AFRC Institute of ENGINEERING RESEARCH

OECD Approval No. 1078
Restricted Code

Test in accordance with the OECD restricted standard code for the official testing of agricultural tractors

Massey-Ferguson 390 Two-Wheel Drive Tractor with 8-speed Transmission



Manufacturered by	Massey-Ferguson Manufacturing Ltd., Banner Lane, Coventry, Warwickshire, CV4 9GF
Test No.	R87/70573/OECD
Report No.	714
Date	April 1987

THE BRITISH SOCIETY FOR RESEARCH IN AGRICULTURAL ENGINEERING

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Tractor manufacturer's name and address:	Massey-Ferguson Manufacturing Limited Banner Lane, Coventry, Warwickshire CV4 9GF
Submitted for test by:	The manufacturer
Selected for test by:	The manufacturer with the agreement of the testing station
Place of running in:	Coventry
Duration of running in:	60 hours

I. SPECIFICATION OF TRACTOR

TRACTOR

Make:	Massey-Ferguson
Trade name:	Massey-Ferguson
Model:	M-F 390 with 8-speed transmission
Type:	Four wheel, rear wheel driven, unit construction
Serial No:	5008U31199
1st Serial No:	5008U01001

ENGINE

Make:	Perkins
Model:	A4.248
Type	4-stroke, direct injection, naturally aspirated diesel
Serial No:	LF 31141U110250N
Cylinders	
Number/disposition:	4, vertical, in-line
Bore/stroke:	101.1 mm/127.0 mm
Capacity:	4078 cm^3
Compression ratio:	16:1
Arrangement of valves:	Overhead
Cylinder liners:	Dry

Fuel System	
Fuel feed system:	AC Delco mechanical feed pump.
Make, type and model of fuel filter(s):	C.A.V. paper element filter with transparent sediment bowl
Capacity of fuel tank:	108 l
Make, type and model of injection pump:	C.A.V. distributor, DPA3241F570
Serial No:	C315 WX
Manufacturer's production setting of injection pump:	14.9-15.7 l/h at 2000 rev/min engine speed at full load and 40°C pump inlet temperature
Injection pump timing:	Delivery starts 24° before T.D.C., static
Make, type and model of injectors:	C.A.V. 4-hole, BDLL 150S6600
Injection pressure:	17.1 M Pa
Governor	
Make:	C.A.V.
Type:	Mechanical incorporated in injection pump
Governed range of engine speed:	750 to 2380 rev/min
Rated engine speed:	2200 rev/min
Air cleaner	
Pre-cleaner	
Make and type:	Nelson-Burgess, Visibowl, centrifugal
Location:	Above engine cover
Main	
Make and type:	Nelson-Burgess, oil bath
Maintenance indicator:	None
Oil capacity	1 l
Location:	Under engine cover
Lubrication system	
Type of feed pump:	Forced feed from eccentric rotor pump
Total oil capacity including filter(s):	7.5 l
Oil change period:	250 hours
Type of filter(s):	Full flow replaceable element canister
Number:	1
Filter change period:	250 hours
Recommended oil:	See "Fuels and lubricants used in tests"

Cooling system	
Type of coolant:	Water or water and anti-freeze solution
Specification of pump	
Type:	Centrifugal
Description of fan:	Belt driven, puller
Number of fan blades:	4
Fan diameter:	457 mm
Coolant capacity:	15.1 l
Type of temperature control:	Thermostat
Superpressure system:	69 kPa
Starting system	
Safety device:	Operable only when high/low gear and pto selectors are in neutral position
Starter motor	
Make:	Lucas
Type:	Electrical, pre-engaged, solenoid operated
Model and power rating:	M127, 12V, 2.8 kW
Cold starting aid:	Lucas C.A.V. Thermostart
Electrical system	
Voltage:	12
Generator:	Alternator
Make:	Lucas
Model:	A127
Type:	Belt driven
Power:	0.54 kW
Batteries	2, M.F. Powerpart, lead-acid
Rating:	420 A CCA rating each or equivalent 75 Ah at 20-hour rating
Exhaust system	
Make:	Nelson-Burgess
Type:	Spark arrester silencer
Model:	17AE10
Location:	Under engine cover with vertical stack pipe
Height of outlet above ground:	2450 mm

