AFRC Institute of ENGINEERING RESEARCH

OECD Approval No. 1084 Restricted Code
Date of approval: 14th September 1987

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

Massey-Ferguson 350 Two-wheel Drive Tractor with 8-speed Transmission



Manufacturered by	Massey-Ferguson Manufacturing Limited, Banner Lane, Coventry, Warwickshire CV4 9GF
Test No.	R87/70569/OECD
Report No.	712
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 350 with 8-speed transmission
Type:	Four wheel, rear wheel driven, unit construction
Serial No:	5000 U28025
1st Serial No:	5000 U01001

ENGINE

Make:	Perkins
Model:	AD3.152
Type	4-stroke, direct injection, naturally aspirated diesel
Serial No:	CE311 60U 7885 78N
Cylinders	
Number/disposition:	3, vertical, in-line
Bore/stroke:	91.4 mm/127.0 mm
Capacity:	2500 cm^3
Compression ratio:	16:1
Arrangement of valves:	Overhead, in-line
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:	68 l
Make, type and model of injection pump:	C.A.V., distributor, DPA 3238F480
Serial No:	08823 COG
Manufacturer's production setting of injection pump:	9.9-10.4 l/h at 2000 rev/min engine speed and 40°C pump inlet temperature
Injection pump timing:	Delivery starts 20° before T.D.C., static
Make, type and model of injectors:	C.A.V. 4-hole BDLL 150S6602
Injection pressure:	17.7 MPa
Governor	
Make:	C.A.V.
Type:	Mechanical incorporated in injection pump
Governed range of engine speed:	750 to 2470 rev/min
Rated engine speed:	2250 rev/min
Air cleaner	
Pre-cleaner	
Make and type:	Nelson-Burgess, Visibowl, centrifugal
Location:	Above engine cover, forward of radiator
Main	
Make and type:	Nelson-Burgess, oil bath
Oil capacity:	0.5 l
Maintenance indicator:	None
Location:	Under engine cover, forward of radiator
Lubrication system	
Type of feed pump:	Forced feed from eccentric rotor pump
Total oil capacity including filter(s):	6.8 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:	2
Fan diameter:	394 mm
Coolant capacity:	9.8 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
Make:	Perkins
Type:	Electrical, pre-engaged, solenoid operated
Starter motor model and power rating:	3M113, 12V, 1.8 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	1, M.F. Powerpart, lead-acid
Rating:	420 A CCA rating or equivalent 75 Ah at 20-hour rating
Exhaust system	
Make:	Nelson-Burgess
Type:	Silencer
Model:	16 BC 53
Location:	Under engine cover with vertical stack pipe
Height of outlet above ground:	2272 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
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:	Pedal operated
Transmission oils	
Gear box, transmission, final drives and power lift housing:	
Capacity	49.8 l
Change period:	1000 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: 2250 rev/min, km/h
Forward			
1	L	192.50	2.60
2	L	131.25	3.81
3	L	96.09	5.21
4	L	71.59	6.99
1	H	48.13	10.40
2	H	32.81	15.25
3	H	24.02	20.83
4	H	17.90	27.96
Reverse			
R	L	141.35	3.54
R	H	35.34	14.16

L = Low range H = High range

Rear tyre size: 14.9-24

Tyre radius index: 590 mm

FRONT AXLE

Make: Massey-Ferguson

Type: Non-driven, extendable

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 500
Tyre sizes, Front, Rear:	6.50-16, 14.9-24
Height above ground:	469 mm
Distance from the median plane of the tractor:	Central
Distance behind rear axle:	296 mm
Pto speed at rated engine speed:	679 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

