Institut za mehanizaciju poljoprivrede - Zemun

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Report on Test in Accordance with O.E.C.D. STANDARD CODE for the Official Testing of Agricultural Tractors



Agricultural tractor RAKOVICA 65

Manufactured by: Industrija Motora Rakovica
Beograd, Yugoslavia

Date of test: October–December 1979

This Bulletin is based on engineering tests in accordance with the O.E.C.D. STANDARD–CODE for the Official Testing of Agricultural Tractors.

It does not contain an evaluation of the performance of the tractor on practical work.

This Report has been aporoved by the O.E.C.D. Co–ordinating Centre (C.E.M.A.G.R.E.F.) as being in accordance with the O.E.C.D. STANDARD –CODE.

Date of Approval: October 23rd 1981

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TABLE OF CONTENTS

Specification of tractor	1 to 8
Conditions during test	9
Fuels and lubricants used in tests	1o
COMPULSORY TESTS	
1. Main Power-take off performance	11 to 14
2. Drawbar performance	15 and 16
3. Turning space and turning circle	17
4. Location of centre of gravity	17
5. Braking	18
6. Ambient noise, emitted by the tractor	19
7. Noise at the driver's ear level	19
8. Power lift and hydraulic pump performance	2o to 23

Tractor manufacturer:	IMR-Industrija Motora Rakovica 11o9o Rakovica-Beograd, Yugoslavia
Submited for test by:	The manufacturer
Selected by:	Representatives of IMP
Place of running-in:	Laboratory of IMP
Duration of running-in:	cca 5o hours

SPECIFICATION OF TRACTOR

TRACTOR

Make:	IMR
Model:	RAKOVICA 65
Type:	Standard-unit construction, four wheels, rear wheels driven
Serial N°:	6o25474/877

ENGINE

Make:	IMR
Model:	DM 34/T
Type:	Four stroke, water cooled diesel, direct injection
Serial N°:	39993
Cylinders:	4, vertical, in-line, bore 91,44 mm, stroke 127 mm displacement 3336 cm^3, compression ratio 17,4:1, overhead valves, replaceable dry cylinder liners
Fuel system:	IPM membrane type feed pump with hand primer; KRON two paper element fuel filters on pressure side of feed pump, first filter with sediment bowl fuel tank capacity 6o l; CAV-IPM distributor type DPA 324o F 968 injection pump, Serial N° 4668o PS, manufacturer's production setting 54 mm^3 at 12oo rev/min engine speed (cca48 mm^3 at 23oo rev/min engine speed); injection timing 16° before T.D.C.; CAV-IPM injector nozzles of multi hole type (four holes), model EE, injection pressure setting 19o^{+} 5,o bar, (working pressure cca 17o bar)

Governor:	CAV-IPM, mechanical, all range, incorporated in fuel injection pump, governed range of engine speed 500±30 to 2400±30 rev/min, rated engine speed 2300 rev/min
Air cleaner:	Main IKARUS with oil bath, oil capacity 0,8 l centrifugal pre-cleaner KRON
Lubrication system:	Forced feed from gear pump with strainer in sump, full flow replaceable paper element filter; total oil capacity 7,8 l; recommended oil quality MIL-L-2104C; recommended oil viscosities: winter SAE 20 summer SAE 30 tropics SAE 40 oil and filter change interval 200 h
Cooling system:	Water cooling with impeller pump; pressurized system set to 0,4 bar overpressure fan with 6 blades, 406 mm diameter; pump delivery 126 l/min of water, fan delivery 2,17 m^3/S of air, both at 2300 engine rev/min water capacity 20,2 l; temperature control by membrane type thermostat
Starting system:	Electrical ISKRA solenoid-engaged starter motor OSN 1/n-12/2,5/10-1, 2,5 kW; heating plug in intake manifold as aid for cold starting
Exhaust:	Vertical, above bannet, on left hand side of the engine, mouth 2300 mm above ground; silencer dimensions: dia 100 mm; length 595 mm
Electrical system:	12 Volt, negative earth; ISKRA alternator AAG 0603 14V 28A; two 12V lead-acid batteries, each with 56 Ah capacity at 20-hour rating