TRANSMISSION

Clutch	
Make:	Laycock
Type:	Dry, for transmission and pto
Number of plates:	2
Diameter of plates:	305 mm and 254 mm
Method of operation:	Mechanically by pedal
Gear box	
Make:	Massey-Ferguson
Type:	Mechanical, manual operation
Arrangement:	4 forward and 1 reverse speeds with high/low range selector
Number of speeds:	8 forward, 2 reverse
Available options:	8 and 12 speed synchromesh and 12 speed multi-power
Rear axle and final drives	
Make:	Massey-Ferguson
Type:	Crown wheel and pinion, with outboard epicyclic reduction gears
Differential lock	
Type:	Mechanical
Method of engagement:	Pedal operated
Method of disengagement:	Automatic
Transmission oils	
Gear box, transmission final drives and power lift housing:	
Capacity	49.8 l
Change period:	1000 hours
Filter change period:	250 hours
Recommended oil:	See "Fuels and lubricants used in tests"

Gear	Group No.	Number of engine revolutions for one revolution of the driving wheels	Nomimal travelling speed at rated engine speed: 2200 rev/min km/h
Forward			
1	L	227.64	2.62
2	L	155.21	3.85
3	L	113.63	5.26
4	L	84.66	7.05
1	H	55.64	10.73
2	H	37.94	15.74
3	H	27.78	21.50
4	H	20.69	28.86
Reverse			
R	L	167.15	3.57
R	H	40.86	14.61

L = Low range H = High range

Rear tyre size: 18.4-30

Tyre radius index: 720 mm

POWER TAKE-OFF

Main power take-off

Type: Independent, mechanically operated, through second plate in main clutch

Method of engagement: By hand lever

Number of shafts: 1

Power take-off proportional to engine speed

Location:	At rear of tractor
Diameter of power take-off shaft:	34.9 mm
Number of splines:	6 to ISO standard
Tyre sizes, Front, Rear:	7.50-16, 18.4-30
Height above ground:	603 mm
Distance from the median plane of the tractor:	Central
Distance behind rear axle:	296 mm
Pto speed at rated engine speed:	664 rev/min
Engine speed at standard power take-off speed (540 rev/min):	1789 rev/min
Engine to pto ratio:	3.3125:1
Power restriction:	I.S.O. recommendation, 48 kW
Direction of rotation (viewed facing driving end):	Clockwise

Power take-off proportional to ground speed

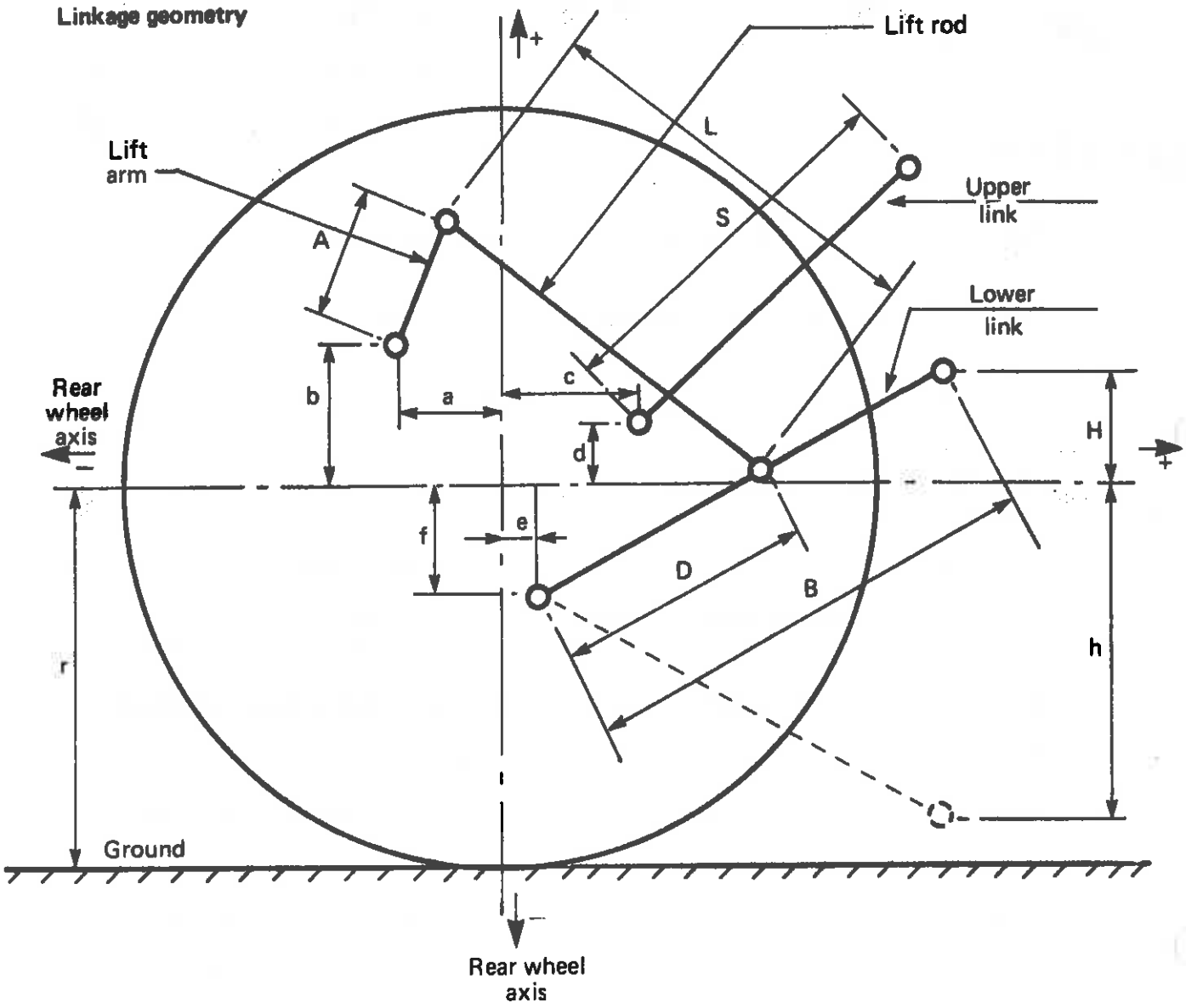
Speed of shaft:	540 rev/min
Size of tyre:	18.4-30
Travelling distance for one revolution of power take-off shaft:	327 mm
Number of pto shaft revolutions for one revolution rear wheels:	13.8
Direction of rotation with forward gear engaged:	Clockwise