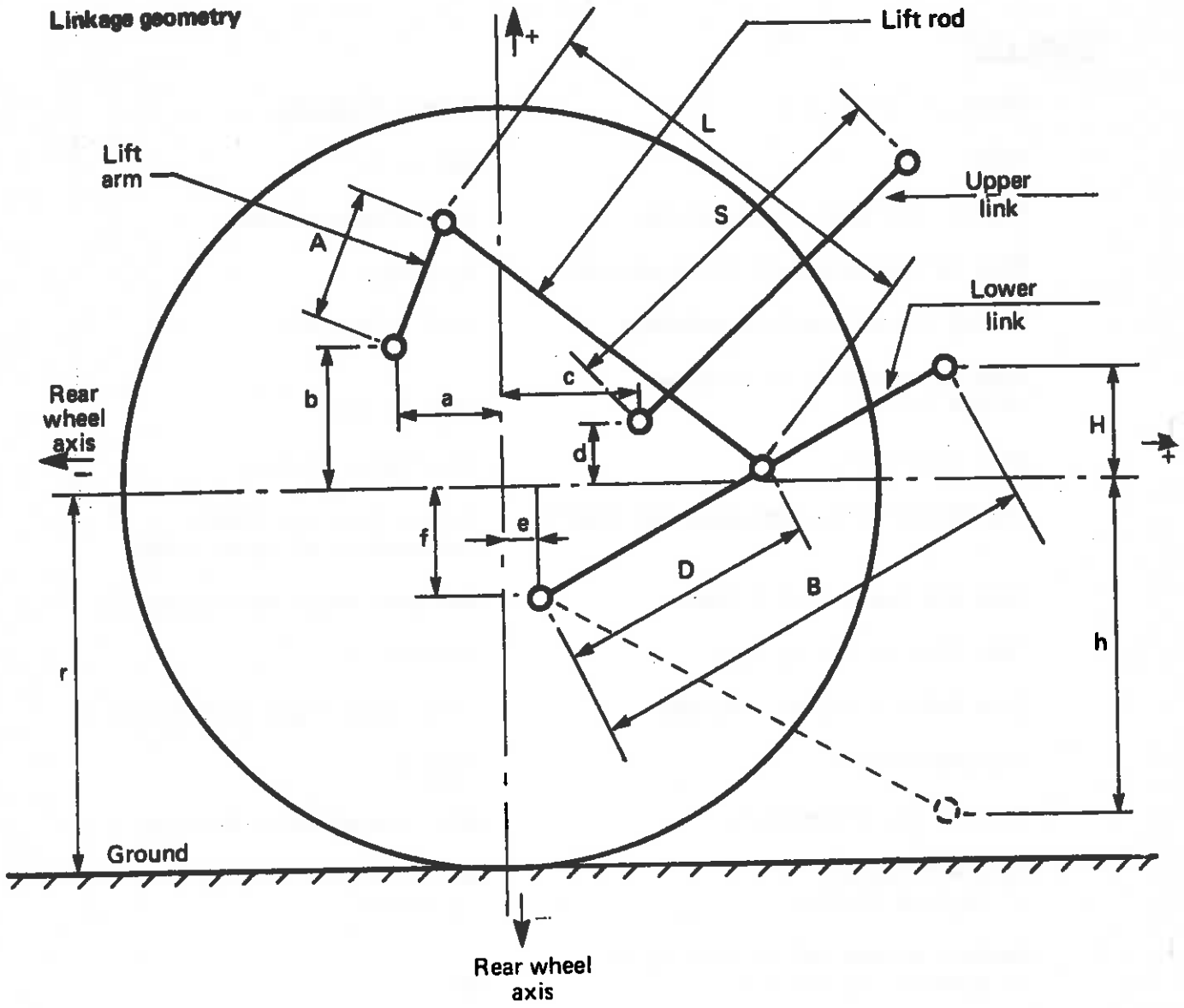
Speed of shaft:	540 rev/min
Size of tyre:	14.9-24
Travelling distance for one revolution of power take-off shaft:	268 mm
Number of pto shaft revolutions for one revolution rear wheels:	13.8
Direction of rotation with forward gear engaged:	Clockwise

