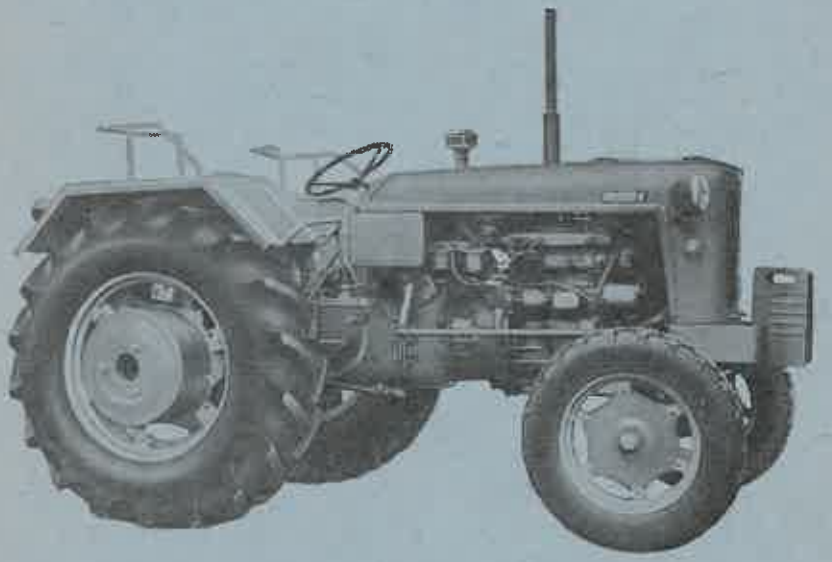
SOCIALISTIC REPUBLIK OF CROATIA
INSTITUTE FOR MECHANIZATION IN AGRICULTURE
AGRICULTURAL FACULTY OF THE ZAGREB UNIVERSITY

TEST BULLETIN: O. E. C. D. No. 272

Report on test in accordance with O. E. C. D. Tractor Test Code
Date of Approval: 12th June 1969.



RAKOVICA 60 - SPECIAL
IMR DIESEL TRACTOR
Equipped with 14 - 30 rear tyres

Manufactured by: IMR — Industrija motora Rakovica, Beograd, YUGOSLAVIA
Date of Tests: July 1968. / Mai 1969.

Institut za mehanizaciju poljoprivrede
Ferenčica 104
ZAGREB — YUGOSLAVIA

This report has been approved by the O. E. C. D. Coordinating Centre (C. N. E. E. M. A., Antony, France) as beeing in accordance with the O. E. C. D. Tractor Test Code.

Date of Approval: 12th June 1969 Serial No.: 272

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

TABLE OF CONTENTS

Tractor manufacturer:	IMR — Industrija motora Rakovica, Beograd
Submitted for test by:	Manufacturer
Selected by:	The representatives of the Institute from series production
Place of runnings-in:	Beograd and Zagreb
Duration of running-in:	50 hours

SPECIFICATION OF TRACTOR

Tractor

Make:	IMR — Industrija motora Rakovica, Beograd
Model:	RAKOVICA 60 - SPECIAL
Type:	Diesel tractor, unit construction
Serial No.:	5019245/R

Engine

Make:	IMR — Industrija motora Rakovica, Beograd
Model:	M 34/T
Type:	Water cooled 4-stroke Diesel engine
Serial No.:	M 10556
Cylinders:	4 cylinders, vertical in line, 91·4 mm (3·6 in) bore, 127 mm (5 in) stroke; capacity 3 330 cm^3 (203 in^3); compression ratio 17·4:1; overhead valves; replaceable dry cylinder liners
Fuel system:	Fuel: commercially available Diesel oil; C.A.V. type DPA 324 8740 distributor fuel injection pump, serial No. A 48/650/6; Industrija precizne mehanike type DB injection nozzles; injection pressure 120 kp/cm^2 (1700 lb/in^2); injection timing 20° before TDC; A. C. mechanical type feed pump, sediment bowl on suction side of feed pump; two filters, paper element; capacity of fuel tank 60 l (13·2 UK gal)
Governor:	C. A. V. mechanical, incorporated in injection pump; governed range of engine speed 500—2400 rev/min, rated engine speed 2300 rev/min
Air cleaner:	Main filter Make: »Ikarus«, Zemun; oil bath type, oil capacity 0·8 l (1·4 pt) Pre-cleaner Make: »Ikarus«, Zemun; centrifugal type