TRANSMISSION

Clutch:	KRON - Novi Beograd, KS 214; dry, dual friction disc type double acting clutch, tractor and p.t.o. shaft drive disc dia 27o mm, mechanically pedal operated
Gearbox:	Own make; mechanical with sliding gears, 3 forward and 1 reverse gear and low and high speed selector with two paars of cylindrical gears; N° of speeds (totally): 6 forward 2 reverse
Rear axle and final drive:	Own make; Bevel gear drive with crown wheel and pinion; bevel gear type differential with lock, pedal operated, self disengaging; final drives with cylindrical gears;
Oil capacities:	Gearbox, rear axle and final drives 2o l
Oil changing period:	8oo - 1ooo hours
Recommended oil qualities:	Winter hypoid oil SAE 9o Summer hypoid oil SAE 14o according to MIL-L-21o5B

Total ratios and speeds

Gear	Total ratio engine: driving wheel	Nominal travelling speed (km/h) at rated engine speed	at standard p.t.o. speed 54o rev/min
Forward speeds			
1 low	2o6,18	2,69	2,33
2 low	13o,44	4,25	3,69
3 low	74,91	7,41	6,42
1 high	55,1o	1o,o7	8,73
2 high	34,88	15,91	13,79
3 high	2o,o4	27,69	24,o1
Reverse speeds			
low	136,98	4,o5	3,51
high	36,69	15,12	13,11

Calculated with driving wheel rolling radius 64o mm given in the tyre manufacturer's specification

Power take-off

Main p.t.o.	Semi-independent p.t.o.; at rear of tractor in the median plane; driven through the first disc of the double acting clutch, mechanically pedal operated; height above ground 64o mm, dimensions 29x34,9x x8,7 mm; 6 splines acc. to JUS M.Ll.6o1; DIN 9611 form A; BS 1495; dimensions and location acc. to ISO 5oo
Proportional to engine speed p.t.o.	Speed at rated engine speed (23oo rev/min) 623 rev/min; standard p.t.o. speed 54o rev/min at 1994 engine rev/min; direction of rotation clockwise, viewed from tractor rear

Ground p.t.o.	Distance travelled for one revolution of p.t.o. o,338 m (calculated with rolling radius 64o mm); number of p.t.o. revolutions for one revolution of driving wheel 11,89; direction of rotation clockwise, facing driving end of p.t.o. and with tractor in forward gear
Fast p.t.o.	Located at rear of tractor in the median plane, normally covered with a plate; height above ground 76o mm; dimensions 29x34,9x8,7 mm, 6 splines acc. to JUS M.L1.6o1 Speed equal to engine speed; direction of rotation contra clockwise, viewed from tractor rear
Belt pulley:	Available optionally; located at rear of tractor, connected to fast p.t.o. shaft; width 17o mm; diameter 24o mm; speeds at rated engine speed (23oo rev/min) linear 28,9o m/s rotational 23oo rev/min engine speed at standard belt pulley speed (945 m/min) 1253 rev/min; direction of rotation clockwise viewed face of pulley
Power lift:	Own make; block construction;
Hydraulic system:	Hydraulic gear pump PPT with 27,2 l/min delivery at rated engine speed (23oo rev/min), driven by the engine, with control valve at suction side; control valve for lifting and sinking, draught control, position control, both stepless mixable;

opening pressure of relief valve 165 bar,
the working pressure up to 160 bar;
single acting ram with 110 mm bore, 90 mm stroke;
oil capacity 14 l, max 2,5 l may be taken off trough oil tappings;
recommended oil quality acc.to MIL-L-2105;
viscosity SAE 90 - SAE 140;
change period 1000 h (2 times yearly);
strainer on suction side of gear pump, maintained each 1000 h by washing.

Implement linkage: Three point linkage category I and II (alternativlly) in acc.with ISO
lift rods adjustable from 440 to 580 mm,
lifting range above ground
with shert lift rods from 510 to 860 mm
with long lift rods from 195 to 570 mm
(rear wheels static radius 645 mm)

Pull attachment

Swinging drawbar: Height above ground (mm): 335 445 790
455 545 690

adjustable by using diferent holes for fixing drawbar to the rear axle housing and by turning drawbar;

diameter of coupling pin 32,5 mm;
horizontal distance of clevis hole centre to:
rear axle centre 664 mm
p.t.o. shaft end 380 mm

Swingable about 130 mm to either side with fixing points in the median position and 42, 84 and 126 mm to both sides;
pivot point 174 mm behind the rear axle.