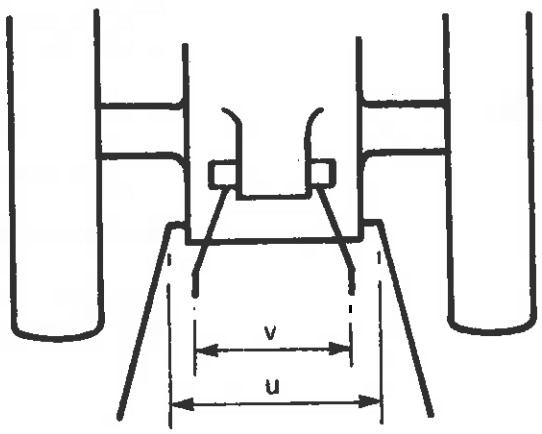
POWER LIFT

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:	1 or 2 to ISO standard 730/1
Category adapter:	Replacement ball ends
Controls	Draught or position control, top link sensing


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


v
u

Linkage dimensions for the lifting test

Rear tyres: (size 14.9-24) radius index:		(r)	590 mm	
Front tyres:(size 6.50-16) radius index:		(r')	343 mm	
Length of lift arms:		(A)	267 mm	
Length of lower links:		(B)	952 mm	
Distance of lift arm pivot point from rear wheel centre line:	horizontally:	(a)	196 mm	
	vertically:	(b)	233 mm	
Horizontal distance between the two lower link points:		(u)	492 mm	
Horizontal distance between the two lift arm end points:		(v)	534 mm	
Length of upper link:		(S)	740 mm	
Distance of upper link pivot point from rear wheel centre line	horizontally:	(c)	186 mm	
	vertically:	(d)	205 mm	
Distance of lower link pivot point from rear wheel centre	horizontally:	(e)	32 mm	forward
	vertically:	(f)	212 mm	
Distance of lower link points to lift rod pivot points on lower link:		(D)	428 mm	
Length of lift rods:		(L)	614 mm	
Height of lower hitch points relative to the rear wheel centre line, situated 590 mm above the ground level				
- in low position:		(h)	447 mm	
- in high position:		(H)	274 mm	
Height of lower hitch points when locked in transport position:			Any height within lift range	

SWINGING DRAWBAR

Tyre sizes	Front:	6.50-16
	Rear:	14.9-24
Height above ground,	maximum:	396 mm
	minimum:	248 mm
Type of adjustment:		Inverting drawbar or 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:		111 mm to 254 mm
horizontally:		241 mm and 356 mm
Lateral adjustment:		440 mm and 510 mm
Distance of pivot point from rear axles horizontally:		130 mm forward
Diameter of drawbar pin hole:		25.4 mm

FRONT TOWING HITCH

Vertical height to centre of clevis:	512 mm
Width of clevis:	65 mm
Diameter of pin hole:	30 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:	0.7 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, 3 per side
Method of operation:	Independent or combined pedal, hydraulic actuation

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:	6.50-16
Ply rating:	6
Type of casing:	Cross-ply
Maximum permissible load on each tyre:	615 kg
Corresponding inflation pressure:	310 kPa
Track widths:	1226 mm to 1838 mm
Method of adjustment:	Extending axle

DRIVING WHEELS

Number:	2
Location:	At rear
Tyres:	Goodyear Traction Suregrip
Size:	14.9-24
Ply rating:	6
Type of casing:	Crossply
Maximum permissible load on each tyre:	1510 kg
Corresponding inflation pressure:	140 kPa
Track widths:	1403 mm by 102 mm steps to 2117 mm
Method of adjustment:	Reversing wheels and offset lug rims

WHEELBASE 2083 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 6.50-16: rear 14.9-24

	Height above ground of centre, mm	Size, mm	Distance from outside edge of tractor to centre, at 1505 mm track width, mm
Headlights	1025	100 x 160	805
Sidelights	1330	110 x 35	205
Rear lights	1375	73 x 50	425
Mudguard reflectors	1375	46 x 46	365
Rear axle reflectors	555	80 dia	499

CONDITIONS DURING TEST

Overall dimensions

(front: 6.50-16, rear: 14.9-24 tyres fitted)

