AFRC Institute of ENGINEERING RESEARCH

OECD Approval No. 1087 Restricted Code
Date of Approval: 17th September 1987

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

Massey-Ferguson 360 Four-Wheel Drive Tractor with 8-speed Transmission



Manufacturered by	Massey-Ferguson Manufacturing Limited, Banner Lane, Coventry, Warwickshire. CV4 9GF
Test No.	R87/70598/OECD
Report No.	719
Date	August 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 360 with 8-speed transmission
Type:	Four wheel drive, unit construction
Serial No:	5222U51139
1st Serial No:	5221U01001

ENGINE

Make:	Perkins
Model:	AT3. 1524
Type	4-stroke, direct injection, diesel turbo charged
Serial No:	CN 311 85U798227P
Cylinders	
Number/disposition:	3, vertical, in-line
Bore/stroke:	91.4 mm/127.0 mm
Capacity:	2500 cm^3
Compression ratio:	15.5:1
Arrangement of valves:	Overhead
Cylinder liners:	Dry
Supercharging	
Make:	Holset
Model:	H1D
Type:	Exhaust driven
Supercharging pressure:	0.06 MPa

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, DPA3238F470
Serial No:	24033 AEG
Manufacturer's production setting of injection pump:	11.1-12.7 l/h at 2250 rev/min engine speed at full load and 55°C pump inlet temperature
Injection pump timing:	Delivery starts 16° before T.D.C., static
Make, type and model of injectors:	C.A.V. 4-hole, LRB 6701503
Injection pressure:	21.2 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:	Donaldson, centrifugal
Location:	In main cleaner
Main	
Make and type:	Donaldson, FLG-06, 2-stage dry paper element
Location:	Under engine cover
Maintenance indicator:	Warning light on instrument panel
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:	4
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
Starter motor	
Make:	Lucas
Type:	Electrical, pre-engaged, solenoid operated
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:	241579
Type:	A127, Belt driven
Power:	0.54 kW
Batteries	1, M.F. Powerpart, lead-acid maintenance free
Rating:	420 ACCA rating or equivalent 75 Ah at 20-hour rating
Exhaust system	
Make:	Nelson-Burgess
Type:	Spark arrester silencer
Model:	16BC53
Location:	Vertical on left hand side
Height of outlet above ground:	2391 mm

TRANSMISSION

Clutch	
Make:	Laycock
Type:	Dry, for transmission only
Number of plates:	1
Diameter of plates:	305 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:	None
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
Front axle and final drives	
Make:	Massey-Ferguson
Type:	Crown wheel and pinion with Autolock differential and epicyclic reduction gear final drives
Driven from:	Rear axle pinion shaft via spur gears and propellor shaft on left-hand side
Differential lock:	Automatic incorporated in Autolock differential

Transmission oils

Gear box, transmission, final drives and power lift housing:	
Capacity	49.8 l
Change period:	1000 hours
Front axle	
Differential:	5.8 l
Final drives:	2.8 l
Change period:	1000 hours
Type of oil filter:	None
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
1	L	235.97	2.19
2	L	160.89	3.22
3	L	87.76	5.90
4	L	71.51	7.24
1	H	58.99	8.77
2	H	40.22	12.86
3	H	21.94	23.58
4	H	17.88	28.94
Reverse			
1	L	173.28	2.99
2	H	43.32	11.95

L = Low range H = High range

Rear tyre size: 13.6-28

Tyre radius index: 610 mm

POWER TAKE-OFF

Main power take-off

Type:	Independent of main clutch
Method of engagement:	Lever and hydraulically operated multiplate clutch
Number of shafts:	1
Method of changing power take-off speeds:	Not applicable

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:	8.3-24, 13.6-28
Height above ground:	465 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 LIFT

