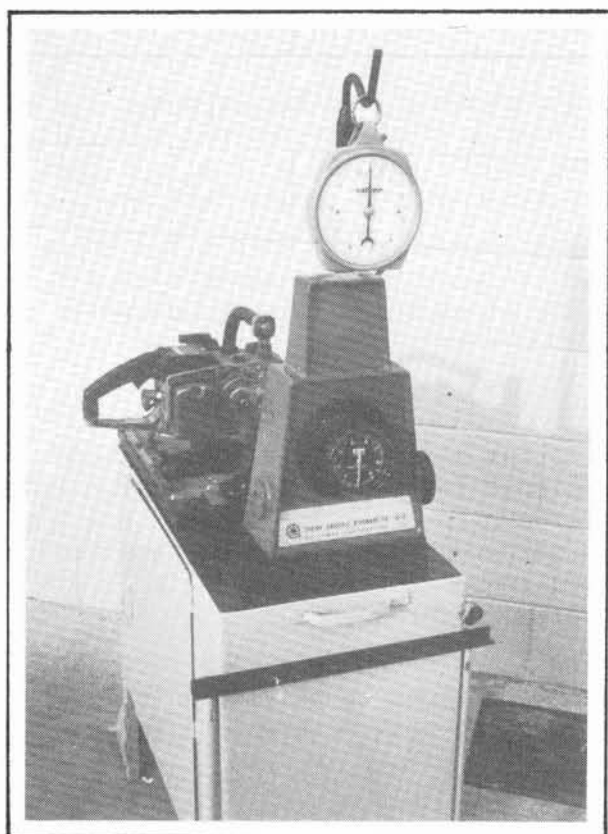


# CHAINSAW TESTING AND SELECTION

**A Report by R.J.Evans, Engineering Division, N.Z. Forest Service**



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Since 1972 the Engineering Division of the N.Z. Forest Service has had facilities for testing chainsaw performance. The tests determine power, noise, vibration, and fuel consumption; physical details are also recorded.

This Technical Release shows tables of values recorded for saws tested in 1979. It also describes test procedures and discusses aspects of chainsaw selection.

## TESTING PROCEDURE

### RUNNING IN

Before testing, each new chainsaw is run in with bar and chain fitted. The saw throttle is adjusted so that the saw runs at 3000 to 3500 RPM, which is above the clutch engagement speed. The saw is allowed to run for one tank full of fuel.

### OUTPUT POWER

This test is performed on a hydraulic dynamometer (a modified GO - Power Model DY-6D). The engine loading is controlled by varying the flow of water through a small impeller

wheel; increasing the water flow increases the applied load. Measured torque is determined by a spring balance acting on the impeller casing at a known radius.

The chainsaw is secured by means of its guide bar fixing screws, and a special adaptor connects the clutch centre with the dynamometer impeller shaft. The chainsaw mounting is resiliently isolated from the dynamometer.

With the chainsaw engine held at full throttle the load is adjusted until the maximum smooth running speed is achieved. From maximum speed the load is increased to reduce speed in increments of 500 RPM down to the minimum smooth running speed. At each speed, the torque is recorded. This procedure is performed twice to obtain an average set of readings.

From the readings and calculations, graphs of torque and power against speed are plotted, from which peak torque and peak power are derived. Peak power figures corrected for temperature and pressure are shown in the tables on Pages 4, 5, & 6. In theory, the peak cutting rate should be achieved at this peak power speed.

Maximum torque generally occurs in the 5500 to 6500 RPM region. At this point the chain should have maximum cutting pull.

### FUEL CONSUMPTION

This test is carried out on the dynamometer. Four tests are run with the applied load set to produce peak power running speed. From the fuel measurements, fuel consumption is calculated in terms of litres/hour and litres/kW hour. The values refer to continuous peak power running.

### NOISE LEVEL

Chainsaw noise level is measured with a microphone extension attached to the right ear protector of a person operating the chainsaw. The microphone is connected to a meter measuring noise level in dBA. The dBA scale indicates noise level in proportion to human ear sensitivity to noise at high, low, and medium frequencies.