Length, m	Width, min. m	Width, max. m	Height at top of, exhaust silencer, m	Height at top of, steering wheel, m
3.49	1.78	2.50	2.27	1.58

Ground clearance

Clearance: 224 mm limited by drawbar bracket

Track setting

Front: 1328 mm
Rear: 1505 mm

Tractor mass

(without driver but with tanks full)

Front, kg	Rear, kg	Total, kg
781	1248	2029

Fuel and lubricants used in tests

Fuel

Laboratory tests: Diesel oil to Class D British Standard 2869:1970 specific gravity 0.8386 at 15°C, Cetane index 53.5

Track tests: 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 50°C	As recommended
Classification	MF 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: 4th 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						
34.9	2250	679	10.05	8.43	0.242	3.47
POWER AT RATED ENGINE SPEED						
34.9	2250	679	10.05	8.43	0.242	3.47
POWER AT STANDARD POWER TAKE-OFF SPEED						
31.2	1789	540	8.36	7.01	0.225	3.73
PART LOADS						
(i) The torque corresponding to maximum power at rated engine speed						
34.9	2250	679	10.05	8.43	0.242	3.47
(ii) 85% of the torque obtained in (i)						
30.4	2306	696	8.87	7.44	0.245	3.43
(iii) 75% of the torque defined in (ii)						
23.0	2337	705	7.12	5.97	0.260	3.23
(iv) 50% of the torque defined in (ii)						
15.6	2375	717	5.53	4.64	0.297	2.82
(v) 25% of the torque defined in (ii)						
7.8	2401	725	4.17	3.50	0.449	1.87
(vi) Unloaded						
0	2438	736	3.51	2.93	-	-

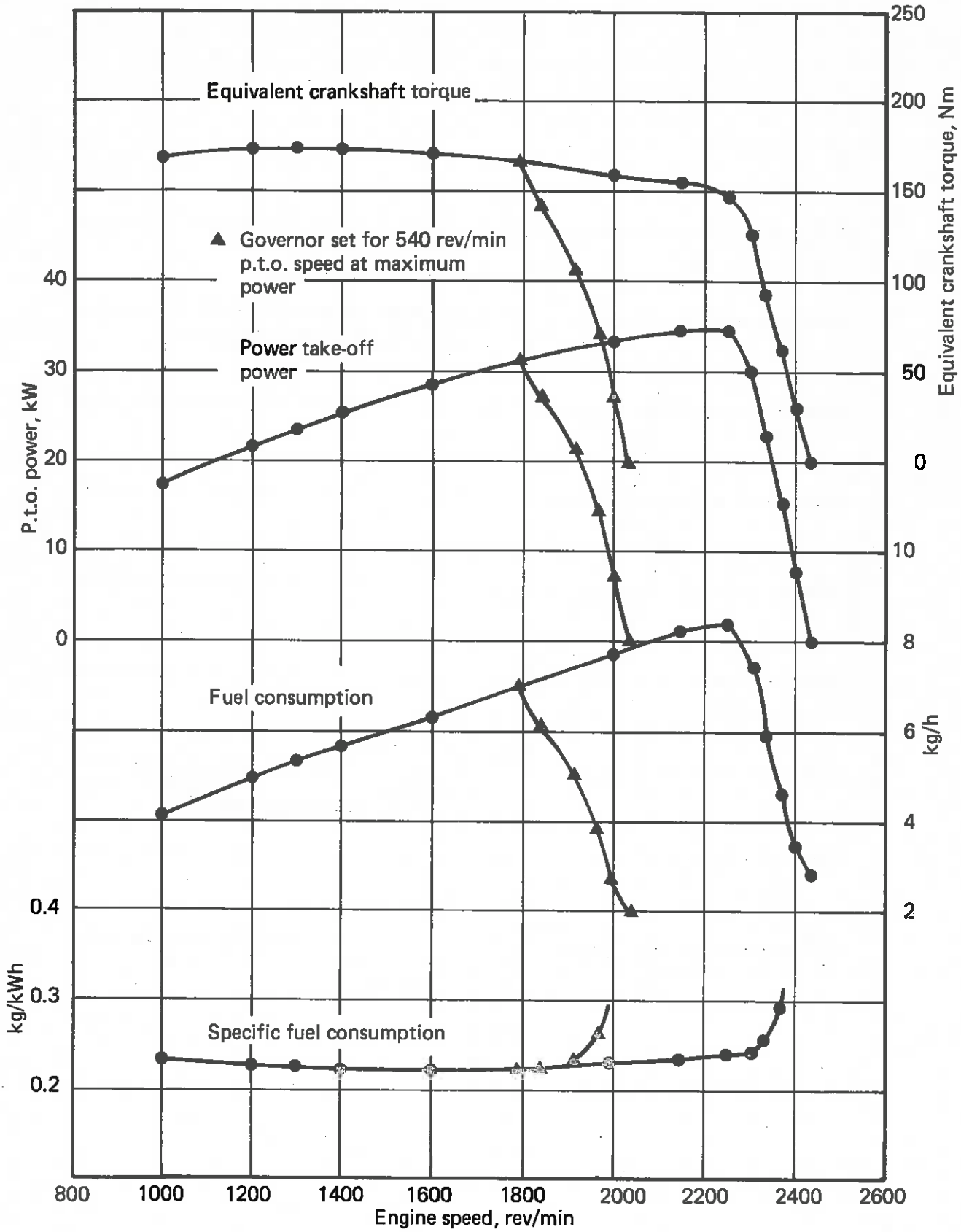
Part loads, the governor hand lever in the position corresponding to the standard p.t.o. speed at full load (540 rev/min).