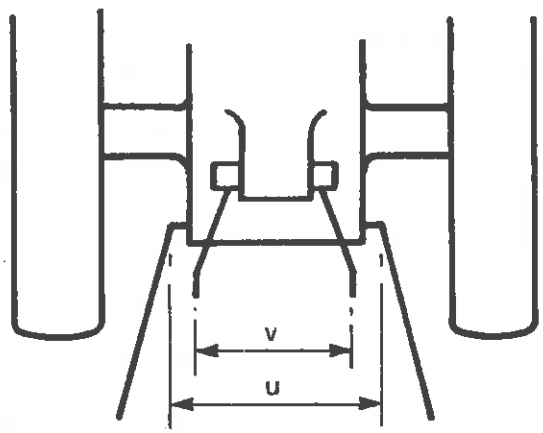
POWER LIFT

Make:	Massey-Ferguson
Type:	Hydraulic
Number and type of cylinders:	One, single acting,
Type of linkage lock for transport:	Hydraulic
Relief valve pressure setting:	20.5 - 24.0 MPa
Opening pressure of cylinder safety valve:	None fitted
Lift pump type:	4-cylinder piston
Transmission between pump and engine:	Driven from pto shaft, independent of main clutch
Make and number of filters:	Own make metal mesh strainer
Time between oil changes:	1000 hours
Time between filter changes:	Clean mesh every 1000 hours
Oil capacity:	47.4 l
Site of oil reservoir:	Main transmission housing
Type and number of tapping points:	One on centre housing top cover
Maximum volume of oil available to external cylinders:	18 l
Recommended oil	See "Fuels and lubricants used in tests"

THREE-POINT LINKAGE

Category:	2 to ISO standard
Category adapter:	None
Controls	Draught or position control, top link sensing


Linkage geometry
+
Lift rod
L
Lift
arm
S
Upper
link
A
Lower
link
b
a
c
H
Rear
wheel
axis
−
d
+
f
e
D
B
h
r
Ground
−
Rear wheel
axis


v
u

Linkage dimensions for the lifting test

		Compulsory test	Supplementary test
Rear tyres: (size 18.4-30) loaded radius:	(r)	720 mm	720 mm
Front tyres:(size 7.5-16) loaded radius :	(r')	360 mm	360 mm
Length of lift arms:	(A)	267 mm	267 mm
Length of lower links:	(B)	1005 mm	1005 mm
Distance of lift arm pivot point from rear wheel centre line: horizontally:	(a)	196 mm	196 mm
Distance of lift arm pivot point from rear wheel centre line: vertically:	(b)	233 mm	233 mm
Horizontal distance between the two lower link points:	(u)	492 mm	492 mm
Horizontal distance between the two lift arm end points:	(v)	534 mm	534 mm
Length of upper link:	(S)	783 mm	792 mm
Distance of upper link pivot point from rear wheel centre line horizontally:	(c)	200 mm	186 mm
Distance of upper link pivot point from rear wheel centre line vertically:	(d)	171 mm	205 mm
Distance of lower link pivot point from rear wheel centre horizontally:	(e)	32 mm forward	32 mm forward
Distance of lower link pivot point from rear wheel centre vertically:	(f)	212 mm	212 mm
Distance of lower link points to lift rod pivot points on lower link:	(D)	567 mm	567 mm
Offset above link centre line:		51 mm	51 mm
Length of lift rods:	(L)	710 mm	683 mm
Height of lower hitch points relative to the rear wheel centre line, situated 720 mm above the ground level			
- in low position:	(h)	520 mm	447 mm
- in high position:	(H)	118 mm	173 mm
Height of lower hitch points when locked in transport position:		Any height within lift range	