Steering: "SOKO" - Mostar
globoid worm gear;
manual control with arm and connecting rod

Brakes

Service brake:	Own make; mechanically acting band type brake with drums located in the rear axle housing before final drive; operated with 2 pedals coupled by a latch.
Steering brake:	Divided pedals of service brake, for normal use locked together;
Trailer brake:	Optional equipment, fitted on the tested tractor; make PPT; single line air brake, operated by pedal mounted valve; air compressor with 75 mm bore, 28 mm stroke driven by the engine at 2390 rev/min speed by rated engine speed (2300 rev/min); compressor delivery 0,30 m^3/min at atmospheric pressure and rated engine speed; pressure control valve with filter and coupling for tyre pressurizing, operating within 4,8-5,3 bar; compressed air tank with 20 l capacity; maximum air pressure 7 bar; standardized coupling head;

Wheels

Steering wheels:	2 wheels in front with pneumatics 6,00-19 6 ply, diagonal type tyre casing; maximum permissible load per tyre 600 kg at 2,0 bar inflation pressure and 30 km/h; rims 4,5E x 19 track width adjustable from 1370 to 1870 mm in 100 mm steps

Driving wheels:	2 wheels at rear with pneumatics 14,9-28 6 ply, diagonal type tyre casing; maximum permissible load per tyre 151o kg at 1,3 bar inflation pressure and 3o km/h rims W12x 28 track width 128o; 145o; 151o; 169o; 171o; 175o and 196o mm adjustable by turning wheels and dises
Wheel base:	2o5o mm
Seat:	POLIESTER - Priboj, Derby G 3oo upholstered seat with back rest; adjustable spring with shock absorber; range of adjusments: - vertically 5o mm - horizontally 5o mm
Number of grease points:	8 with grease
Lighting equipment:	Electrical, 12 Volt, negative earth

	Dimensions mm	Height above ground to centre mm	Distance from outside edge of tractor to centre 1) mm
Head lights	Ø 13o	131o	55o
Position lights	Ø 5o	11oo	58o
Rear lights	Ø 5o	125o	27o
Reflector	Ø 1oo	137o	42o

unrestricted beam angle of Head lights in plan view 32°

1) with the rear wheels track width 145o mm

CONDITION DURING TEST

Weights Ready for use as tested

	without driver	with driver
Without ballast:		
front	845 kg	86o kg
rear	141o kg	147o kg
total	2255 kg	233o kg
With ballast:		
front	1115 kg	113o kg
rear	2o5o kg	211o kg
total	3165 kg	324o kg

Ballast:

front: 8 weights 3o kg each and weight carrier 2o kg — total 26o kg

rear: 4 weights 6o kg each — total 24o kg
water in tyres 41o kg

Track setting

Front axle 137o mm
Rear axle 151o mm

Dimensions

Total length: 332o mm without ballast
345o mm with front ballast

Total width: 19oo mm with rear wheels track width 151o mm and without rear ballast; 193o mm with rear ballast

Total height: 1685 mm to the top of steering wheel
23oo mm to the top of exhaust pipe

Ground clearance: 45o mm in tractor's median plane, below the gearbox housing

FUELS AND LUBRICANTS USED IN TESTS

Fuel:	INA Diesel - fuel D_2 in all tests Specific gravity at $15^{o}C$ o,823 g/cm^3 Cetane number 56 Viscosity 4,9 mm^2/S at $15^{o}C$
Engine oil:	Galax Super SAE 2o (JUS B.H3.143)
Transmission and final drive oil:	Hypol SAE 9o (JUS B.H3.3o4)
Power lift oil:	Hydraulic oil HD 7o

COMPULSORY TESTS

(1) MAIN POWER TAKE-OFF PERFORMANCE

Date and location of tests: 15. Avgust 1979
Institut for Agricultural Mechanization - Zemun