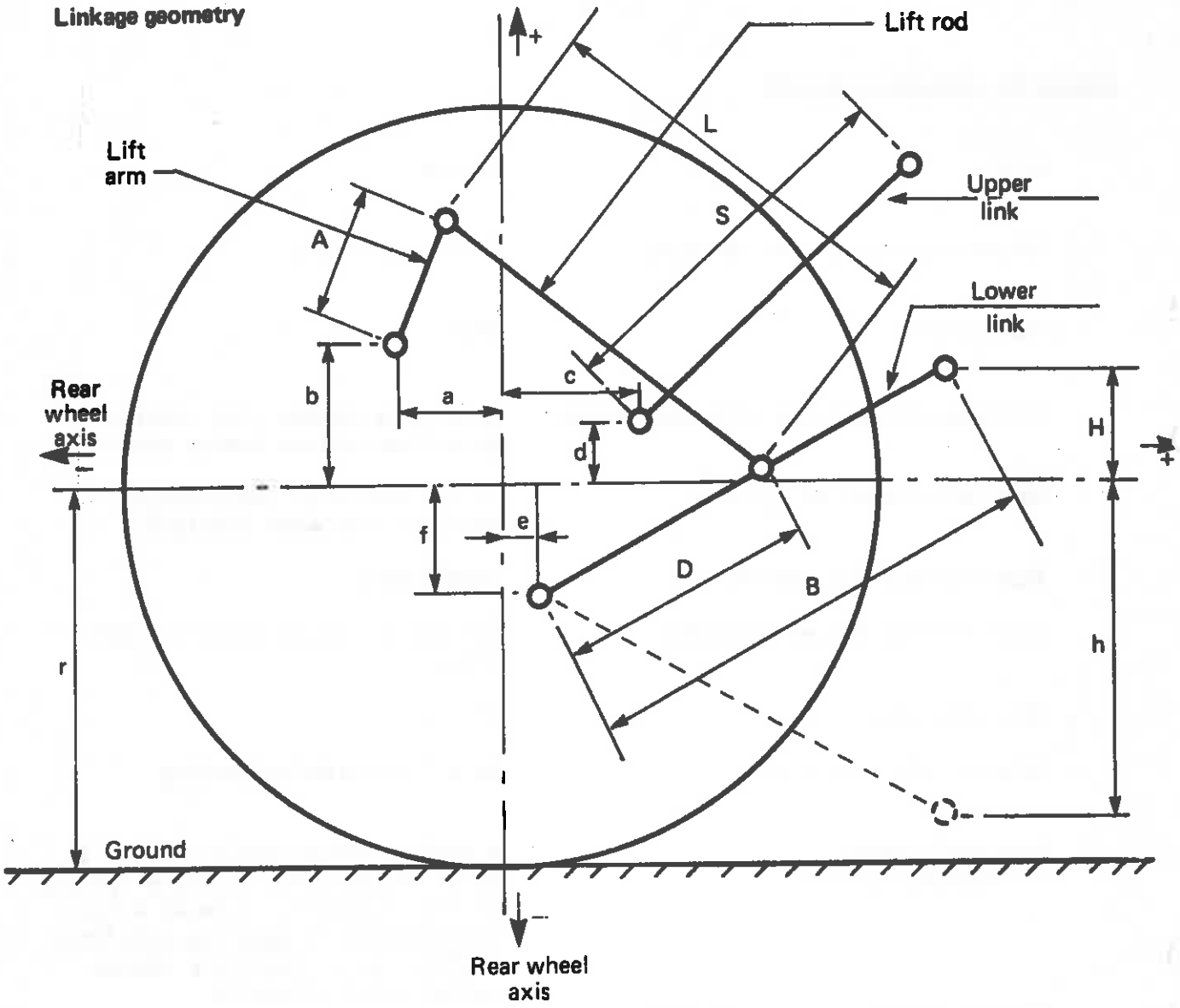
Make:	Massey-Ferguson
Type:	Hydraulic
Number and type of cylinders:	One, single acting
Type of linkage lock for transport:	Hydraulic
Relief valve pressure setting:	20.5 - 24.0 MPa
Opening pressure of cylinder safety valve:	None fitted
Lift pump type:	4-cylinder piston
Transmission between pump and engine:	Driven from pto shaft, independent of main clutch
Make and number of filters:	1, 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, a valve allows flow to spool valves and quick release couplings when selected
Maximum volume of oil available to external cylinders:	18 l
Recommended oil	See "Fuels and lubricants used in tests"

