LOGGING INDUSTRY RESEARCH ASSOCIATION

NEW ZEALAND

PROJECT REPORT

RESTRICTED CIRCULATION

- CHAINSAWS -

A CRITERIA FOR SELECTION

P.R.1 1977

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION (INC.)

P.O. Box 147 Rotorua New Zealand

N.Z.Logging Industry Research Assoc.Inc

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- SUMMARY -

Fifteen chainsaws in the ultralightweight to medium weight range were purchased and evaluated by LIRA in conjunction with Consumers' Institute. The purpose of the evaluation was to identify the key criteria for selection when purchasing saws.

Mechanised testing was carried out on each saw to assess its performance and noise and vibration levels and also check the basic specifications. User tests conducted by professional forest workers generally confirmed the findings on the good and bad features of a particular saw.

This report places special emphasis on the safety features of chainsaws as highlighted in the testing.

ACKNOWLEDGEMENTS

LIRA acknowledges the work done by Mr R.Turner, Consumers' Institute; N.Z.Forest Service Head Office Engineering staff; Golden Downs Forest Experimental Workshop staff; and Mr G.Bonner, N.Z.Forest Service Golden Downs for organising the field evaluations and compiling the user test reports.

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INTRODUCTION

Chainsaws are purchased and used by every organisation in the logging industry from small contractors to large companies. An evaluation of saws was initiated by LIRA in co-operation with Consumers' Institute because of a common interest in identifying criteria for saw selection particularly with regard to safety features.

A survey of the logging industry[1] conducted in 1974 by the Forest Research Institute, identified the reasons for the selection of saws and the size range most popularly used in logging. The medium capacity (80cc) range of saws is the most commonly used, however it was decided to concentrate testing on the lightweight range for the following reasons:

(a) The lightweight (40cc - 60cc) saws were most commonly purchased by less experienced operators engaged in small tree felling (including silvicultural operations and trimming.

(b) Farmers and other infrequent users also purchased this range for scrub cutting and odd jobs, thus the Consumers' Institute and LIRA's interests overlapped.

(c) The design features of the smaller professional saws were mostly repeated in the larger models and all the prominent professional saw manufacturers produced machines in this size range.

(d) The total cost of the evaluation would be considerably less than one which involved the purchase of the larger range of saws.

1.1 SELECTION OF SAWS:

The Consumers' Institute were mostly interested in ultralightweight saws that would be purchased by the home handyman. Three of the more common saws in this

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[1] "Survey of the Logging Industry" by Fraser, Murphy, and Terlesk. (F.R.I.Economics of Silviculture. Branch Report No.84. Unpublished)

range were purchased:-

Echo 302	30cc.
McCulloch MiniMac 30	30cc.
Husky 35VR	35cc.

The lightweight saws (which are used infrequently and professionally) acquired for testing were:-

Husqvarna 140S	40cc.
Echo 451VL	44cc.
Dolmar 118	45cc.
Stihl 031AV	48cc.
Jonsered 52E	49cc.
McCulloch Pro 10-10	55cc.
Partner R417	55cc.
Homelite 350	57cc.
Sachs Dolmar KMS4	58cc. (Rotary)

Three of the most popular mediumweight professional saws purchased for testing were:-

Husqvarna 380S	77cc.
McCulloch SP81	80cc.
Stihl 045AV(E)	81cc.

The fifteen saws selected were considered to be a representative range to meet the test requirements of both LIRA and the Consumers' Institute.

1.2 BUYING PROCEDURE:

All saws were current models purchased by LIRA in early 1976, with the exception of the Sachs-Dolmar Rotary Engined saw which was loaned by the New Zealand agents for testing against conventional models. The saws were purchased off the shop floor in Rotorua and Wellington with some agents running the saws, as in normal sales procedure. No specific attention was given to the saws prior to the mechanical testing.

1.3 GENERAL COMMENTS:

The three ultra-lightweight saws are not professional saws although saws of this size have been seen to be carried on logging machines and used for trimming or heading off after logs are broken out. The Dolmar 118 and the McCulloch Pro 10-10 are not sold in New Zealand as professional saws although their price is comparable with professional saws of similar size.

The testing procedure was carried out under the control of the Consumers' Institute, with the mechanical testing done on a contract basis by the N.Z.Forest Service Engineering Division.

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TESTING METHODS

Testing procedure was in three parts. Firstly the saws were subjected to a series of mechanical tests which, as well as assessing a form of engine efficiency, measured noise and vibration. Secondly the saws were used and assessed by professional forest workers whose comments, although somewhat subjective, are considered valuable in this type of evaluation. Thirdly, each saw was critically examined to analyse design features and safety devices considered most desirable in a chainsaw.

A series of tests on saw chain were carried out and are commented on in Section 4 of this report.

COMMENT ON THE GRAPHS IN THIS SECTION:

The four graphs in this section outline some of the mechanical test results with brief detail below on what they imply.

The results are based on the saw engines without bar and chain.

Performance figures are not usually available to prospective buyers, and according to the F.R.I. Survey, do not rate highly in influencing saw selection.

Figure 1 - significance:
The more power required the heavier the weight.
Different use of capacity gives different maximum power.
Different construction or safety devices give different weight.

Figure 3 - significance:
The maximum power achieved for each cubic centimetre of engine displacement indicates, along with specific fuel consumption, engine efficiency.
Higher performance engines require more attentive maintenance to ensure that they perform to maximum capacity.
Maximum power per kilogram of weight indicates how effectively materials have been used in design. However, attention is required to ensure robustness has not suffered and component life is satisfactory.

Figure 4 - significance:
The lower fuel consumption figures indicates the better use of fuel. For a saw's running time per tank of fuel, tank size is equally as important as fuel consumption.
Saw cost or purchase price comparisons could be influenced by trade-in or discounts. Price is also affected by the extras supplied such as safety devices.

2.1 ENGINE TESTS:

The N.Z.Forest Service Engineering Division Experimental Workshop at Golden Downs Forest subjected the chainsaws to a series of mechanical tests. These tests included a check on the key specifications (viz. weight dry and fully rigged, fuel capacity, muffler volume and type, etc.). The chainsaw motors (less guide bar and chain) were run on a small dynomometer to establish torque, power and fuel consumption characteristics. Noise and vibration levels were also taken with the saws fully rigged.

The saws were weighed empty of fuel and without bar and chain before an accurate measure of their fuel capacity (petrol and chain oil) was taken. With the bars and chains fitted they were again weighed to establish the "all up" weight.

All the saws were given a run-in period at 3000 to 4000 RPM for one tank of fuel. This was regardless of any setting up the saws may have had at the time of purchase. The fuel mixture during the run-in period and during all the mechanical tests was as stipulated by the manufacturers.

Dynomometer tests establish the torque produced by the engine at varying engine speeds. The torque and engine speed readings provided the power characteristics of the engine. Carburettor adjustments were made on the saws whilst under load to achieve maximum readings.

The drive from the saw to the dynomometer was taken off the clutch centre, thus eliminating the effects of clutch shoes and to compensate for vibration.

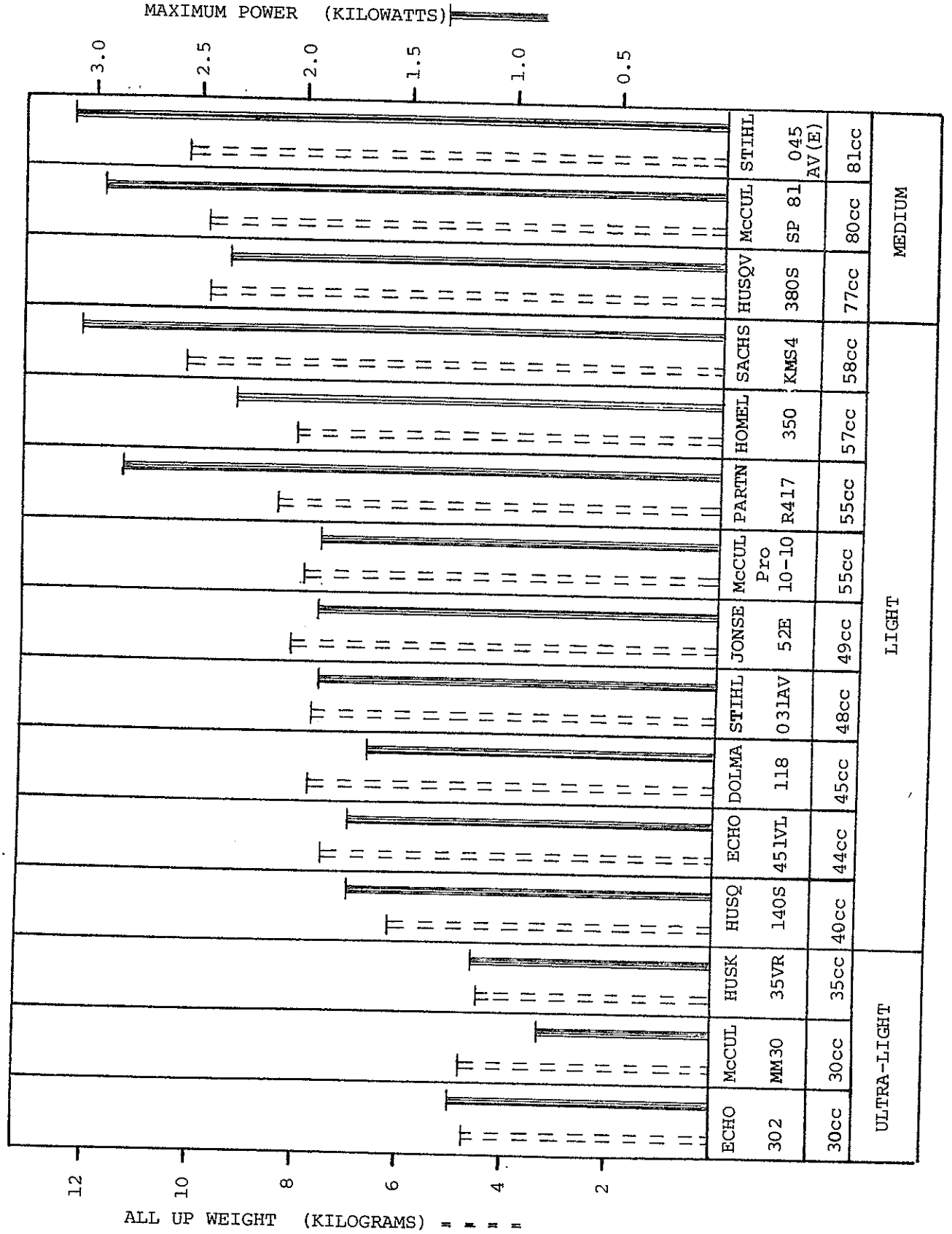
2.1.1 TORQUE:

Torque was measured in the metric "Newton-Metre" (Nm).

Torque is a measure of the turning force exerted upon the engine crankshaft. A saw exhibiting good torque characteristics is one that has maximum torque speed slightly below the maximum power engine speed, and where the torque level is maintained as engine speed decreases. This gives the saw engine the ability to recover maximum power under load. (Comparative torque and power curves of individual saws are shown in the graphs with the Evaluation and Specification sheets, Appendix I).

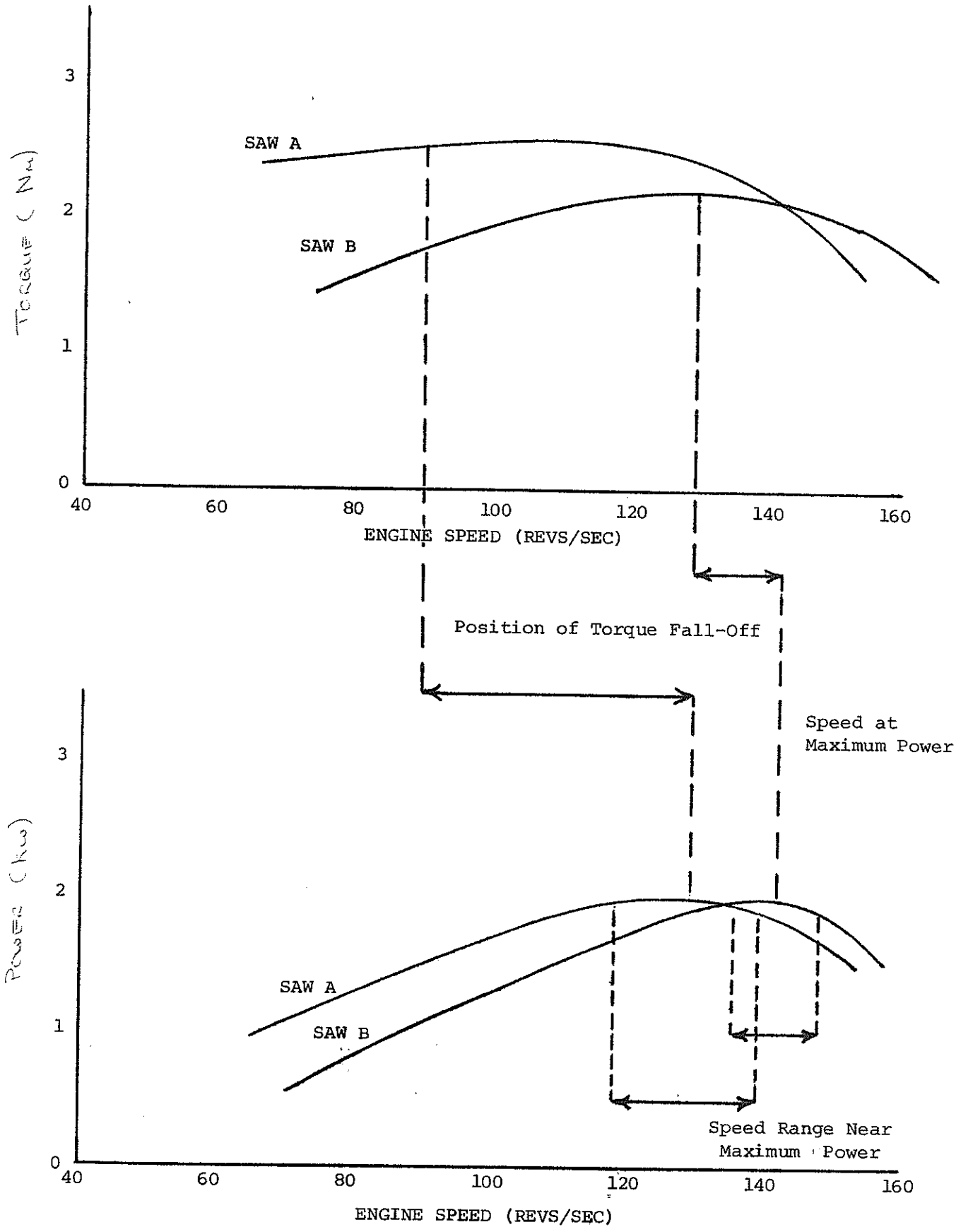
For graph showing torque and power curves for two saws of similar size, see *Fig.2* on page 7.

The torque readings were taken at approximately 250-300



WEIGHT AND POWER COMPARISON

Fig.1



TORQUE AND POWER CURVES FOR TWO SAWS OF SIMILAR SIZE

Fig.2

The torque readings were taken at approximately 250-300 RPM intervals up to maximum speed. All the saws exhibited satisfactory torque characteristics over 5000 RPM.

2.1.2 POWER:

Power was measured in kilowatts (Kw), the metricated equivalent for "brake horse power". Whereas torque can be read directly off the dynomometre, maximum power was calculated by multiplying torque and engine speed.

The result figures published for both torque and power are corrected to standard pressure, viz. Atmospheric Pressure, (Golden Downs being 274 metres above sea level). Humidity, temperature and barometric pressure are measured at the time of testing each saw and the correction to standard pressure made accordingly.

For graph showing power per cc.rating/power to weight, see *Fig.3* on page 9.

2.1.3 FUEL CONSUMPTION:

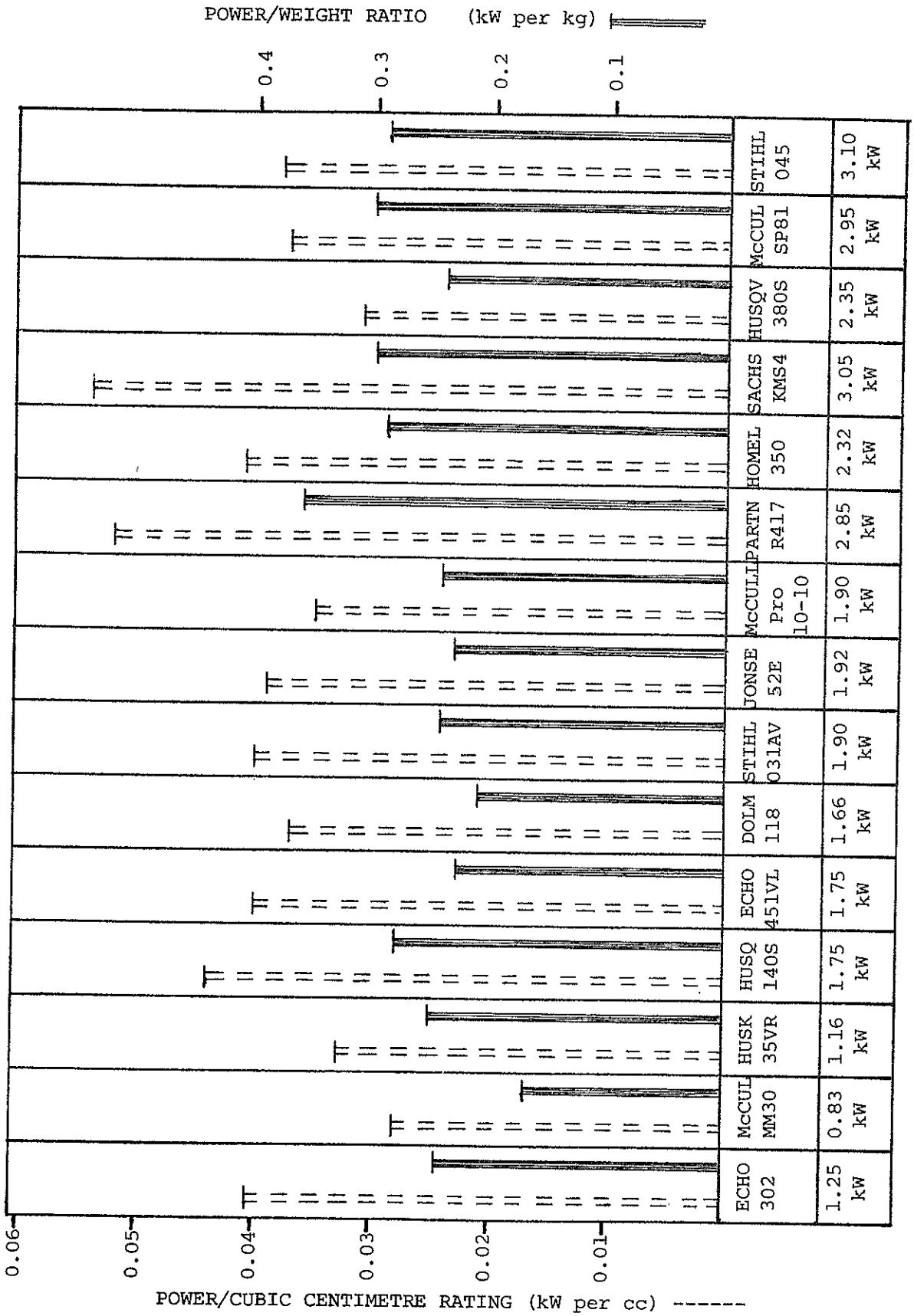
Fuel consumption readings were taken over a measured period while the saws were running at maximum power. Five of the smaller saws were not given the fuel consumption test as a connection into the fuel line to record usage was not possible. Specific fuel consumption is expressed in litres per kilowatt per hour.

For graph showing specific fuel consumption/saw cost per maximum power, see *Fig.4* on page 10.

2.2 NOISE TESTS, PROCEDURE AND DISCUSSION:

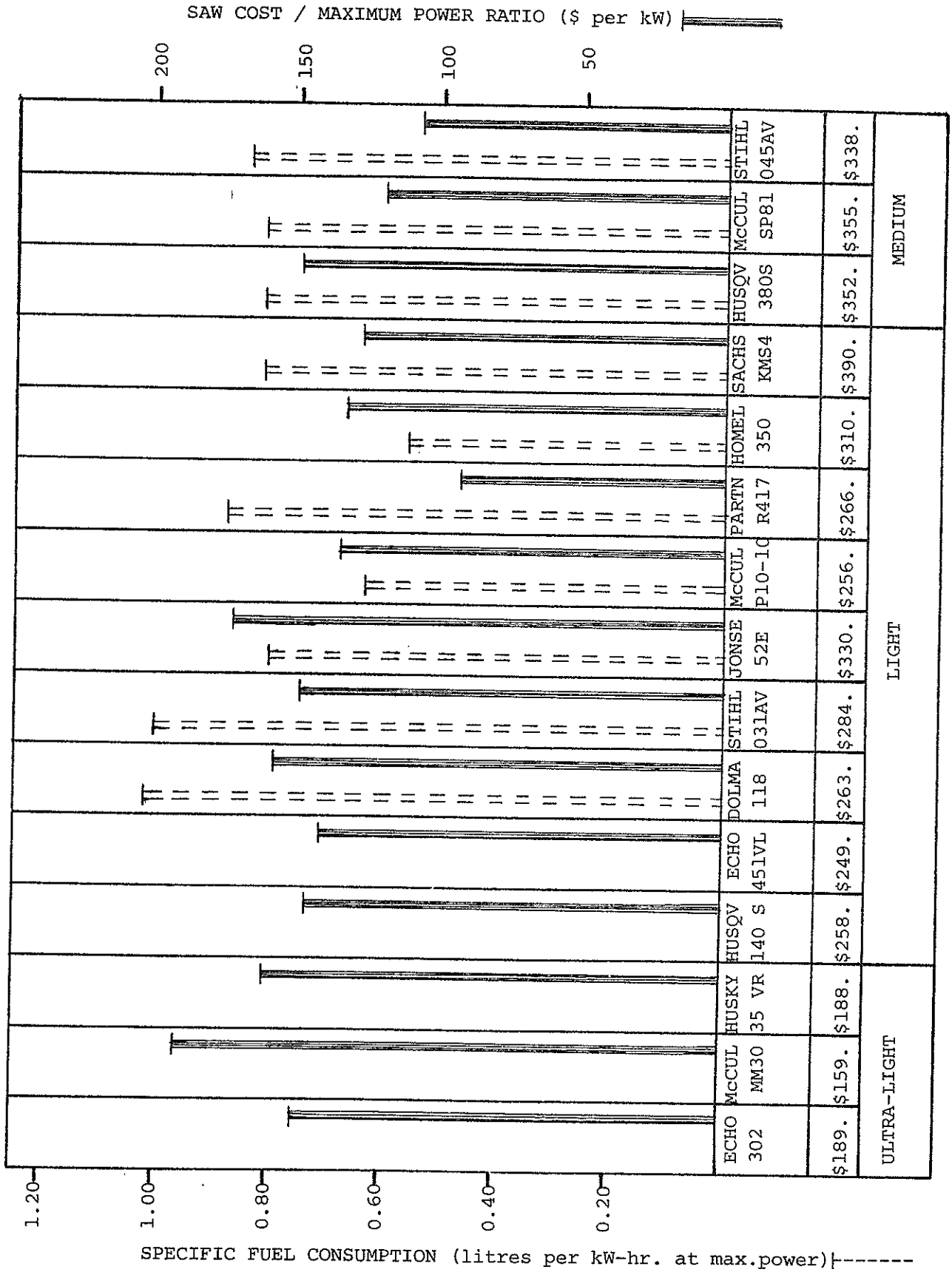
Noise is a health hazard of considerable importance to the professional forestry worker, and yet ear defenders are very rarely worn. Excessive noise is not only a nuisance but may contribute to fatigue, loss of concentration, and an increase in the accident rate. Most importantly, it can have a harmful effect on a worker's hearing facilities.