Type of dynamometer: Hydraulic brake SCHENCK U1-3o

Power	Speed engine	Speed p.t.o.	Fuel consumption hourly	Fuel consumption specific		Specific energy
kW	rev/min	rev/min	l/h	kg/h	kg/kWh	kWh/l
	MAXIMUM POWER					
	At 2-hour test					
4o,26	23oo	623	13,54	11,1o	o,276	2,97
	At standard p.t.o. speed (54o rev/min)					
38,12	1994	54o	12,oo	9,87	o,259	3,18
	At speed recommended by the manufacturer for drawbar work					
4o,26	23oo	623	13,54	11,1o	o,276	2,97
	PART LOADS					
	Governor hand lever in position giving maximum power					
(i) 85 % of torque at maximum power						
34,92	2348	636	11,77	9,65	o,276	2,96
(ii) unloaded						
o,58	243o	658	4,26	3,49	-	-
(iii) 5o % of the load defined in (i)						
17,68	2378	674	7,58	6,27	o,352	2,33
(iv) maximum power						
4o,26	23oo	623	13,54	11,1o	o,276	2,97
(v) 25 % of the load defined in (i)						
8,98	2411	653	5,77	4,73	o,527	1,56
(vi) 75 % of the load defined in (i)						
26,25	2352	637	9,53	7,82	o,298	2,75

Power	Speed engine	Speed p.t.o.	Fuel consumption hourly	Fuel consumption hourly	Fuel consumption specific	Specific energy
kW	rev/min	rev/min	l/h	kg/h	kg/kWh	kWh/l
Governor hand lever in position giving standard p.t.o. speed at full load (540 rev/min)						
(i) 85 % of the torque at full load						
32,95	2031	550	10,30	8,48	0,257	3,20
(ii) unloaded						
0,34	2145	581	2,09	1,72	-	-
(iii) 50 % of the load defined in (i)						
16,91	2090	566	6,35	5,22	0,309	2,66
(iv) full load						
38,12	1994	540	12,00	9,87	0,259	3,18
(v) 25 % of the load defined in (i)						
8,68	2123	575	4,79	3,94	0,454	1,81
(vi) 75 % of the load defined in (i)						
25,10	2075	562	8,33	6,85	0,273	3,01