Lubrication system: Forced feed from gear type pump with metal strainer in sump; A.C. make full flow paper oil filter; oil capacity (engine sump) 8 l (14 pt); recommended oil change period 250 hours

Cooling system: Water cooled impeller assisted with 400 mm (15·8 in) dia 6-blade belt driven fan; thermostat for temperature control, pressurized at 0·2 kp/cm² (3 lb/in²); cooling water capacity 14 l (13·1 UK gal)

Starting system: Electrical, »Iskra« type SN1/N-12/2,5/10 starter motor; heating tube in suction manifold for cold starting

Electrical system: Voltage: 12 V
Generator: »Iskra« type DNA-12/130/1900
Batteries: Two lead acid batteries, »Munja« type 12-56D9, 12 V, capacity 56 Ah

Transmission

Clutch: »Ikarus«, Zemun, dual dry clutch, two 270 mm (10·6 in) dia plates, operated by single foot pedal

Gearbox: IMR — Industrija motora Rakovica, Beograd, sliding gear type, 6 forward speeds and 2 reverse, comprising 3 forward speeds and one reverse speed gearbox and dual range reduction gear at the output end

Rear axle and final drive: Own make crown wheel and pinion and differential with bull gear final drives; pedal operated differential lock

Oil capacity: Gearbox and differential 20 l (35 pt), final drives 1·8 l (3 pt) each; recommended changing period after 1000 h

Gear ratios and speeds:

Gear	Number of engine revolutions for one revolution of driving wheel	Nominal travelling speed for 2300 rev/min rated speed of engine	
		km/h	(mile/h)
Forward			
1	205·96	2·86	(1·78)
2	130·44	4·55	(2·82)
3	74·89	7·86	(4·88)
4	55·08	10·72	(6·66)
5	34·88	16·90	(10·5)
6	20·03	29·5	(18·3)
Reverse			
1	136·98	4·3	(2·68)
2	36·69	16·05	(9·96)

Power take-off

Main: At rear of tractor, 34'9 mm (1⅜ in) dia 6-spline; (acc. to JUS M. L1. 601 Form A); height above ground 695 mm (27'4 in). Proportional engine speed giving 624 rev/min at 2300 rev/min rated engine speed; 540 rev/min (standard p. t. o. speed) at 2000 rev/min engine speed; direction of rotation clockwise viewed from driving end. Proportional ground speed: distance travelled for 1 revolution of p. t. o. 0'35 m (13'8 in). Number of p. t. o. revolutions for one revolution of driving wheel 11'95. Direction of rotation, clockwise for engaged forward gears

Fast: Situated above the main p. t. o. and in center-line at rear of tractor. Height above ground 825 mm (32'5 in). Connected directly with the engine it is provided to drive the belt pulley; 2300 rev/min at 2300 rev/min engine speed. Direction of rotation: anti-clockwise viewed from driving end

Belt pulley (Not fitted on tractor tested); figures acc. to manufacturer's specification)
Location: at rear of tractor, driving device attached to fast p. t. o. Height above ground 825 mm (32'5 in); 240 mm (9'5 in) dia × 170 mm (6'7 in) face width, 1430 rev/min and 18 m/s (59 ft/s) at rated engine speed 2300 rev/min. Direction of rotation, anti-clockwise viewed from tractor righthand side, opposite direction of rotation by reversing pulley unit; manually engaged by p. t. o. engaging lever