The noise tests conducted, measured sound pressure on a precision sound-level meter which consisted of a sensitive microphone attached at the right hand ear of



POWER/CAPACITY RATIOS & POWER/WEIGHT RATIOS

(Fig.3)



SPECIFIC FUEL CONSUMPTION FIGURES & COST/POWER RATIOS

(Fig.4)

a pair of ear-muffs worn by the test operator, an amplifier, and a sound level indicator. The decibel (dB) is the unit used to describe the sound pressure level, with an A-frequency weighting network most suitable for the examination of chainsaw noise problems. The decibel scale is a logarithmic scale which means that an increase of three decibels represents a doubling of the energy measured. It takes a considerable noise intensity to produce a relatively small change in the decibel reading. The chainsaws tested varied from 101 to 113 dBA, therefore the saw tested at the highest range is generating sixteen times more noise energy than a saw at 101 dBA. 140 dBA is the level at which noise causes physical pain. The Health Department rate chainsaws with levels between 100 and 109 dBA as a Class II hazard and recommend that the operators be issued with ear protectors and be given annual hearing tests.

The Health Department's recommended maximum length of time any person should be subjected to a 90 dBA continuous noise level without ear protection is eight hours in any one day. This is reduced to four hours at 93 dBA (a doubling of the intensity requires a halving of the exposure). Accordingly any person operating a saw at 113 dBA should limit their time to only a few minutes in any one day.

Well fitted ear plugs can give up to 20 dBA reduction whilst ear-muffs in good condition and well fitted can give up to 30 dBA reduction.[1]

The figures given for noise on the graph *(see Fig.5)* were obtained when cutting into a beech log at full throttle. The tests were conducted in the open to obviate any false readings due to reflection from buildings, fences, etc.

2.3 VIBRATION DISCUSSION:

Vibration in chainsaws arises from two main sources:-

(a) The imbalance within the rotating and reciprocating members of the engine as a result of a lightweight 2-stroke action engine design.

(b) The reactive forces established between the cutting chain and the materials on which it is being used.

It has been estimated that up to 50% of the vibration measured can result from the chain.

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[1] N.Z.Forest Service Engineering Division. Report on Chainsaw Noise. (Ref.No.526 - File 1.30.21/26) by J.L.Wilson, September 1970. Unpublished.

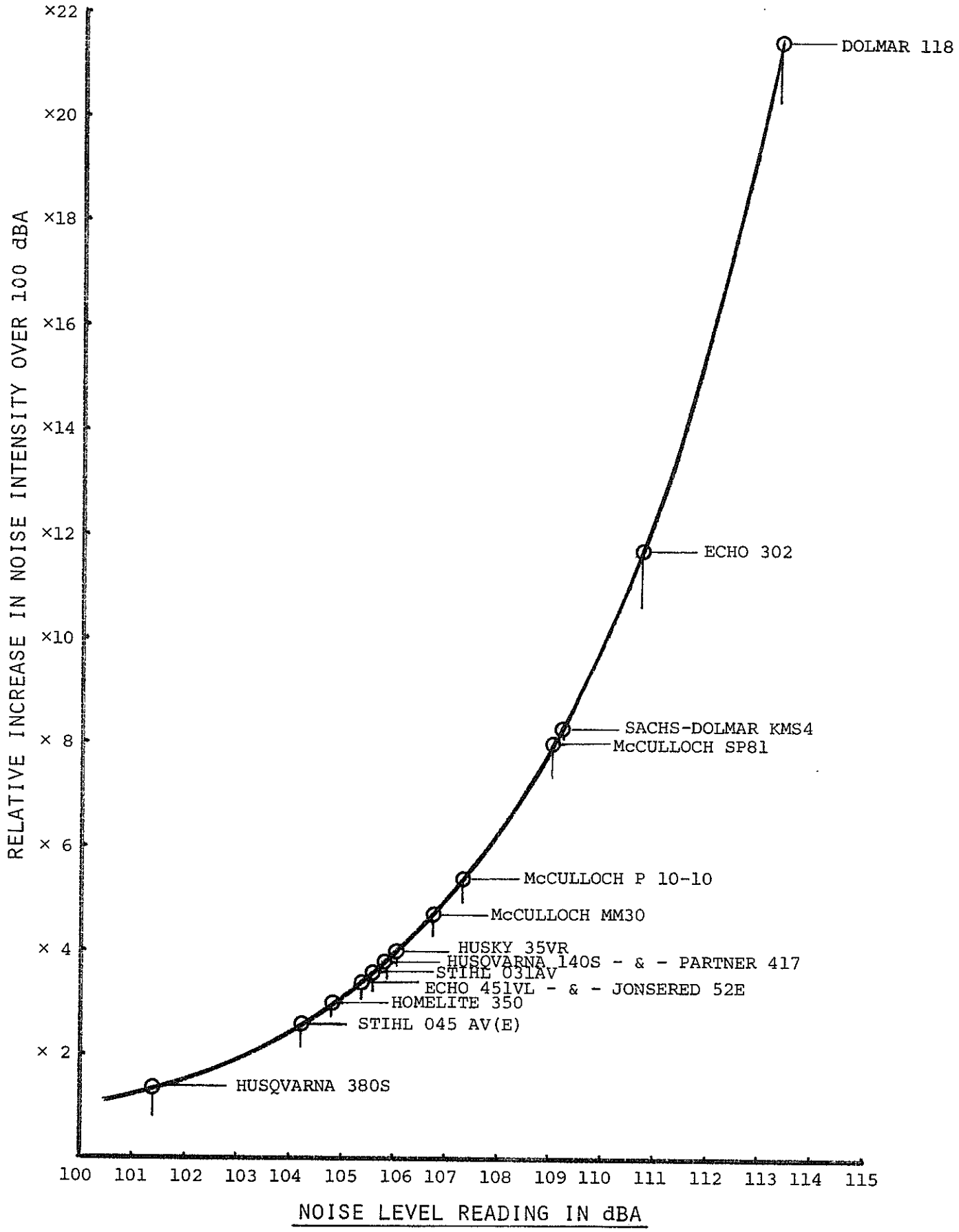
RELATIVE INCREASE IN NOISE INTENSITY OVER 100 dBA
×22
×20
×18
×16
×14
×12
×10
× 8
× 6
× 4
× 2
DOLMAR 118
ECHO 302
SACHS-DOLMAR KMS4
McCULLOCH SP81
McCULLOCH P 10-10
McCULLOCH MM30
HUSKY 35VR
HUSQVARNA 140S - & - PARTNER 417
STIHL 031AV
ECHO 451VL - & - JONSERED 52E
HOMELITE 350
STIHL 045 AV(E)
HUSQVARNA 380S
100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115
NOISE LEVEL READING IN dBA

Fig.5

By the design of a well balanced motor and by using resilient mounted handles, the degree of vibration transmitted to the hands of the operator can be substantially reduced.

Chainsaw vibration is mostly high speed. Lower vibration transmission to the user can be obtained by increasing the weight of the saw on the "user" side of the isolating bushes. Some manufacturers have achieved this by making the handles, fuel tank, oil tank, carburettor, airbox, and other parts of the saw as a complete unit and separated by rubber bushings from the cylinder, crankcase, clutch, chain, or other moving parts of the saw. By having the carburettor dampened from vibration a saw is more likely to maintain its correct operating settings. Excessive vibration can cause wear on the needles in the carburettor affecting performance or necessitating regular carburettor adjustments.

2.3.1 VIBRATION AND THE OPERATOR:

Vibration is recognised as the fundamental cause of a neuro-vascular disease commonly called "white finger", or "Reynaud's Phenomenon". The symptoms of the disease are numbness of the fingers, blanching, and particularly in cold weather, pain. The use of any vibrating tool for long periods without regular rest periods can cause the tactile corpuscles in the hand to be over stimulated. As a result a hypersensitive reaction is provoked and the small intricate blood vessels in the skin contract, stopping the blood from circulating. Some individuals seem more prone to the malady than others, but overseas research has shown that cutting down the degree of vibration at the handles of a chainsaw is a positive step in the reduction of the rate of incidence of white finger, as is reducing the exposure period by having regular organised rest periods.

2.3.2 VIBRATION TESTING:

In this phase of the testing vibration recordings were obtained by the operator holding accelerometers to the front and rear handles.

The vibration level shown is the mean of the readings taken at idle, full throttle, and full throttle cutting into a beech log, (each saw being equipped with bar and chain, unsharpened, as supplied by the retailer at time of purchase).

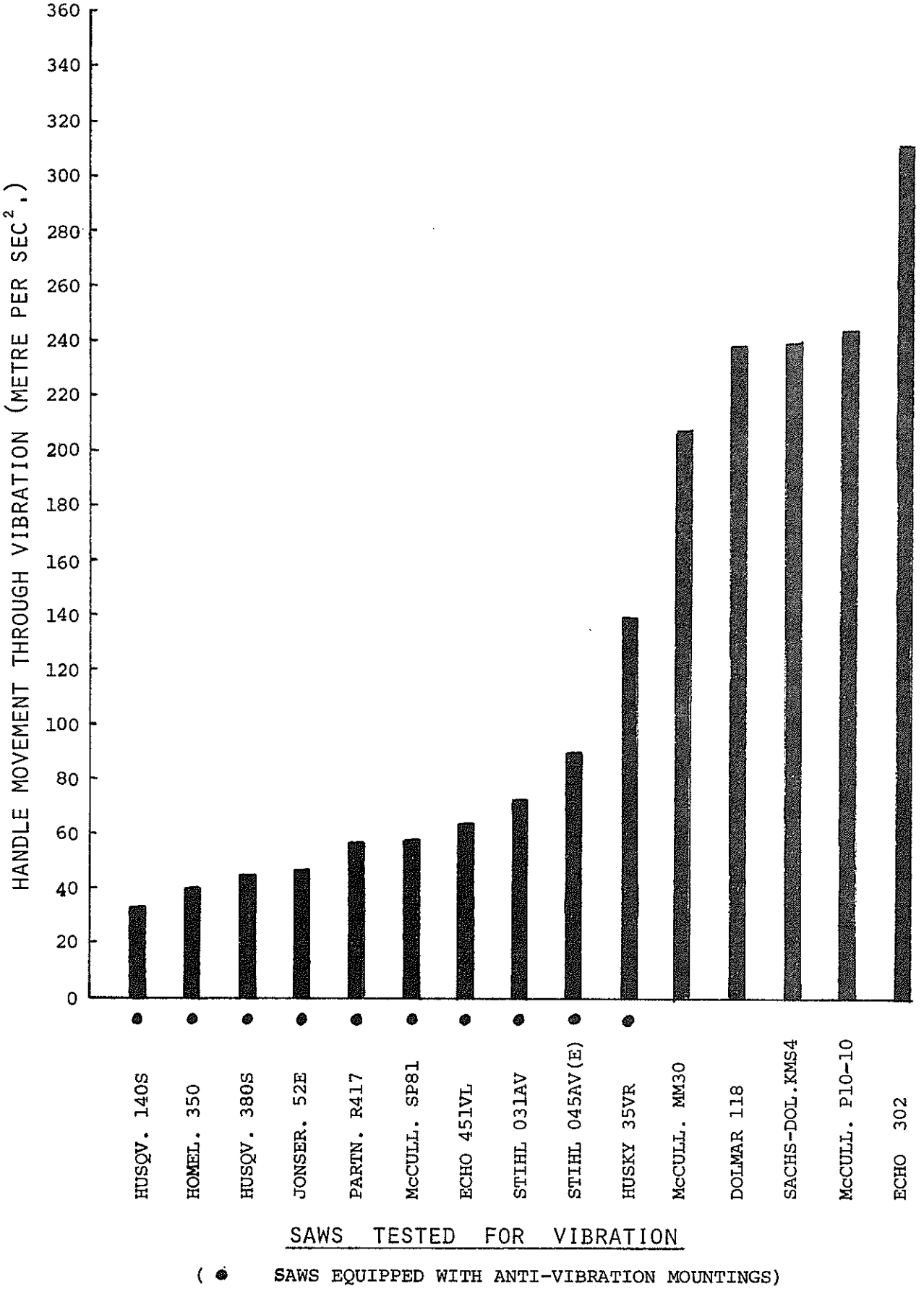
HANDLE MOVEMENT THROUGH VIBRATION (METRE PER SEC^2.)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
HUSQV. 140S
HOMEL. 350
HUSQV. 380S
JONSER. 52E
PARTN. R417
McCULL. SP81
ECHO 451VL
STIHL 031AV
STIHL 045AV(E)
HUSKY 35VR
McCULL. MM30
DOLMAR 118
SACHS-DOL.KMS4
McCULL. P10-10
ECHO 302
SAWS TESTED FOR VIBRATION
(● SAWS EQUIPPED WITH ANTI-VIBRATION MOUNTINGS)

Fig.6

The results measured are expressed as metres per second^2 acceleration which are root mean square values that give the average measurement.

The results obtained are shown on page 14. All the saws with antivibration devices had reduced vibration levels to varying degrees.

2.4 USER TESTS:

The saws were tested by professional forest workers in the Golden Downs Forest area, apart from the three ultra-lightweights which were considered too small for forestry work. These small saws were given a detailed operational assessment by an experienced Forest Service Officer.

A questionaire was prepared and discussed with the test operators, prior to testing and this gave all an indication of the type of information required. A group of saws were then issued to each of the selected gangs on a three day rotational basis, and their comments and judgements solicited from them at the end of the test periods for those saws.

Much of the comment from the test operators was either on the very good or very bad features of each saw.

Limitations with this type of user testing are:-

(a) Subjective comment from test operators.
(b) Operator bias depending on what type of saw is regularly used.
(c) Limitations on the length of time each operator used each saw and thus became fully familiar with its characteristics.
(d) The logistics of managing such a trial with a large number of saws and the time involved compiling the results created difficulties for controlling Forest Service Officer who also had his normal daily tasks to perform.

Apart from the above limitations, the tests were considered extremely useful in identifying features on which to base the criteria for selection and as mentioned earlier, all operators were quick to identify the very good or very bad features of a particular saw.

2.5 DESIGN ASSESSMENT:

Throughout the evaluation period several critical design evaluations were held on the test saws to identify those features considered desirable or undesirable in chainsaw design. Many of the points highlighted in the assessment were confirmed in the user tests.

Comment on the particular features of each saw as identified below are included in the individual saw summaries. If a feature is not mentioned it can be assumed that it was considered satisfactory on the test saw.

(1) *Routine Maintenance (Daily Use):*

Details that are attended to in daily routine maintenance or daily use were examined for ease of accessibility and operation.

Included are removal of cutter-bar and changing chains, cleaning air filter and general cleaning down. Refueling and re-oiling are discussed under a separate heading in (5) below.

(2) *Other Maintenance (Periodic):*

This included the servicing of a saw not necessarily in the field, viz. changing starter cords, replacing spark plugs, carburettor adjustments, automatic oiler flow control, cleaning fuel filter, cleaning exhaust ports, and other cleaning.

(3) *General Design Features:*

(i) Safety features incorporated *(see also section on Safety)* chain brakes, anti-kickback guards, safety throttle lock, rear hand chain guard, were assessed where included.

(ii) Smoothness of external design. This can have an effect on a saw when trimming or pushing through heavy undergrowth.

(iii) Shape of handles and external coverings. Also balance and handling.

(4) *Muffler:*

Location, direction of emission, likelihood of burns to the operator, and possible forest fire risk.

(5) *Fuel and Oil Tanks:*

This aspect is commented on separately as it is considered critical in saw design. Many saws are designed with small refueling apertures in positions where the inevitable overspill flows directly into the engine, clutch, carburettor, or starter, causing a rapid build up of sawdust that makes cleaning difficult and could affect performance, i.e. overheating. Usually the smaller the saw the more critical this problem is. The location of filler holes, size of aperture,

identification of caps, ease of unscrewing and tightening, and the retaining chains or clips on the caps were assessed in this section.

(6) *Controls:*

Included the location and grouping of controls, and the activating of the ignition switch for emergency use.

(7) *Standardisation of Screwheads:*

Some saws require several different tools to carry out periodic maintenance.

- 3 -

SAFETY - GENERAL

The chainsaw is potentially a very dangerous tool and should be respected and handled with care. There are very few other saws or cutting machines which are allowed to be operated without a form of guarding over the revolving cutting edge. Furthermore, chainsaws are used in conditions where the footing is poor and the operator is often clambering over logs or debris, thus increasing the hazard.

In this section on safety there is discussion on one of the most serious hazards when using chainsaws, that of kickback. Chainsaw and saw chain manufacturers are attempting to improve the safety features of their saws, and examples of these features as identified in the saws tested are also discussed.

3.1 KICKBACK - CAUSES AND EFFECTS:

This is one of the most common chainsaw accidents that can occur and is potentially very dangerous. Kickback is the sudden movement of the saw guidebar up and back towards the operator and is most often caused by the reaction of the moving chain striking or jamming at the top quarter of the bar nose against the wood being cut or a branch beyond the object being cut. Kickback injuries most commonly sustained are to the hand on the forward handle (usually the left hand) which can slip onto the revolving chain, or to the upper body and head should the severity of the reaction cause the saw to flip back with the revolving chain striking the operator. Several developments have taken place in recent years to reduce the incidence of kickback and to prevent an injury should kickback occur.

3.2 SAFETY CHAIN:

This type of chain has now been on the market for nearly 20 years. Research by chain manufacturers is continuing aimed at producing a chain that will minimise kickback effects and still have satisfactory cutting rates. Safety chain is fitted with a sloping

ramp or pawl which shields the blunt leading edge of the cutter depth guage and cutter when these are passing around the tip of the bar. Early developments were towards a rising and lowering pawl as the guard link, however this method has generally been superceded by a fixed pawl. No chain will completely eliminate kickback but provided the chain is correctly maintained and correctly tensioned on the cutter-bar the incidents of kickback should be reduced.

3.3 CHAINBRAKES:

This is a device fitted to saws to stop the movement of the chain should kickback of the saw occur, thus reducing the injury to the operator if he is struck by the chain. The device may also be used to prevent chain movement when carrying the saw with the motor running.

Of the saws tested the McCulloch models - Mini Mac 30, Pro 10-10, and SP 81, and the Jonsered 52E were fitted with chainbrakes. Newer models of some of the other saws that were tested are now fitted with these mechanisms. The chainbrake device consists of a type of brake that when applied stops movement of the clutch drum, hence the sprocket and chain. The brakes are operated by a spring and triggered by a lever mounted in front of the front handle bar of the saw. If the operator's forward hand slides off the front handle as a result of sudden kickback and strikes the lever, or if the saw violently kicks back so that the lever strikes the back of the operator's wrist, the brake should be activated. It should be noted that the operator's hand is in a position to operate the device only when the saw is held in an upright position, therefore in felling the device is not likely to be activated and the operator is not protected by this device.

The effectiveness of chainbrakes was not tested in the evaluation except to check that their function, location, and activation, was straightforward and did not interfere with any other aspect of the saw.

The chain brakes on the McCulloch models were very effective in operation. Activation of the brake lever clamped a high tensile sprung band onto the clutch drum and the whole mechanism was simple and positive. Two poorer features however were that there was no stop to prevent the activating lever from being forced back against the fingers of the hand on the front handle should a log roll back whilst cross-cutting. Also, the brake mechanisms were so located that

removal of the clutch cover was time consuming and fiddly because the cramped and limited turn of the spanner in removing or tightening the holding studs.

The Jonsered 52E chain brake mechanism when activated resulted in a small brake pad being forced against the clutch drum. This method did not seem to be as effective as the brake band, however tests were not carried out. The linkages and pivot points from handle to pad vibrated excessively and required considerable force to operate.

3.4 HAND GUARDS:

The Stihl models, the Sachs Dolmar KMS 4 and the Husky 35VR were fitted with simple guards to prevent the hand on the front handle from slipping directly onto the revolving chain should the operator's grasp be broken. As with the chainbrakes, these guards are only effective if the saw is being used in an upright position.

3.5 SAFETY MITTS:

The leather lace-on safety mitt was supplied by several of the saw distributors when the chainsaws were initially purchased. Use of the safety mitt is advocated in the Dept. of Labour "Safety Code for Bush Undertakings" (1972) but acceptance of it as an effective anti-kickback protection varies considerably from individual operators and areas throughout the country. The main advantage of the safety mitt, if used, is that it prevents the hand from leaving the bar should kickback occur.

3.6 DISCUSSION - ANTI-KICKBACK DEVICES:

Opinion and acceptability of chainbrakes, chain guards, or laced-on mitts, is currently wide ranging. At siminars conducted by LIRA in Rotorua and the Nelson area, diverging opinion was given on the pro's and con's of the various devices. One thing is clear however, and that is that some form of protection against kickback regardless of what form it takes, is better than no protection at all. LIRA intends to conduct further research into chainsaw safety accessories in the future.

3.7 THROTTLE TRIGGER SAFETY LOCK:

This device prevents the accidental throttle engagement when carrying the saw whilst it is idling. The lock protrudes through the top of the rear handle and prevents throttle engagement unless the palm of the hand depresses the trigger lock.

Of the saws evaluated, the Echo 302, Mini Mac 30, Echo 451VL, Dolmar 118, and the McCulloch Pro 10-10, were not fitted with this device. Of the others, all worked satisfactorily with the exception of the Husqvarna 380S where the throttle safety lock periodically jammed inside the handle. Safety trigger locks are seen to be a very useful and practical safety device and should be fitted on all saws.

3.8 REAR HANDLE CHAIN GUARD:

Injury can occur to an operators hand on the rear handle should a broken chain backlash. The rear handle chain guard is a broadening of the lower portion of the rear handle to protect the hand. Seven of the saws tested were fitted with guards - Husqvarna 140S and 380S, Stihl 031AV and 045AV, Sachs-Dolmar KMS4, McCulloch SP81, and the Jonsered 52E.

3.9 DECOMPRESSION VALVE BUTTON:

The McCulloch SP81 was the only saw tested with a compression reduction valve. This effectively reduces compression during starting of the saw. The valve in the cylinder head closes for full compression automatically when the saw fires but must be manually reset when starting the saw. The safety feature of easier and safer starting is evident when using the device, however users not familiar with the saw tested, or with decompression buttons, found its use a nuisance if the saw fired (closing the valve) and did not start. The location of the button on the SP81 does not allow the operator to immediately see if the valve is closed and the saw is under full compression. Verbal comment from regular users of McCulloch saws with this device indicated that once familiar with it, it is not a problem.

- 4 -

CHAIN TESTS

Four samples of chain were tested by the NZFS Engineering Division Workshop at Golden Downs for cutting rate ability, tensile strength and kickback reaction.

The chains tested were:-

Oregon 73L	3/8 Pitch	.063 gauge
Laser SM 408	404 "	.058 "
Carlton	3/8 "	.058 "
Stihl	3/8 "	.063 "

The chains supplied with each of test saws were not tested. Firstly because the amount of chain on each saw was insufficient for the three tests, and secondly because of the wide variety of different chain brands that may be used with any one saw. The operator is therefore able to choose whichever chain brand suits his purpose (depending on gauge and pitch) regardless of the type of chainsaw motor purchased.

The four brands tested represent a large proportion of chain purchased in this country.

4.1 CUTTING RATE TESTS:

A cutting rate test rig consisted of a chainsaw with 20 inch guide bar, mounted on a horizontal pivoted arm. The saw was weighted to produce specific loads at the centre of the bar and then allowed to pivot vertically down through a test baulk of radiata. The time taken for each cut was measured by stop watch.

Five cutting tests were made on each chain at guide bar loads of 3, 4, 5, and 6 kilograms, totalling twenty cuts in all.

The average times for all cuts were:-

Oregon	49.2 cm^2/sec.
Laser	48.8 cm^2/sec.
Carlton	45.0 cm^2/sec.
Stihl	32.3 cm^2/sec.

The chains were tested in the conditions they were received with no attempt made to sharpen them, although

they were run in for several minutes and correctly tensioned prior to the tests commencing.