STANDARD SPECIFIC FUEL CONSUMPTION:
0,276; 0,352; 0,257; 0,309 kg/kWh

No load, maximum engine speed: 2436 rev/min

Equivalent crankshaft torque at maximum power: 16,71 daNm

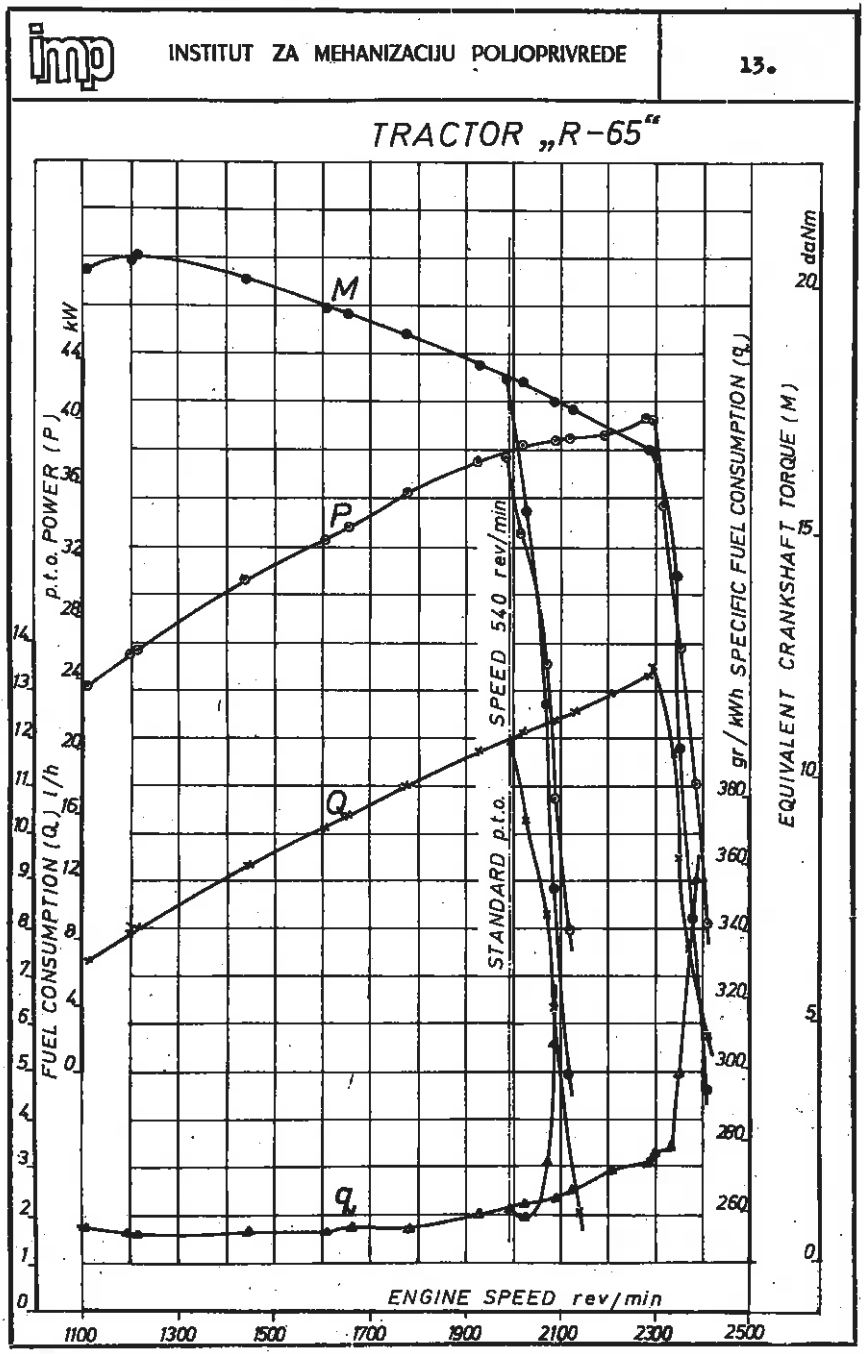
Maximum equivalent crankshaft torque: 20,63 daNm at 1211 engine rev/min

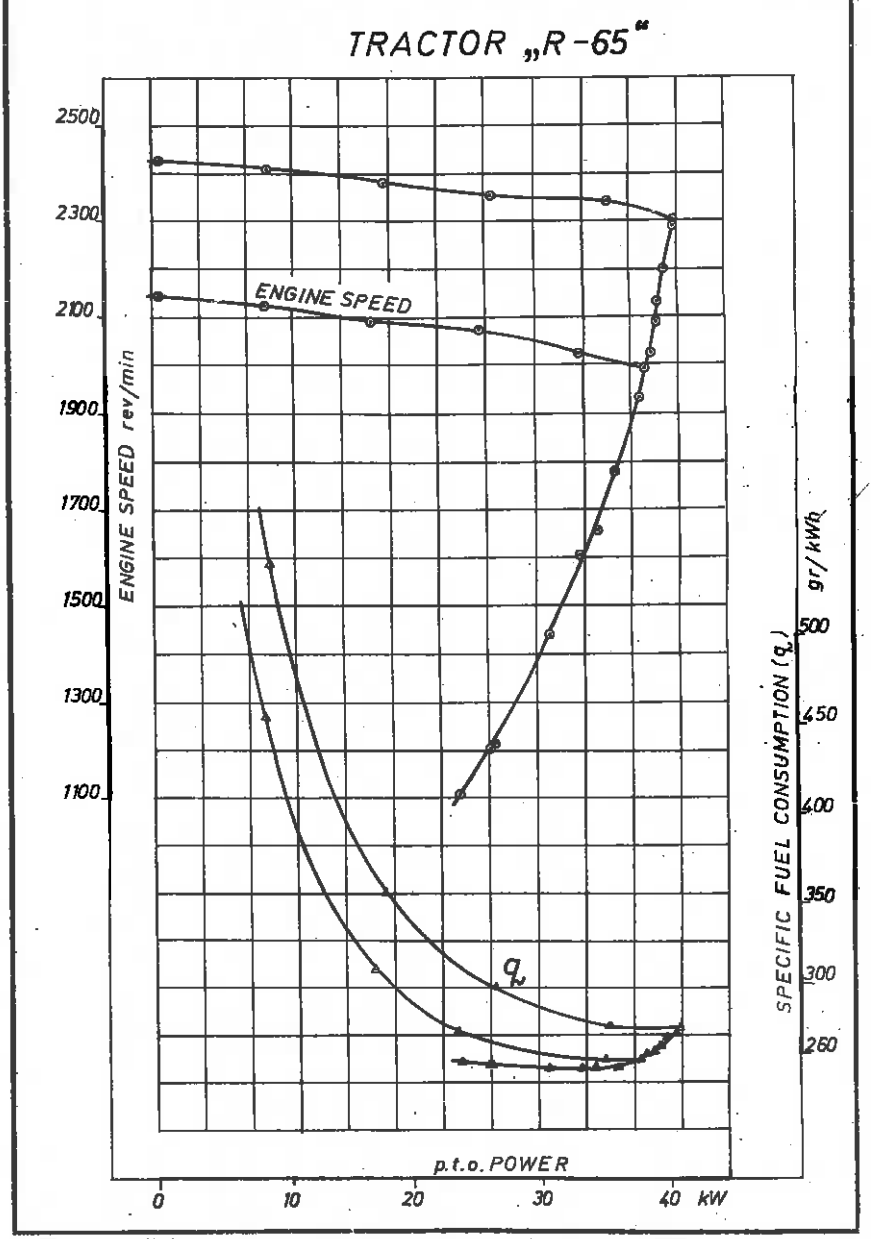
Mean atmospheric conditions:

- temperature: 18 °C
- pressure: 1004 mbar
- humidity: 56 %

Maximum temperatures:

- coolant: 86 °C
- engine oil: 97 °C
- fuel: 21 °C
- air intake: 23 °C


TRACTOR „R-65“
M
P
Q
q
p.t.o. POWER (P) kW
FUEL CONSUMPTION (Q) l/h
gr/kWh SPECIFIC FUEL CONSUMPTION (q)
EQUIVALENT CRANKSHAFT TORQUE (M) daNm
STANDARD p.t.o. SPEED 540 rev/min
ENGINE SPEED rev/min
1100
1300
1500
1700
1900
2100
2300
2500


TRACTOR „R-65"
ENGINE SPEED
ENGINE SPEED rev/min
2500
2300
2100
1900
1700
1500
1300
1100
q
SPECIFIC FUEL CONSUMPTION (q)
gr/kWh
500
450
400
350
300
260
p.t.o. POWER
0
10
20
30
40 kW

(2) DRAWBAR PERFORMANCE

Date of tests: 6th and 8th November 1979

Type of track: Tarmacadam

Note: The test was started with new, run-inn tyres

Gear	Driving speed	Power	Drawbar pull	Engine speed	Slip of wheels	Specific energy	Specific fuel consumpt.	Temperatures Fuel	Co-olant	Engine oil	Atmospheric conditions Temperature	Relative humidity	Pressure
	km/h	kW	daN	rev/min	%	kWh/l	kg/kWh	°C	°C	°C	°C	%	mbar
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	(i) MAXIMUM POWER with ballast height of drawbar above ground 550 mm driving wheels inflation pressure 1,0 bar												
1 L	2,36	16,3	2480	2375	15,0	2,10	0,391	16	80	82	15	59	1012
2 L	3,73	25,6	2470	2350	15,0	2,19	0,376	16	80	82	16	56	1012
3 L	6,84	32,6	172	2300	8,6	2,41	0,342	16	81	84	16	56	1012
1 H	9,57	33,3	1250	2300	5,8	2,46	0,334	16	83	84	16	56	1012
2 H	15,50	32,5	755	2300	3,4	2,42	0,340	16	81	85	16	56	1012
3 H	27,40	31,7	415	2300	1,9	2,34	0,352	16	80	84	16	56	1012
	(ii) FIVE-HOUR-TEST at 75 % of drawbar pull at maximum power in 3rd low gear												
3 L	7,18	25,6	1290	2350	6,1	2,39	0,344	16	80	82	16	56	1012