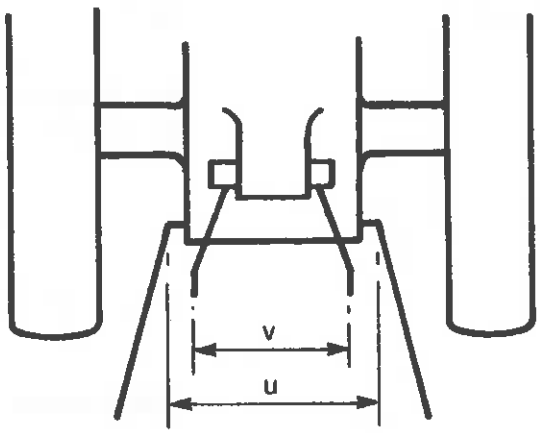
AUXILIARY HYDRAULIC SYSTEM

Make:	Cessna
Relief valve pressure setting:	17.0 - 20.6 MPa
Pump type:	Gear
Transmission between pump and engine:	Driven in tandem with steering pump from engine timing gears
Make and number of filter:	Parker Hannifin replaceable canister and mesh strainer
Time between oil changes	1000 hours
Time between filter changes:	250 hours, clean strainer 1000 hours
Oil capacity:	47.4 l
Site of oil reservoir:	Main transmission housing
Type and number of tapping points:	2 quick release couplings via 2 spool valves with separate returns to ISO standard. A valve allows combination of main and auxiliary systems up to auxiliary system relief valve pressure
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
Lift arm
Upper link
Lower link
Rear wheel axis
Ground
Rear wheel axis
L
S
A
b
a
c
d
e
f
D
B
H
h
r
+
-


v
u

Linkage dimensions for the lifting test

Rear tyres: (size 13.6-28) radius index:		(r)	610 mm
Front tyres:(size 8.3-24) loaded radius:		(r')	470 mm
Length of lift arms:		(A)	267 mm
Length of lower links:		(B)	903 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)	678 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)	620 mm
Height of lower hitch points relative to the rear wheel centre line, situated 610 mm above the ground level			
- in low position:		(h)	491 mm
- in high position:		(H)	188 mm
Height of lower hitch points when locked in transport position:		Any height within lift range	

SWINGING DRAWBAR

Tyre sizes	Front:	8.3-24
	Rear:	13.6-28
Height above ground,	maximum:	372 mm
	minimum:	234 mm
Type of adjustment:		Inverting drawbar and clevis
Distance of hitch point from rear axle centre:		646 mm and 696 mm
Distance of hitch point from power take-off shaft ends:		
vertically:		93 mm to 234 mm
horizontally:		350 mm and 400 mm
Lateral adjustment:		505 mm and 532 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:	637 mm
Width of clevis:	63 mm
Diameter of pin hole:	33 mm

STEERING

Method of operation:	Hydrostatic system with hand operated steering motor powered from engine mounted pump operating two rams.
Pump:	Cessna gear type in tandem with auxiliary hydraulic system pump.
Motor:	Danfoss OSPC-ON
Oil cooler:	Mounted to front of radiator
Rams:	Massey-Ferguson double acting, one each side
Working pressure:	14 MPa
Oil capacity:	47.4 l
Oil change period:	1000 hours
Make and model of filter:	Parker Hannifin replaceable canister and metal strainer
Filter(s) change period:	250, hours
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
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
Front tyres:	Goodyear Dyna Torque
Size:	8.3-24
Ply rating:	8
Type of casing:	Cross-ply
Maximum permissible load on each tyre:	935 kg
Corresponding inflation pressure:	310 kPa
Track widths:	1330 mm by 8 steps to 1690 mm
Method of adjustment:	By reversing wheels and offset lug rims