4.2 TENSILE STRENGTH:

The four brands tested were considered satisfactory in this test eventually breaking under high tensile load at the rivets; no links failed.

Fracture Load:

Oregon	839.15 Kg	(1850 lbs)
Laser	825.55 Kg	(1820 lbs)
Carlton	814.21 Kg	(1795 lbs)
Stihl	782.46 Kg	(1725 lbs)

It is unlikely that loads to this degree would be imposed on a chain in normal operations.

4.3 KICKBACK REACTION:

The equipment[1] for this aspect of the testing consisted of a saw guide bar pivoted about the chain sprocket centre and driven at 1430 RPM by an electric motor. A test baulk of beech was released at a pre-determined weight and speed against the guide bar nose. Upward movement of the guide bar as a result of kickback energy was then measured. Twelve tests were made on each chain with the results indicating the average kickback energy produced.

Carlton	3.26 Kg/cm. (not safety chain)
Stihl	19.60 Kg/cm.
Oregon	21.80 Kg/cm.
Laser	22.50 Kg/cm.

The above results are indicative comparisons between the various chains *UNDER THESE TEST CONDITIONS*. They should not be interpreted as the maximum violence of kickback that may be expected in the field as the violence of kickback is dependent on many factors.

LIRA intends to conduct further kickback testing as an extension to this project.

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[1] The rig for testing Kickback Reaction was designed by NZFS Engineering Division for their Experimental Workshop at Golden Downs.

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EVALUATION AND SPECIFICATION SUMMARY SHEETS

The results of the various tests have been summarised for each of the saws and appear in Appendix I.

Key specification and performance data are indicated, including graphs of power and torque characteristics.

The discussion section highlights the main points from the user test and the design assessment.

- 6 -

CRITERIA FOR SELECTION OF CHAINSAWS

The F.R.I. Survey of the Logging Industry referred to on page one of this report, indicated that the majority of purchasers of saws consider the availability of after-sales and spare parts service is the key factor that influences the make of saw purchased. Within regional locations in New Zealand one brand of saw often dominates sales in the area because of the quality of service supplied by the agent of that saw. It was not possible to assess this factor in the criteria for selection.

Noise, then vibration, are the next highest considerations although combined they outweight any other single factor. The test results show conclusively the saws tested with low noise and vibration levels. The period of exposure must be considered when assessing these features, i.e. professional or casual use.

The noise generated by most of the saws was acceptable on a daily use pattern, however those saws at the uppermost extreme as indicated in *Fig.5,* are not safe unless used for only very short duration or with some form of effective ear defenders.

Vibration and its effects to the individual operator is very hard to assess. It is considered that saws not having antivibration devices are unacceptable for professional use.

Safety devices are sometimes used as a pitch for selling saws. Any device needs to work effectively without interfering with other functions of the saw. Chainbrakes are a useful device but the mechanism needs to be simple and positive so that after prolonged use it does not become loose, vibrate or difficult to operate. Plastic hand guards are considered a minimum anti-kickback protection device however an advantage of them is that they are at least always in position to protect. Lace-on safety mitts, if worn, are an effective alternative to decrease the likelihood of injury should kickback occur.

Throttle trigger safety locks are very effective and should be on all saws.

Decompression valves would seem to be an advantage especially on higher compression saws, but operators not conversant with them should show some caution until fully familiar with them.

Controls on powersaws should be within reach of the operator's hand while holding the rear handle. Ignition switches on the test saws were well placed for emergency use, exceptions being the Dolmar 118 and the Echo 451VL. On the Echo, the action of the switch should be reversed. The choke lever on the Echo 451 was exposed and fouled stalling the saw when it was pushed through heavy undergrowth. Manual and automatic oilers were fitted on the three McCulloch models tested, the Echo 451VL and the Husky 35VR. The manual oiler plunger on the Husky was poorly located to be of much use. Refueling, to eliminate or reduce spillage during filling is assisted by the size and location of the filler holes. Of the saws tested, the Homelite 350 and Stihl 045 AV(E) are well designed for easy refuelling whilst the two Echo models and the Dolmar 118 were particularly poor. Retaining chains on fuel and oil caps are a useful aid. Caps should be shaped for easy removal and identification. The Partner R417 requires a tool to remove the oil filler cap.

Routine maintenance incorporates factors that are attended to daily or fairly frequently. All of the saws tested had easy access to the air filters although the quality of filter especially on the Husqvarna 140S and the Dolmar 118 was not high. Guide bar and chain maintenance should be simple and straight forward. The cramped space around the clutch drum on the McCulloch SP81 made fitting the chain difficult compared to other saws. Also on this saw, the chainbrake mounting made the removal or tightening of the clutch cover nuts difficult with the type of tool supplied. The necessity for regular cleaning and the ease with which it can be done is very dependent on the saw design. Several of the saws tested were very cramped around the cooling fins which lead them to become clogged with needles and debris very quickly and also make cleaning difficult. The Stihl 031AV, Homelite 350, and Echo 451VL required the most attention in this respect. Cleaning of a saw should be possible without having to virtually dismantle the saw.

The changing of the starter cords was straight forward on most of the test saws with the exception of the Echo 451VL, the Sachs Dolmar KMS4, and the Stihl 045AV(E). On these three saws, the

type of starter mechanism or the procedure required to change the cords was slow and fiddly compared to other saws.

Smoothness of external design is important especially for saws to be used for trimming or in silvicultural operations. The development of smooth lines on the European produced saws is a result of the trimming techniques used, especially in Scandinavia.

The balance and handling on most of the saws tested was satisfactory. Balance of a saw is generally affected by fitting longer guidebars than the recommended length. The distance between the front and rear handle should allow a good comfortable stance when holding the saw upright. The cramped hand position on the McCulloch MM30 required a wrist action when cutting and also tended to encourage dangerous one-handed operation. The Husqvarna 380S with the curved front handle was considered very well balanced. The diameter and covering on the front handle also affects the handling qualities of a saw. Most of the user test operators prefered a fairly heavy thick rubber grip. The front handle of the McCulloch Pro 10-10 was constructed from smallish diameter, uncovered alloy, which made handling difficult if the operator's hands were oily or sweaty.

APPENDIX I

EVALUATION AND SPECIFICATION SUMMARY SHEETS

EVALUATION AND SPECIFICATION SUMMARY

SAW: *Echo* MODEL: *CS 302*

SPECIFICATION:

Engine Displacement: *30cc.*
Purchase Price: *$189.00* (early 1976)
Weight: Bare - *3.7* Kg. All Up - *4.7* Kg.
AntiVibration Mounts: *No*
Chain Oiler: *Automatic*
Muffler: *Baffle* Capacity: *55cc.*
Fuel Tank Capacity Measured: *0.35 litre* Published: *0.33 litres*
Chain Oil Capacity Measured: - Published: *0.20 litres*
Fuel Ratio: *20:1*
Chain Type: *Oregon* Pitch: *¼"* Gauge: *0.50"*
Bar Type: *Echo Solid Nose* Clear Length: *29cm.(12")* Width: *85mm*
Sprocket: *8 Tooth*
Stroke: *28mm.* Bore: *37mm.*
Compression Ratio: *8:1* Ignition: *Flywheel Mag*
Spark Plug: *N6K BM 6A* Carburettor: *Tillotson Hu-14A*
Clutch - Centrifugal: *3 shoe*

PERFORMANCE:

Power (Maximum): *1.25* Kilowatts (Kw) at *7800* RPM
Torque (Maximum): *1.66* Newton Metre (Nm) at *5400* RPM
Fuel Consumption: *Not tested* Litres/Hour/Kw.
Running Time at Maximum Power: *Not Tested*
Noise (Full Load Cutting): *110.7* dBA
Vibration (Average Front and Rear Handles: *312* Metres/Sec^2

DISCUSSION:

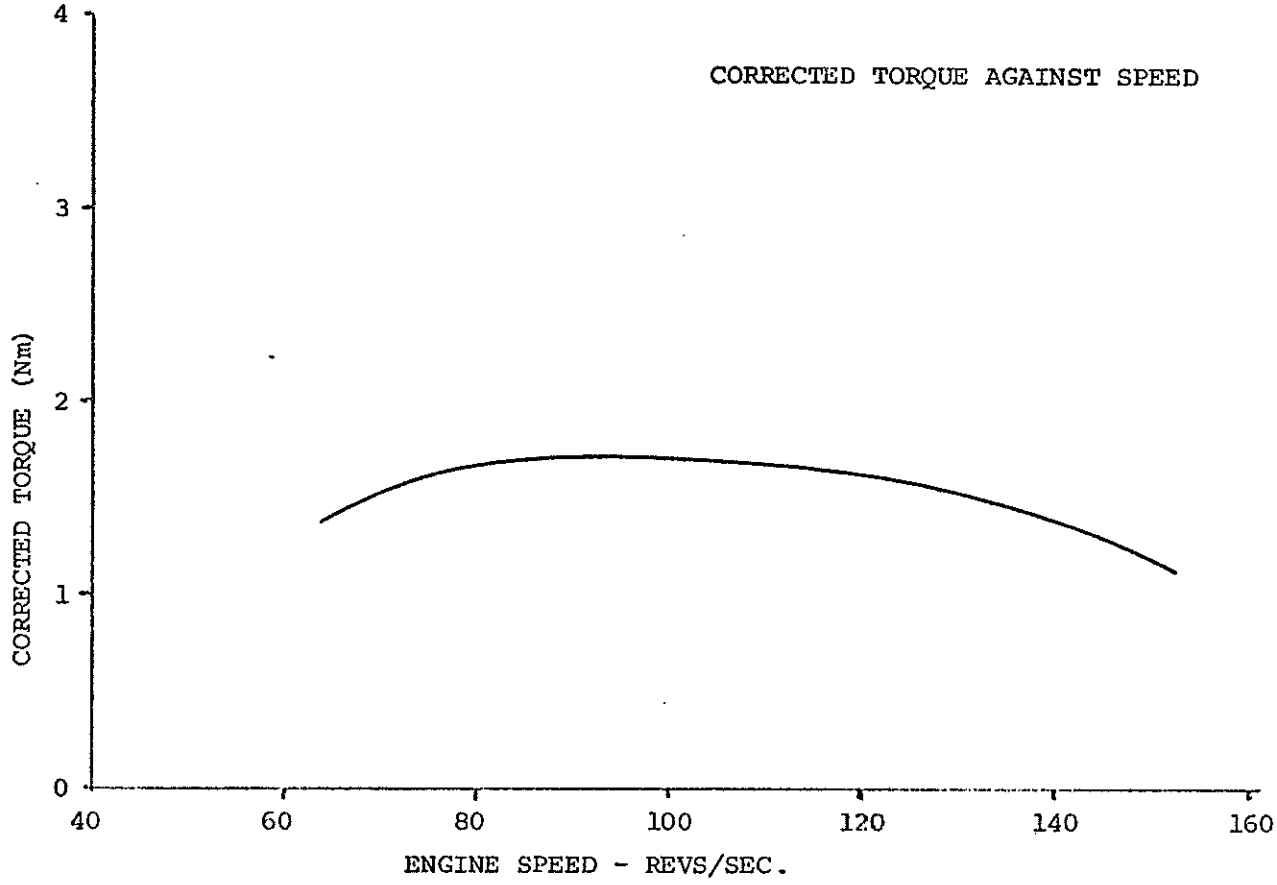
General performance and balance was very good when compared with the test saws of comparable size. The handles are widely spaced and although rigidly mounted, are ideal for controlled cutting. Cutter bar and chain maintenance is excellent with the reversed clutch simplifying this aspect. Plug and air filter maintenance is very easy, as is the removal of the starter mechanism for cord replacement.

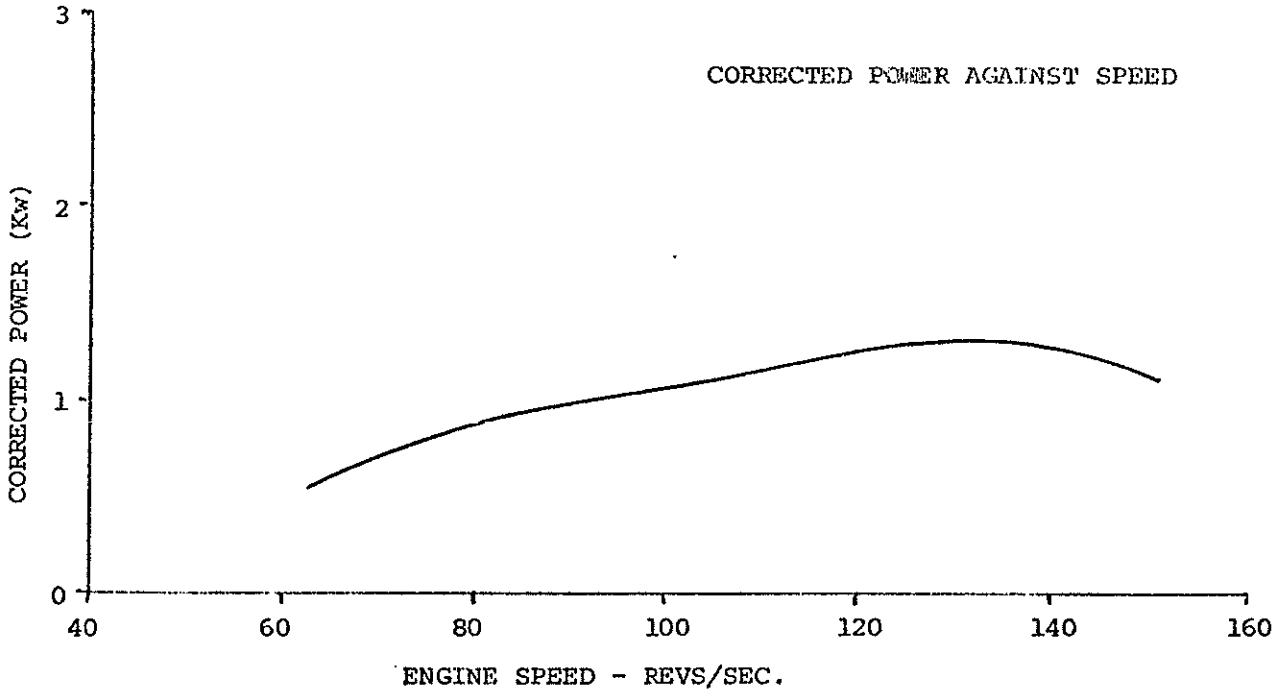
Sawdust clogging was a problem around the ignition coil, however cleaning around the engine was easy. Access under the flywheel cover required the use of an Allen Key and necessitated the removal of the front handle. Control layout was

good although the sliding ignition switch should be reversed for emergency use. Refueling was a poor feature with the oil and fuel filler holes in the middle of the saw body and obstructed by the arched handle. This necessitated the use of a funnel or pouring from a height, and spillage tended to soak the whole saw, presenting cleaning problems. The saw is solid, compact, and has a clean uncluttered exterior. It was considered the only ultra-lightweight tested as being suitable for light professional forestry work. However, the Echo 302 had the highest vibration level and the second highest noise level of all the saws tested and these aspects are excessive for prolonged use.

POWER AND TORQUE CURVES

SAW: ECHO CS 302
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *McCulloch* MODEL: *Mini Mac 30*

SPECIFICATION:

Engine Displacement: *30cc.*

Purchase Price: *$170.00* (early 1976)

Weight: Bare - *3.45* Kg. All Up - *4.80* .Kg.

AntiVibration Mounts: *No.*

Chain Oiler: *Manual/Automatic*

Muffler: *Baffle* Capacity: *51 cc.*

Fuel Tank Capacity Measured: *0.35litres* Published: -

Chain Oil Capacity Measured: - Published: -

Fuel Ratio: *40:1*

Chain Type: *McCulloch* Pitch: ¼" Gauge: *0.050"*

Bar Type: *McCulloch Solid Nose* Clear Length: *30cm. (12")*

Sprocket: *8 tooth*

Stroke: *30.6mm.* Bore: *35mm.*

Compression Ratio: - Ignition: *McCulloch HT Magneto*

Spark Plug: *Champion CJ8* Carburettor: -

Clutch - Centrifugal: *2 shoe*

PERFORMANCE:

Power (Maximum): *0.83* Kilowatts (Kw) at *6400* RPM

Torque (Maximum): *1.22* Newton Metre (Nm) at *6000* RPM

Fuel Consumption: *Not tested* Litres/Hour/Kw.

Running Time at Maximum Power: *Not tested*

Noise (Full Load Cutting): *106.7* dBA

Vibration (Average Front and Rear Handles: *208* Metres/Sec^2

DISCUSSION:

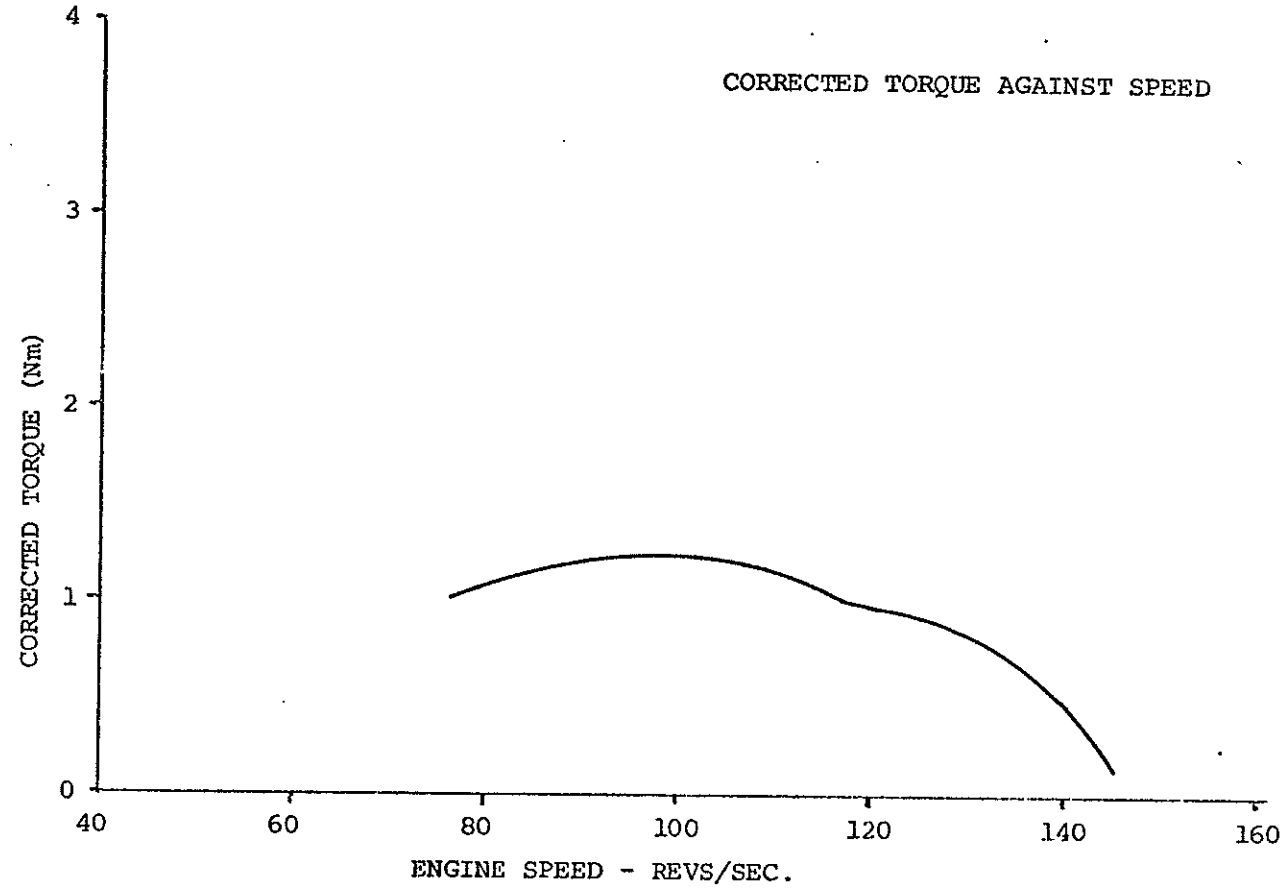
The design of the MM-30 is generally sturdy, functional, compact and appealing to look at. The pistol grip handle is mounted on top of the saw with the tendency for operators to use it with one hand, a dangerous practice with the use of powersaws. The cramped handle position when using two hands means that both hands are near the centre of the saw, preventing leverage when cutting. For this reason it is considered that the saw has very limited application in forestry work. Control layout is good although the ignition switch on the test saw was very tight and awkward to operate. A manual oiler as well as automatic is considered a good feature. Cutter bar and chain maintenance is good although some juggling is required to get the chain on and to correctly position the tension adjustment screw which is on the clutch cover, when

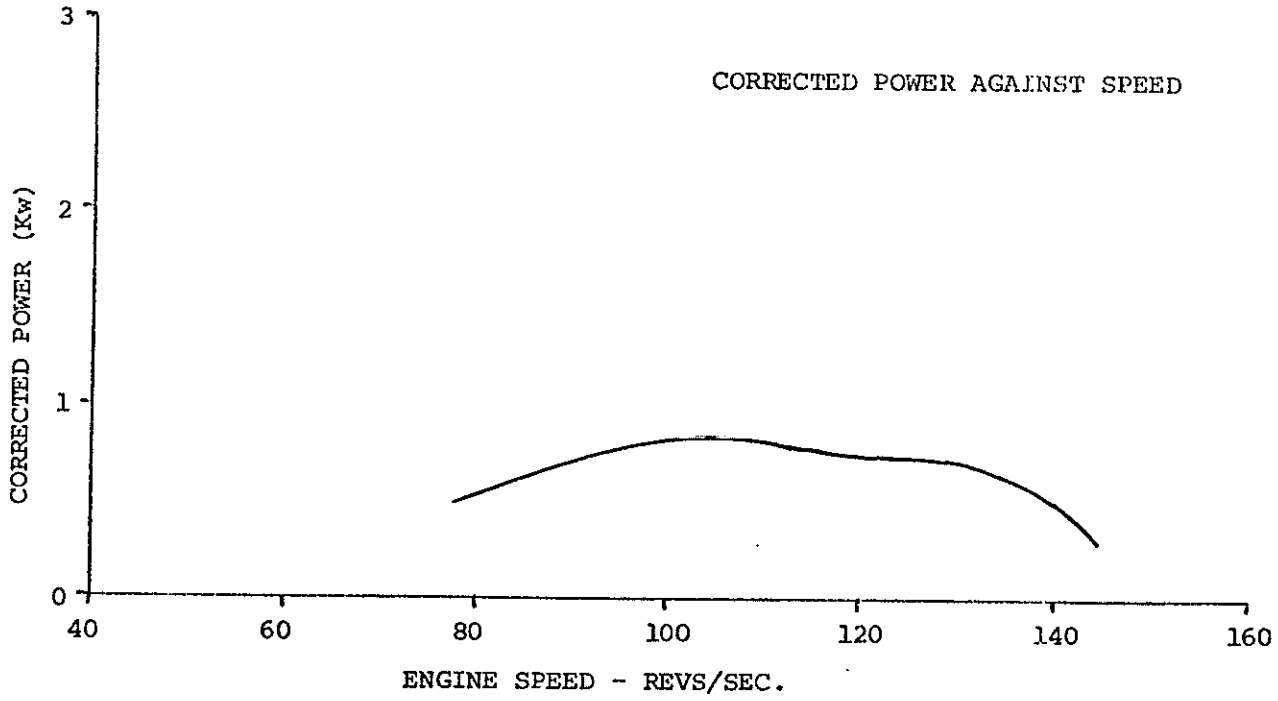
Cont.....2

replacing the chain or guide bar. Access to the very small air cleaner, spark plug, and starter cord, for cleaning or replacement is straightforward. The saw is difficult to keep clean and to service if used in dirty conditions and must virtually be dismantled to gain access to the flywheel side. Most cleaning around the cooling fins can be done from the cutter bar side when the side cover is removed. Refueling is good with large filler holes (for a saw of this size) being raised sufficiently above the body of the saw to aid in avoiding overfilling. Spillage will however pour directly into the engine area through the throttle opening. The chainbrake must be pushed forward to allow filling. The chainbrake fitted was very effective once activated but required considerable force to operate. Vibration and noise levels were above average for the saws tested, however this saw is considered robust and functional for use by infrequent users such as carpenters, bridge builders or farmers. The main disadvantage from a safety angle is the handle arrangement as mentioned above.