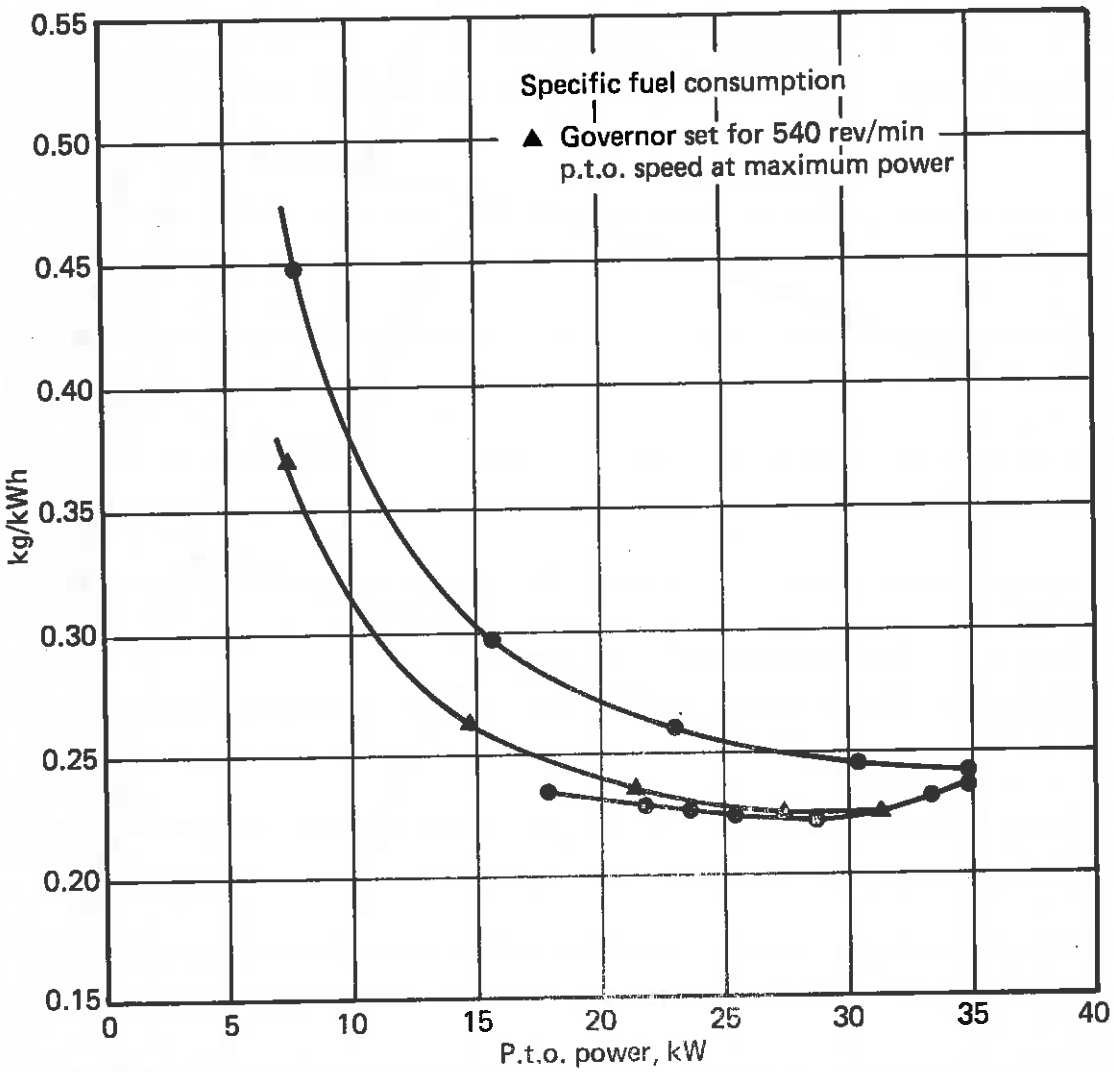
Power, kW	Speed, rev/min		Fuel consumption, Hourly,		Specific,	Specific energy,
	Engine	P.t.o.	l/h	kg/h	kg/kWh	kWh/l
(i) The torque corresponding to maximum power at standard p.t.o. speed						
31.2	1789	540	8.36	7.01	0.225	3.73
(ii) 85% of the torque obtained at maximum power						
27.3	1838	555	7.33	6.15	0.225	3.72
(iii) 75% of the torque defined in (ii)						
21.3	1916	578	5.97	5.01	0.235	3.57
(iv) 50% of the torque defined in (ii)						
14.6	1962	592	4.57	3.83	0.262	3.19
(v) 25% of the torque defined in (ii)						
7.4	1998	603	3.27	2.74	0.370	2.26
(vi) Unloaded						
0	2037	615	2.38	2.00	-	-