DRIVING WHEELS

Number:	4
Location:	At front and rear
Rear tyres:	Goodyear Dyna Torque
Size:	13.6-28
Ply rating:	6
Type of casing:	Crossply
Maximum permissible load on each tyre:	1430 kg
Corresponding inflation pressure:	160 kPa
Track widths:	1400 mm by 102 mm steps to 2112 mm
Method of adjustment:	Power assisted variable truck

WHEELBASE 2132 mm

PROTECTIVE STRUCTURE SPECIFICATION

OECD approval number:	CSS 052/14
Trade name and model:	Massey Ferguson 300H
Manufacturer:	Massey-Ferguson Manufacturing Ltd
Description:	A two-post folding ROPS of steel welded and bolted construction to the rear of the operator's seat, bolted to the rear axle casings.

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 8.3-24: rear 13.6-28

	Height above ground of centre, mm	Size, mm	Distance from outside edge of tractor to centre, at 1500 mm track width, mm
Headlights	1005	100 x 160	785
Front work lights	1565	130 x 70	220
Rear light, left side	980	110 x 70	547
Rear axle reflectors	575	80 dia	478

CONDITIONS DURING TEST

Overall dimensions

(front: 8.3-24 rear: 13.6-28 tyres fitted)

Length, m	Width, min. m	Width, max. m	Height at top of, Protective structure, m	Height at top of, Steering wheel, m
3.50	1.78	2.49	2.36	1.64

Ground clearance

Clearance: 178 mm limited by drawbar clevis in lowest position

Track setting

Front: 1445 mm
Rear: 1540 mm

Tractor mass

(without driver but with tanks full and ROPS fitted)

Front, kg	Rear, kg	Total, kg
1057	1429	2486

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, steering and hydraulics		
Type:	SAE 15W/30	
Viscosity:	54 cSt at 50°C	As recommended
Classification:	MIL-L-2104-C	
Front differential and final drives		
Type:	SAE 15W/30	
Viscosity:	54 cSt at 50°C	As recommended
Classification:	MIL-L-2104-C	
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: 20th July 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						
36.7	2250	679	11.38	9.50	0.259	3.22
POWER AT RATED ENGINE SPEED						
36.7	2250	679	11.38	9.50	0.259	3.22
POWER AT STANDARD POWER TAKE-OFF SPEED						
33.4	1789	540	9.57	7.99	0.239	3.49
PART LOADS						
(1) The torque corresponding to maximum power at rated engine speed						
36.7	2250	679	11.38	9.50	0.259	3.22
(2) 85% of the torque obtained in (1)						
31.6	2283	689	10.23	8.54	0.270	3.09
(3) 75% of the torque defined in (2)						
24.1	2315	699	8.57	7.15	0.297	2.81
(4) 50% of the torque defined in (2)						
16.2	2342	707	6.81	5.68	0.351	2.38
(5) 25% of the torque defined in (2)						
8.1	2358	712	5.10	4.26	0526	1.59
(6) Unloaded						
0	2402	725	3.65	3.05	-	-