POWER AND TORQUE CURVES

SAW: McCULLOCH MINI MAC 30
ATMOSPHERIC CORRECTION
FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Husky* MODEL: *35VR*

SPECIFICATION:

Engine Displacement: *35cc.*
Purchase Price: *$168.00* (early 1976)
Weight: Bare - *3.5* Kg. All Up - *4.55* Kg.
AntiVibration Mounts: *Yes*
Chain Oiler: *Manual/Automatic*
Muffler: Capacity: *65cc.*
Fuel Tank Capacity Measured: *0.34 litres* Published:
Chain Oil Capacity Measured: Published:
Fuel Ratio: *16:1*
Chain Type: *Windsor* Pitch: ¼" Gauge: *.050"*
Bar Type: *Windsor Sprocket Nose* Clear Length: *30cm. (12")*
Sprocket: *8 tooth*
Stroke: Bore: *36.5mm.*
Compression Ratio: Ignition: *Conventional Mag*
Spark Plug: *Champion C5-8* Carburettor: *Tillotson*
Clutch - Centrifugal: *2 shoe*

PERFORMANCE:

Power (Maximum): *1.16* Kilowatts (Kw) at *7200* RPM
Torque (Maximum): *1.73* Newton Metre (Nm) at *6000* RPM
Fuel Consumption: *Not tested* Litres/Hour/Kw.
Running Time at Maximum Power: *Not Tested*
Noise (Full Load Cutting): *106* dBA
Vibration (Average Front and Rear Handles: *140.5* Metres/Sec^2

DISCUSSION:

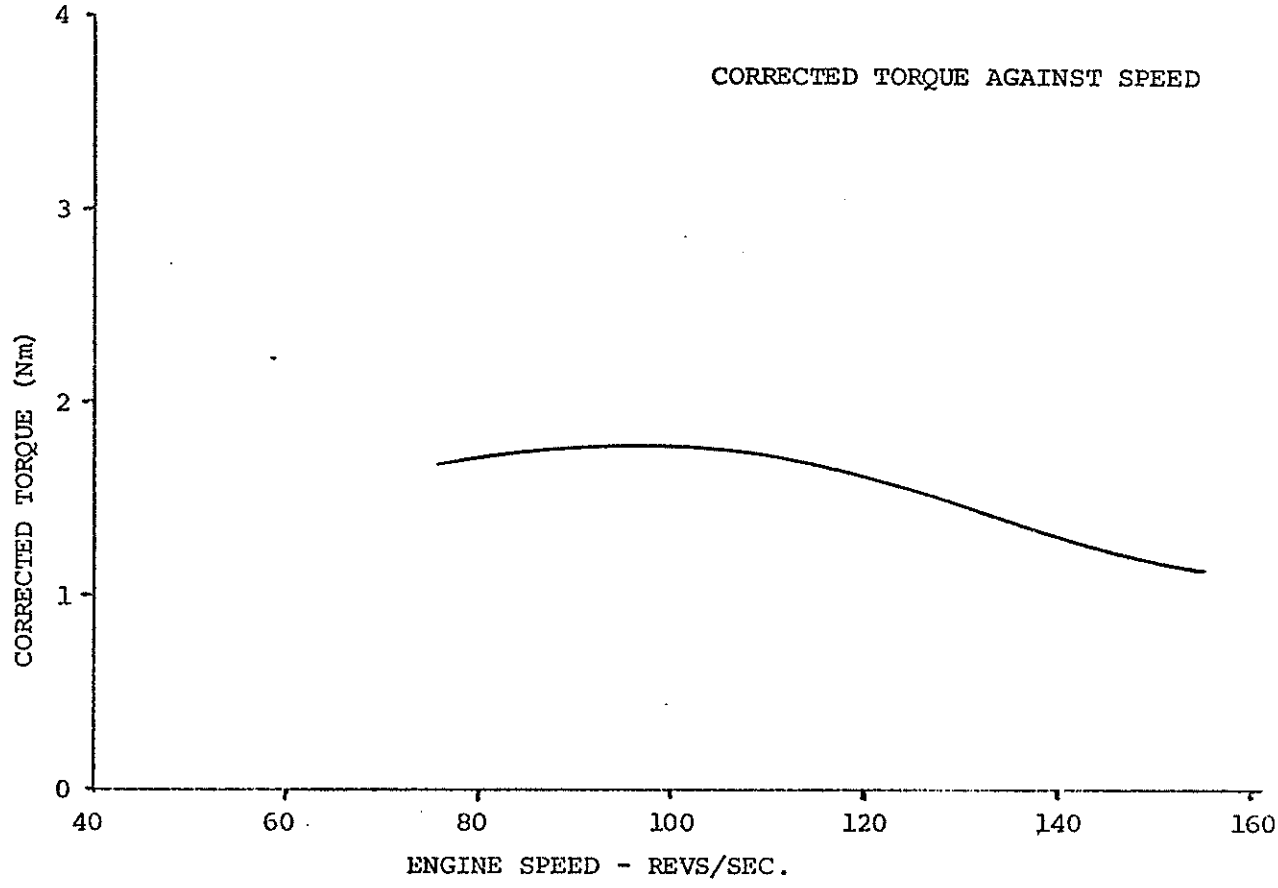
This saw is considered to be of no value in forestry work due to its very light construction. It's general performance was considered poor with the clutch slipping often whilst under load. Access for cleaning involved the removal of three screws and a nut which allowed the removal of both side covers thus exposing the whole engine. These same standard slotted screws vibrated loose very easily during use.

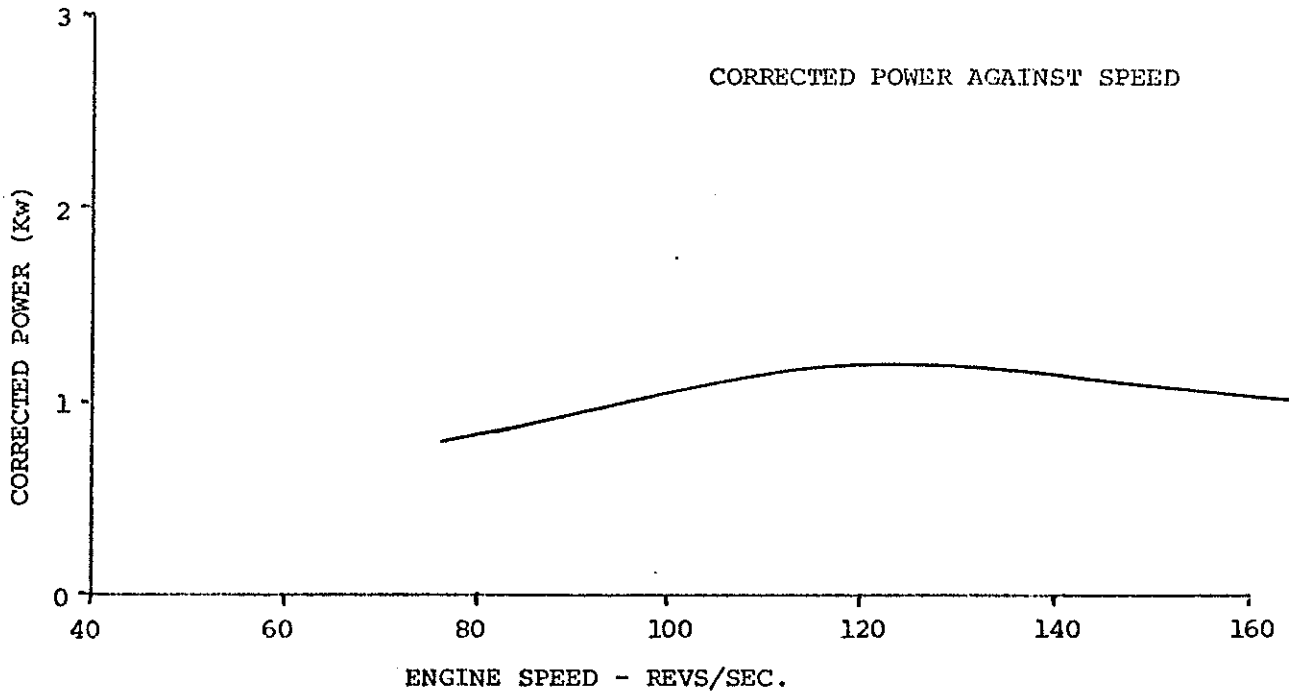
The ignition switch on the test saw was very stiff to operate and the manual oiler plunger button, located on the right side of the front handle, could only

be reached from one hand position. Handling characteristics were considered very poor with the front arched handle too close to the body of the saw for a comfortable grip. Bucking spikes are moulded as part of the tank casting and proved very ineffective. The large filler holes for refuelling are well positioned although spillage flows directly into the engine cavity and flywheel housing. Cutter bar maintenance is fair but a poor bar adjuster is fitted, also the air filter is very fragile and not well supported. A trigger safety lock mounted under the pistol handle proved very effective.

POWER AND TORQUE CURVES

SAW: HUSKY 35 VR
ATMOSPHERIC CORRECTION
FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Husqvarna* MODEL: *140S*

SPECIFICATION:

Engine Displacement: *40cc.*
Purchase Price: *$259.00* (early 1976)
Weight: Bare - *4.6* Kg. All Up - *6.2* .Kg.
AntiVibration Mounts: *Yes*
Chain Oiler: *Automatic*
Muffler: Capacity: *217cc.*
Fuel Tank Capacity Measured: *0.55 litres* Published: *.51 litres.*
Chain Oil Capacity Measured: - Published: *.251 litres*
Fuel Ratio: *20:1*
Chain Type: *Windsor Timber King J50* Pitch: $^{3}/_{8}$" Gauge: *.050*
Bar Type: *Windsor Special Dura-Tip* Clear Length: *35cm. (14")*
Sprocket:
Stroke: *32mm.* Bore: *40mm.*
Compression Ratio: Ignition: *Conventional (Femsa MDL-*
Spark Plug: *Bosch WKA 225T36* Carburettor: *Walbro HDC-10*
Clutch - Centrifugal: *2 shoe*

PERFORMANCE:

Power (Maximum): *1.75* Kilowatts (Kw) at *8600* RPM
Torque (Maximum): *2.07* Newton Metre (Nm) at *7600* RPM
Fuel Consumption: *Not tested* Litres/Hour/Kw.
Running Time at Maximum Power: *Not tested*
Noise (Full Load Cutting): *105.8* dBA
Vibration (Average Front and Rear Handles: *32.85* Metres/Sec^2

DISCUSSION:

This was the smallest saw tested in the lightweight group and was considered to have excellent balance, handling, and well positioned controls. The saw is compact with clean exterior lines, and has very effective antivibration mountings. Chain and cutter bar maintenance is simple with the outer cover held by only one nut.

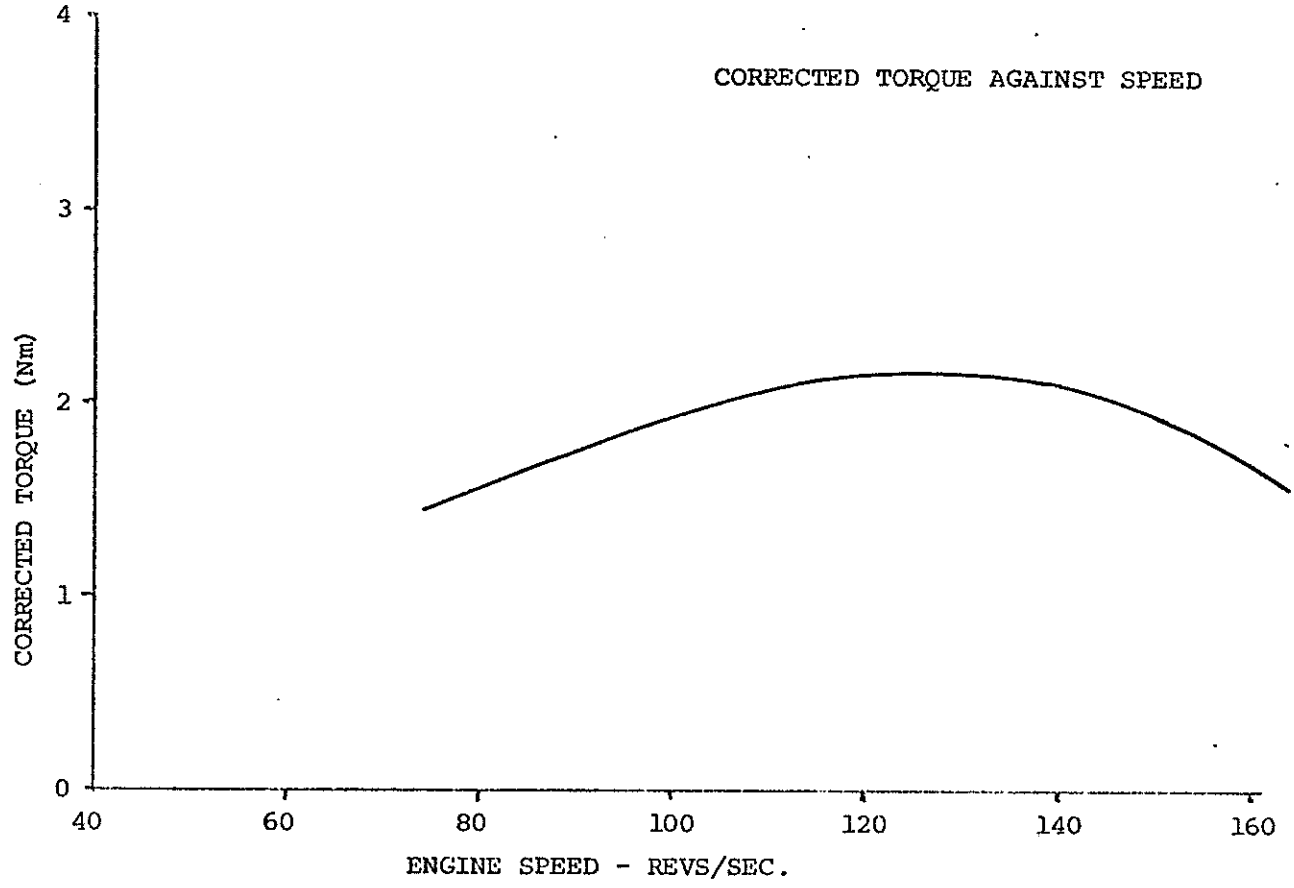
Maintenance access for airfilter, spark plug, carburettor, and ignition servicing is also very simple, however the airfilter on the test saw was not very effective

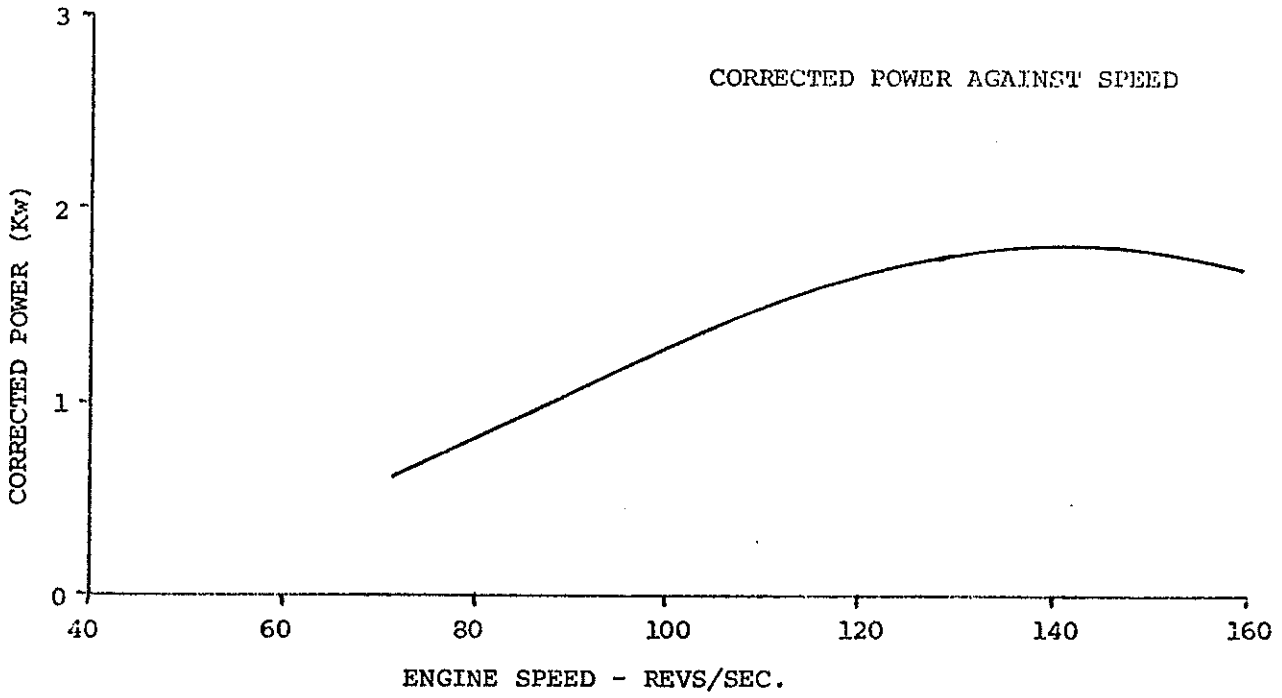
and dust particles accumulated in the throat of the carburettor. Changing the starter cord was a simple task although the standardisation of screws would assist. Cleaning the saw was no problem and refueling was by way of well located large filler holes with oil spillage passing under the muffler and the flywheel housing which is well sealed against petrol overflow.

The safety throttle lock device was considered by some test operators to be positioned too high on the pistol handle for a natural grip.

POWER AND TORQUE CURVES

SAW: HUSQVARNA 140S
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Echo* MODEL: *CS 451 VL*

SPECIFICATION:

Engine Displacement: *44cc.*
Purchase Price: *$249.00* (early 1976)
Weight: Bare - *5.7* Kg. All Up - *7.5* Kg.
AntiVibration Mounts: *Yes*
Chain Oiler: *Manual/Automatic*
Muffler: *Expansion Box*
Capacity: *139cc.*
Fuel Tank Capacity Measured: *0.681itres* Published: *0.57 litres*
Chain Oil Capacity Measured: - Published: *0.25 litres*
Fuel Ratio: *20:1*
Chain Type: *Oregon* Pitch: $^3/_8$" Gauge: *0.050"*
Bar Type: *Oregon Solid Nose* Clear Length: *38cm. (15")*
Sprocket: *7 teeth*
Stroke: *32mm.* Bore: *42mm*
Compression Ratio: Ignition: *Mag Flywheel*
Spark Plug: *N6K BM-6A* Carburettor: *Tillotson Hu-9A*
Clutch - Centrifugal: *3 shoe*

PERFORMANCE:

Power (Maximum): *1.75* Kilowatts (Kw) at *7200* RPM
Torque (Maximum): *2.60* Newton Metre (Nm) at *5400* RPM
Fuel Consumption: *Not Tested* Litres/Hour/Kw.
Running Time at Maximum Power: *Not Tested*
Noise (Full Load Cutting): *105.3* dBA
Vibration (Average Front and Rear Handles: *62.8* Metres/Sec^2

DISCUSSION:

The 451 VL was the cheapest of the lightweight saws tested and overall did not impress by its performance or design when compared with other saws in this group.

Spark plug, carburettor, ignition and the small but effective air filter are all easily accessible for servicing. The inverted clutch simplified guide bar and chain maintenance. Balance and handling was considered good with the resilient mounted front handle having a good all round rubber handgrip. Changing of the starter cord was found to be time consuming, requiring the use of an Allen Key

and Phillips Screwdriver. The external lines are not particularly smooth and the side mounted muffler is proud and burns to the operator could occur. The choke control is exposed and fouled, stalling the saw when pushed through heavy undergrowth. The prominent idle adjustment screw also tended to foul. The sliding ignition switch action should be reversed for stopping the saw in an emergency. Maximum throttle opening on the test saw could not be achieved unless the throttle trigger was depressed inside the pistol grip handle. The petrol filler hole is a reasonable size but the oil hole is small and both are badly placed in the top centre of the saw. Oil spillage entered the engine and flywheel area creating fouling problems. This problem was not helped when the saw was worked hard and continuously as overheating pressurised the fuel tank forcing fuel out of the cap, thus soaking the saw. The cramped area about the cooling fins is difficult to clean and choked with debris in a very short time during normal use.

