapy water then rinsed in clean water and allowed to dry thoroughly before re-fitting. You can also tap the filters against a hard surface to dislodge the build-up of dust in the fleece.

Do not use a brush to remove dirt from the filter as this will push the dirt further into the fleece.

Polyamide (Nylon Mesh) Filters

These filters are ideally suited to damp environments and cutting green timber. They do not provide the same fine filtration that a fleece filter will be able to. You can clean them in the same way as a fleece filter, but with the added advantage that dirt can be brushed from the filter by *gently* brushing across the face(s) of the filter.

Polyethylene Filters

Found on the newer Stihl chainsaws, these filters provide all the advantages of fleece filters (extremely fine particle filtration) and is oil and water repellent. These can be cleaned in warm, soapy water, rinsed and dried or when out working, can be removed and tapped against a hard object to dislodge the build-up of dirt and dust.

Summer / Winter Settings

Often overlooked, many saws have a summer and winter setting for air-flow. In the summer, the ambient temperature of the air being drawn into the carburettor allows the engine to run efficiently; however, in the winter the ambient temperature can be much cooler which will reduce engine efficiency.

To overcome this problem, many chainsaws have a mechanism whereby air that has been warmed by the engine is drawn through to the air filter compartment, this warmer air is then used, improving engine performance. The main photo shows the engine cover for the Makita EA5000P chainsaw and clearly shows the piece that either blanks the engine from the air filter compartment (currently set for the summer setting) or if reversed, would allow the warmer air through the hole. You may find that any summer / winter setting is accomplished not by a piece in the engine cover, but by a sliding part in the housing near the air filter (*inset photo: Makita DCS4301*).

Checking And Adjusting The Spark Plug

The spark plug is a critical component in the ignition system of the chainsaw, and is largely maintenance-free; but that doesn't mean that it doesn't need checking, and ideally replacing after approximately 100 hours of use.

The spark plug generates a spark caused by applying a high voltage across it (one side of the spark plug is earthed, and the other side is connected to the coil). When you initially pull on the starter cord, you will be rotating the flywheel which has some magnets fitted into it; as the magnets fly past the coil, a


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EA5000P

high voltage is created causing a spark to be generated across the electrodes on the spark plug. This spark must be created at exactly the right moment, around the point at which the piston is at *top dead centre* causing the fuel mixture in the engine to be compressed.

The compressed fuel is highly explosive and so as soon as the spark is generated, it explodes, forcing the piston back down the barrel. This constant sparking will eventually wear away the electrodes - hence the need to replace the spark plug.

Gaining access to the spark plug is usually through removing the engine top cover, or air filter cover, then removing the plug cap - don't pull too hard on this otherwise you risk pulling the cap away from the plug cable.

Use the correct plug spanner, or combi-spanner, to undo and remove the spark plug - beware if you are doing this after running the engine as the spark plug will be very hot.

Checking The Plug Gap

The spark is produced across the electrode gap at the base of the spark plug, and this needs to be set to ensure a good spark; if the gap is too wide, then the spark produced will be very weak and if there is no gap then no spark will be produced. Although there are some differences in plug gap, the common measurement is 0.5mm, which should be checked using a set of feeler gauges (*see the user guide for your chainsaw to find out the relevant plug gap*).

The feeler gauge should be a 'tight-ish' fit in the gap - too loose and gauge will move freely about, too tight and you'll have to force the gauge into the gap. There should be just a little resistance when you insert and move the gauge around if the gap is correctly set. Should the gap be too wide, you

will need to close it, this can be achieved by gently tapping the electrode. If the gap is too narrow then you will need to prise open the electrodes, which is best done using the correct tool.

Cleaning & Checking

The electrodes will become dirty through the buildup of carbon on them - this can be easily removed using a brass wire brush and should be done before checking the plug gap.

Give the spark plug a general check, looking for signs of damage to the ceramic section, ensuring that the screw-on adapter at the top of the plug (that the plug cap fits over) is secure and for signs of electrode wear.

If you do need to replace the spark plug, ensure that you use the correct type, as specified by the manufacturer.

Electrode Colour

The colour of the spark plug provides a clue as to the state of tune of the engine and should be checked. Whilst discussing the air filter, mention was made of the carburettor's function of mixing the fuel and oil; the correct ratio of these two items will result in the carbon buildup on the electrode being a grey / brown (often referred to as *biscuit-brown*) colour.

However, if the ratio is changed then the colour will also change, providing a useful indication as to engine efficiency and performance. If there is a lack of air within the mix, the carbon will turn dark brown / black; this lack of air is commonly caused by a blocked air filter.