Standard specific fuel consumption, kg/kWh

a) 0.245
b) 0.297
c) 0.225
d) 0.262

No load, maximum engine speed		2438 rev/min
Equivalent crankshaft torque at maximum power		147.9 Nm
Maximum equivalent crankshaft torque		173.8 Nm at 1300 rev/min engine speed
Mean atmospheric conditions	temperature	20°C
	pressure	1024 m bar
	relative humidity	55%
Maximum temperature	coolant	83°C
	engine oil	95°C
	fuel	53°C
	air intake	19°C


Equivalent crankshaft torque
▲ Governor set for 540 rev/min p.t.o. speed at maximum power
Power take-off power
Fuel consumption
Specific fuel consumption
P.t.o. power, kW
Equivalent crankshaft torque, Nm
kg/h
kg/kWh
Engine speed, rev/min
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
40
30
20
10
0
250
200
150
100
50
0
10
8
6
4
2
0.4
0.3
0.2



Power take-off test

2. LIFTING FORCE AND HYDRAULIC POWER

Date of tests: 13th and 18th February 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	143	721	18.5	20.5	17.0	-
On the frame	143	892	16.6	20.5	25.4	16

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	-267	-235	-100	0	100	200	300	445	560

Lifting forces at hitch points
(corresponding pressure 20.5 MPa)

kN	-	18.5	19.4	20.3	21.1	22.2	23.1	24.1	-

Lifting forces at test frame
(corresponding pressure 20.5 MPa)

kN	16.6	17.2	17.5	18.0	18.1	18.0	17.7	16.9	16.6

Hydraulic power test

Sustained pressure with relief valve open	22.8 MPa
Pump delivery rate at minimum pressure	21.5 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	19.0 l/min
Pressure	20.5 MPa
Power	6.5 kW