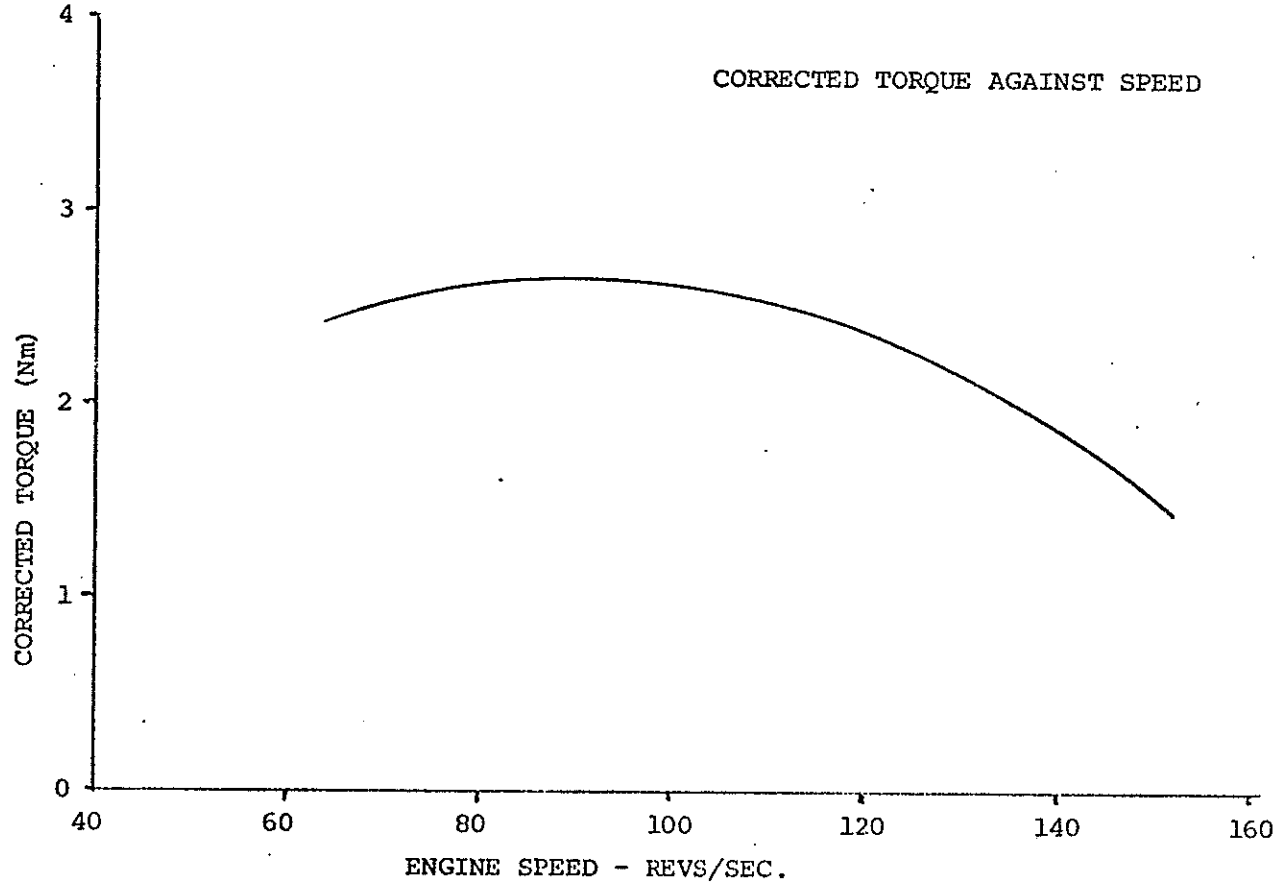
COMMENTS FROM NEW ZEALAND AGENTS:

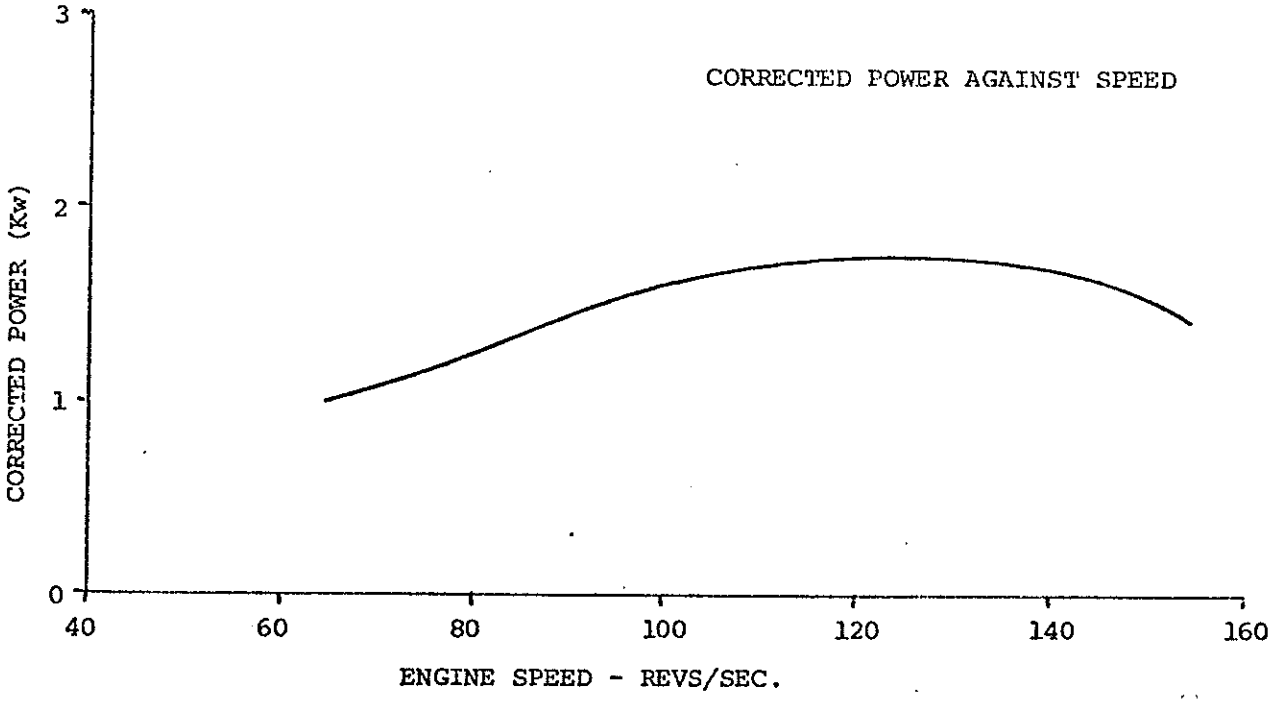
Agency Distributors (International) Limited reported that the Echo Model 451 has been superceded by the 452 and the key changes advised are:

- *Improved cooling and redesigned air intake that (quote) "will not plug up with sawdust as fast as on a 451".*
- *Redesigned cylinder fins and increased cutouts for improved air circulation and cooling.*
- *Redesigned crankcase in respect to fuel and oil tank location. Both are situated at the front of the saw engine with the oil tank acting as a buffer between the fuel tank and engine crankcase.*
- *Fuel and oil filler holes are also in the front of the saw (quote) "this reduces spillage of fuel and oil over the top of the saw and starter assembly".*

POWER AND TORQUE CURVES

SAW: ECHO CS 451 VL
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Dolmar* MODEL: *118*

SPECIFICATION:

Engine Displacement: *45cc.*
Purchase Price: *$263.00* (early 1976)
Weight: Bare - *5.55* Kg. All Up - *7.8* Kg.
AntiVibration Mounts: *Yes*
Chain Oiler: *Automatic*
Muffler: *Expansion Box* Capacity: *77cc.*
Fuel Tank Capacity Measured: *0.5 litres* Published: *.45 litres*
Chain Oil Capacity Measured: - Published: *.2 litres*
Fuel Ratio: *25:1 for 40 hours then 40:1*
Chain Type: *Dolmar* Pitch: $^3/_8$" Gauge: *.058"*
Bar Type: *Dolmar* Clear Length: *43cm. (17")*
Sprocket: *7 tooth*
Stroke: *32mm.* Bore: *42mm.*
Compression Ratio: Ignition: *Bosch KD1*
Spark Plug: *Bosch WKA 225T36* Carburettor: *Walbro HDC-22*
Clutch - Centrifugal:

PERFORMANCE:

Power (Maximum): *1.66* Kilowatts (Kw) at *7700* RPM
Torque (Maximum): *2.28* Newton Metre (Nm) at *6600* RPM
Fuel Consumption: *1.19* Litres/Hour/Kw.
Running Time at Maximum Power: *15 mins.*
Noise (Full Load Cutting): *113.3* dBA
Vibration (Average Front and Rear Handles: *238.8* Metres/Sec^2

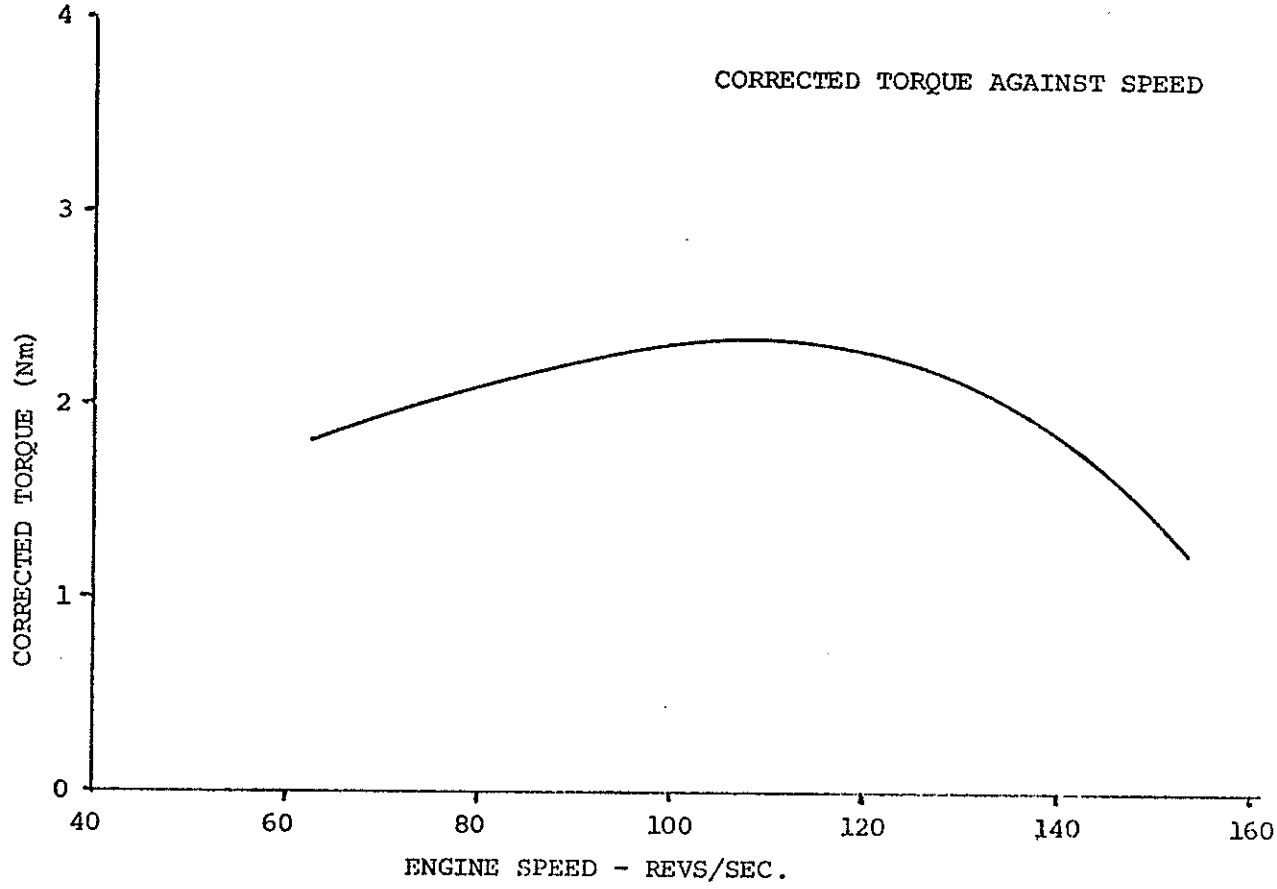
DISCUSSION:

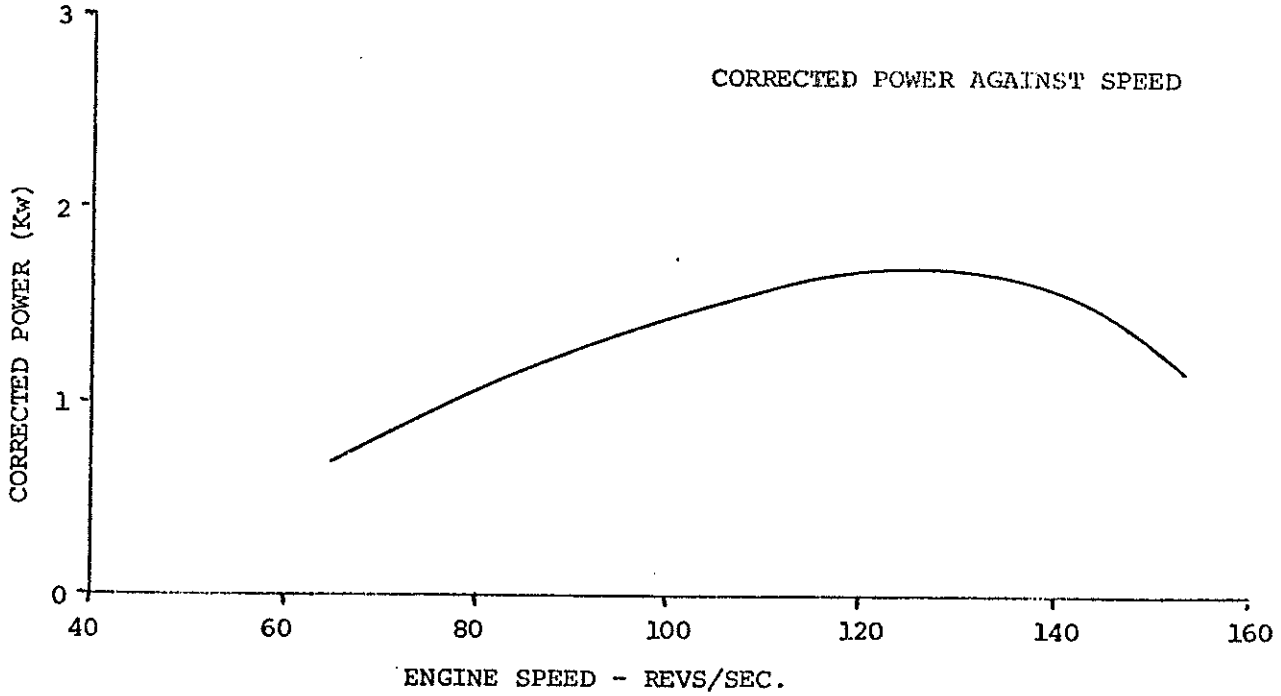
The general performance of this saw did not impress in the user testing partly because of the length of the cutter bar supplied with it for the power output of the unit. The saw's antivibration system was rather ineffective when compared to other saws with resilient mountings. The noise level measured was also extremely high, the worst tested. The combined noise and vibration would preclude this saw from professional use. Spark plug and air filter access is very good although the airfilter which is attached to the top cover is poorly designed, having a small surface area and is difficult to clean. If damaged, the

replacement of the whole top cover would be required. The cork gasket between the top cover and the carburettor distorted badly and pulled away after limited use. Cutter bar and chain maintenance was good and the engine could be easily cleaned when the flywheel cover was removed. Starter cord replacement proved difficult due to the type of retaining circlip used. A type that could be removed with a screw driver would assist during field maintenance. Refueling was a very poor feature with petrol spillage or overflow soaking much of the saw or running into the engine and flywheel housing. The small oil filler hole did not assist in this matter. Balance, handling, and control location, were considered satisfactory with the exception of the poorly positioned stop button. The rear positioned muffler exhausts in a right hand direction and although not a fuming problem, proved very ineffective as a noise reducer.

POWER AND TORQUE CURVES

SAW: DOLMAR 118
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Stihl* MODEL: *031 AV*

SPECIFICATION:

Engine Displacement: *48cc.*

Purchase Price: *$261.00* (early 1976)

Weight: Bare - *5.8* Kg. All Up - *7.75* Kg.

AntiVibration Mounts: *Yes*

Chain Oiler: *Automatic*

Muffler: *Expansion Box* Capacity: *284cc.*

Fuel Tank Capacity Measured: - Published: *0.54 litres*

Chain Oil Capacity Measured: - Published: *0.31 litres*

Fuel Ratio: *40:1*

Chain Type: *Stihl Oilomatic* Pitch: $^{3}/_{8}$" Gauge: *.063"*

Bar Type: *Stihl Solid Nose* Clear Length: *38cm. (15")*

Sprocket: *7 tooth*

Stroke: *32mm.* Bore: *44mm.*

Compression Ratio: Ignition: *Bosch Flywheel Mag.*

Spark Plug: *Bosch WkA 175 T6* Carburettor: *Tillotson*

Clutch - Centrifugal:

PERFORMANCE:

Power (Maximum): *1.90* Kilowatts (Kw) at *7800* RPM

Torque (Maximum): *2.50* Newton Metre (Nm) at *6000* RPM

Fuel Consumption: *1.04* Litres/Hour/Kw.

Running Time at Maximum Power: -

Noise (Full Load Cutting): *105.5* dBA

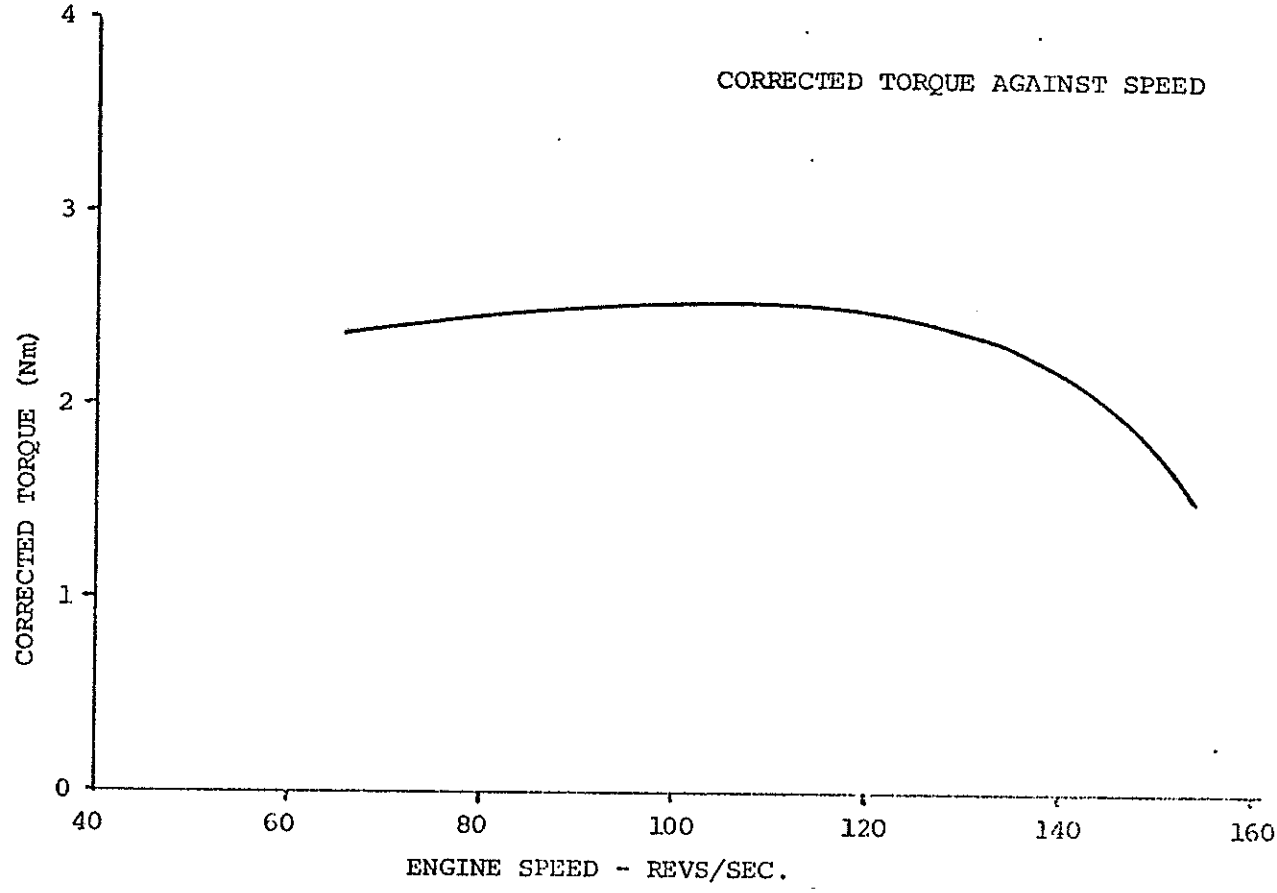
Vibration (Average Front and Rear Handles: *73.0* Metres/Sec^2

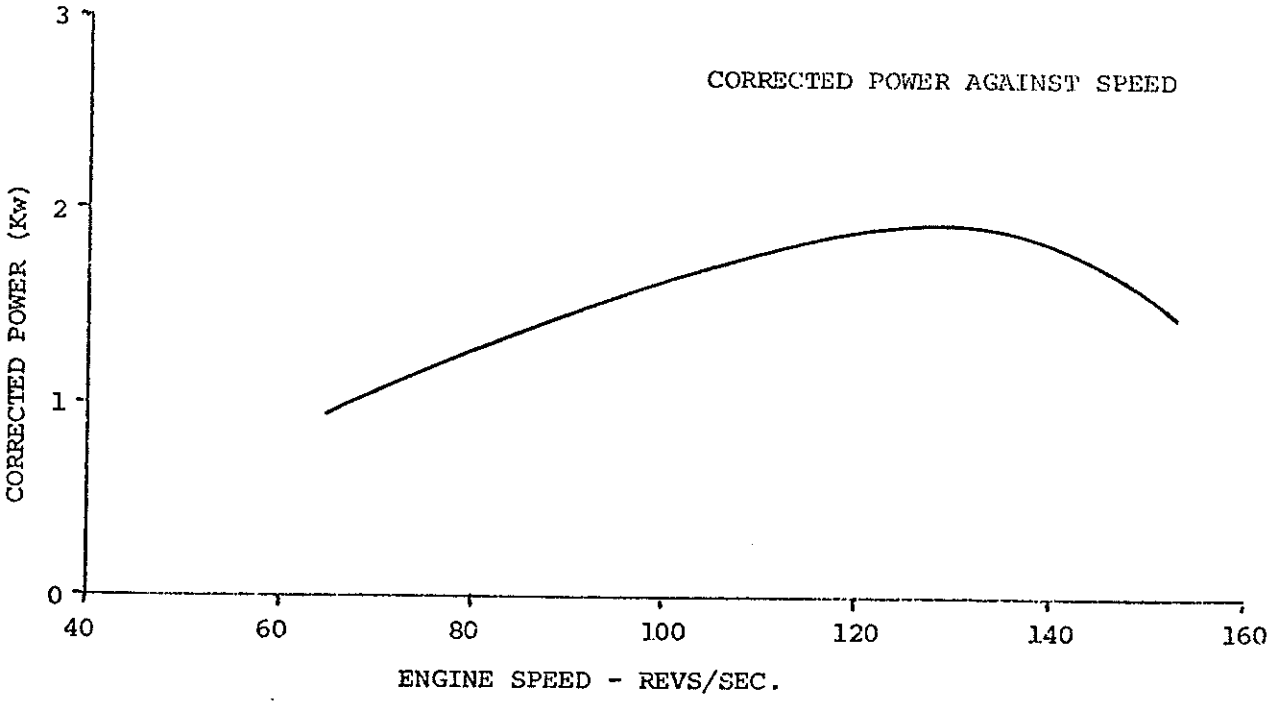
DISCUSSION:

The 031 AV has many features that are repeated in the 045 AV model. Spark plug, air filter, chain and cutter bar, and starter cord assembly were easy to maintain. Cleaning around the engine cooling area was difficult and oil overspill around the base of the engine did not help in this respect. Access to the flywheel housing is very restricted and time consuming. The engine is virtually sealed in and only partial cleaning is possible. This was considered the poorest feature of the 031 especially as a saw of this size would be used on silvicultural thinning work where needles or heavy undergrowth create fouling problems in a very short time.

POWER AND TORQUE CURVES

SAW: STIHL 031AV
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Jonsered* MODEL: *52E*

SPECIFICATION:

Engine Displacement: *49cc.*

Purchase Price: *$277.00* (early 1976)

Weight: Bare - *6.45* Kg. All Up - *8.15* Kg.

AntiVibration Mounts: *Yes*

Chain Oiler: *Automatic*

Muffler: *Front* Capacity: *246cc.*

Fuel Tank Capacity Measured: *0.75 litres* Published: *0.8 litres*

Chain Oil Capacity Measured: Published: *0.3 litres*

Fuel Ratio: *25:1*

Chain Type: *Oregon* Pitch: *.325"* Gauge: *.058"*

Bar Type: *Sandvik Roll top Sprocket Nose* Clear Length: *36cm. (14")* Width: *60mm*

Sprocket: *8 tooth*

Stroke: *32mm.* Bore: *44mm.*

Compression Ratio: *8.5:1* Ignition: *Electronic*

Spark Plug: *Champion CJ6* Carburettor: *Tillitson*

Clutch - Centrifugal:

PERFORMANCE:

Power (Maximum): *1.92* Kilowatts (Kw) at *8100* RPM

Torque (Maximum): *2.47* Newton Metre (Nm) at *6300* RPM

Fuel Consumption: *.804* Litres/Hour/Kw.