Power lift Own make hydraulic, gear type pump driven directly from engine; suplies oil to a single acting ram cylinder and external tapping. Ram is with relief valve, oppening pressure 200 kp/cm² (2844 lb/in²) (manufacturer's figure); oil capacity 8'5 l (15 pt); maximum oil pressure 195 kp/cm² (2780 lb/in²)
Category 1 and 2 implement linkage, controls for draught and position
Lift height above ground:
maximum from 450 mm (18'4 in) to 1055 mm (41'6 in); minimum from 115 mm (4'5 in) to 795 mm (31'4 in), utilizing either of the two holes placed in the lower ends of the tie rods connecting the hydraulic power-lift arms with the lower links of the three - points hitch

Drawbar Swinging drawbar: vertical heights above ground to centre of clevis 415 mm (16'3 in), 520 mm (20'5 in), 505 mm (19'9 in), 610 mm (24'0 in), 755 mm (29'8 in), 855 mm (33'7 in), changed by reversing hitch and inverting drawbar; distance from rear axle 670 mm (25'4 in), position relative to p. t. o. 110 mm (4'3 in) to rear, lateral adjustment 126 mm (5 in) apart either side of center line; pivot position relative to rear axle wheel centre 170 mm (6'7 in) to rear

Hitch

Trailer hitch: fixed on three point implement linkage; height above ground 505 mm (19'9 in); distance from rear axle 450 mm (19'9 in); distance from rear axle 450 mm (17'7 in)
Towing hitch: at front of tractor, height above ground 645 mm (25'4 in)

Steering

Make: »Soko«, Mostar; worm and nut type operated by steering wheel

Brakes

Foot brake: mechanically acting as contracting band type brake on drums on differential half shafts, operated by pedals
Parking brake: lever operated both pedals of the foot brake for parking
Steering brake: operated by the single parts of the divided foot pedal of the foot brake; at normal use both parts are connected

Wheels

Steering wheels:

Two at front, Borovo — Tractor - T1, 6'50 - 20 tyres, 6 ply rating; maximum permissible weight on each tyre 550 kg (1210 lb) at 1'5 kp/cm² (21 lb/in²), track widths 1370 mm (54 in) by 100 mm (3'9 in) steps to 1870 mm (73'5 in) changed by extending front axle

Driving wheels:

Two ar rear, Dunlop RT 40, 14 - 30 tyres, 6 ply rating; maximum permissible weight on each tyre 1500 kg (3300 lb) at 1'1 kp/cm² (15 lb/in²); track widths 1250 mm (49'3 in) to 1960 mm (77'3 in) by 7 steps changed by reversing disc and rim and by offset lugs on rims

Wheelbase:

2050 mm (81'0 in)

Tractor and balast weights

(Without driver but with full fuel tank, oil and coolant)

Weight without ballast:

Front: 840 kp (1855 lb)
Rear: 1390 kp (3065 lb)
Total: 2230 kp (4920 lb)

Ballast:

Front: 4 frame weights on the front axle = 120 kp (264 lb)
Rear: weights — 4 per wheel, total 480 kp (1060 lb)
water — 500 kp (1100 lb)

Weight with full ballast:

Front: 984 kp (2175 lb)
Rear: 2286 kp (5040 lb)
Total: 3270 kp (7215 lb)

Seat

Own make, leaf spring suspension, torsion spring shok absorber, range of adjustment 30 mm (1'2 in) fore and aft

Number of grease points

Whole tractor: 15

Overall dimensions

Overall lenght: 3480 mm (137 in) with front ballast weight and three-point linkage down

Overall width: 1915 mm (75'7 in) at 1490 mm (58'6 in) track — no ballast weights;
1935 mm (76'2 in) at 1490 mm (58'6 in) track — with 4 weights per wheel

Overall height: 1670 mm (65'6 in) to top of steering wheel
2310 mm (91 in) to top of exhaust pipe