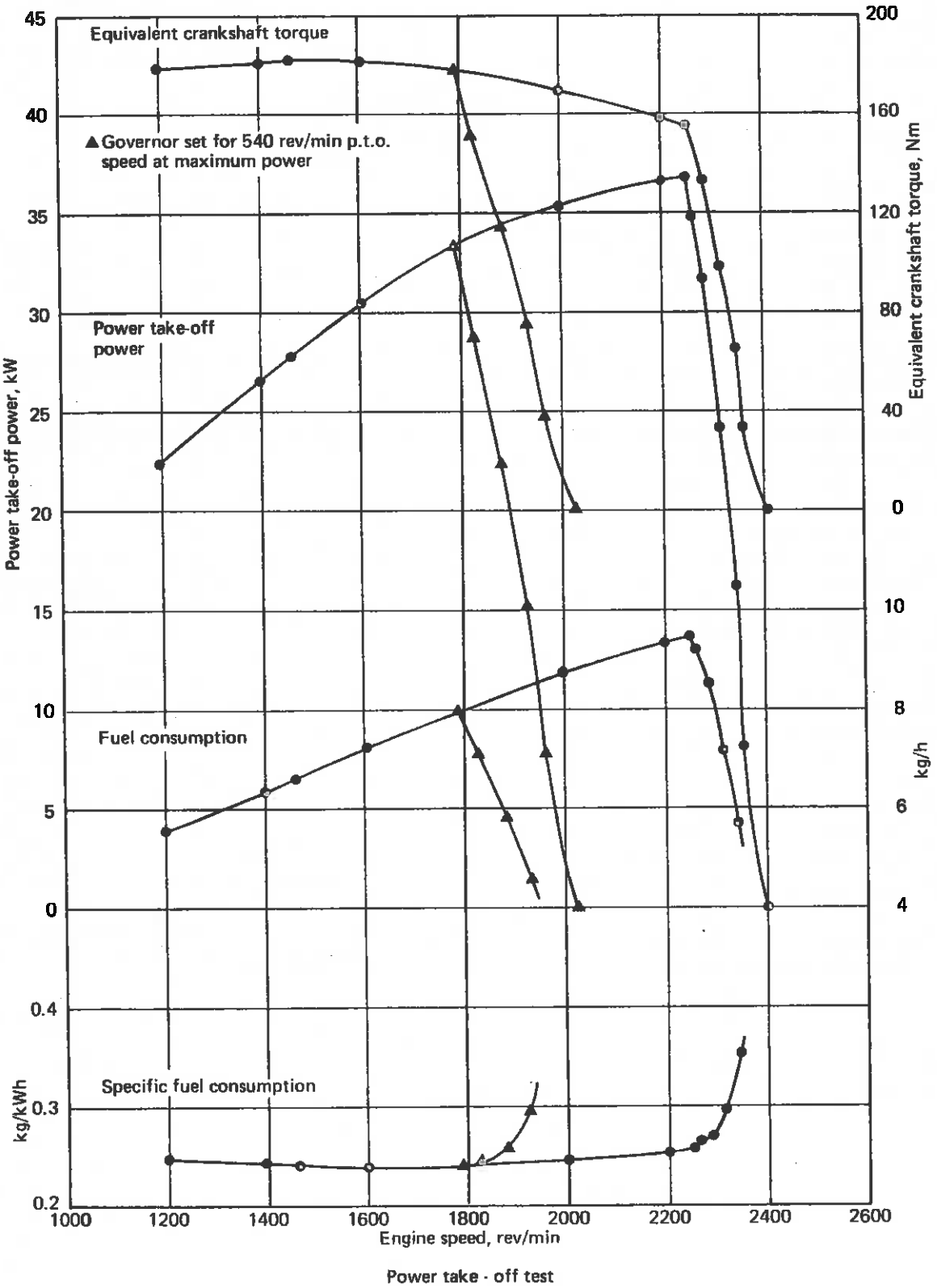
Part loads, the governor hand lever in the position corresponding to the standard p.t.o. speed at full load (540 rev/min).

Power, kW	Speed, rev/min		Fuel consumption, Hourly,		Specific,	Specific energy,
	Engine	P.t.o.	l/h	kg/h	kg/kWh	kWh/l
(1) The torque corresponding to maximum power at standard pto speed						
33.4	1789	540	9.57	7.99	0.239	3.49
(2) 85% of the torque obtained at maximum power						
28.9	1821	550	8.47	7.07	0.245	3.41
(3) 75% of the torque defined in (2)						
22.4	1879	567	6.95	5.80	0.259	3.22
(4) 50% of the torque defined in (2)						
15.3	1926	581	5.44	4.54	0.297	2.81
(5) 25% of the torque defined in (2)						
7.8	1961	592	3.85	3.21	0.412	2.03
(6) Unloaded						
0	2021	610	2.54	2.12	-	-