SWINGING DRAWBAR

Tyre sizes	Front:	7.50-16
	Rear:	18.4-30
Height above ground,	maximum:	532 mm
	minimum:	378 mm
Type of adjustment:		Inverting drawbar and clevis
Distance of hitch point from rear axle centre:		537 mm and 652 mm
Distance of hitch point from power take-off shaft ends:		
vertically:		71 mm to 225 mm
horizontally:		241 mm and 356 mm
Lateral adjustment:		210 mm and 390 mm
Distance of pivot point from rear axles horizontally:		130 mm forward
Diameter drawbar pin hole:		25.4 mm

FRONT TOWING HITCH

Vertical height to centre of clevis:	686 mm
Width of clevis:	65 mm
Diameter of pin hole:	33 mm

STEERING

Method of operation:	Hydrostatic system with hand operated steering motor powered by engine mounted pump operating a ram integral with track rod
Pump:	Bendix Hydralquip, gear type with integral oil reservoir
Motor:	Danfoss OSPC-ON
Ram	Massey-Ferguson double acting, integral with track rod
Working pressure:	17 MPa
Oil capacity:	1.2 l
Oil change period:	Top up only
Make and model of filter:	Bendix paper element integral with reservoir
Filter(s) change period:	None
Recommended oil:	See "Fuels and lubricants used in tests"

BRAKES

Service brake

Make:	Girling
Type:	Oil immersed multi-plate discs, 4 per side
Method of operation:	Independent or combined pedal, hydraulic actuation
Trailer braking take-off	None fitted

Parking brake

Type:	Mechanical by cable connected to both service brakes
Method of operation:	Hand lever with ratchet

STEERING WHEELS

Number:	2
Location:	At front
Tyres:	Goodyear Super Rib Tractor
Size:	7.50-16
Ply rating:	6
Type of casing:	Cross-ply
Maximum permissible load on each tyre:	745 kg
Corresponding inflation pressure:	280 kPa
Track widths:	1278 mm to 1890 mm
Method of adjustment:	Extending axle

DRIVING WHEELS

Number:	2
Location:	At rear
Tyres:	Goodyear Traction Suregrip
Size:	18.4-30
Ply rating:	6
Type of casing:	Crossply
Maximum permissible load on each tyre:	2120 kg
Corresponding inflation pressure:	110 kPa
Track widths:	1500 mm by 102 mm steps to 2112 mm
Method of adjustment:	Reversing wheels and power adjusted variable track

WHEELBASE	2286 mm

DRIVER'S SEAT

Make:	Grammer DS44
Type of suspension:	Spring
Type of damping:	Hydraulic
Range of adjustment, longitudinal:	150 mm
vertical:	60 mm

LIGHTING

Unrestricted beam angle of head light in plan view 110°
Tyres: front 7.50-16: rear 18.4-30

	Height above ground of centre, mm	Size, mm	Distance from outside edge of tractor to centre, at 1500 mm track width, mm
Headlights	1175	100 x 160	720
Sidelights	1520	110 x 35	235
Rear lights	1575	73 x 50	437
Mudguard reflectors	1575	46 x 46	380
Rear axle reflectors	687	80 dia	533

CONDITIONS DURING TEST

Overall dimensions

(front: 7.50-16 rear: 18.4-30 tyres fitted)

Length, m	Width, min. m	Width, max. m	Height at top of, exhaust silencer, m	Height at top of, steering wheel, m
3.88	1.98	2.59	2.45	1.74

Ground clearance

Clearance: 353 mm limited by drawbar bracket

Track setting

Front: 1380 mm
Rear: 1500 mm

Tractor mass

(without driver but with tanks full)

Front, kg	Rear,kg	Total,kg
1156	1778	2934

Fuel and lubricants used in tests

Fuel

Type: Diesel oil to Class D British Standard 2869:1970 specific gravity 0.8345 at 15°C, Cetane index 53.5