Minimum ground clearance: 510 mm (20 in)

Lighting

	Height above ground of centre		Diameter		Distance from outside edge of tractor to centre	
	mm	(in)	mm	(in)	mm	(in)
Headlights	1230	(48'5)	130	(5'1)	610	(24'0)
Side lights	1100	(43'5)	50	(1'9)	625	(24'6)
Rear lights	1230	(48'5)	50	(1'9)	270	(10'6)
Reflector	1340	(52'8)	100	(3'9)	310	(12'2)

Unrestricted beam angle of headlight in plan view 23°

FUELS AND LUBRICANTS USED IN TESTS

Laboratory tests

Fuel: Diesel oil, specific gravity at 20°C (68°F): 0'832 kg/dm³; cetane No. 58
(commercially available quality acc. to JUS B.H2.411)

Engine oil: SUPER HD S1—30 (SAE) (acc. JUS B. H3. 143)

Transmission oil: HYPENOL 140 (SAE) (acc. JUS B. H3. 304)

Track tests

Fuel: Diesel oil, specific gravity at 20°C (68°F) 0'830 kg/dm³ cetane No. 58
(commercially available quality acc. to JUS B. H2. 411)

Engine oil: SUFER HD S1—30 (SAE) (acc. JUS B.H3. 143)

Transmission oil: HYPENOL 140 (SAE) (acc. JUS B.H3. 304)

COMPULSORY TESTS

(1) MAIN POWER TAKE-OFF PERFORMANCE

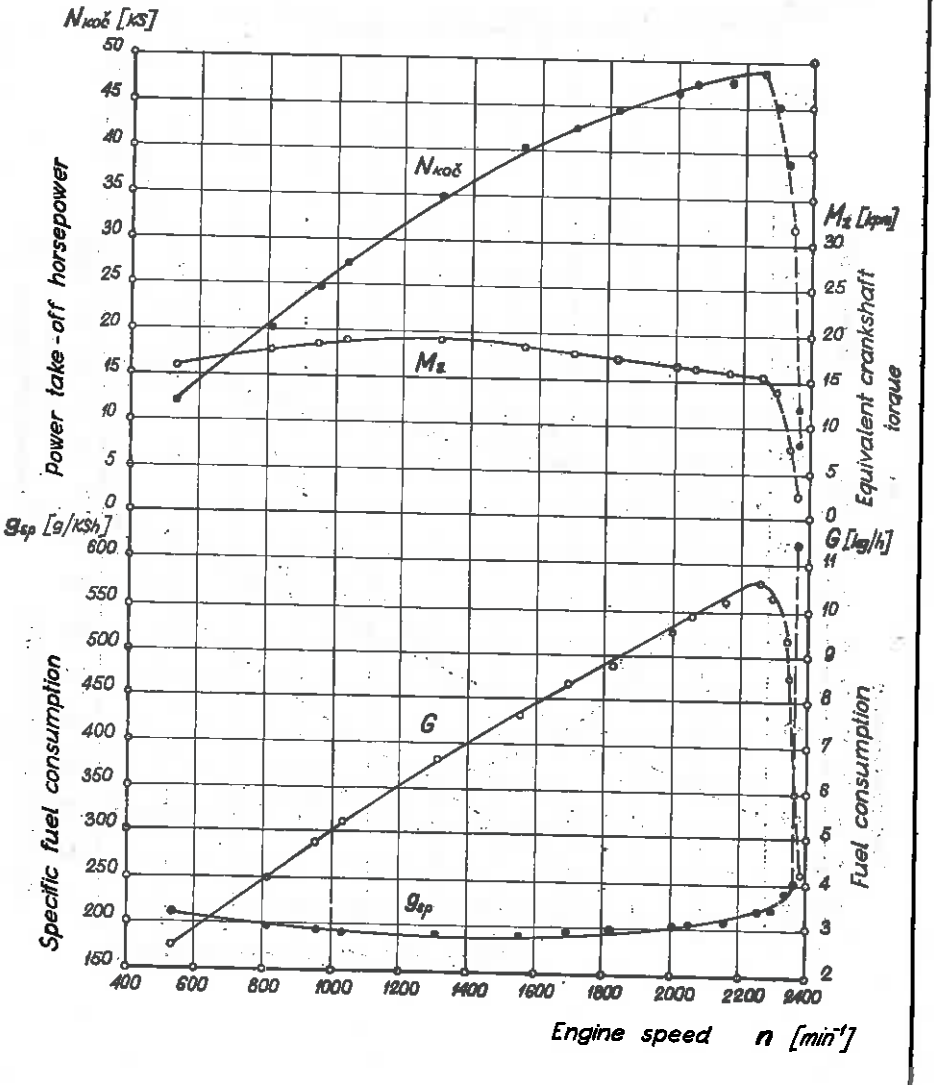
Date and location of tests: 1st August 1968, Zagreb
Type of dynamometer: Electrical swing frame, Siemens — Schuckert