Running Time at Maximum Power: *29 mins.*

Noise (Full Load Cutting): *105.3* dBA

Vibration (Average Front and Rear Handles: *46.6* Metres/Sec^2

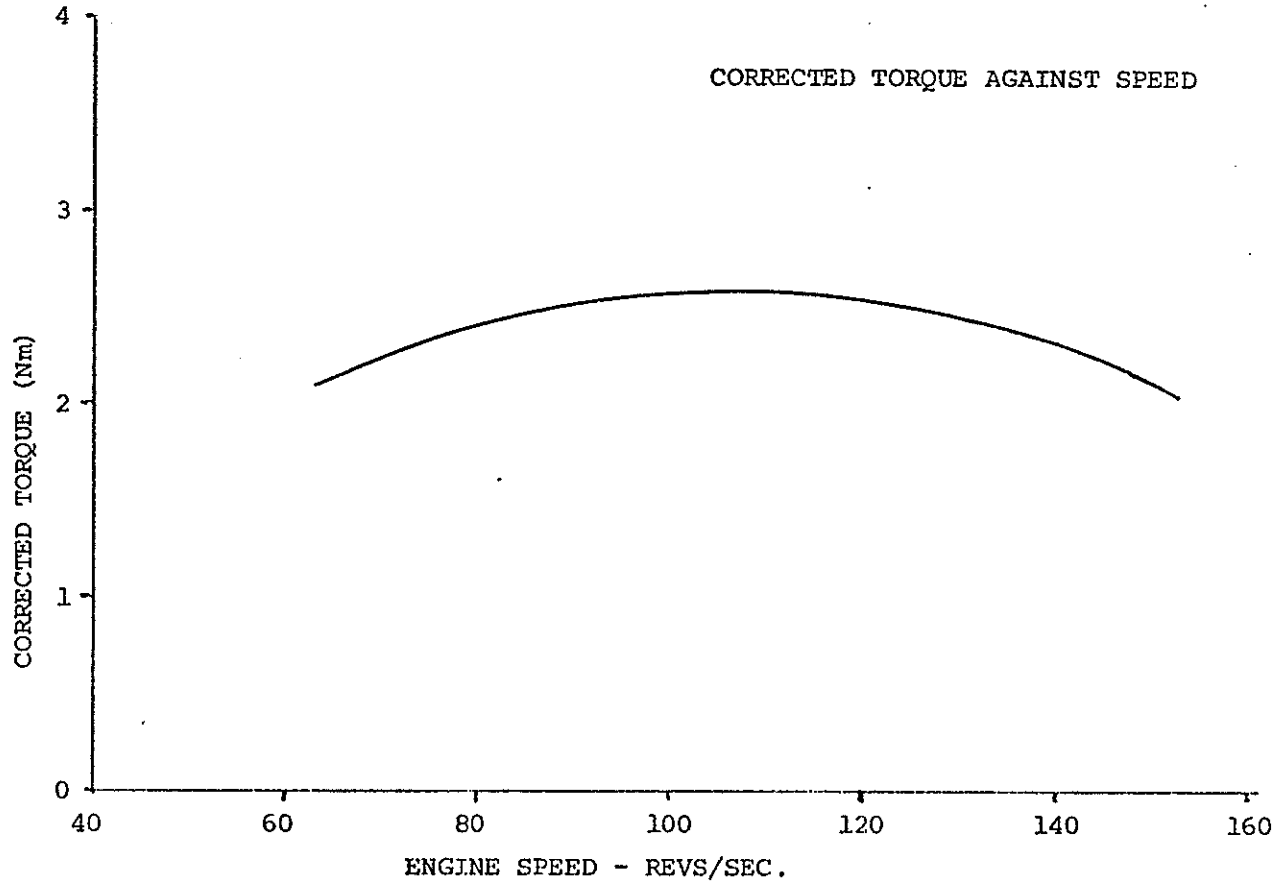
DISCUSSION:

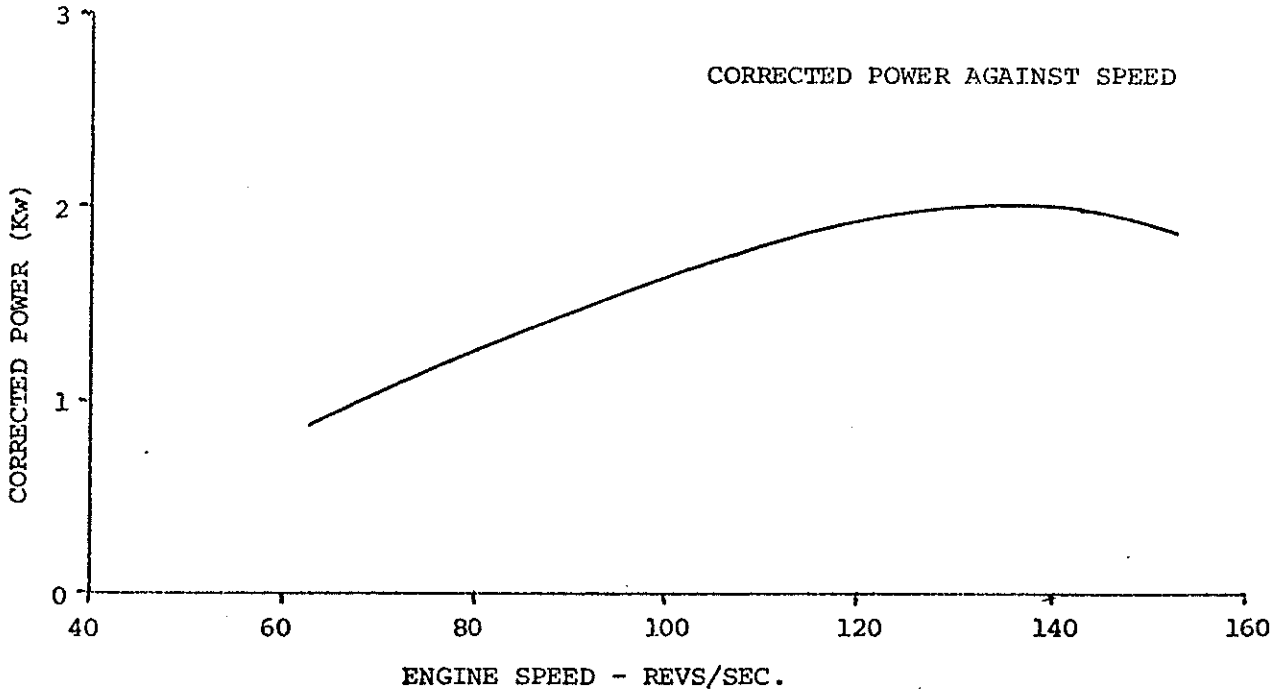
The 52E drew favourable comment from users on its balance, handling and compactness. Daily maintenance points have easy access for quick servicing. Controls are well positioned although the ignition switch is small and protected by a rim which makes its use very difficult in an emergency, or if the operator was wearing gloves. Refuelling of petrol is good with a large aperture, however the chain lubrication oil filler hole is small and not particularly accessible. Oil overspill flows under the exhaust which contributes to a build up of material between the exhaust and saw body. Both caps are fitted with securing chains. A poor feature highlighted during the user tests, was clutch slippage. This occurred due to a build up of oil and sawdust inside the recessed inverted clutchdrum. Surplus oil from the chain

lubrication attracted sawdust around the clutch-well and this eventually worked into the clutchdrum proper. The saw was fitted with a well located safety throttle lock and chain brake, however the latter was considered poor in design and operation. Considerable force was required to activate the brake and the design of the mechanism resulted in loose linkages that vibrated excessively. The brake pad on the clutch drum does not appear to be as effective as the brake-bands used in other chain brake mechanisms, however this aspect was not tested.

POWER AND TORQUE CURVES

SAW: JONSERED 52E
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *McCulloch* MODEL: *Pro 10-10A*

SPECIFICATION:

Engine Displacement: *55cc.*

Purchase Price: *$280.00* (early 1976)

Weight: Bare - *60* Kg. All Up - *7.9* Kg.

AntiVibration Mounts: *No.*

Chain Oiler: *Manual/Automatic*

Muffler: *Reed* Capacity: *91cc.*

Fuel Tank Capacity Measured: *0.75litres* Published: -

Chain Oil Capacity Measured: - Published: -

Fuel Ratio: *40:1*

Chain Type: Pitch: Gauge:

Bar Type: *McCulloch Solid Nose* Clear Length: *38cm.(15")*

Sprocket: *7 tooth*

Stroke: *35mm.* Bore: *44mm.*

Compression Ratio: Ignition: *McCulloch HT Magneto*

Spark Plug: *Champion DJ8* Carburettor:

Clutch - Centrifugal: *2 shoe*

PERFORMANCE:

Power (Maximum): *1.9* Kilowatts (Kw) at *7800* RPM

Torque (Maximum): *2.6* Newton Metre (Nm) at *4800* RPM

Fuel Consumption: *0.636* Litres/Hour/Kw.

Running Time at Maximum Power: *37 minutes.*

Noise (Full Load Cutting): *107.3* dBA

Vibration (Average Front and Rear Handles: *245.3* Metres/Sec^2

DISCUSSION:

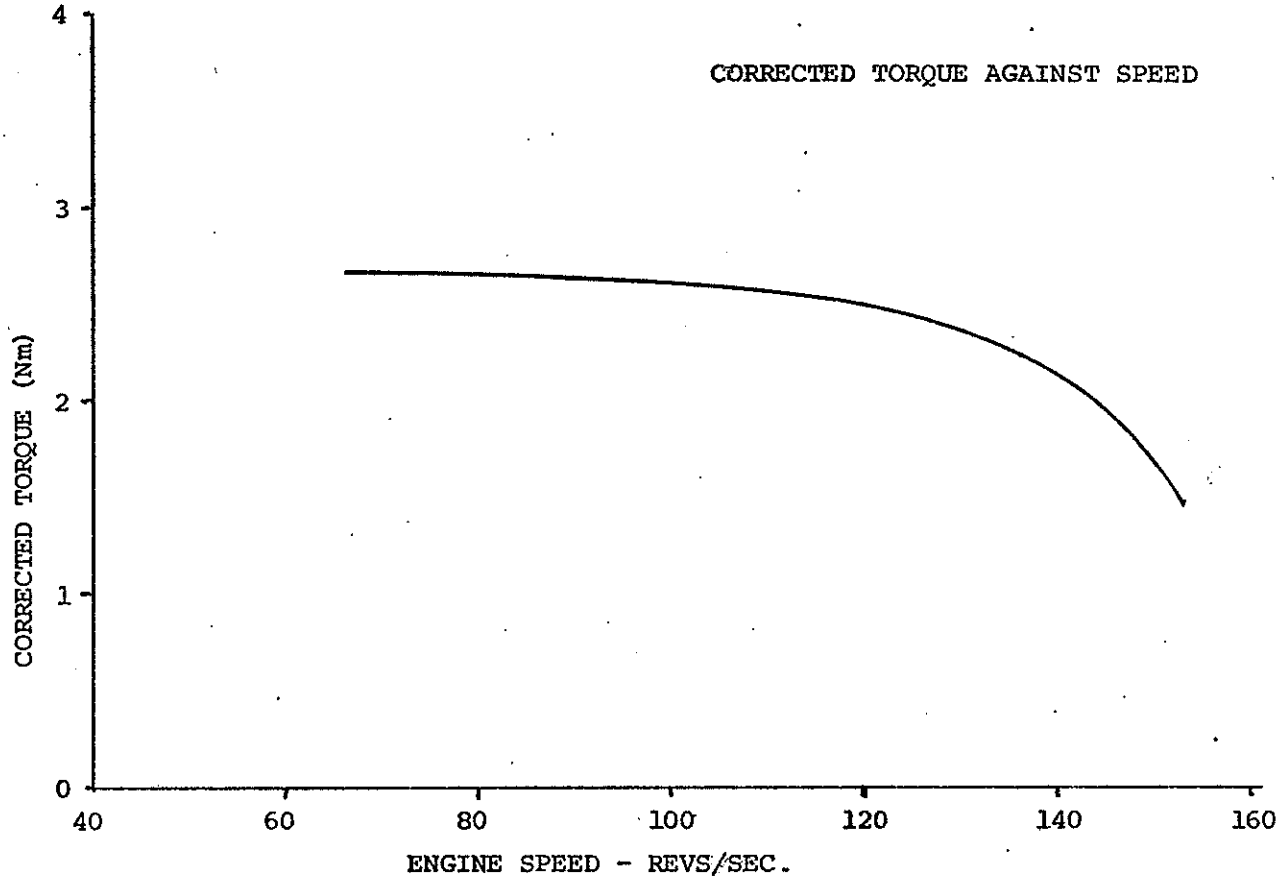
The 10-10A is advertised as a casual user saw although its cost in New Zealand is similar to professional saws in the same size range. It is not fitted with anti-vibration mounts and in testing recorded the second highest vibration level. Controls are well located including the manual oiler,and the saw had good balance however operators criticised the front arched handle as being too thin and difficult to hold with oily or sweaty hands. The muffler expels directly into the ground when felling and although not considered a fire hazard, one left handed test operator found the exhaust blew directly onto his leg. Maintenance of the air filter and spark plug is excellent but the tightening or loosening of the clutch cover stud for chain and bar servicing is made difficult by the

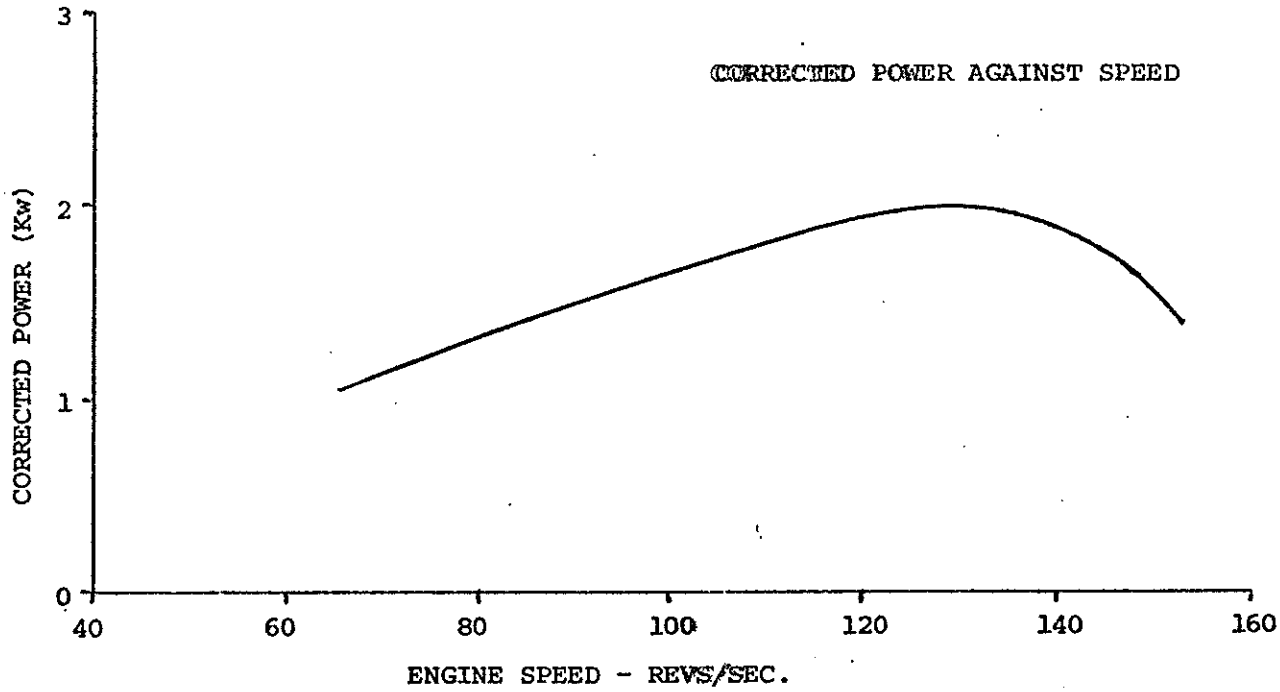
Cont.....2

location of the chainbrake. Clearance around the clutch on this model is good and not prone to debris accumulation. Cleaning of the engine cooling fins is not difficult except where debris collects between the engine and fuel tank. Starter cord replacement is simple although the cover is considered fragile and broke on the test saw. The fuel filler hole is a reasonable size but spillage tended to flow over the saw. However a sealing edge around the air filter prevents the filter becoming soaked. The oil filler hole is small and oil overflow spills directly into the flywheel housing. The saw is fitted with an efficient chainbrake although some operators expressed concern that the activating lever could be forced back against the fingers of their forward hand.

POWER AND TORQUE CURVES

SAW: McCULLOCH PRO 10-10
ATMOSPHERIC CORRECTION
FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Partner* MODEL: *R 417*

SPECIFICATION:

Engine Displacement: *55cc.*

Purchase Price: *$266.00* (early 1976)

Weight: Bare - *6.4* Kg. All Up - *8.45* Kg.

AntiVibration Mounts: *Yes*

Chain Oiler: *Automatic*

Muffler: *Front Mounted* Capacity: *331cc.*

Fuel Tank Capacity Measured: *0.72litres* Published: *0.80 litres*

Chain Oil Capacity Measured: - Published: *0.35 litres*

Fuel Ratio: *40:1*

Chain Type: *Partner* Pitch: $^3/_8$" Gauge: *.058"*

Bar Type: *Partner Solid Nose* Clear Length: *40cm. (18")*

Sprocket: *7 tooth*

Stroke: Bore:

Compression Ratio: Ignition:

Spark Plug: *Champion CJ6* Carburettor: *Tillotson*

Clutch - Centrifugal:

PERFORMANCE:

Power (Maximum):	*2.85*	Kilowatts (Kw) at	*9000*	RPM
Torque (Maximum):	*3.3*	Newton Metre (Nm) at	*6900*	RPM
Fuel Consumption:	*.875*	Litres/Hour/Kw.		
Running Time at Maximum Power:	*17.4mins.*			
Noise (Full Load Cutting):	*105.7*			dBA
Vibration (Average Front and Rear Handles:	*57.5*			Metres/Sec^2

DISCUSSION:

The R 417 was considered a very well balanced saw, being easy to control and handle and assisted by full wrap-around heavy rubber covered handle. Controls are well placed for easy use. Spark plug and air filter servicing access is easy although the latter is some bother to remove as it is screwed to the carburettor.

Cutter bar and chain maintenance is very good and the large, well designed, throat clears shavings positively. Starter cord changing was considered the most straightforward of the saws tested and could be done very quickly. Removal of the

flywheel housing cover could be simplified by using slotted studs, thus enabling their removal with other than a socket tool. Large refueling holes are on the cutter bar side of the saw and present no overflow problems. A tool is required for removal of the oil filler cap and this is not considered a good feature. The engine is fully exposed when the top and flywheel covers are removed and cleaning of the fins and internal area can be done very easily. The front mounted muffler expels downwards and was not considered a fuming hazard. Although not considered a fire hazard at the time of testing, Partner saws (including the R417) are not favoured in some localities in New Zealand due to the potential fire risk they create with their muffler location and exhaust direction. Overall, operators rated this saw highly, it being very functional and practical in design. It was particularly popular in silvicultural thinning to waste operations where its smooth lines made pushing through heavy undergrowth less difficult.

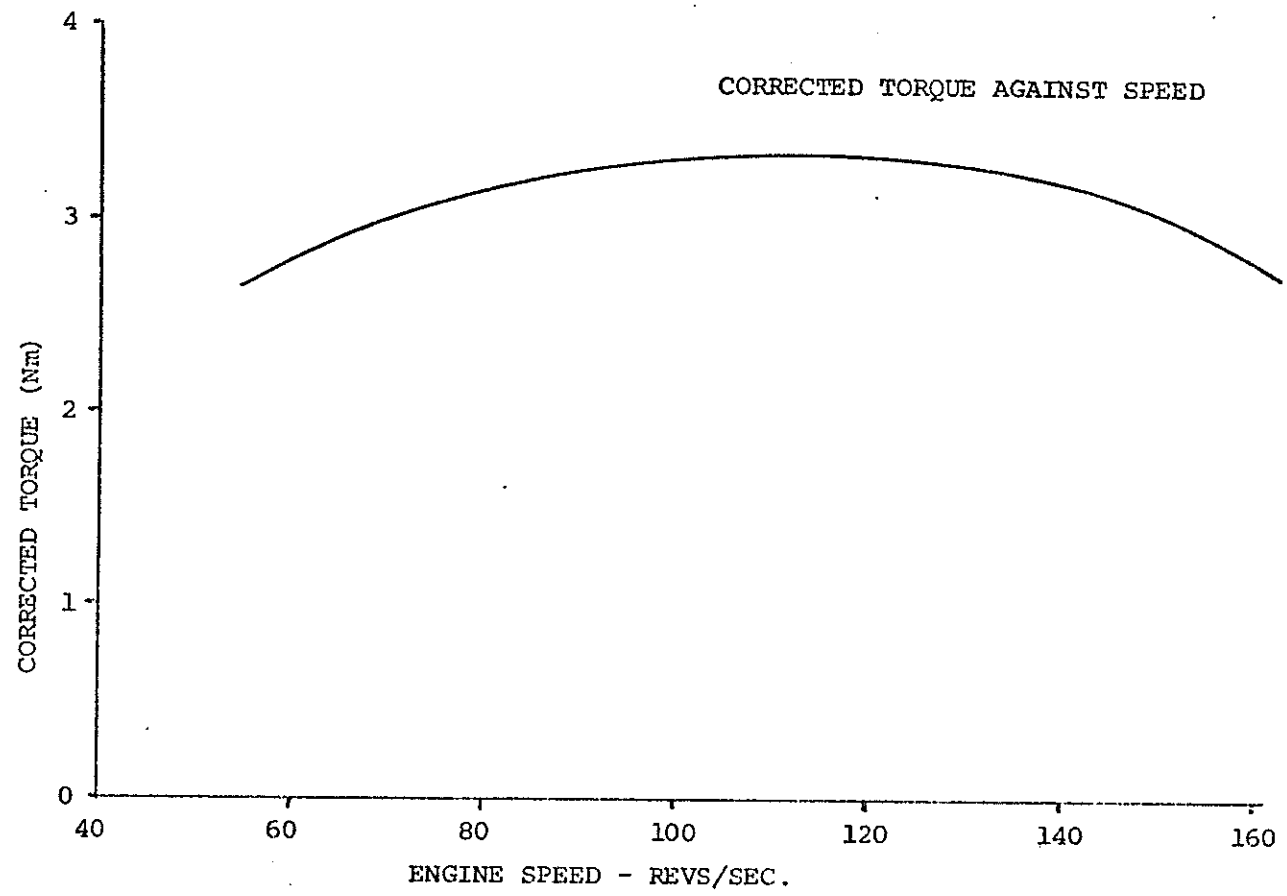
COMMENTS FROM NEW ZEALAND AGENTS:

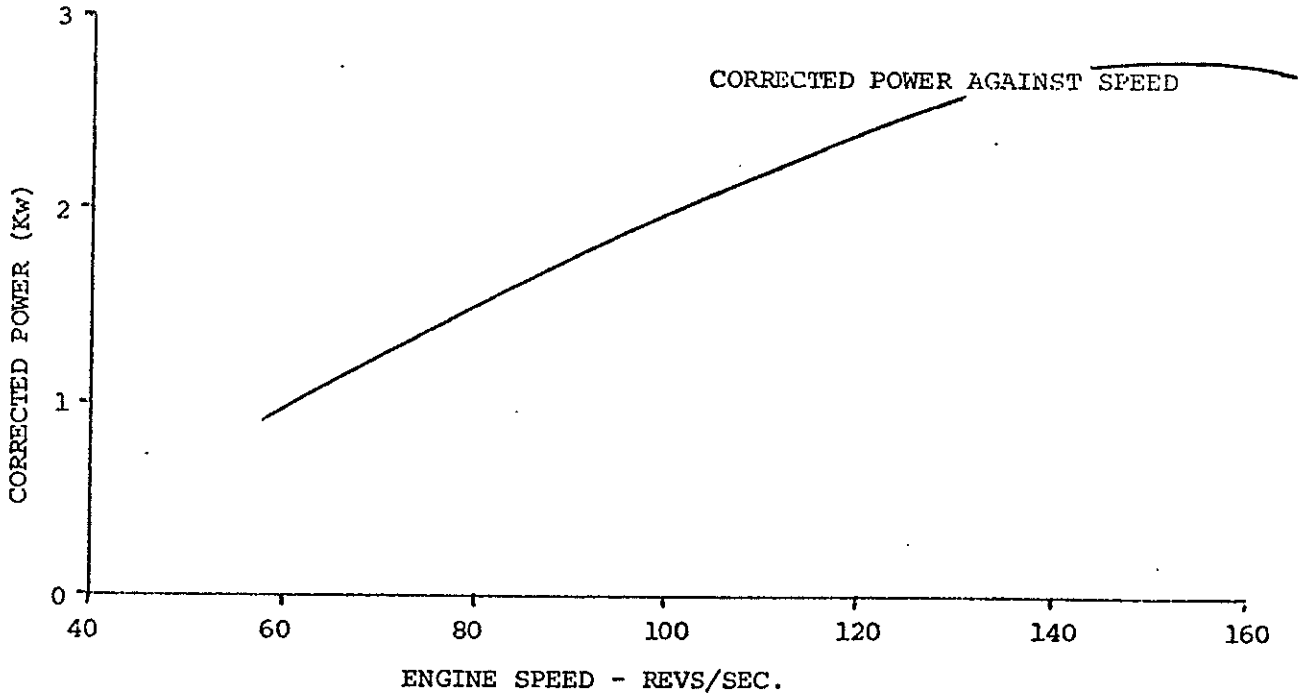
Marine Power & Service Limited, agents for Partner Saws reported that their principals had been involved in the forest fire hazard problem in New Zealand, and have made modifications to remedy that situation.