Oils	Recommended	Used during test
Engine		
Type:	SAE 15W/30	
Viscosity:	54cSt at 50°C	As recommended
Classification:	MIL-L-2104-C	
Transmission, final drives, and hydraulics		
Type:	SAE 15W/30	
Viscosity:	54 cSt at 50°C	As recommended
Classification:	MIL-L-2104-C	
Steering		
Type:	SAE 10W	
Viscosity:	18.5 cSt at 15°C	As recommended
Classification:	M-F CMS 1110	
Hydraulic brakes		
Type:	Mineral	
Viscosity:	7.2 cSt at 50°C	As recommended
Classification::	M-F CMS 1151A	
Recommended grease:	Consistency 2 lithium	As recommended
Number of lubrication points:	13	

II TEST RESULTS

A COMPULSORY TESTS

1. MAIN POWER TAKE-OFF PERFORMANCE

Date of tests: 26th February 1987

Type of dynamometer: Water brake, Heenan & Froude

Power, kW	Speed, rev/min		Fuel consumption, Hourly,		Specific,	Specific energy,
	Engine	P.t.o.	l/h	kg/h	kg/kWh	kWh/l
MAXIMUM POWER - 2 HOUR TEST						
54.5	2200	664	16.18	13.51	0.248	3.37
POWER AT RATED ENGINE SPEED						
54.5	2200	664	16.18	13.51	0.248	3.37
POWER AT STANDARD POWER TAKE-OFF SPEED						
48.3	1789	540	13.49	11.26	0.233	3.58
PART LOADS						
(i) The torque corresponding to maximum power at rated engine speed						
54.5	2200	664	16.18	13.51	0.248	3.37
(ii) 85% of the torque obtained in (i)						
47.0	2234	675	13.95	11.64	0.248	3.37
(iii) 75% of the torque defined in (ii)						
35.7	2262	683	11.54	9.63	0.270	3.09
(iv) 50% of the torque defined in (ii)						
24.0	2286	690	9.14	7.63	0.318	2.63
(v) 25% of the torque defined in (ii)						
12.2	2309	697	6.78	5.66	0.464	1.80
(vi) Unloaded						
0	2339	706	4.48	3.74	-	-

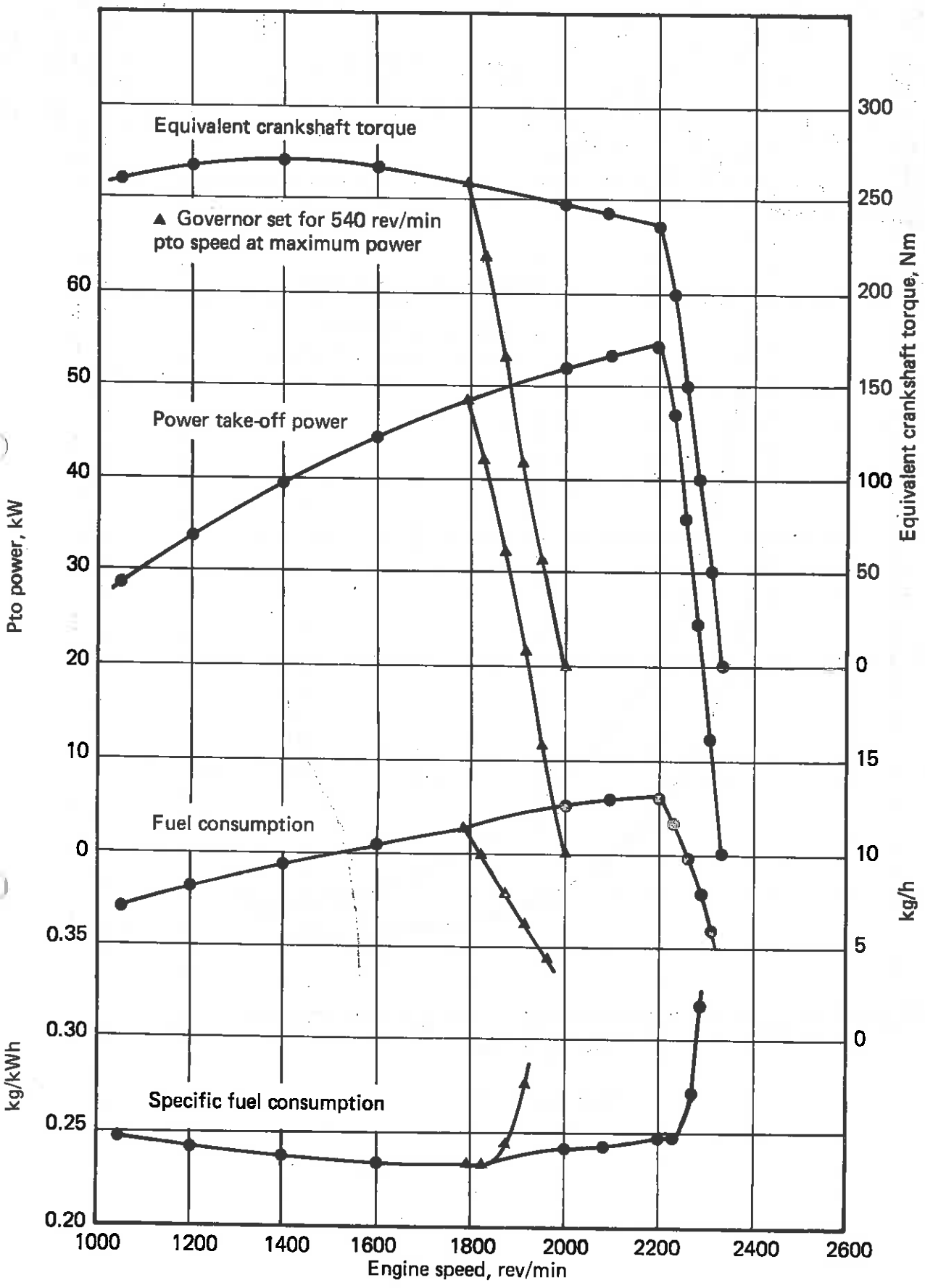
Part loads, the governor hand lever in the position corresponding to the standard p.t.o. speed at full load (540 rev/min).