Noise levels are recorded with the affect of any noise reflecting objects, background noises, and wind, minimised. Noise level and engine speed are measured with the chainsaw idling and at wide open throttle (W.O.T.). The chainsaw is held free at thigh height for these two tests.

While the operator saws at wide open throttle through a pine log of about 30 cm diameter, an average noise level is assessed from a generally roving scale pointer as the chainsaw goes through the widest portion of the log. The operator, as far as possible, keeps the saw cutting at peak power running.

An average of three readings are taken for each type of test. Before the tests the noise level meter is checked and adjusted if necessary, to agree with a standard noise level calibrator placed over the microphone. This procedure is repeated after completing the tests.

### VIBRATION

The test procedure for vibration is similar to the noise test, using the same instrument, tachometer, operations and conditions. Instead of the extension microphone, miniature accelerometers are placed between the operator's hands and the chainsaw handles. Vibration is measured in 3 perpendicular planes on each handle. The accelerometers, via the sound level meter, sense vibration in decibels, in the same way that a microphone senses air vibration for sound.

In addition to the meter reading the vibration is recorded on a tape recorder. The recordings are analysed at the DSIR Acoustics Department to provide a table of decibel vibration values for each of the 3 planes on both handles and for each chainsaw.

## **CHAINSaw SELECTION**

The first factors that are considered when selecting chainsaws for a Government contract are operator safety, namely noise and vibration. After this, other factors must be considered - overall performance in comparison to cost, ease of servicing, availability of spare parts and after sales service provided by the agent. Operator opinion cannot be ignored, although this is not always available - especially where new models are concerned.

### NOISE

The New Zealand standard limit of noise exposure, set by the Health Department, is basically equivalent to a continuous noise level of 85 dBA for an 8 hour day. Chainsaws operating in various types of forestry operation, are continually varying between idle, wide open throttle, and off. The actual acceptable level of chainsaw noise at W.O.T. can therefore be higher than the standard continuous level of 85 dBA.

In 1970 the NZFS established acceptable W.O.T. chainsaw noise levels which would allow a chainsaw to be operated within normal working hours and still be within the New Zealand standard acceptable noise exposure limit. Since the chainsaw noise pattern is different for different types of operation, acceptable noise levels for the main types of operation were established. The limits, which apply to the present New Zealand standard, are:

Thinning	102 dBA	Class I saws
Clearfelling	105 dBA	Class II & III saws

It will be seen from the tables that all chainsaws tested produced noise levels in excess of those given above. It therefore follows that ear protectors (ear muffs or ear plugs) must be worn by operators employed full time on chainsaw operations.

## VIBRATION

The actual method of measuring and analysing chainsaw handle vibration has been updated to comply with the recently introduced International Standards Organisation (I.S.O.) draft standard ISO/DIS5349. The acceptable limits of vibration shown in this draft are only recommendations. The actual safe limits have not been established at the present stage.

Based on the recommended acceptable vibration limits at the various frequencies, the overall acceptable vibration limit has been calculated. The vibration values given in the tables show the ratios of measured vibration levels to this calculated limit. It should be noted that the values should only be regarded as comparative and measured in conditions which, as far as possible, simulate New Zealand forest operating conditions.

## **AVAILABILITY OF TESTING FACILITIES**

The New Zealand Forest Service chainsaw tests are primarily used to select chainsaws for the 2 yearly Government contract. They may be performed at a fee for private firms and others. Requests should be sent to: Engineering Division, N.Z. Forest Service, Private Bag, Wellington, from whom full details of the testing procedure are available.

Current fees are:

- a) Standard test comprising noise, vibration, power and fuel consumption:  
\$140 for each chainsaw tested.
- b) Single tests of noise, vibration, or power and fuel consumption:  
\$50 for each test.
- c) Requests for special tests or experimentation will also be considered.