1	2	3	4	5	6	7	8	9	10	11	12	13	14
			(iii) FIVE HOUR-TEST at drawbar pull corresponding to 15 % wheel slip in test (i)										
2 L	-	-	247o	235o	-	-	-	16	81	86	16	56	1o12
			(iv) without ballast				height of drawbar above ground 695 mm driving wheels inflation pressure o,9 bar						
1 L	2,41	13,2	197o	238o	15,o	1,71	o,455	15	8o	81	16	67	1oo8
2 L	3,75	2o,5	197o	235o	15,o	2,21	o,372	15	8o	83	16	67	1oo8
3 L	6,68	32,1	172o	23oo	11,5	2,36	o,349	16	82	83	17	61	1oo8
1 H	9,41	32,8	1255	23oo	7,6	2,42	o,339	16	82	84	17	61	1oo8
2 H	15,55	33,7	765	23oo	4,3	2,49	o,329	16	82	83	17	61	1oo8
3 H	27,35	32,8	43o	23oo	2,3	2,42	o,339	16	81	83	17	61	1oo8

Remark: Five hour test at pull corresponding to 15 % wheelslip (test iii) was carried out with additional ballast. Therefore results of test for power, wheelslip, driving speed and fuel consumption would not have any practical value.

Total engine oil consumption during ten hours duration of tests (ii) and (iii) was 43 gr/h.

(3) TURNING SPACE AND TURNING CIRCLE

Wheel equipment front: 6,00-19 6 ply
rear: 14,9 -28 6 ply

Track of wheels front: 137o mm
rear: 151o mm

	Without brakes		With brakes	
	left-hand m	right-hand m	left-hand m	right-hand m
Radius of turning space	3,55	3,73	3,26	3,39
Radius of turning circle	3,48	3,67	3,19	3,3o

(4) LOCATION OF CENTRE OF GRAVITY

Height above ground 725 mm

Distance forward from rear axle centre 755 mm

Distance from tractor's median plane 12 mm to the right

(5) BRAKING PERFORMANCE

(i) SERVICE BRAKE

Date of test: 14th November 1979
Type of track: Tarmacadam
Type of decelerometer: Siemens B1

Mass of tractor with driver:

ballasted: 283o kg
unballasted: 233o kg

Note: Manufacturer does not recommend water ballast for road work

Cold braked

		With ballast	Without ballast
Travelling speed	km/h	27,5	27,5
Deceleration	m/s^2	4,4	4,3
Stopping distance	m	7,65	7,8o
Force on pedal	daN	54	67
Force on pedal to achieve a deceleration of 2,5 m/s^2	daN	34	41
Brake fade characteristics	(hot test)		
Deceleration	hot/cold %	1oo	1oo
Stopping distance	cold/hot %	1oo	98
Force on pedal	cold/hot %	1o4	1o6

(ii) PARKING BRAKE

Tractor with ballast
Tractor facing up 16 % slope
Pull on handbrake 49 daN, tractor does not roll
Tractor facing down 16 % slope
Pull on handbrake 49 daN, tractor does not roll

(6) AMBIENT NOISE EMITTED BY THE TRACTOR

Date of test: 12th November 1979
Type of track: Tarmacadam
Type of sound lever meter: BRUEL & KJAER mod. 2209

Results of test

Gear: 3rd high
Travelling speed
before acceleration: 20,5 km/h
Sound level: 89,2 dB(A)

(7) NOISE AT THE DRIVER'S EAR LEVEL

Date of test: 12th November 1979
Type of track: Tarmacadam
Type of sound lever meter: BRUEL & KJAER mod. 2209

Results of test

+) Tractor without cab or frame

Gear	Drawbar pull at which the tractor develops the maximum sound level	Travelling speed nominal	Travelling speed effective	Sound level
	daN	km/h	km/h	dB(A)
1 L	2010	2,69	2,4	98,1
2 L	2010	4,25	3,8	98,2
3 L+)	1670	7,41	6,8	99,2
1 H	1200	10,07	9,7	99,6
2 H	740	15,55	15,3	98,1
3 H	light load	27,69	27,8	98,0