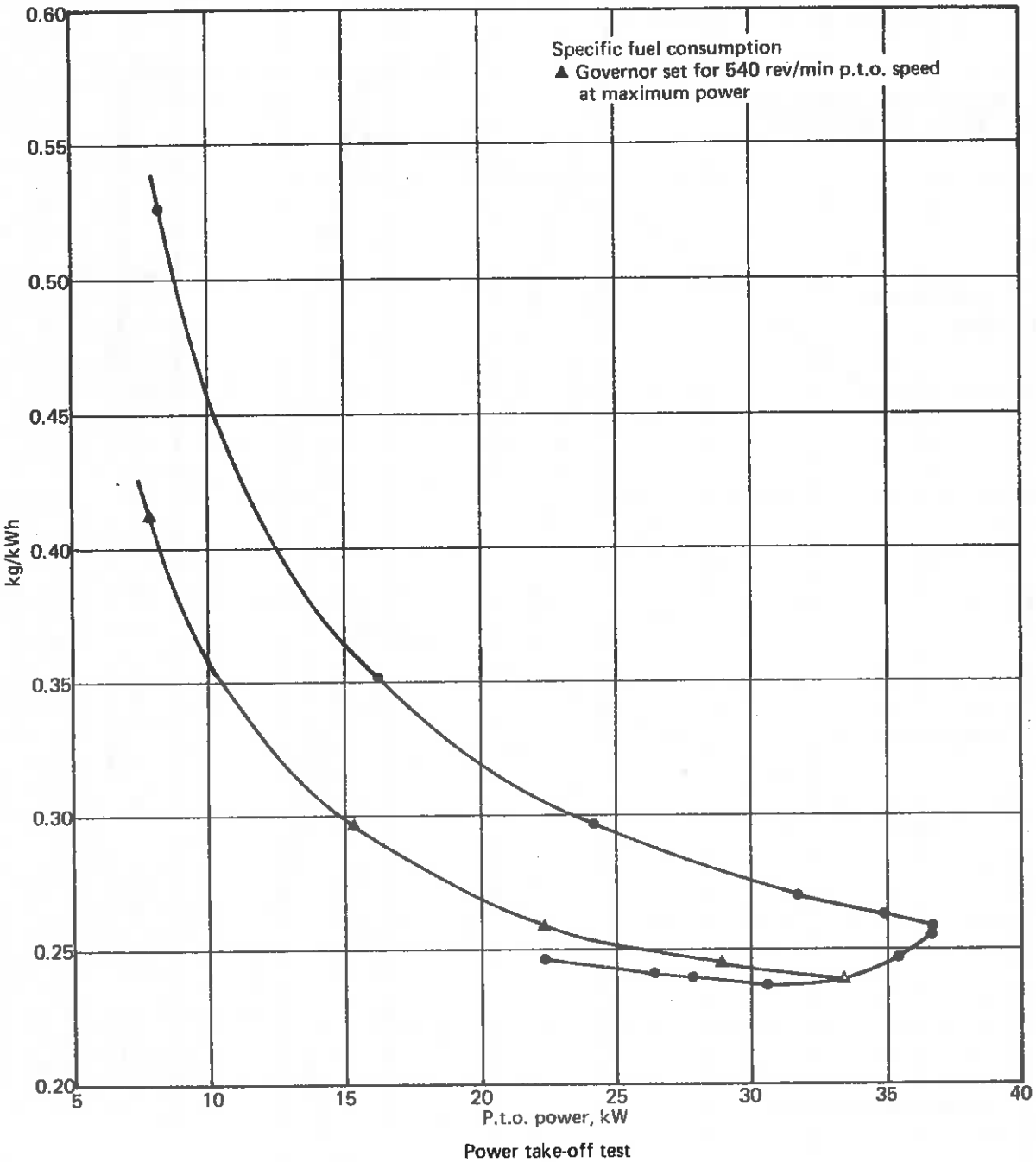
Standard specific fuel consumption, kg/kWh

