SOCIALISTIC REPUBLIC OF CROATIA
INSTITUTE FOR MECHANIZATION, TECHNOLOGY AND BUILDINGS IN AGRICULTURE
Z A G R E B

TEST BULLETIN: O.E.C.D. No. 915

Report on Test in Accordance with O.E.C D. Standard Code for the Offical Testing of Agricultural Tractors

Date of Approval: 12th December 1984



AGRICULTURAL TRACTOR

RAKOVICA 47 (2WD)

Manufactured by: IMR – Industrija motora Rakovica, Beograd, Yugoslavia

Date of tests: September – November 1984.

This report has been approved by the O. E. C. D. Coordinating Centre (C. N. E. E. M. A., Antony, France) as being in accordance with the O. E. C. D. Standard Code for the Official Testing of Agricultural Tractor Performance.

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This bulletin is based on engineering tests in accordance with O. E. C. D. Tractor Code. It does not contain evaluation of the performance of the tractor on practical farm work.

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In this report all measurements are given in SI units. The relation with former Technical System of Units is given by following relations:

Forces: 1N = 0.102 kp or 1 kp = 9.81 N
Powers: 1 kW = 1.36 HP or 1 HP = 0.736 kW
Pressures: 100 kPa = 1.02 kp/cm^2 = 750.1 mm Hg or 1 kp/cm^2 = 98.1 kPa

Tractor manufacturer's name and adress:	IMR-Industrija motora Rakovica, 11090 Beograd, Patrijarha Dimitrija 7–13
Submitted for test by:	Manufacturer
Selected for test by:	Manufacturer in agreement with the Institute
Place of running-in:	Beograd
Duration of running-in:	50 hours

SPECIFICATION OF TRACTOR

TRACTOR

Make:	IMR-Industrija motora Rakovica
Model:	Rakovica 47
Type:	Wheel tractor, unit construction, rear wheel driven
Serial No.:	47992-R-84

ENGINE

Make:	IMR-Industrija motora Rakovica
Model:	DM 33/T
Type:	Naturally aspirated, 4-stroke diesel engine, water cooled, direct ignition
Serial No.:	Y 827 L 3470
Cylinders:	3 in line, vertical, bore 91,7 mm, stroke 127 mm, displacement 2500 cm^3, compression ratio 16.5:1, interchangeable dry cylinder liners, overhead valves
Fuel system:	Diaphragm fuel feed pump with sediment bowl; double fuel filter with replaceable cartridge; rotary fuel injection pump IPM-C.A.V. DPA 3733 F 020, serial No. R 31089 KAY 47 E; manufacturer's production setting 50-52 mm^3/stroke at rated engine speed and full load; injection timing 20^{O} before TDC; IPM-C.A.V. injection nozzles; injection pressure 18.6 MPa; capacity of fuel tank 60 l.
Governor:	C. A. V. mechanical centrifugal variable speed governor; governed range of engine speed 500 to 2460 rev/min; rated engine speed 2300 rev/min.
Air cleaner:	TPR – Rogatica; horizontal; dry filter with replaceable cartridge and maintenance indicator; centrifugal prefilter; air inlet above bonnet
Exhaust silencer:	Own make; single chamber absorption silencer; 100 mm dia x 600 mm; 1550 mm long; on left of the engine showing upward; 2700 mm above ground level.

Lubrication system: Forced feed from excentric rotor pump; oil filter with replaceable cartridge; recommended filter change period 400 hours; recommended oil quality acc. MIL-L-2104 A

$-20^{o}C$ to $-5^{o}C$	SAE 10 or SAE 5W/20
$-5^{o}C$ to $30^{o}C$	SAE 20 or SAE 15W/40
over $30^{o}C$	SAE 30 or SAE 15W/40

Oil capacity: 5.5 l

Recommended oil change period: 200 hours

Cooling system: Water cooling with impeller pump, pressurized system set to 500 kPa overpressure, with by-pass thermostat; fan with 6 blades 406 mm dia; water capacity 13.5 l

Starting system: Electrical
Solenoid engaged starter motor ISKRA AZJ 0404;12 V; 3 kW; flame plug in inlet manifold