## **TABLE GUIDE**

*BAR CLEAR LENGTH - the dimensions between bar tip and bucking spikes or chainsaw body.*

*PEAK POWER AT REVS PER MIN - maximum power on the power/speed curve and speed at which it occurs.*

*CHAIN PITCH AND SPROCKET - details used to calculate chain speed at peak power to indicate peak cutting rate.*

*TANK RUN TIME - continuous running at peak power speed.*

*W.O.T. - wide open throttle, i.e. trigger fully depressed.*

*R.H.S. - right hand side*

*EXHAUST DIRECTION - 'horizontal degrees' clockwise from guide bar looking down on the saw.  
'vertical degrees' from the guide bar looking at the side of the saw.*

			Echo 452VL	Pioneer P28	Stihl 031AV	Stihl 028AV	Husqvarna 340SE	Echo CS500	Husqvarna 444SE
Cylinder Displacement	cc		44.3	51	43	43	40	49.9	44
Weight, All up, Fueled	kg		8.18	7.71	8.0	7.62	6.8	7.4	6.7
Bare, No bar	kg		6.25	6.26	5.72	5.8	4.9	5.72	5.23
Bar, clear length	cms		40	41	40	-	36	40	-
Peak Power	kw		1.65	1.44	2.45	1.8	2.1	2.1	2.0
At Revs per minute			7000	7500	8000	8000	9500	8750	8250
Watts/kg, all up			200	187	306	236	309	284	299
Watts/cc displacement			37.2	28.2	51	41.9	52.5	42	45.5
Chain Pitch	ins		.375	.325	.375	.325	-	.375	-
Sprocket, No. of Teeth			-	8	7	7	7	7	-
Chain Speed at Peak Power	m/min		-	991	1067	925	-	1167	-
Fuel Tank Capacity	Litres		.515	.45	.59	.52	.5	.56	.51
Fuel Consumption at Peak Power	L/hr		1.53	1.5	1.95	1.76	1.55	1.77	1.61
	L/kwhr		.93	1.04	.8	.98	.74	.84	.81
Tank Run Time	minutes		20	18	18.2	17.7	19.3	18.8	19
Fuel Oil Ratio			20:1	24:1	25:1	25:1	25:1	20:1	25:1
Chain Oiler Type			Auto/Manual	Auto	Auto	Auto	Auto	Auto	Auto
Noise Level dBA	At idle		90	86.3	80.7	77.3	81.7	86.7	86
	At W.O.T. cutting		105.7	106.3	106.8	108.33	108.7	110.5	111
Vibration Level	Front handle		.99	1.08	.69	.74	.85	.65	1.46
At W.O.T. Cutting	Rear handle		1.31	1.04	1.33	.64	.94	2.01	.62
	avg		1.15	1.06	1.01	.69	.90	1.33	1.04
Ignition Type			Magneto	-	Electronic	Electronic	Electronic	Magneto	Electronic
Exhaust Muffler	Volume cc		137	134	229	240	248	199	248
	Position		RHS Low	RHS Low	Front Top	Front Top	Front Top	RHS Bottom	Front Top
Exhaust Direction	Horizontal		90°	0°	0°	0°	45°	90°	45°
(Bar at 0°)	Vertical		0°	45° down	45° down	45° down	0°	0°	0°
Handle Grips	Front		Rubber	Rubber	Rubber	Rubber	Plastic	Rubber	-
	Rear		Rubber	Plastic	Plastic	Plastic	Plastic	Rubber	-

TABLE 1. CHAINSAW TEST RESULTS: LIGHT DUTY, CLASS 1: 40-50 cc 5-6 kg Bare. 41 cm Bar