POWER AND TORQUE CURVES

SAW: PARTNER R417

ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Homelite* MODEL: *350 AO*

SPECIFICATION:

Engine Displacement: *57cc.*

Purchase Price: *$310.00* (early 1976)

Weight: Bare - *6.2* Kg. All Up - *8.1* Kg.

AntiVibration Mounts: *Yes*

Chain Oiler: *Automatic*

Muffler: *Baffled Expansion Box* Capacity: *94.5cc.*

Fuel Tank Capacity Measured: *0.7 litres* Published: *0.61 litres*

Chain Oil Capacity Measured: - Published: *0.31 litres*

Fuel Ratio: *32:1*

Chain Type: *Oregon* Pitch: $^{3}/_{8}$" Gauge: *.050"*

Bar Type: *Homelite Solid Nose* Clear Length: *38cm. (15")*

Sprocket: -

Stroke: *36mm.* Bore: *44mm.*

Compression Ratio: - Ignition: *Conventional Mag*

Spark Plug: Carburettor: *Tillotson*

Clutch - Centrifugal: *3 shoe*

PERFORMANCE:

Power (Maximum): *2.32* Kilowatts (Kw) at *8200* RPM

Torque (Maximum): *2.9* Newton Metre (Nm) at *6800* RPM

Fuel Consumption: *.564* Litres/Hour/Kw.

Running Time at Maximum Power: *32 mins.*

Noise (Full Load Cutting): *104.7* dBA

Vibration (Average Front and Rear Handles: *40.5* Metres/Sec^2

DISCUSSION:

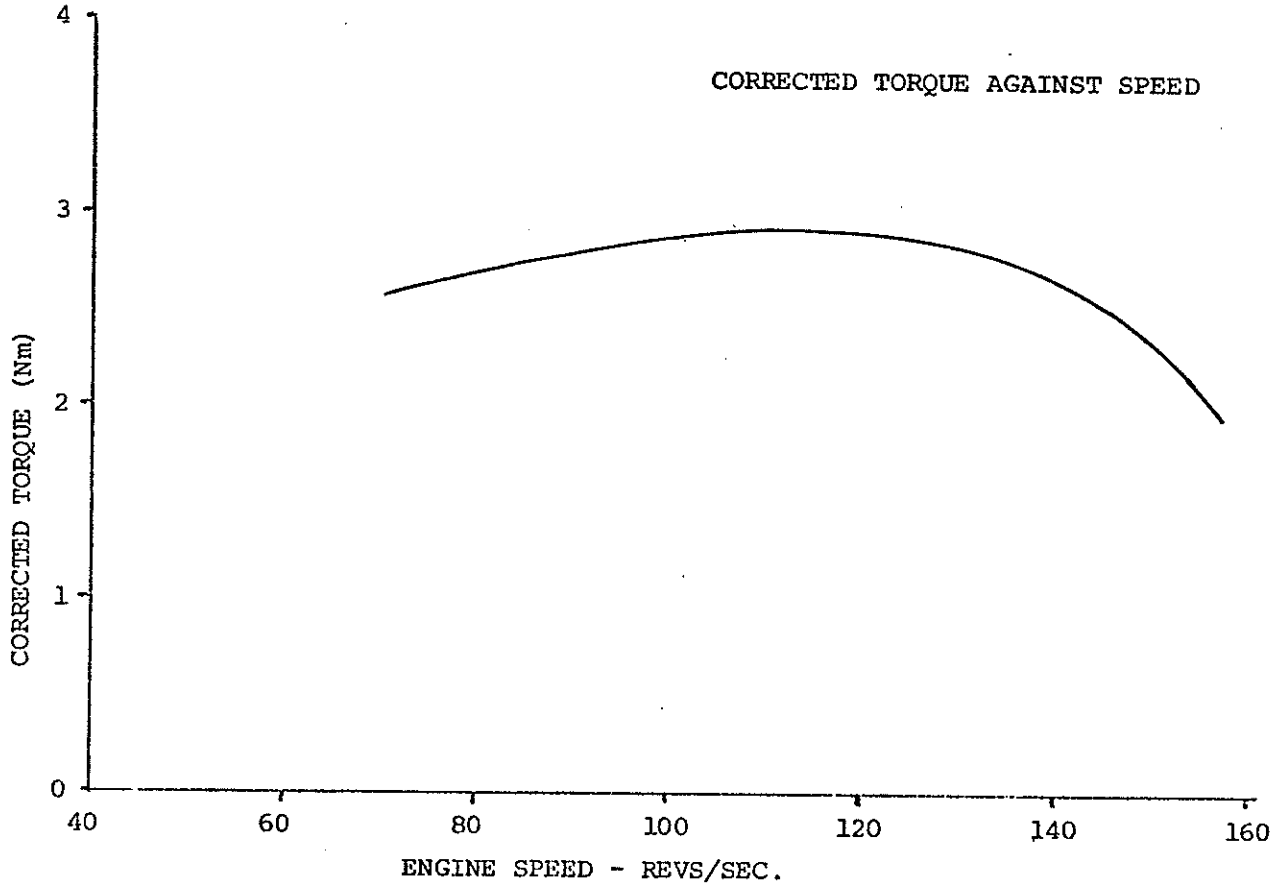
Appearance and design are sound having clean uncluttered lines. Most operators favoured the heavy rubber covered front bar handle. Controls are well located and include a large ignition switch. The muffler, recessed on the right rear side of the saw, exhausts downwards and is well protected from contact with the operator. Maintenance features on the saw rated highly, especially when compared with the other non-European saws tested. Access to the small but high quality air filter was easy although debris accumulated in the carburettor-well area. The Spark plug cover on the 350 eliminates the HT lead cable and although slightly more time consuming to remove, access is not difficult. Chain and bar maintenance are very

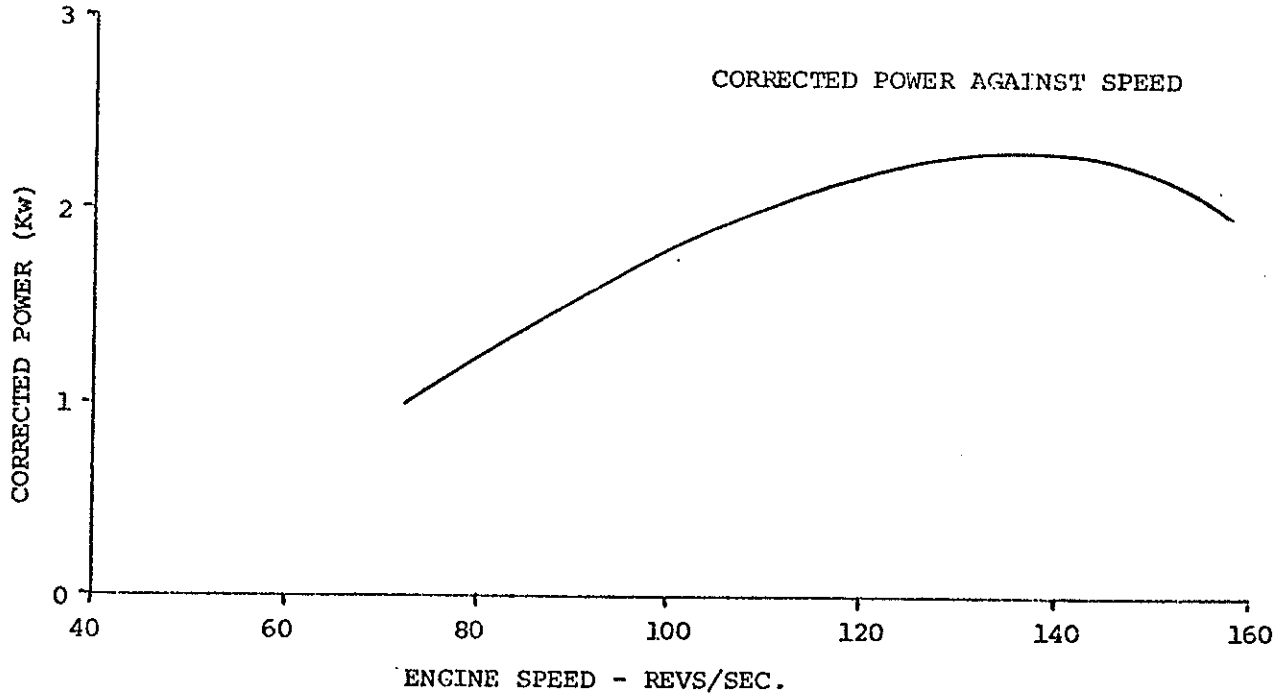
good and a large uncluttered throat allows positive shaving clearance. The chain adjusting screw is at right angles to the guide bar on the outer cover and lends itself to simple adjustments. Starter cord replacement was not considered a good feature. The rewinding spring could easily spring loose and difficulty was experienced mating the starter pawls attached to the flywheel with those on the starter mechanism shaft. The flywheel cover also required some juggling to refit.

Cleaning about the head and cooling fins was time consuming and laborious due to the restricted space. Within a short time in normal operating conditions the cooling fins and the area around the muffler became packed with needles and debris, creating a potential fire risk. A throttle lock safety device was fitted and the 350 is one of the first Homelite models to feature antivibration mounts and these proved very effective in the testing.

POWER AND TORQUE CURVES

SAW: HOMELITE 350
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Sachs Dolmar* MODEL: *KMS4*

SPECIFICATION:

Engine Displacement: *58cc.*

Purchase Price: *$390.00 (not purchased)* (early 1976)

Weight: Bare - *8.0* Kg. All Up - *10.2* .Kg.

AntiVibration Mounts: *No*

Chain Oiler: *Automatic*

Muffler: *Expansion Box* Capacity: *250cc.*

Fuel Tank Capacity Measured: *0.6 litres* Published: *0.6 litres*

Chain Oil Capacity Measured: Published: *.25 litres*

Fuel Ratio: *25:1 until run in, then 50:1*

Chain Type: *Oregon* Pitch: $^{3}/_{8}$" Gauge: *.058"*

Bar Type: *Sprocket Nose* Clear Length: *48cm (19")* Width: *3"*

Sprocket: *7 tooth*

Stroke: Bore:

Compression Ratio: Ignition: *Ducati Electronic Mag*

Spark Plug: *Boschwka 225T6* Carburettor: *Tillotson HS 173A*

Clutch - Centrifugal:

PERFORMANCE:

Power (Maximum): *3.05* Kilowatts (Kw) at *8600* RPM

Torque (Maximum): *3.5* Newton Metre (Nm) at *7700* RPM

Fuel Consumption: *.817* Litres/Hour/Kw.

Running Time at Maximum Power: *15mins.*

Noise (Full Load Cutting): *109.2* dBA

Vibration (Average Front and Rear Handles: *240.2* Metres/Sec^2

DISCUSSION:

This saw was the only rotary engine tested and was loaned by the distributors, Rotary Engines N.Z.Limited. Although a heavy saw when compared with others in the under 60cc. range, the power output achieved was comparable to saws in the 80cc. range with similar weights.

Handling and balance were considered good for controlled cutting due to the wide spread of the handles. Controls were not rated highly as the choke lever was flimsy and exposed to snagging in thick undergrowth, and the ignition switch was small and not well positioned for right and left handed operators or for easy use in an emergency.

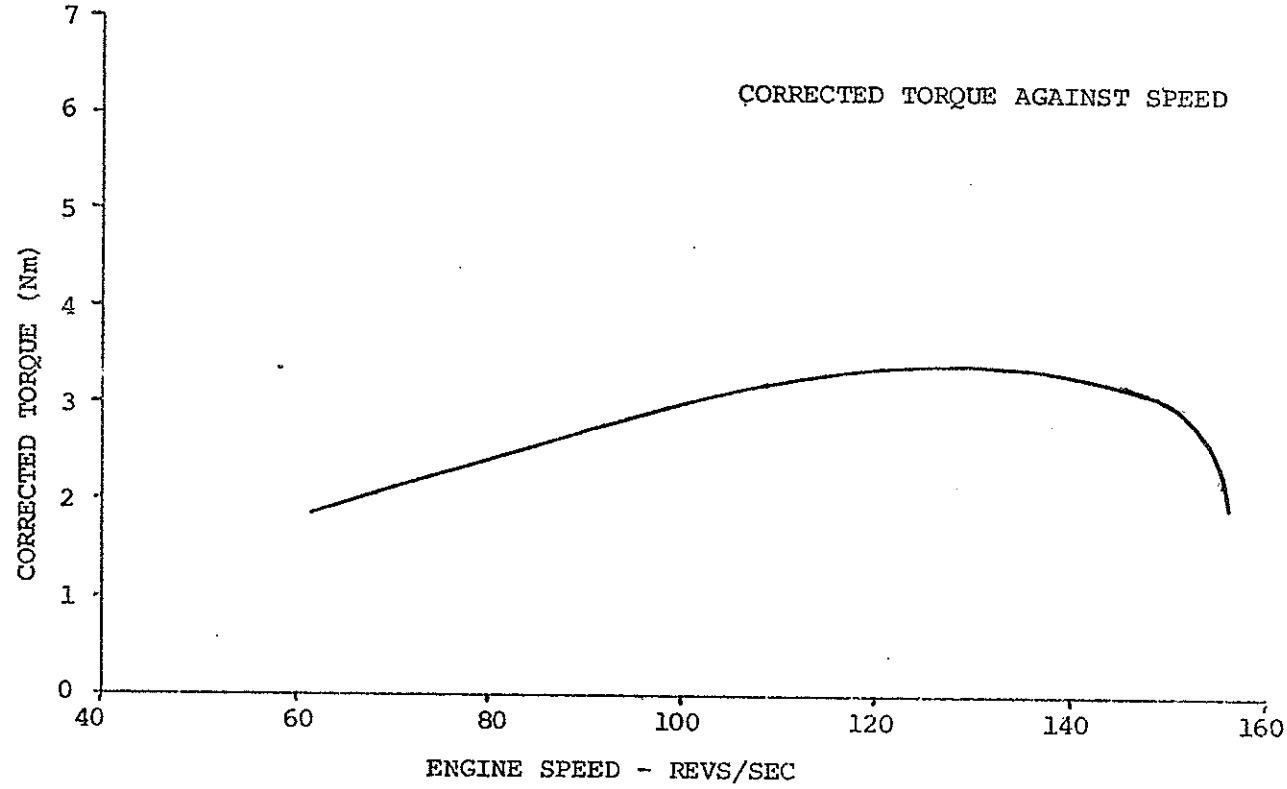
During refueling the saw is required to be placed on its side with the cutter bar uppermost and while supported by the front handle, must be propped to prevent tipping over. The oil filler hole is poorly located with excess or spilt oil flowing around the air filter cover and directly into the cooling fins, thus creating considerable fouling due to dust accumulation. Daily maintenance such as air filter, spark plug, chain and cutter bar, are easy to service requiring minimal effort.

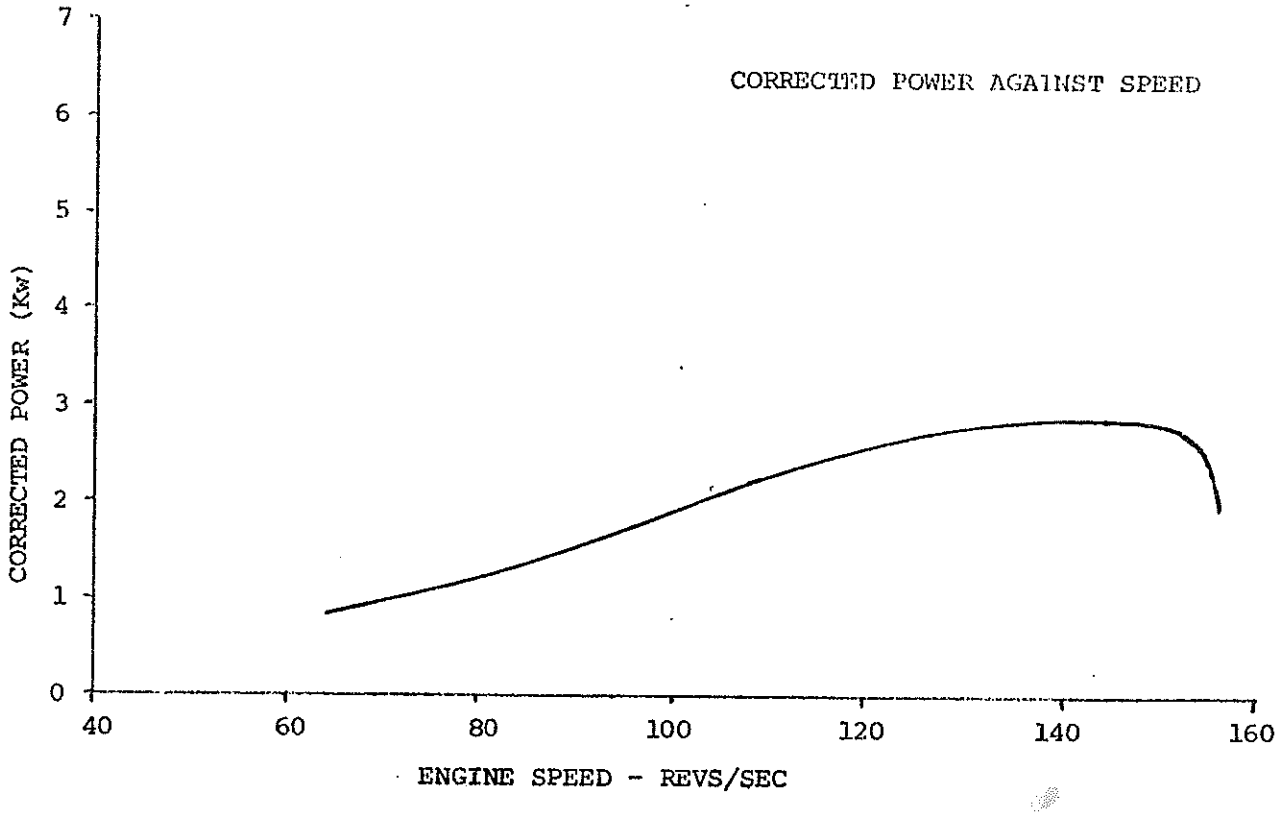
The high capacity fan and large area taken up by cooling fins would suggest that the aspect of cooling is critical in this saw. However, cross bars joining the fins are at right angles to the air flow direction and provide a trap for debris, which results in rapid accumulation and requires regular cleaning. The oil overflow compounds this problem. Starter cord maintenance was time consuming due to the type of circlip used, and was not suited to operators who do not usually carry comprehensive tool kits. During testing the arched handle snapped off at the lower mounting and this appeared to be a weak area in the design.

The saw is not fitted with antivibration mounts and the vibration level when tested indicate that KMS4 is no better than conventional saws without vibration mountings.

POWER AND TORQUE CURVES

SAW: SACHS DOLMAR KMS4
ATMOSPHERIC CORRECTION
FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *McCulloch* MODEL: *Super Pro 81*

SPECIFICATION:

Engine Displacement: *80cc.*
Purchase Price: *$393.00* (early 1976)
Weight: Bare - *7.70* Kg. All Up - *9.80* Kg.
AntiVibration Mounts: *Yes.*
Chain Oiler: *Automatic/Manual*
Muffler: *Reed type* Capacity: *90.5 c.c.*
Fuel Tank Capacity Measured: *0.78litres* Published: -
Chain Oil Capacity Measured: - Published: -
Fuel Ratio: *40:1*
Chain Type: *McCulloch* Pitch: 3/8" Gauge:
Bar Type: *McCulloch SlimLine Solid Nose* Clear Length: *48cm. (19")*
Sprocket: *7 tooth*
Stroke: *38mm.* Bore: *52mm.*
Compression Ratio: Ignition: *McCulloch HT Magneto*
Spark Plug: *Champion CJ8* Carburettor: *Tillotson.*
Clutch - Centrifugal: *2 shoe*

PERFORMANCE:

Power (Maximum): *2.95* Kilowatts (Kw) at *6900* RPM
Torque (Maximum): *4.25* Newton Metre (Nm) at *6300* RPM
Fuel Consumption: *0.815* Litres/Hour/Kw.
Running Time at Maximum Power: -
Noise (Full Load Cutting): *109* dBA
Vibration (Average Front and Rear Handles: *58.4* Metres/Sec^2

DISCUSSION:

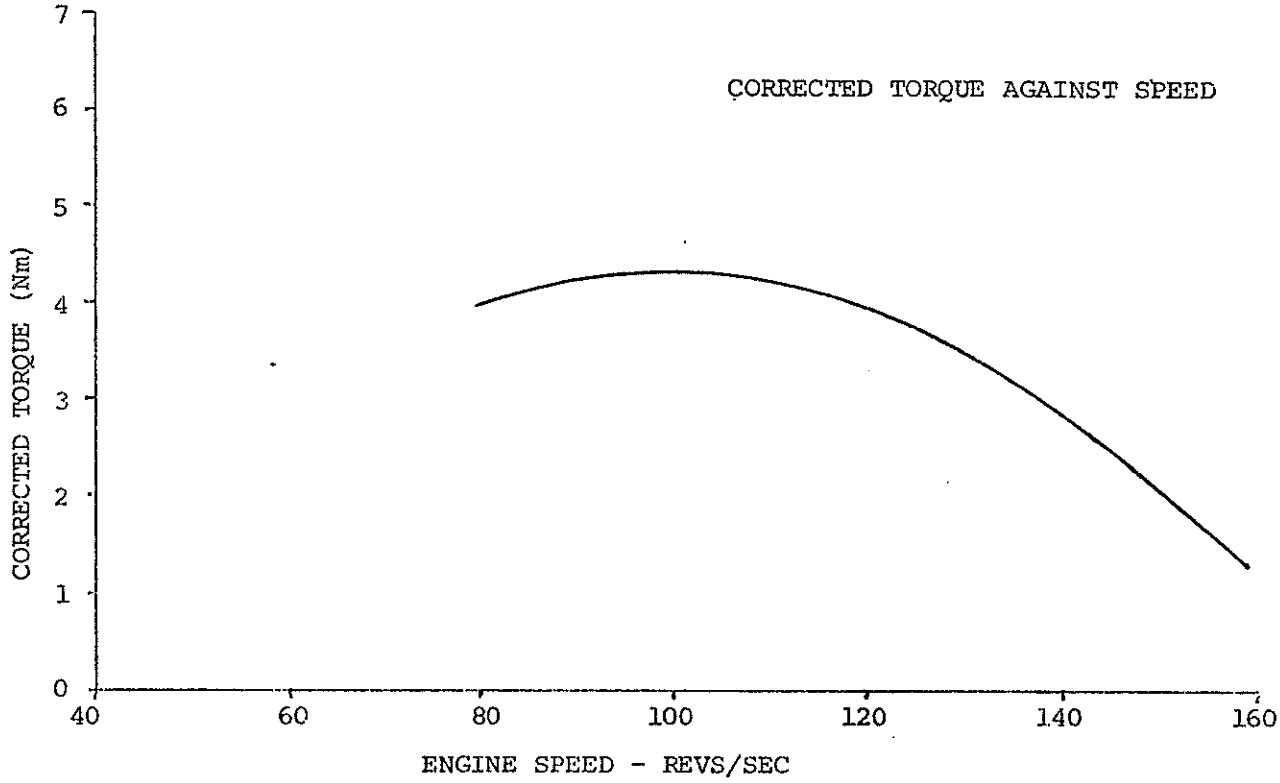
The SP 81 is one of McCullochs professional saws in the medium weight range. Routine maintenance access to the air filter and spark plug is excellent, however cutter bar and chain maintenance was considered a chore. The chainbrake mounting made access to the clutch cover nuts very difficult and only a quarter rotation of the combination spanner is possible. Fitting and removal of the chain was not easy due to the limited space around the clutch and sprockets. The restricted space between the clutch and the clutch cover meant too that the saw tended to clog up in this area when cutting "stringy" barked species or