If the ratio moves in the other direction - lack of fuel / too much air - then the electrode colour will turn to a very light brown, or you may even spot small whitish deposits on the electrode (which would be very serious for the engine). Running the saw without an air filter would potentially cause this shift in the air : fuel ratio.

Miscellaneous Tasks

Exhaust

The exhaust is often forgotten about when it comes to maintenance, but this part of the engine is more than just a safety feature that directs exhaust gases away from the operator; it performs an important role in a two stroke engine by providing a back pressure to the cylinder that helps with the scavenging system.

A two stroke engine is not particularly efficient as it suffers from a fundamental problem of having the exhaust port open at the same time as the inlet port. This means that a fresh fuel charge can escape unburnt out of the exhaust port… not ideal in these environmentally aware times! From an early stage in the development of the two-stroke engine, moves were made to reduce this from happening and the system of *scavenging* was created. Thi solution saw the fresh fuel entering the cylinder, via a *transfer port*, away from the exhaust port. This fresh charge pushed the spent fuel out but by the

time the spent fuel had been ejected, the piston had risen up and cut off the fresh fuel in order to compress it. This scavenging system relies on the back pressure from the exhaust chamber to function properly[14].

With this in mind, it's worth just checking that the bolts holding the exhaust on to the saw are secure and done up tightly. Make sure there are no holes in the exhaust, and no damage that allows the gases to escape from anywhere they're not supposed to. Clean around the exhaust too, as there can be a build up of sawdust, oil, grease and dirt that should be removed on an ongoing basis.

Oil / Fuel Filter

These filters are fitted to the relevant tank and should be cleaned or replaced as stated by the manufacturer in the user guide for the saw. The fuel filter is usually an easy task, requiring you to drain fuel out of the tank (or run the saw until the fuel has gone), then hook the filter out using a piece of wire bent into a hook. The filter can be then removed from the end of the rubber tube and a new one pushed back on. Push the filter and hose back into the tank, refill and the task is complete.

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[14] This system has undergone various changes, but the more modern *stratified scavenging* system, charges the cylinder with fresh air to push the spent gases out, before the fresh charge of fuel comes in.

The oil filter can be a different story, with manufacturers using different methods - some have fixed filters, others have loose filters on the end of a rubber tube (that's not actually long enough to hook out the filler cap). With these chainsaws, you will need to empty the tank and dispose of any oil in line with waste disposal requirements, then swill a degreasing agent around the oil tank before disposing of that and refilling with chain oil.

Cleaning

Remove as much dirt, oil and grease from the power unit as you can, keeping the saw clean is not just good housekeeping but allows you to see any potential problems or issues such as missing screws and broken parts before they become a major issue. Good quality, professional chainsaws are not cheap items, and if you rely on them for your work, it makes a great deal of sense to look after them.

Fuel

Those saws that utilise two-stroke, or four-mix engines, will require oil to be pre-mixed with the petrol in order to provide lubrication for the engine components as neither engine has an oil sump fitted to it. You should use a good quality oil for this purpose, but especially for the 4-mix engines which really are miniature 4-stroke engines complete with valves, springs, con-rods, etc. These components can be susceptible to carbon buildup on them, dramatically reducing the performance of the engine; with these engines a good quality, fully synthetic oil should be used.

Fuel Mix

For most modern engines, the mix of fuel and oil is 50 parts petrol to 1 part oil, denoted as 50:1. There are older engines, and some other small machine engines that will use a different ratio, such as 25:1 or 40:1, so it pays to check the requirements of your machine before mixing fuel for it. A lack of oil in the mix, such as might be encountered if the operator used a 50:1 mix into an engine requiring 25:1, would be disastrous due to the lack of lubrication causing increased friction, overheating and seizure of the engine.

Table 1 shows the amount of oil that would be required to ensure the correct fuel mix for a range of mix ratios and petrol volumes.

Table 1 showing the amount of oil required to be mixed with fuel for different mix ratios

	5 litres	**4 litres**	**3 litres**	**2 litres**	**1 litre**
50:1	100ml	80ml	60ml	40ml	20ml
40:1	125ml	100ml	75ml	50ml	25ml
25:1	200ml	160ml	120ml	80ml	40ml

With 100ml of oil being mixed with 5 litres of fuel so common, manufacturers produce small packs of oil that contain just 100ml to ensure that the correct amount will be mixed with 5 litres. This is an ideal solution for many as it ensures little chance of spillage during the mixing, no wastage of oil and the correct mix every time. It is also a comparatively expensive way of buying oil and so not for everyone - especially if you have different machines that require different mix ratios.

The cheapest way is to bulk buy oil and then decant it into a container marked for 100ml, but an excellent ‘middle ground’ is to buy the containers of oil that have a separate graduated system on them; the main container can also be refilled as required.

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