+) The 3rd L gear corresponds to the travelling speed nearest to 7,5 km/h

(8) POWER LIFT AND HYDRAULIC PUMP PERFORMANCE

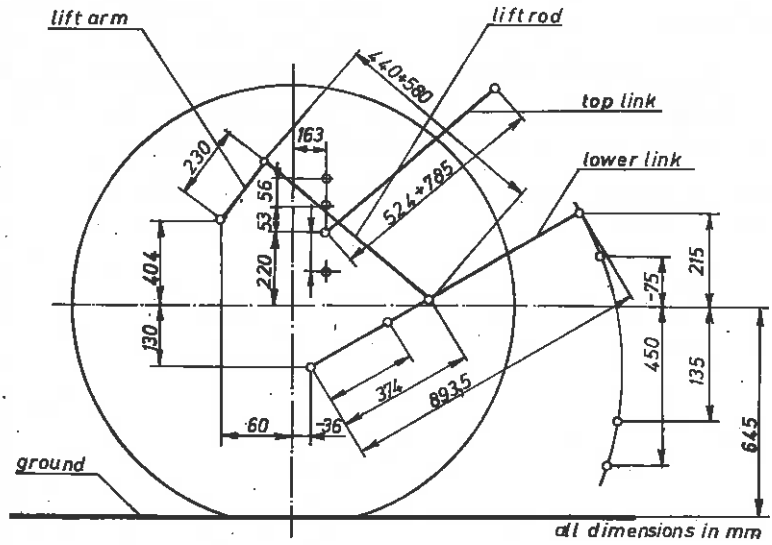
Date of tests: 29th September 1979

HYDRAULIC PUMP

(1) Opening pressure of relief valve	165 bar
Sustained pressure by open relief valve	16o bar
(2) Pump delivery rate at minimum pressure at rated engine speed	29,9 l/min
(3) Pump delivery rate at max.hydraulic power	26,7 l/min
corresponding delivery pressure	154 bar
hydraulic power	6,9 kW

POWER LIFT

Dimensions of linkage geometry for the table on page 23



LIFTING FORCES

Lifting heights relative to horizontal lower links

mm	-350	-320	-300	-200	-100	-40	0
At hitch points				maximum mechanical advantage			
daN	-	-	-	-	-	-	2270
				minimum mechanical advantage			
daN	-	1940	1915	1740	1535	-	1350

Max.force exerted throughout the whole range 1255 daN

Front of tractor does not lift when
tractor is fitted with front ballast

At test frame				maximum mechanical advantage			
daN	-	-	-	-	-	1995	1925
				minimum mechanical advantage			
daN	1775	-	1730	1415	1210	-	1055

Max.force exerted throughout the whole range 1000 daN

Front of tractor does not lift when fitted with maximum
front ballast

+45	+55	+1oo	+2oo	+28o	+3oo	+35o
length of lift rods 44o mm						
-	-	2o15	166o	-	1425	1255
length of lift rods 58o mm						
119o	-	-	-	-	-	-
length of lift rods 44o mm						
-	-	1595	1345	1ooo	-	-
length of lift rods 58o mm						
-	875	-	-	-	-	-

All values of forces are given for pressure at maximum hydraulic power (154 bar), calculated from measurements at maximum oil pressure (16o bar).

LINKAGE GEOMETRY when connected to the standard frame	maximum mechanical advantage	minimum mechanical advantage
Projected length in side view:		
Lower links	893,5 mm	893,5 mm
Lift arms	230 mm	230 mm
Lift rods	440 mm	580 mm
Top link	690 mm	700 mm
Distance of lift rod connection point from pivot point of lower link	374 mm	374 mm
The following dimensions are given relative to rear axle centre line 645 mm above ground		
Lower link pivot point	36 mm forward, 130 mm below	36 mm forward, 130 mm below
Top link pivot point	163 mm behind, 329 mm above	163 mm behind, 220 mm above
Lift arm pivot point	60 mm forward, 404 mm above	60 mm forward, 404 mm above
Maximum and minimum height of lower link hitch points	215 mm above, 135 mm below	75 mm below, 450 mm below
Height of lower link hitch points above ground when locked in highest transport position	860 mm	570 mm