Electrical equipment: 12 Volt
3-phase alternator ISKRA AAG 1302
14 V; 28 A
2 batteries 55 Ah at 20 hours rating; lead acid type

Transmission:

Clutch: Make: Kron – Beograd; double effect type clutch, pedal operated, transmission clutch 270 mm dia, p.t.o. clutch 180 mm dia

Gearbox: Own make; sliding gear type with 3 forward + 1 reverse speeds; group gear with 2 forward groups, sliding gear shifted; totally 6 forward + 2 reverse speeds

Rear axle and final drive: Own make; bevel gear drive with crown wheel and pinion; bevel gear differential with lock, pedal operated, self disengaging; spur gear final drives

Total ratios and speeds

Speed range	Gear	Number of engine revolutions for one revolution of driving wheel	Nominal travelling speed for rated speed of engine* 2300 rev/min (km/h)
Slow	1	206.18	2.44
	2	130.44	3.93
	3	74.91	6.85
	reverse	136.98	3.73
Fast	4	55.10	9.3
	5	34.88	14.7
	6	20.04	25.6
	reverse	36.69	13.9

*Calculated with a tyre dynamic radius index of 592 mm

Transmission lubrication:-	Gear box, rear axle 20 l, final drives 2x2.8 l; recommended oil type acc. MIL-L-2105 B classification, viscosity SAE 90 (winter) or SAE 140 (summer). Recommended oil change period 800 – 1000 hours

Power take off

Main power take-off:	Semi independent p.t.o. driven by the first disc of the dual disc clutch; Proportional to engine speed: standard p.t.o. speed 540 rev/min at 1994 rev/min of the engine, 623 rev/min at rated engine speed; ratio of rotation speeds: engine speed/p.t.o. speed = 3.69 Proportional to ground speed take-off: 11.93 revolutions of the p.t.o. to 1 revolution of rear wheels: 0.312 m distance covered to 1 revolution of p.t.o. P. T. O. 34.9 mm dia with 6 splines in accordance with ISO 500 type 1; 284 mm rear of the rear axle centre line, 592 mm above ground in median plane of the tractor; direction of rotation: clockwise viewed from rear of the tractor; p.t.o. speeds can be set by aid of tractor meter.
Fast:	P. T. O. 34.9 mm dia with 6 splines in accordance with ISO 500 type 1; in median plane of the tractor; 111 mm rear of the rear axle centre line; 721 mm above ground in median plane of the tractor, directly driven by the engine; ratio of rotation speeds: engine speed/p.t.o. speed = 1 direction of rotation: anticlockwise viewed from rear of the tractor
Belt pulley:	Attached to fast p.t.o.; 240 mm dia by 170 mm face width; 1430 rev/min and 18 m/s linear speed at rated engine speed
Power lift:	Own make; hidraulic power lift in unit construction; gear type oil pump directly driven by engine feeds oil to the single ram cylinder; oil filter with replaceable cartridge, single control valve for lifting, lowering, floating position, draft and position control, and for two separate auxilary single-action cylinders; top-link control; maximum working pressure 19.6 MPa; overpressure relief valve setting; 21.6 MPa. Separate oil reservoir under driver's seat with capacity 7 l; 2.5 l of oil may be taken off for auxilary cylinders. Recommended oil type acc. MIL-L-2105: SAE 90 – SAE 140; recommended oil and filter change period 1000 hours

Implement linkage:

Three point linkage, category II according to ISO 730/I.

Rear tyres 12.4/11-28 loaded radius	592 mm
Front tyres 6.00-16 loaded radius	340 mm
Length of lift arms	230 mm
Length of lower links	893 mm
Distance of lift arm pivot point from rear wheel centre line:	
horizontally	54 mm
vertically	378 mm
Horizontal distance between the 2 lower link points	521 mm
Horizontal distance between the 2 lift arm end points	537 mm
Length of upper link	524-785 mm
Distance of upper link point from rear wheel centre line:	
horizontally	205 mm
vertically	236-291-346 mm
Distance of lower link points to lift rod pivot points on lower link	374 mm
Height of lower links locked in transport position	854 mm
Length of lift rods	440-580 mm

Swinging drawbar:

Reversible; height above ground adjustable 282-392-402-492-637-737 mm by using different holes for fixing and by turning drawbar; hitch hole diametre 32.5 mm; distance of hitch hole centre from p.t.o. shaft end 380 mm; from rear axle centre 664 mm; lateraly swingable 43-84-126 mm to either side, distance of pivot point to rear axle centre: 174 mm rear.