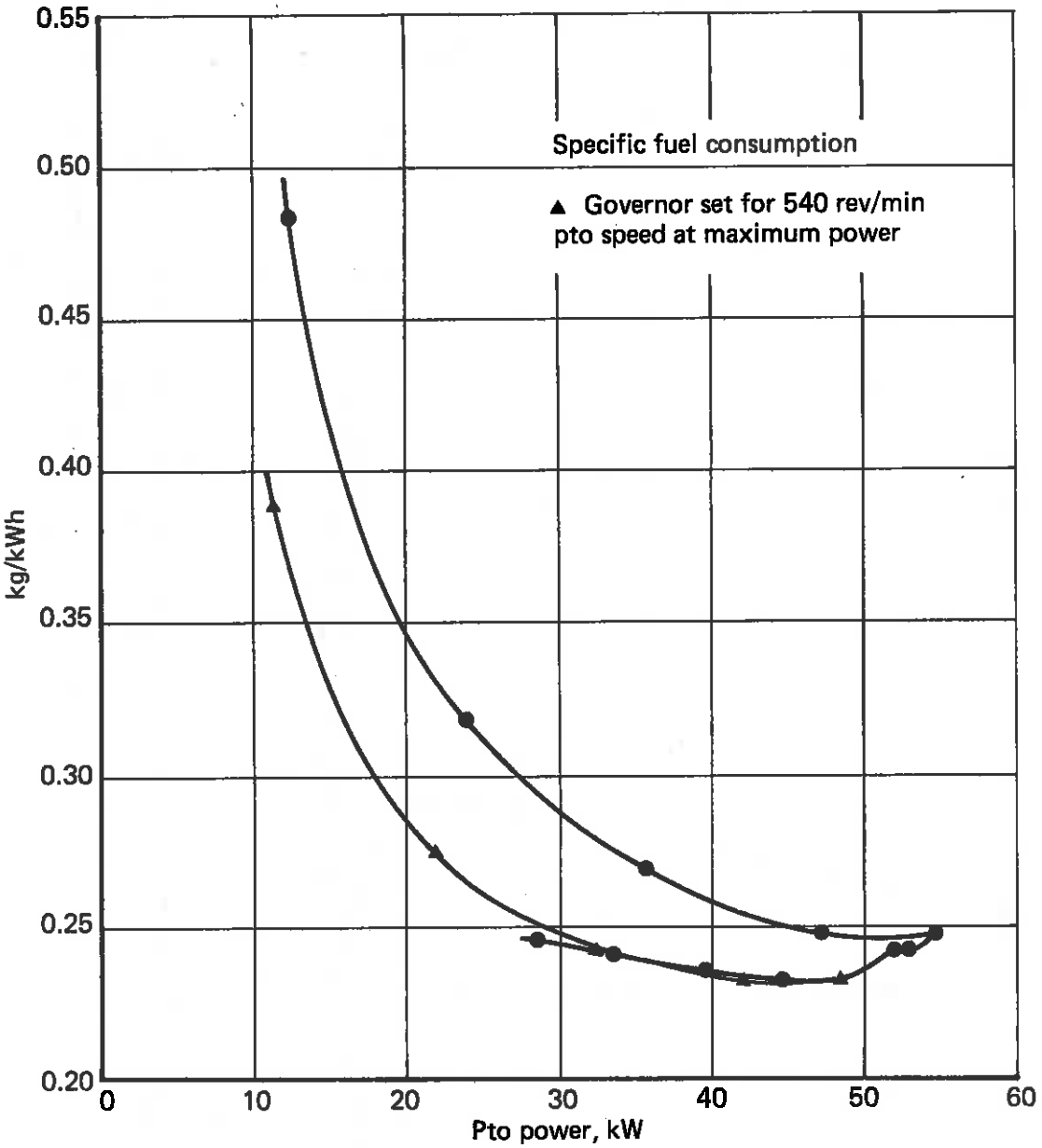
Power, kW	Speed, rev/min		Fuel consumption, Hourly,		Specific,	Specific energy,
	Engine	P.t.o.	l/h	kg/h	kg/kWh	kWh/l
(i) The torque corresponding to maximum power at standard p.t.o. speed						
48.3	1789	540	13.49	11.26	0.233	3.58
(ii) 85% of the torque obtained at maximum power						
41.9	1828	552	11.71	9.77	0.233	3.58
(iii) 75% of the torque defined in (ii)						
32.3	1875	566	9.44	7.88	0.244	3.42
(iv) 50% of the torque defined in (ii)						
22.0	1918	579	7.26	6.06	0.275	3.03
(v) 25% of the torque defined in (ii)						
11.2	1954	590	5.20	4.34	0.388	2.15
(vi) Unloaded						
0	2004	605	3.22	2.69	-	-