Horsepower, metric hp (hp)	Speeds, Engine rev/min	Speeds, P.t.o. rev/min	Fuel consumption, Per hour, l/h (UK gal/h)	Fuel consumption, Specific, g/metric hp h (lb/hp h)	Fuel consumption, Hp hour / unit of vol., metric hp h/l (hp h/UK gal)
Maximum power — 2 hour test					
48·8 (48·1)	2253	608	12·40 (2·73)	212 (0·474)	3·94 (17·7)
Standard p. t. o. speed (540 rev/min)					
46·5 (45·9)	2000	540	11·40 (2·51)	204 (0·456)	4·08 (18·3)
Speed recommended by the manufacturer for belt pulley work and for drawbar work					
48·2 (47·5)	2300	620	12·30 (2·71)	212 (0·474)	3·94 (17·7)
Fuel consumption at part loads					
(i) 85 % of torque at maximum power					
43·3 (42·7)	2332	630	11·52 (2·54)	222 (0.496)	3·75 (16·8)
(ii) unloaded					
1·9 (1·9)	2386	645	5·51 (1·23)	—	0·34 (1·52)
(iii) 50 % of the load defined in (i)					
21·8 (21·5)	2352	635	8·34 (1·84)	319 (0·713)	2·61 (11·7)
(iv) maximum power					
48·8 (48·1)	2253	608	12·40 (2·73)	212 (0·474)	3·94 (17·7)
(v) 25 % of the load defined in (i)					
10·9 (10·7)	2370	640	6·40 (1·41)	488 (1·090)	1·71 (7·66)
(vi) 75 % of the load defined in (i)					
32·7 (32·2)	2352	635	10·1 (2·22)	258 (0·577)	3·23 (14·5)

No load, maximum engine speed: 2386 rev/min
Equivalent crankshaft torque at maximum power: 15·5 kpm (112 lb ft)
Maximum equivalent crankshaft torque: 19·1 kpm (138 lb ft) at 1315 rev/min engine speed
Mean atmospheric conditions: temperature 26°C (79 °F)
pressure 753 mm Hg (29·61 in Hg)
relative humidity 58 %
Maximum temperature: coolant 99 °C (210 °F)
engine oil 112°C (237°F)
fuel 33°C (91°F)