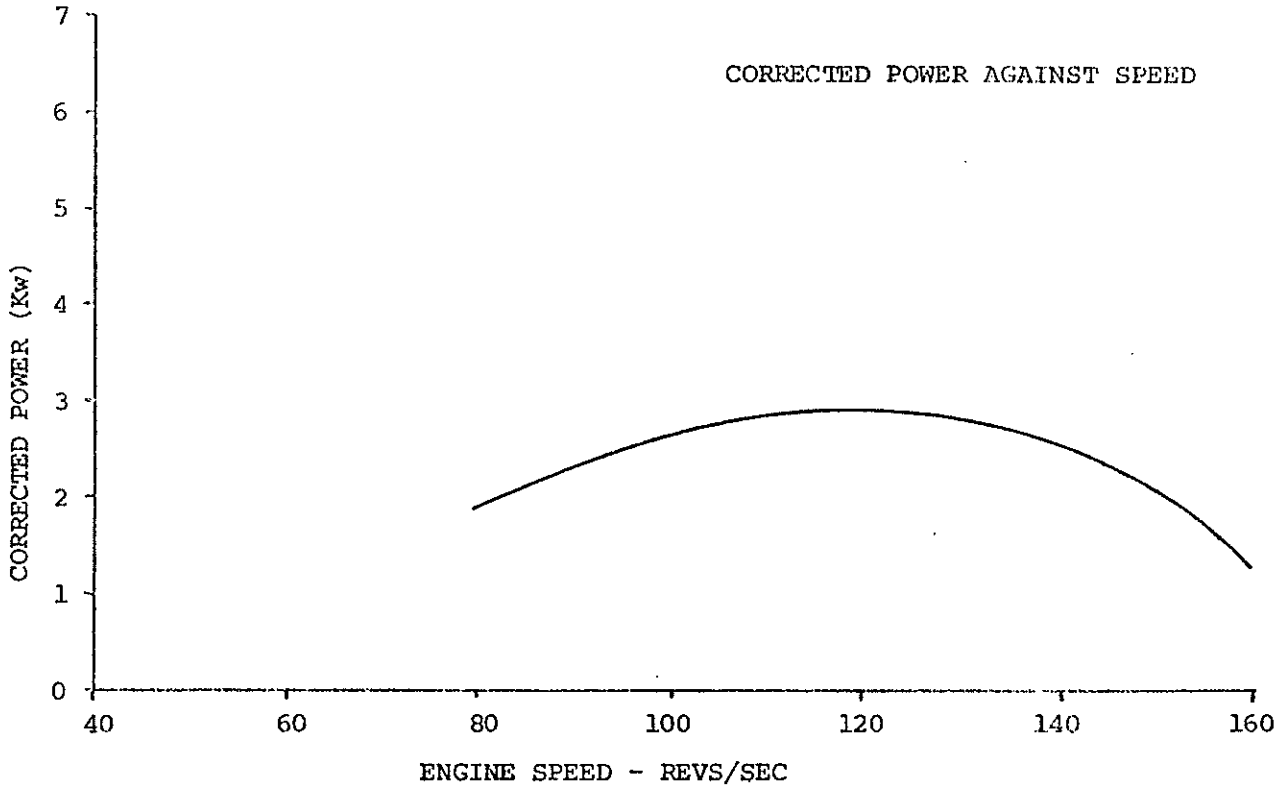
Cont.....2

when cutting with the grain. Removal of the flywheel cover requires the removal of seven screws. Changing starter cords is very simple once the mechanism is removed. It was considered that the slotting of studs to allow the use of a screwdriver would assist in this respect. The split design of this saw separates the fuel tank from the engine and accumulates debris in this area. Cleaning here and about the engine is not easy. External appearance is smooth although the muffler, which is not a very effective noise reducer, protrudes on the right hand side. The front handle is covered by a smooth plastic covering partway around the bar. Many of the test operators found it too thin for comfortable handling when compared with some other saws. Controls are well grouped for easy access and the manual oiler is considered a good feature. Fuel filler holes are large however fuel overspill flows directly into the flywheel. As mentioned in the safety section, the SP 81 was fitted with a decompression valve to ease starting. Users not familiar with this device found it to be inconvenient if the saw was being stopped and started continuously or if the engine fired without the saw starting. The chainbrake lever on the test saw was tight and difficult to operate, however it was very effective in operation. A stop is required to prevent the chainbrake lever being forced against the fingers of the operators forward hand.

POWER AND TORQUE CURVES

SAW: McCULLOCH SP 81
ATMOSPHERIC CORRECTION
FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Husqvarna* MODEL: *380S*

SPECIFICATION:

Engine Displacement: *77cc.*

Purchase Price: *$353.00* (early 1976)

Weight: Bare - *7.0* Kg. All Up - *9.78* Kg.

AntiVibration Mounts: *Yes*

Chain Oiler: *Automatic*

Muffler: *Front* Capacity: *404cc.*

Fuel Tank Capacity Measured: *0.88 litres* Published: *0.81 litres*

Chain Oil Capacity Measured: - Published: *0.5 litres*

Fuel Ratio: *25:1*

Chain Type: *Windsor* Pitch: $^{3}/_{8}$" Gauge: *.058"*

Bar Type: *Husqvarna* Clear Length: *50cm. (20")*

Sprocket: *8 tooth*

Stroke: *36mm.* Bore: *52mm.*

Compression Ratio: Ignition: *Bosch Type KCK*

Spark Plug: *Bosch 225T36* Carburettor: *Tillotson HS*

Clutch - Centrifugal: *3 shoe*

PERFORMANCE:

Power (Maximum): *2.35* Kilowatts (Kw) at *7200* RPM

Torque (Maximum): *3.9* Newton Metre (Nm) at *4500* RPM

Fuel Consumption: *0.816* Litres/Hour/Kw.

Running Time at Maximum Power: *27.5 mins.*

Noise (Full Load Cutting): *101.3* dBA

Vibration (Average Front and Rear Handles: *45* Metres/Sec^2

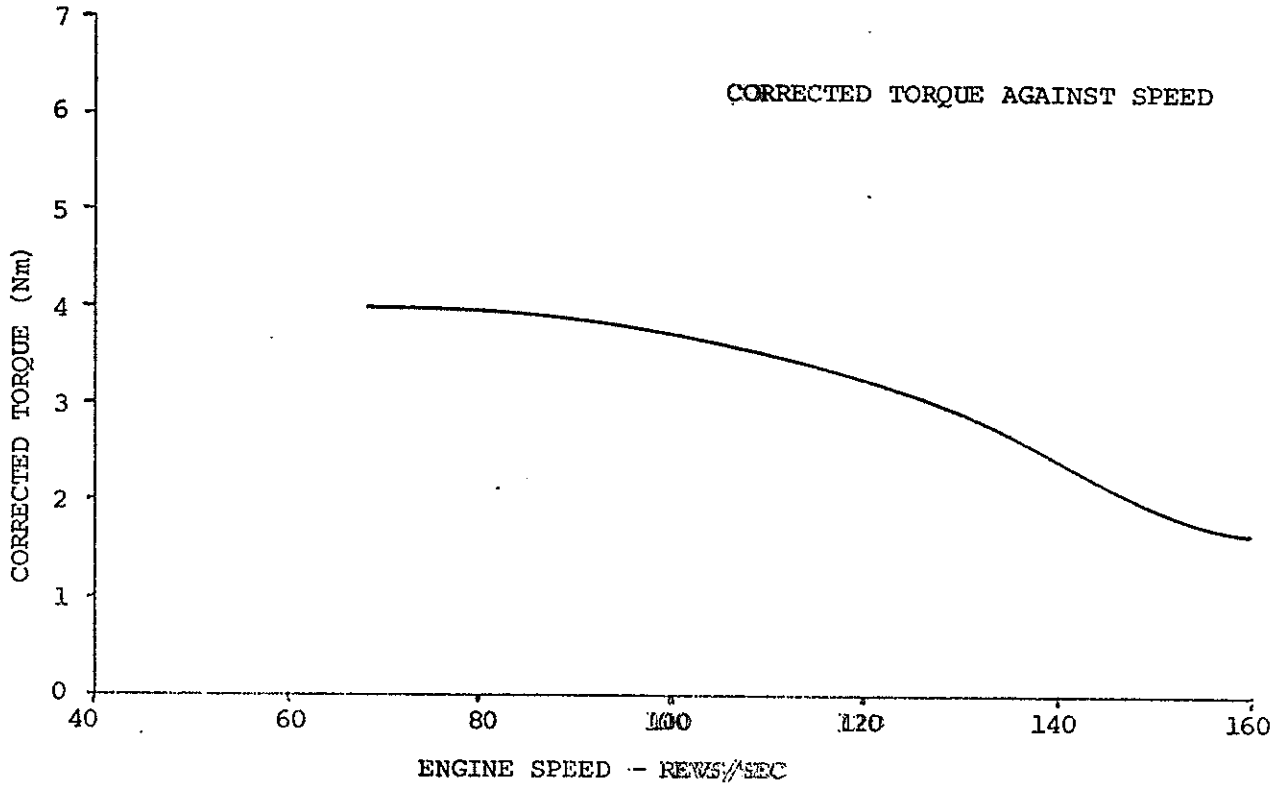
DISCUSSION:

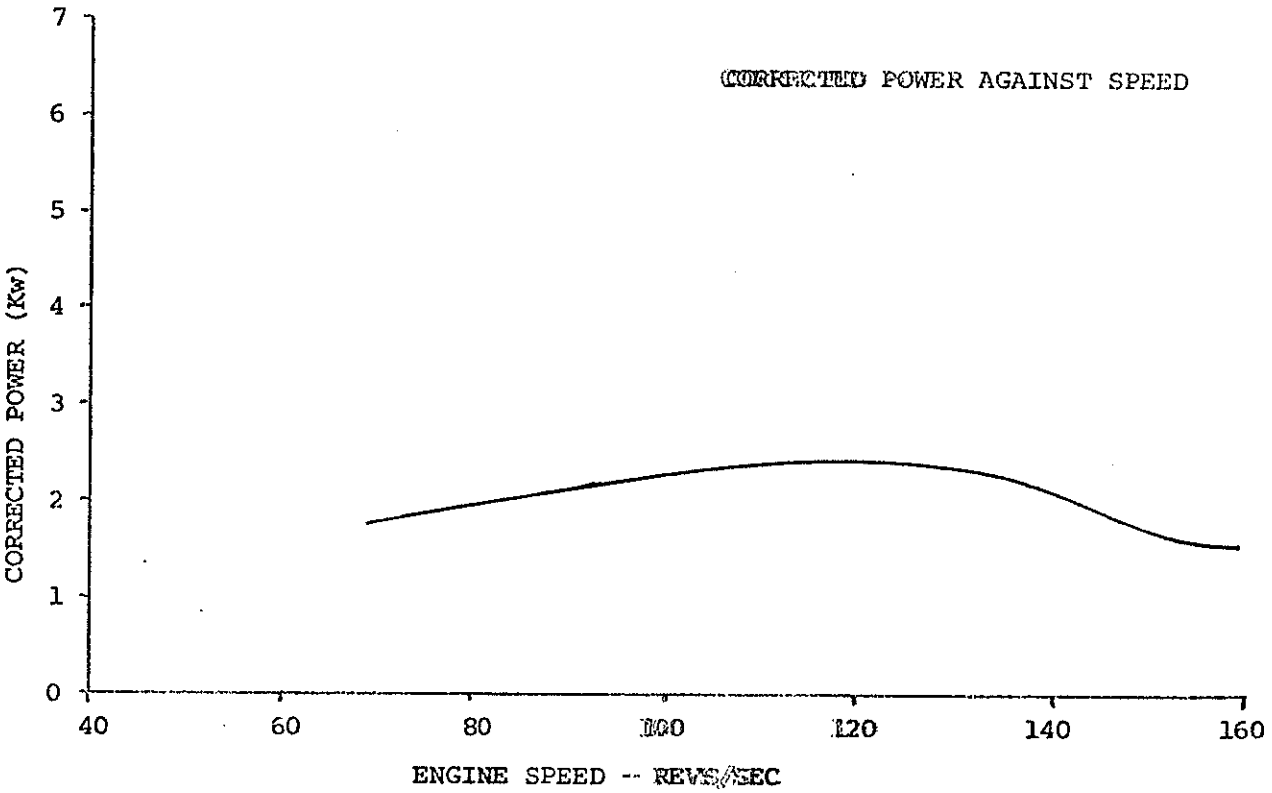
The dominant feature established from the testing of the 380S was the very low noise and vibration levels recorded when compared with other saws. Operators not familiar with the softness of the antivibration mounts commented that it gave a feeling of insecure control over the saw, however, a longer familiarisati period for each operator may have proved that this is not a real problem for concern. Balance and handling is good with the curved front handle ideal for a natural stance. The saw is smooth in design on the bottom and right hand side and the controls are well located. The ignition switch would be more natural if operated vertically rather than horizontally. The trigger safety lock failed on

the test saw and constantly jammed inside the pistol grip handle. Refuelling was a very good feature with large filler holes and no overspill problems. Although the unsecured caps appear similar and could possibly be confused, the oil cap is vented which aids identification. Maintenance features overall were rated very good. With the removal of the top cover, the spark plug, airfilter, carburettor and cylinder head are exposed for servicing, and cleaning access about the engine is no problem. Chain and cutter bar maintenance, and starter cord replacement are also straightforward and quick to service. Safety devices on the model tested were the safety throttle lock and the rear handle chain guard.

POWER AND TORQUE CURVES

SAW: HUSQVARNA 380S
ATMOSPHERIC CORRECTION FACTORS APPLIED





EVALUATION AND SPECIFICATION SUMMARY

SAW: *Stihl* MODEL: *045 AV(E)*

SPECIFICATION:

Engine Displacement: *81cc.*
Purchase Price: *$328.00* (early 1976)
Weight: Bare - *7.9* Kg. All Up - *10.6* Kg.
AntiVibration Mounts: *Yes*
Chain Oiler: *Automatic*
Muffler: *Expansion Box* Capacity: *53lcc.*
Fuel Tank Capacity Measured: *0.88 litres* Published: *.821 litres*
Chain Oil Capacity Measured: - Published: *.35 litres*
Fuel Ratio: *40:1*
Chain Type: *Stihl Oilomatic* Pitch: $^3/_8$" Gauge: *063"*
Bar Type: *Stihl Solid Nose* Clear Length: *50cm. (20")*
Sprocket: *7 tooth*
Stroke: *38mm.* Bore: *52mm.*
Compression Ratio: Ignition: *Electronic Thryistor*
Spark Plug: *Bosch WKA 175T6* Carburettor: *Tillotson H6*
Clutch - Centrifugal:

PERFORMANCE:

Power (Maximum): *3.1* Kilowatts (Kw) at *8100* RPM
Torque (Maximum): *3.8* Newton Metre (Nm) at *7400* RPM
Fuel Consumption: *2.68* Litres/Hour/Kw.
Running Time at Maximum Power: *20mins.*
Noise (Full Load Cutting): *104.2* dBA
Vibration (Average Front and Rear Handles: *89.4* Metres/Sec^2

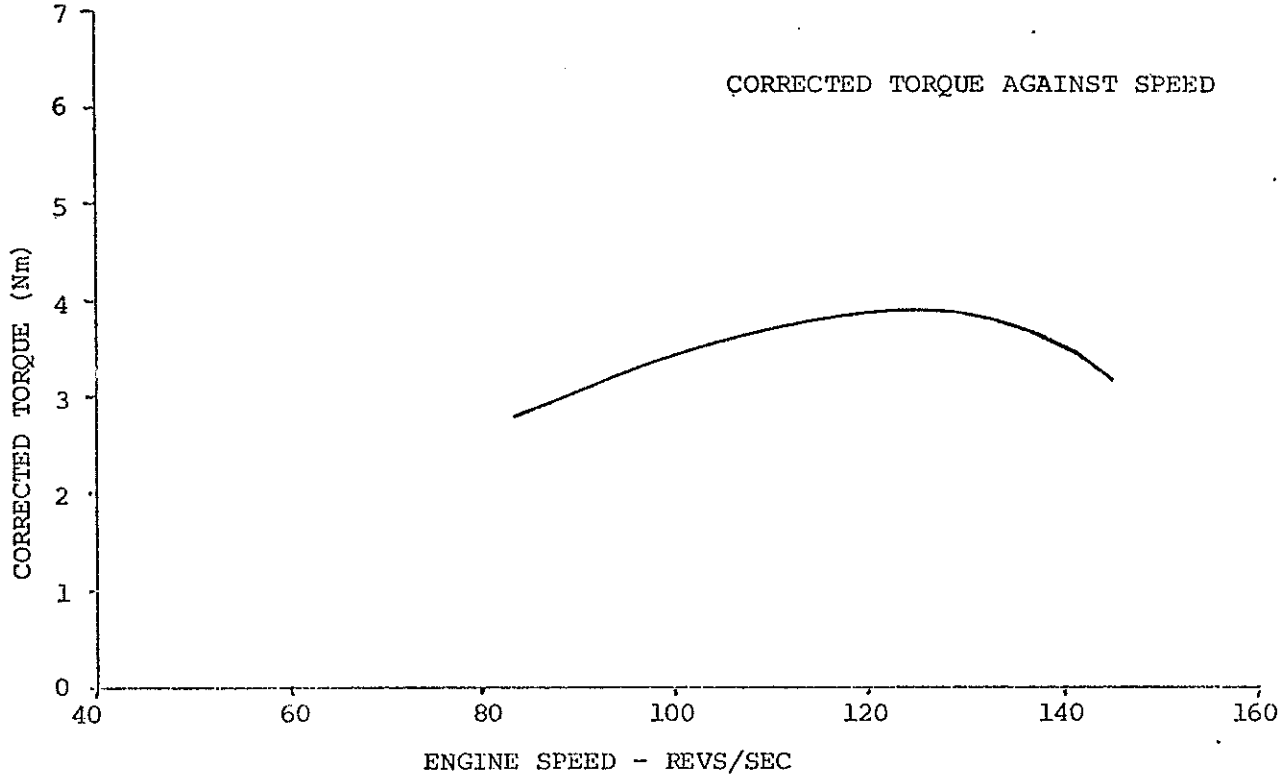
DISCUSSION:

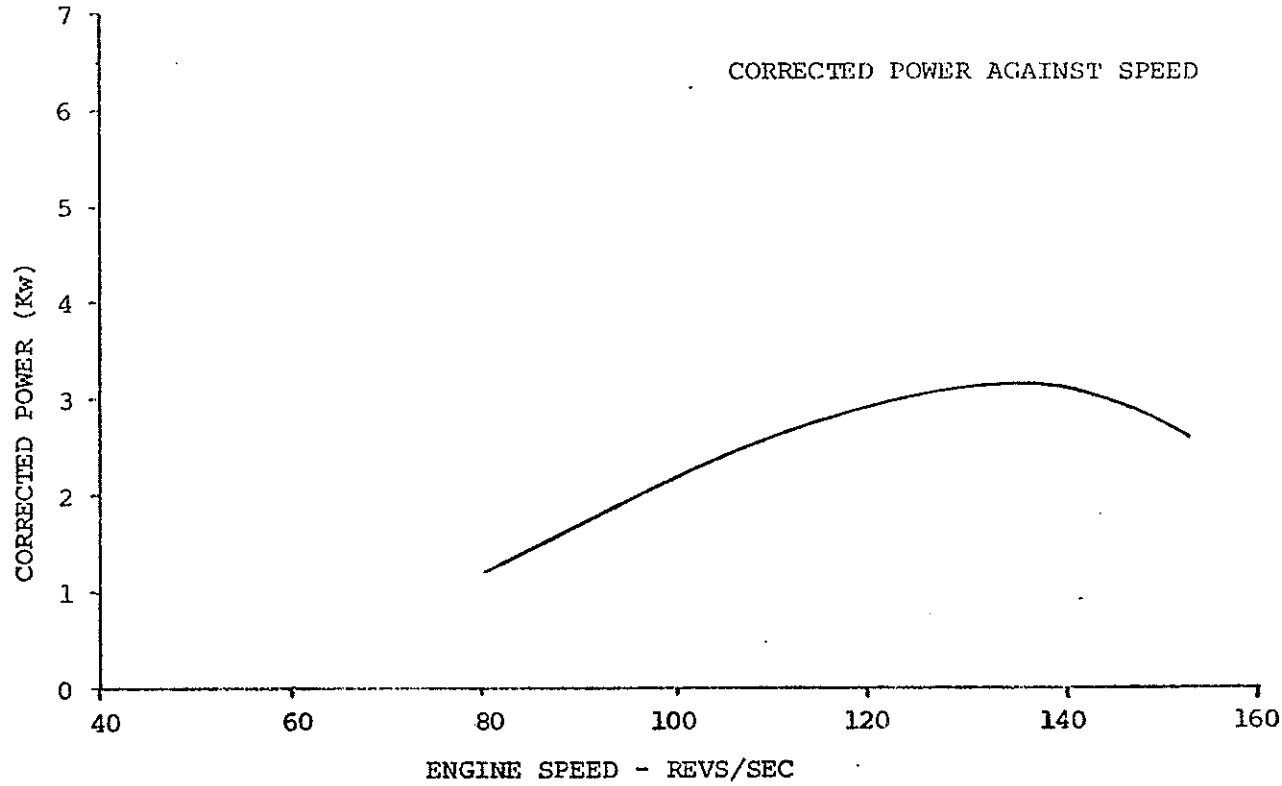
The handling characteristics of the 045 were considered very good although the saw is bulky in design when compared with other makes. The location of controls are satisfactory with the exception of the choke which can only be operated if the hand is rolled off the trigger lock. Some operators considered the throttle safety lock too high on the handle, with the tendency to depress it with the thumb rather than the palm of the hand. Air filter, spark plug, bar, and chain maintenance were not problem to service, however, starter cord replacement was time consuming as Stihl have retained on this model, a type of starter mechanism which is subject to wear and is now superceded by more positive and simpler systems on other makes of saw. Access to the cylinder head cooling fins is

difficult on the flywheel side of the saw due to the top cover being part of the vibration isolating body, however the cooling area is large and not subject to fouling. Refueling was very good as antispill rims around the filler holes prevented spillage into parts of the saw. The 045 was the only saw tested that had this precaution. A plastic kickback hand guard mounted in front of the forward handle would offer a limited degree of protection.

POWER AND TORQUE CURVES

SAW: STIHL 045 AV(E)
ATMOSPHERIC CORRECTION
FACTORS APPLIED





PRICES AND CHANGES TO SPECIFICATIONS AT DATE OF PUBLICATION

SAW	SPECIFICATION CHANGES	CURRENT PRICE $
Echo 302	No change.	344
McCulloch MM30	No change.	169
Husky 35VR	No longer manufactured.	-
Husqvarna 140S	New Model - 240S	339
Echo CS451VL	New Model - CS452VL, different starter mechanism and changes to fuel and oil tank placement.	289
Dolmar 118	No change.	292
Stihl 031AV	No change.	344
Jonsered 52E	No change	410
McCulloch Pro 10-10	Safety throttle lock now fitted	279
Partner R417	New Model R517	370
Homelite 350AO	No change.	377
Sachs Dolmar McCulloch SP81	Throttle Safety lock fitted, Increased and heavier rubber covering on front handle.	395
Husqvarna 380S	No change.	446
Stihl 045 AV(E)	No change	430

COMMENTS BY NEW ZEALAND AGENTS:

All the New Zealand agents of the various makes of saws evaluated were given opportunity to reply to comments made in this report. Any comments received have been included on the relevant individual Evaluation and Specification summary sheets in Appendix I.