Standard specific fuel consumption, kg/kWh

a) 0.248
b) 0.314
c) 0.233
d) 0.275

No load, maximum engine speed		2339 rev/min
Equivalent crankshaft torque at maximum power		236.4 Nm
Maximum equivalent crankshaft torque		270.6 Nm at 1400 rev/min engine speed
Mean atmospheric conditions	temperature	20°C
	pressure	1014 m bar
	relative humidity	43%
Maximum temperature	coolant	84°C
	engine oil	109°C
	fuel	21°C
	air intake	24°C


Equivalent crankshaft torque
▲ Governor set for 540 rev/min pto speed at maximum power
Power take-off power
Fuel consumption
Specific fuel consumption
Pto power, kW
kg/kWh
Equivalent crankshaft torque, Nm
kg/h
Engine speed, rev/min
60
50
40
30
20
10
0
0.35
0.30
0.25
0.20
300
250
200
150
100
50
0
15
10
5
0
1000
1200
1400
1600
1800
2000
2200
2400
2600



Power take-off test

2. LIFTING FORCE AND HYDRAULIC POWER

Date of tests: 2nd March 1987

Hydraulic fluid

Make and type: SAE 15w/30
Viscosity: 54 cSt at 50°C

Type of hydraulic system: Piston type pump delivering oil from main transmission housing.

Hydraulic fluid temperature at beginning of test: 65°C

Power lift test

	Height of lower hitch point above ground in down position, mm	Vertical movement, mm	Maximum force exerted through full range, kN	Corresponding pressure of hydraulic fluid, MPa	Moment about rear axle, kNm	Maximum tilt angle of mast over range of lift, degrees
At the hitch point	213	638	23.0	20.0	22.4	-
On the frame	200	765	18.5	20.0	29.3	13

Main linkage dimensions - see drawings and table on pages 8 and 9

Lifting heights relative to the horizontal plane including the lower link pivot points

mm	-315	-295	-240	-150	0	150	300	330	410

Lifting forces at hitch points
(corresponding pressure 20.0 MPa)

kN	-	23.0	23.2	24.0	25.5	25.5	25.6	25.7	-

Lifting forces at test frame
(corresponding pressure 20.0 MPa)

kN	20.0	20.0	20.1	20.1	20.1	19.8	18.8	18.6	18.5

Hydraulic power test

Sustained pressure with relief valve open 22.2 MPa

Pump delivery rate at minimum pressure 20.2 l/min

Flow rate corresponding to a hydraulic pressure equivalent to 90 per cent of the actual relief valve pressure setting and corresponding hydraulic power

Flow rate	18.5 l/min
Pressure	20.0 MPa
Power	6.2 kW

Flow rate and hydraulic pressure corresponding to maximum hydraulic power

Flow rate	18.5 l/min
Pressure	20.0 MPa
Power	6.2 kW

Tapping point used for test: Auxiliary service connection

Temperature of hydraulic fluid, if different from $65^{\circ} \pm 5^{\circ}C$ Not applicable