Steering:

"SOKO" – Mostar; mechanical globoid worm type, operated by hand wheel

Brakes

Service brake:

Band brakes, mechanically acting on drums on differential half shafts, pedal operated

Steering brake:

Divided pedal on service brake; for normal use locked together

Parking brake:

Operated by hand lever with ratchet; mechanically acting on service brakes

Wheels

Steering wheels:

2 pneumatics at front 6.00-16, diagonal, 6 ply; maximum permissible weight on each tyre 4.4 kN at 200 kPa pressure; track width 1370-1870 mm, adjustable by extending telescopic half axles in steps of 100 mm

Driving wheels: 2 pneumatics at rear 12.4/11-28, diagonal, 10 ply; maximum permissible weight on each tyre 9.8 kN at 110 kPa pressure; track width 1280, 1450, 1510, 1690, 1710, 1750, 1960 mm, adjustable by wheels and offset lug type rims

Wheelbase: 1965 mm

Lighting:

	Height from ground to centre mm	Dimensions mm	Distance from outside edge of tractor to centre* mm
Headlights	1300	ϕ 145	570
Front blinkers	1100	ϕ 80	630
Rear lights	1360	105 x 95	245
Reflector	1440	ϕ 105	445

*At rear track setting 1410 mm
Unrestricted beam angle of headlights in plan view 32^{o}

Number of grease points: 8 (whole tractor)

Overall dimensions:

	Length m	Width m		Maximum height m
		max	min	
With ballast	3.50	2.33	1.88	2.70
Without ballast	3.20	2.26	1.88	2.70

Ground clearance: 415 mm (at gearbox)

Overturning protection frame: None

Seat: Poliester, Priboj; upholstered seat with back rest. Mechanical suspension adjustable to driver's mass. Damping by hydraulic shock absorber; range of vertical adjustment 110 mm, range of horizontal adjustment 180 mm

CONDITIONS DURING TEST

Masses:

Tractor (without driver but with tanks full)

	Front kg	Rear kg	Total kg
Without ballast	795	1290	2085
With ballast	1040	1375	2415

Ballast:

	No. of weights	Total mass	Water
Front	4 + 1	210	–
Rear	2	120	–

Track setting:

During test front 1370 mm
rear 1410 mm

FUELS AND LUBRICANTS USED IN TESTS

Laboratory and track tests:

Fuel:	INA D-2	
	Density at 15°C	0.831 kg/dm^3
	Viscosity at 50°C	2.6 cSt
	Cetane number	min 50
	Conforms to standard	JUS.B.H2.411
Engine oil:	GALAX SUPER SAE 30	
	Viscosity at 50°C	8°E
Transmission oil:	INA HIPENOL GL 4 SAE 90	
	Viscosity at 50°C	15°E
Hydraulic oil:	INA HIDRAOL HD 100	
	Viscosity at 50°C	13.5°E

COMPULSORY TESTS

(1) MAIN POWER TAKE-OFF PERFORMANCE

Date and location of tests: 1984. 09. 26. Zagreb
Type of dynamometer: SCHENK hydraulic dynamometer Ul-40

POWER	Speed		Fuel consumption			Specific
	Engine	p. t. o.	Hourly		Specific	energy
kW	rev/min	rev/min	l/h	kg/h	kg/kWh	kWh/l
Maximum power – 2 hour test						
29.6	2270	616	10.25	8.52	0.288	2.89
The speed recommended by manufacturer for drawbar work						
29.6	2270	616	10.25	8.52	0.288	2.89
Part loads – at rated engine speed (i) 85 per cent of the torque obtained at maximum power						
26.4	2396	650	9.47	7.87	0.298	2.79
(ii) unloaded						
0.8	2525	685	4.06	3.37	4.184	0.20
(iii) half the torque defined in (i)						
13.5	2448	664	6.55	5.45	0.404	2.06
(iv) the torque corresponding to maximum power						
29.6	2270	616	10.25	8.52	0.288	2.89
(v) one – quarter of the torque defined in (i)						
6.9	2484	674	5.16	4.28	0.618	1.34
(vi) three – quarters of the torque defined in (i)						
20.1	2429	659	7.99	6.64	0.331	2.51