(a) 0.270 (c) 0.245
(b) 0.351 (d) 0.297

No load, maximum engine speed		2402 rev/min
Equivalent crankshaft torque at maximum power		155.8 Nm
Maximum equivalent crankshaft torque		182.0 Nm at 1460 rev/min engine speed
Mean atmospheric conditions	temperature	23°C
	pressure	1028 m bar
	relative humidity	70%
Maximum temperature	coolant	72°C
	engine oil	90°C
	fuel	57°C
	air intake	26°C



Power take - off test



Power take-off test

2. LIFTING FORCE AND HYDRAULIC POWER (without auxiliary system in operation)

Date of tests: 3rd June 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: 60°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	119	679	19.3	21.2	16.8	-
On the frame	119	915	17.3	21.2	25.6	21

Main linkage dimensions - see drawings and table on pages 10 and 11

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

mm	-341	-279	-200	-100	0	100	200	361	528

Lifting forces at hitch points
(corresponding pressure 21.2 MPa)

kN	-	19.3	20.8	22.4	23.8	24.6	25.4	27.4	-

Lifting forces at test frame
(corresponding pressure 21.2 MPa)

kN	18.1	18.8	18.8	18.8	19.0	19.0	18.7	18.0	17.3

Hydraulic power test

Sustained pressure with relief valve open	23.6 MPa
Pump delivery rate at minimum pressure	20.5 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	18.9 l/min
Pressure	21.2 MPa
Power	6.7 kW

Flow rate and hydraulic pressure corresponding to maximum hydraulic power

Flow rate	18.5 l/min
Pressure	22.0 MPa
Power	6.8 kW

Tapping point used for test: Auxiliary service connection fitted for test only

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

3. MAXIMUM DRAWBAR POWER, TRANSMISSION AND FUEL CONSUMPTION CHARACTERISTICS

Date of tests: 24th and 29th June 1987
Type of track: Concrete

Height of drawbar above ground: 225 mm

Tyre size and pressure:
Front: 8.3-24 83 kPa
Rear: 13.6-28 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													
L1*	1.94	12.0	22.3	2334	15.0	0.492	1.70	47	70	83	21	77	1010
L2*	2.83	17.5	22.3	2306	15.0	0.419	1.99	52	70	77	20	78	1010
L3	5.33	27.7	18.7	2246	10.4	0.346	2.41	50	71	80	19	80	1012
L4	6.75	27.0	14.4	2247	6.4	0.349	2.39	51	72	77	18	90	1014
H1	8.37	27.9	12.0	2252	5.0	0.335	2.49	49	72	78	19	89	1013
H2	12.47	27.7	8.0	2248	3.0	0.348	2.40	54	72	76	19	88	1012
(2) TRANSMISSION AND FUEL CONSUMPTION CHARACTERISTICS													
(i) SELECTED GEAR													
H1	8.37	27.9	12.0	2252	5.0	0.335	2.49	49	72	78	19	89	1013
(ii) 75% OF PULL AT MAXIMUM POWER													
H1	8.64	21.6	9.0	2292	3.5	0.372	2.24	52	71	80	19	85	1012
(iii) 50% OF PULL AT MAXIMUM POWER													
H1	8.88	14.8	6.0	2323	2.3	0.439	1.90	48	70	78	19	85	1011
HIGHEST GEAR SAME PULL AS IN (ii) REDUCED ENGINE SPEED													
H2	8.64	21.6	9.0	1559	3.5	0.311	2.68	61	76	71	26	91	1021
HIGHEST GEAR SAME PULL AS IN (iii) REDUCED ENGINE SPEED													
H2	8.94	14.9	6.0	1580	2.3	0.333	2.51	61	74	71	26	91	1022

*Maximum power limited by wheelslip

REPAIRS AND ADJUSTMENTS DURING TESTS: None

REMARKS: None

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

Officer in charge: P.C. Seward

Signed: D W. Smith Head of Testing Group

R. M. Stayner for the Director

Date: 26th August 1987.