Opening pressure of the unloading valve Not applicable

Closing pressure of the unloading valve Not applicable

Date of tests: 10th April 1987
Type of track: Concrete

Height of drawbar above ground: 470 mm

Tyre size and pressure:
Front: 7.5-16 179 kPa
Rear: 18.4-30 83 kPa

Gear	Speed, km/h	Power, kW	Drawbar pull, kN	Engine speed, rev/min	Wheel-slip, %	Specific fuel consumption, kg/kWh	kWh/l	Temperature, °C: Fuel	Coolant	Engine oil	Atmospheric conditions: Temperature, °C	Relative humidity, %	Pressure, m bar
(1) MAXIMUM DRAWBAR POWER IN GEARS													
L3*	4.54	28.9	22.9	2249	15.0	0.333	2.51	30	84	75	14	70	1006
L4*	6.29	37.9	21.7	2223	10.9	0.320	2.61	34	84	83	14	81	1006
H1	9.89	44.8	16.3	2200	5.3	0.304	2.75	39	85	86	14	89	1006
H2	14.90	44.7	10.8	2200	3.6	0.309	2.70	38	87	85	14	89	1006
(2a) TRANSMISSION AND FUEL CONSUMPTION CHARACTERISTICS													
(i) SELECTED GEAR (Speed closest to 7.5 km/h)													
H1	9.89	44.8	16.3	2200	5.3	0.304	2.75	39	85	86	14	89	1006
(ii) 75% OF PULL AT MAXIMUM POWER													
H1	10.21	34.6	12.2	2241	4.0	0.326	2.56	32	84	76	14	84	1006
(iii) 50% OF PULL AT MAXIMUM POWER													
H1	10.54	24.0	8.2	2270	3.0	0.370	2.26	36	84	88	14	85	1006
HIGHEST GEAR SAME PULL AS IN (ii) REDUCED ENGINE SPEED													
H2	10.29	34.9	12.2	1525	4.0	0.290	2.88	37	84	67	12	76	1006
HIGHEST GEAR SAME PULL AS IN (iii) REDUCED ENGINE SPEED													
H2	10.54	24.0	8.2	1549	3.0	0.300	2.78	37	84	73	13	76	1006
(2b) TRANSMISSION AND FUEL CONSUMPTION CHARACTERISTICS													
(i) SELECTED GEAR (Maximum power)													
H2	14.90	44.7	10.8	2200	3.6	0.309	2.70	38	87	85	14	89	1006
(ii) 75% OF PULL AT MAXIMUM POWER													
H2	15.29	34.4	8.1	2240	2.9	0.312	2.67	37	85	87	14	88	1006
(iii) 50% OF PULL AT MAXIMUM POWER													
H2	15.67	23.5	5.4	2271	2.0	0.360	2.32	37	85	87	14	88	1006
HIGHEST GEAR SAME PULL AS IN (ii) REDUCED ENGINE SPEED													
H3	15.29	34.4	8.1	1654	2.9	0.293	2.85	42	84	75	13	76	1006
HIGHEST GEAR SAME PULL AS IN (iii) REDUCED ENGINE SPEED													
H3	15.69	23.1	5.3	1666	2.0	0.327	2.55	37	84	75	12	78	1006

*Maximum power limited by wheelslip.

B. SUPPLEMENTARY TESTS

Lifting force

Linkage set in accordance with the manufacturers recommendations for general use.

Date of tests: 2nd March 1987

Hydraulic fluid

Make and type: SAE 15w/30
Viscosity: 54 cSt at 50°C

Type of hydraulic system: Piston type pump delivering oil from mian transmission housing

Hydraulic fluid temperature at beginning of test: 65°C

Power lift test

	Height of lower hitch point above ground in down position, mm	Vertical movement, mm	Maximum force exerted through full range, kN	Corresponding pressure of hydraulic fluid, MPa	Moment about rear axle, kNm	Maximum tilt angle of mast over range of lift, degrees
At the hitch point	273	620	23.1	20.0	22.5	-
On the frame	273	733	19.1	20.0	30.2	11

Main linkage dimensions - see drawings and table on pages 8 and 9

Lifting heights relative to the horizontal plane including the lower link pivot points

mm	-240	-235	-100	0	100	200	300	370	440

Lifting forces at hitch points
(corresponding pressure 20.0 MPa)

kN	-	23.1	24.2	24.7	25.2	25.4	25.5	26.1	-

Lifting forces at test frame
(corresponding pressure 20.0 MPa)

kN	22.0	22.0	22.0	21.8	21.5	20.9	20.2	19.6	19.1

REPAIRS AND ADJUSTMENTS DURING TESTS: None

REMARKS: None

Test carried out at AFRC Engineering by: P.C. Seward, M.D. Osborne.

Officer in charge: P.C. Seward

Signed: D.W. Smith Head of Testing Group

R.M. Stagner for the Director

Date: 12th June 1987.