Part loads – standard speed of the p. t. o. (540 rev/min)

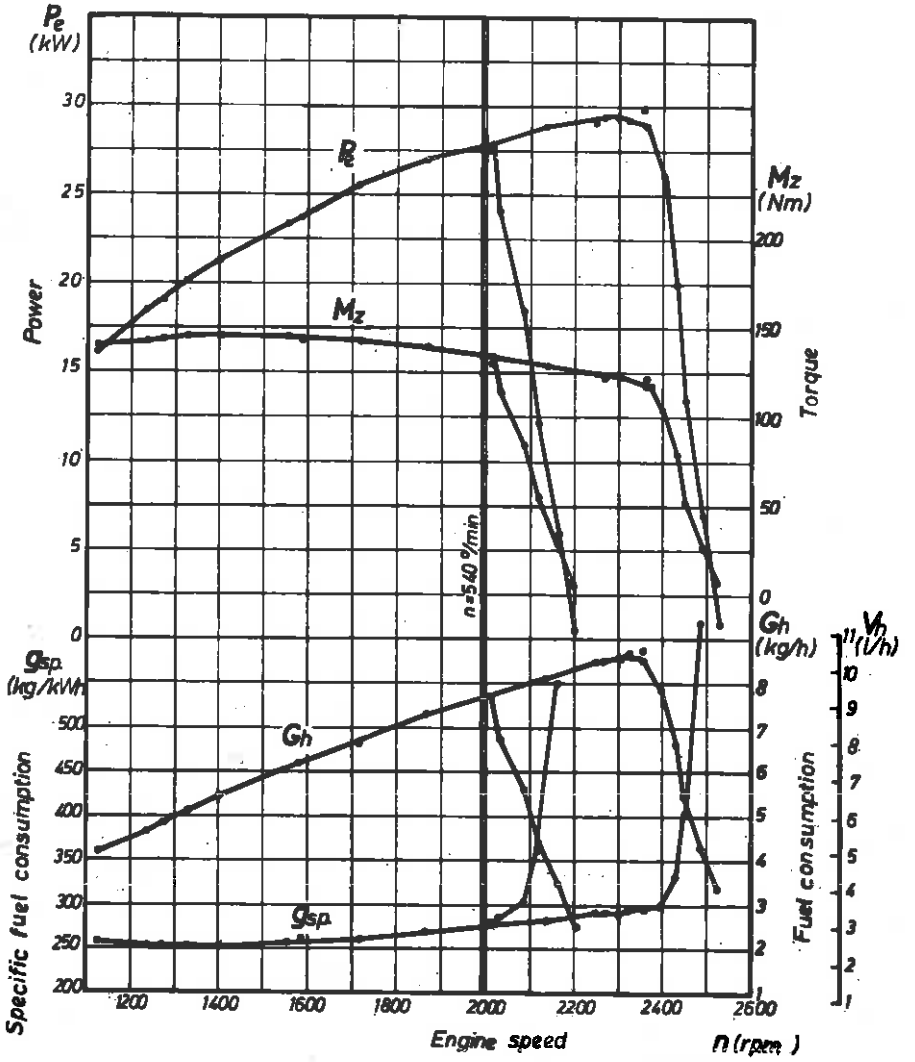
POWER	Speed		Fuel consumption			Specific energy
	Engine	p. t. o.	Hourly		Specific	
kW	rev/min	rev/min	l/h	kg/h	kg/kWh	kWh/l
(i) 85 per cent of the torque obtained at maximum power						
24.1	2031	551	8.1	6.73	0.280	2.97
(ii) unloaded						
0.5	2197	596	3.02	2.51	4.776	0.17
(iii) half the torque defined in (i)						
12.3	2119	575	5.32	4.42	0.361	2.30
(iv) the torque corresponding to maximum power available						
27.6	2009	545	9.27	7.70	0.279	2.97
(v) one – quarter of the torque defined in (i)						
6.3	2160	586	4.19	3.48	0.550	1.51
(vi) three – quarters of the torque defined in (i)						
18.5	2086	566	6.73	5.59	0.302	2.75