		Stihl 045AV	Partner P70	McCulloch PM700	Husqvarna 480CD	Pioneer P51
Cylinder Displacement	cc	81	70	-	77	82
Weight, All up, Fueled	kg	10.52	8.7	9.5	10.1	10.8
Bare, No bar	kg	8.07	6.6	7.3	7.3	8.3
Bar, Clear Length	cms	50	51.5	51	51	51
Peak Power	kw	3.9	2.8	2.86	3.1	4.2
At Revs per min		8250	7750	7500	7500	8500
Watts/kg All up		371	322	301	307	389
Watts/cc displacement		48	40	-	40.3	51.2
Chain Pitch	ins	.375	.375	.325	.375	.375
Sprocket, No. of Teeth		7	7	7	7	7
Chain Speed at Peak Power	m/min	1100	1034	867	1000	1134
Fuel Tank Capacity	Litres	.83	.75	.66	.85	.9
Fuel Consumption at Peak Power	L/hr	2.72	2.16	1.92	2.58	2.4
	L/kwhr	.7	.77	.67	.83	.57
Tank Run Time	minutes	18	20.8	20.5	19.7	22.5
Fuel Oil Ratio		25:1	25:1	40:1	25:1	16:1
Chain Oiler Type		Auto	Auto	Auto/Manual	Auto	Auto
Noise Level dBA	At idle	83.5	83.3	88.8	77.3	93
	At W.O.T. cutting	105.5	111.7	113	113.3	113.3
Vibration Level	Front handle	1.54	.47	1.14	2.31	.49
At W.O.T. Cutting	Rear handle	1.00	1.77	2.06	.83	1.63
	Avg	1.27	1.12	1.6	1.57	1.06
Ignition Type		Magneto	Electronic	Electronic	Electronic	Electronic
Exhaust Muffler	Volume cc	420	448	42.6	296	373
	Position	Front Bottom	Front Top	RHS Bottom	Front Top	RHS Low
Exhaust Direction	Horizontal	0°	0°	-	45°	0°
(Bar at 0°)	Vertical	60°	45°	90°	20°	15°
Handle Grips	Front	Rubber	Plastic	Rubber	Plastic	Rubber
	Rear	Plastic	Plastic	Plastic	Plastic	Plastic

TABLE 2. CHAINSAW TEST RESULTS: LIGHT-MEDIUM, CLASS 2: 70-80 cc 6.5-8 kg Bare. 51 cm Bar

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		Partner P100	Stihl 051AV	Pioneer P60	Husqvarna 2100CD
Cylinder Displacement	cc	100	89	98	99
Weight, All up, Fueled	kg	12.3	13.1	11.3	10.6
Bare, No bar	kg	8.9	8.9	8.3	8.6
Bar, Clear Length	cms	61	63	61	61
Peak Power	kw	4.2	4.3	4.25	4.6
At Revs per min		9000	7500	7750	7500
Watts/kg All up		341	328	376	434
Watts/cc displacement		42	48.3	43.4	46.5
Chain Pitch	ins	.404	.404	.404	.404
Sprocket, No. of Teeth		7	7	7	7
Chain Speed at Peak Power	m/min	1293	1077	1113	1077
Fuel Tank Capacity	Litres	1.05	.95	.95	1.0
Fuel Consumption at Peak Power	L/hr	3.51	3.14	2.9	3.1
	L/kwhr	.84	.74	.68	.69
Tank Run Time	minutes	18	18	19.7	19
Fuel Oil Ratio		25:1	25:1	24:1	25:1
Chain Oiler Type		Auto/Manual	Auto	Auto/Manual	Auto/Manual
Noise Level dBA	At idle	82.1	85.7	91.7	84.5
	At W.O.T. cutting	110.1	112	112.3	116.8
Vibration Level	Front handle	1.93	1.30	1.41	1.64
At W.O.T. Cutting	Rear handle	1.76	2.86	1.36	.68
	Avg	1.84	2.08	1.39	1.16
Ignition Type		-	Electronic	-	Electronic
Exhaust Muffler	Volume cc	585	324	393	431
	Position	Front	RHS Low	RHS Bottom	Front
Exhaust Direction	Horizontal	-	45°	15°	60°
(Bar at 0°)	Vertical	90° down	15° down	0°	0°
Handle Grips	Front	-	Rubber	Rubber	Plastic
	Rear	-	Rubber	Plastic	Plastic

TABLE 3. CHAINSAW TEST RESULTS: MEDIUM, CLASS 3: 90-100 cc 8-9 kg Bare. 61-71 cm Bar

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