Flow rate and hydraulic pressure corresponding to maximum hydraulic power

Flow rate	19.0 l/min
Pressure	20.5 MPa
Power	6.5 kW

Tapping point used for test:	Auxiliary service connection, fitted for test only
Temperature of hydraulic fluid, if different from $65^{o} \pm 5^{o}C$	Not applicable
Opening pressure of the unloading valve	Not applicable
Closing pressure of the unloading valve	Not applicable

3. MAXIMUM DRAWBAR POWER, TRANSMISSION AND FUEL CONSUMPTION CHARACTERISTICS

Date of tests: 22nd April 1987
Type of track: Concrete
Height of drawbar above ground: 450 mm

Tyre size and pressure:
Front: 6.50-16 179 kPa
Rear: 14.9-24 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) MAXIMM DRAWBAR POWER IN GEARS													
L2	3.42	15.2	16.0	2364	15.0	0.378	2.21	45	67	81	17	71	1020
L3	4.56	20.3	16.0	2319	15.0	0.347	2.40	44	72	81	16	80	1020
L4	6.00	26.2	15.7	2250	13.5	0.327	2.55	48	83	81	17	75	1020
H1	9.69	28.8	10.7	2250	5.7	0.297	2.81	48	83	81	15	80	1020
H2	14.66	28.5	7.0	2250	2.9	0.299	2.79	49	83	80	14	80	1020
(2a) TRANSMISSION AND FUEL CONSUMPTION CHARACTERISTICS													
(i) SELECTED GEAR (Speed closest to 7.5 km/h)													
H1	9.69	28.8	10.7	2250	5.7	0.297	2.81	48	83	81	15	80	1020
(ii) 75% OF PULL AT MAXIMM POWER													
H1	10.26	22.8	8.0	2343	6.0	0.318	2.62	47	80	83	15	80	1020
(iii) 50% OF PULL AT MAXIMM POWER													
H1	10.47	15.7	5.4	2369	2.0	0.360	2.32	47	78	82	15	80	1020
HIGHEST GEAR SAME PULL AS IN (ii) REDUCED ENGINE SPEED													
H2	10.16	22.3	7.9	1596	6.0	0.269	3.10	50	83	69	16	74	1020
HIGHEST GEAR SAME PULL AS IN (iii) REDUCED ENGINE SPEED													
H2	10.47	15.7	5.4	1614	2.0	0.284	2.94	49	78	68	16	77	1020
(2b) TRANSMISSION AND FUEL CONSUMPTION CHARACTERISTICS													
(i) SELECTED GEAR (Maximm power)													
H2	14.66	28.5	7.0	2250	2.9	0.299	2.79	49	83	80	14	80	1020
(ii) 75% OF PULL AT MAXIMM POWER													
H2	15.15	22.3	5.3	2311	2.0	0.324	2.58	47	80	81	14	80	1020
(iii) 50% OF PULL AT MAXIMM POWER													
H2	15.63	15.2	3.5	2367	1.3	0.367	2.27	46	78	79	15	90	1020
HIGHEST GEAR SAME PULL AS IN (ii) REDUCED ENGINE SPEED													
H3	15.15	22.3	5.3	1691	2.0	0.283	2.95	52	83	66	16	80	1020
HIGHEST GEAR SAME PULL AS IN (iii) REDUCED ENGINE SPEED													
H3	15.63	15.2	3.5	1741	1.3	0.315	2.65	47	75	65	15	80	1020

B. OPTIONAL TESTS

LOCATION OF CENTRE OF GRAVITY

Height above ground, mm	645
Distance forward from the vertical plane containing the axis of the rear wheels, mm	789
Distance from the median plane of the tractor, mm	0

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. Stayner for the Director

Date: 1st July 1987.