STANDARD SPECIFIC FUEL CONSUMPTION (kg/kWh)

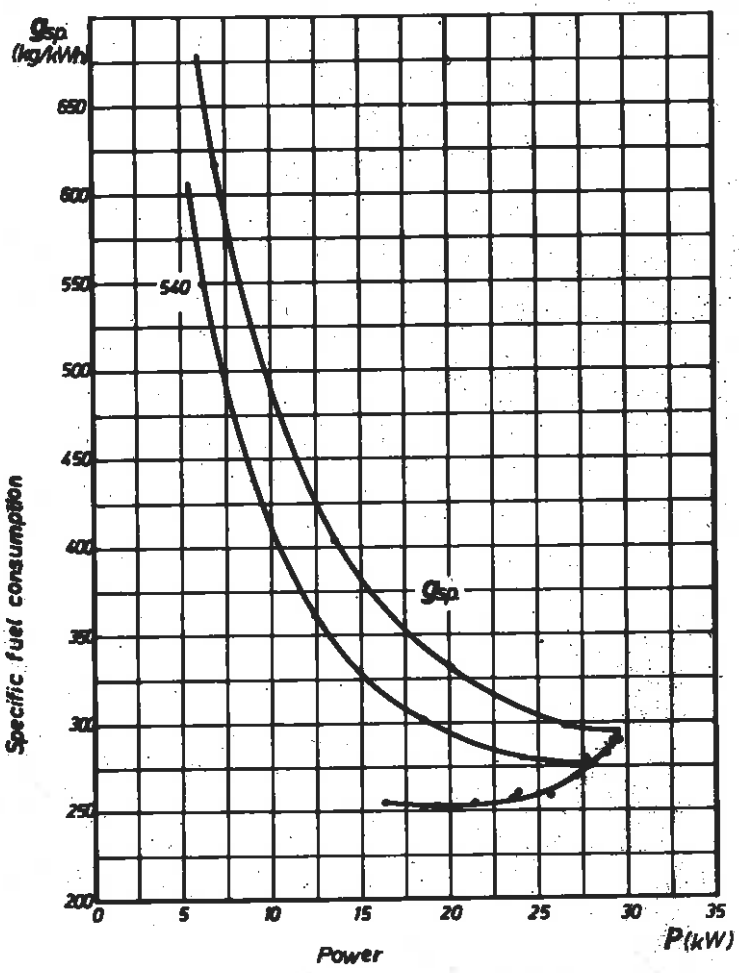
a (i)	0.298
a (iii)	0.404
b (i)	0.280
b (iii)	0.361

No load maximum engine speed:	2525 rev/min	
Equivalent crankshaft torque at maximum power:	125 Nm	
Maximum torque:	145 Nm at 1330-1400 rev/min of the engine	
Mean atmospheric conditions:	temperature	21°C
	pressure	100.7 kPa
	relative humidity	54 per cent
Maximum temperatures:	coolant	79°C
	engine oil	108°C
	fuel	24°C
	engine air intake	24°C

Tractor RAKOVICA 47



Tractor RAKOVICA 47



(2) DRAWBAR PERFORMAN(

Date of tests: 1984. 10. 22–23–30–31.
Type of track: Tarmacadam

Height of drawbar above ground:
unballasted and ballasted: 380 mm
Tyre inflation pressure:
unballasted and ballasted:
front: 200 kPa
rear: 120 kPa