Tractor RAKOVICA 60 - SPECIAL

Power take-off test



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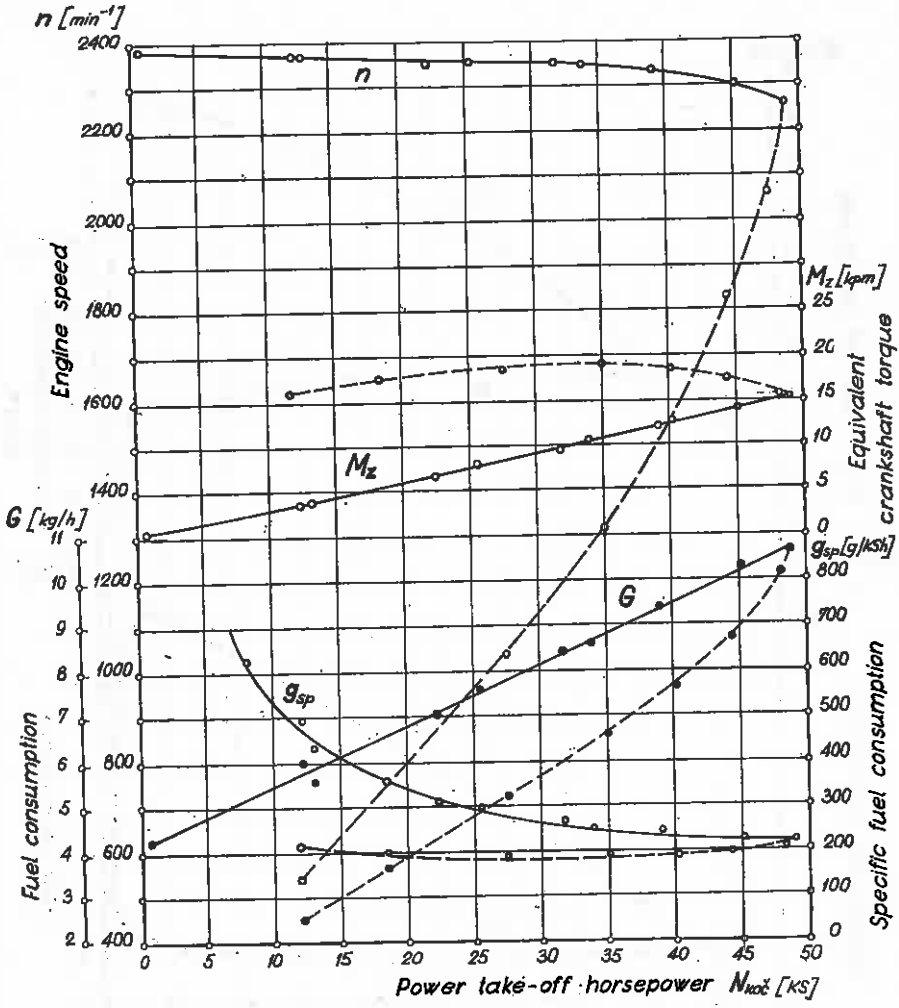