Gear	Speed	Power	Drawbar pull	Engine speed	Wheelslip	Specific fuel consumption	Specific energy	Temperature			Atmospheric conditions		
								fuel	coolant	oil	temperature	relative humidity	pressure
	km/h	kW	kN	rev/min	per cent	kg/kWh	kWh/l	°C	°C	°C	°C	per cent	kPa
(i) Maximum power (unballasted)													
1	2.26	9.5	15.2	2450	14.9	0.542	1.53	19	70	80	20	63	101.4
2	3.54	15.0	15.2	2410	15.0	0.437	1.90	19	72	73	20	62	101.4
3	5.94	23.5	14.2	2413	12.8	0.358	2.32	19	71	72	20	60	101.4
4	8.96	25.6	10.3	2368	7.6	0.345	2.41	20	70	69	20	60	101.4
5	14.0	24.1	6.2	2310	4.8	0.366	2.27	20	70	68	20	59	101.4
(ii) Maximum power (ballasted)													
1	2.26	10.0	16.0	2456	14.9	0.554	1.50	18	70	59	18	62	101.5
2	3.54	15.8	16.1	2380	14.7	0.460	1.81	18	73	70	18	62	101.5
3	5.96	23.5	14.2	2232	11.3	0.370	2.45	19	73	71	18	60	101.5
4	8.74	25.7	10.6	2270	7.6	0.337	2.47	19	72	75	18	60	101.5
5	13.4	24.2	6.5	2250	4.4	0.351	2.37	19	72	72	18	60	101.5
(iii) Five hour test at 75 per cent of pull at maximum power													
3	6.47	19.2	10.7	2360	7.6	0.355	2.34	21	72	88	14	82	101.7
(iv) Five hour test at pull corresponding to 15 per cent wheelslip in test (ii)													
2	3.52	15.8	16.2	–	–	–	–	16	72	86	6	92	101.2

Oil consumption during ten hours' testing (iii) and (iv): 25 g/h

(3) TURNING SPACE AND TURNING CIRCLE

Details of wheel equipment: Tractor without ballast
Tyres: front: 6.00-16
rear: 12.4/11-28
Track of wheels: front: 1370 mm
rear: 1410 mm

	With brakes		Without brakes	
	left-hand m	right-hand m	left-hand m	right-hand m
Radius of turning space	3.18	3.11	3.47	3.37
Radius of turning circle	3.03	2.96	3.32	3.22

(4) LOCATION OF CENTRE OF GRAVITY

Height above ground: 757 mm
Distance forward from the vertical plane containing the axis of the rear wheels: 720 mm
Distance from the median plane: 0 mm

(5) BRAKING

Date of tests: 1984.10.23.

Tractor masses during brake tests (tractor with driver)

	Front kg	Rear kg	Total kg
Ballasted	1035	1455	2490
Unballasted	790	1370	2160

Type 0 (ordinary cold service braking device performance) test

Speed before application of brakes: 28.1 km/h

Ballasted	Braking device control force, N	150	260	310	400	Locked 450
	Mean deceleration m/s^2	1.4	1.8	2.0	2.7	3.4
Unballasted	Braking device control force, N	150	200	300	375	Locked 500
	Mean deceleration m/s^2	1.1	1.5	2.3	2.8	3.4

Type I (fade test)

Braking device control force, N	70	160	200	270	Locked 480
Mean deceleration m/s^2	0.8	2.0	2.6	3.1	3.4

Maximum deviation of tractor from its original course: 0 m

Abnormal vibrations: None

The brakes were heated: By applying force of 120 N to brake pedal and driving the tractor for 1 km

Parking braking device test

	18 per cent slope		12 per cent slope with trailer of 2.1 tone	
	up	down	up	down
Braking device control force, N	110	115	125	120

(6) MEASUREMENT OF EXTERNAL NOISE LEVEL

Date of tests: 1984.10.22.
Type of sound level meter: Bruel &Kjaer type 2203
Type of track: Tarmacadam

Results of tests:
Gear: 6.
Travelling speed before acceleration: 21.1 km/h
Sound level: 92.5 dB(A)

(7) NOISE MEASUREMENTS -- AT DRIVER's EAR

Date of tests: 1984.10.22.
Type of sound level meter: Bruel &Kjaer type 2203
Type of track: Tarmacadam
Cab fitted: No

Results of tests:

	Drawbar pull at which the tractor develops the maximum sound level kN	Measured traveiling speed km/h	Sound level dB (A)
3	14.2	5.96	98
3*	light load	7.56	99
6	light load	28.13	98

*The 3rd gear corresponds to the nominal travelling speed nearest to 7.5 km/h

(8) LIFTING CAPACITY AND HYDRAULIC POWER TEST RESULTS

Date and location of tests: 1984.11.16-7. Zagreb

Hydralic fluid

Make and type: INA HIDRAOL HD 100
Viscocity: 6.6 – 6.9°E/50°C
Viscosity index: min 100
Type of hydraulic system: open centre
Hidraulic fluid temperature at beginning of test 65°C

Power Lift Test

	Height of lower hitch point above ground in down position mm	Vertical move-ment mm	Maximum corrected force exer-ted through full range kN	Corresponding pressure of hydraulic fluid MPa	Moment about rear axle kNm	Max. tilt angle of mast over range of lift degrees
At hitch points	210	580	11.9	18.5	11.05	–
On the frame	210	695	6.24	18.5	9.60	19

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

mm	–235	–160	–95	–20	85	145	220	250	280	385

Lifting forces at hitch points (corresponding pressure 18.5 MPa)

kN	18.5	17.0		14.8	13.6		11.9		12.0	

Lifting forces at test frame (corresponding pressure 18.5 MPa)

kN	16.4		13.1	12.2		15.5		9.5		6.2

Hydraulic power test

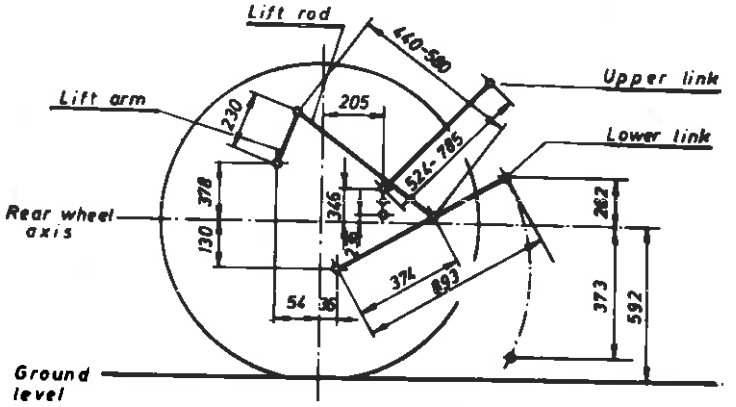
Sustained presure with relief valve open: 20.2 MPa
Pump delivery rate at minimum pressure: 26 l/min
Flow rate corresponding to a hydraulic pressure equivalent to 90 per cent of the actual relief valve pressure setting and corresponding hydraulic power:

flow rate	22.5 l/min
pressure	16.4 MPa
power	6.15 kW

Flow rate and hydraulic pressure corresponding to maximum hydraulic power:

flow rate	22 l/min
pressure	18.2 MPa
power	6.67 kW

Tapping point used for test: outlet for exterior single-action cylinder
Opening pressure of the unloading valve: 18.2 MPa
Closing pressure of the unloading valve: 17.6 MPa

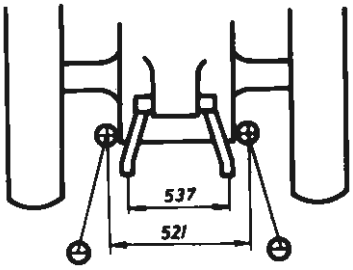


Rear wheel axis

LINKAGE GEOMETRY WHEN CONNECTED TO THE STANDARD FRAME (SEE ATTACHED DRAWING)

Projected length in side view

Lower links	893 mm
Lift arms	230 mm
Lift rods	505 mm
Upper link	738 mm
Distance from lower link point to lift rod pivot point	374 mm
Mast height of the frame	510 mm



The following dimensions are given relative to the rear wheel centre line, situated 592 mm above the ground level:

Lower link pivot point	36 mm behind, 130 mm below
Upper link pivot point	205 mm behind, 236 mm above
Lift arm pivot point	54 mm forward, 378 mm above
Maximum and minimum height of lover hitch point	262 mm above, 373 mm below
Height of lower link hitch points when locked in transport position	262 mm above

Date: 4th December 1984.

Head of Testing Division:

Dr Ivan Piria

Director:

Dr Mile Čuljat