(2) DRAWBAR PERFORMANCE
Date of tests: 14th—17th Mai 1969

Type of track: Tarmacadam

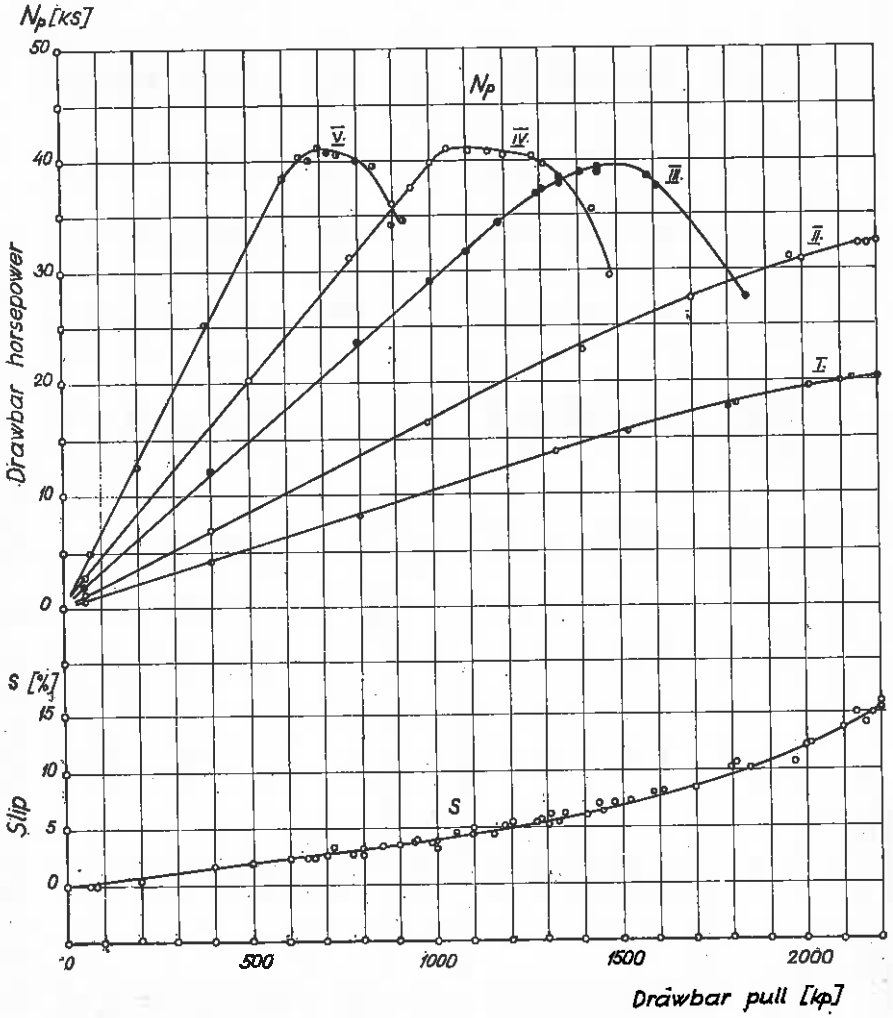
Height of drawbar above ground: 415 mm (16·3 in)

Gear	Horsepower, metric hp (hp)	Drawbar pull, kp (lb)	Engine speed, rev/min	Wheel-slip, %	Specific work, hp h/l (draw-bar hp h/ UK gal)	Specific fuel consumption, g/hp h (lb/drawbar hp h)	Temperature, Coolant °C (°F)	Fuel °C (°F)	Engine oil °C (°F)	Atmospheric conditins, Tempe-rature, °C (°F)	Relative humi-dity, %	Pre-surre, mm Hg (in Hg)
(i) Maximum power (ballasted)												
1	20·2 (19·9)	2135 (4710)	2340	15·0	2·22 (9·95)	384 (0·859)	23 (73)	80 (176)	86 (187)	19 (66)	63	757 (29·80)
2	32·4 (31·9)	2180 (4810)	2320	15·0	2·76 (12·4)	301 (0·674)	23 (73)	80 (176)	86 (187)	20 (68)	61	757 (29·80)
3	39·2 (38·7)	1452 (3205)	2250	6·6	3·10 (13·9)	268 (0·600)	24 (75)	84 (183)	88 (190)	20 (68)	57	757 (29·80)
4	41·0 (40·5)	1050 (2540)	2250	4·7	3·14 (14·2)	264 (0·590)	24 (75)	80 (176)	83 (181)	20 (68)	57	757 (29·80)
5	41·2 (40·7)	700 (1545)	2200	3·0	3·16 (14·4)	262 (0·586)	24 (75)	80 (176)	83 (181)	20 (68)	57	757 (29·80)
(ii) Five hour test at 75% of pull at maximum power												
4	32·8 (32·4)	920 (2030)	2310	5·3	3·00 (13·5)	278 (0·622)	27 (81)	93 (200)	108 (227)	26 (79)	68	751 (29·57)
(iii) Five hour test at pull corresponding to 15% wheelship in test (i)												
2*	26·8 (26·4)	1915 (4225)	2340	—*	—*	* —	24 (75)	90 (194)	92 (198)	22 (72)	75	746 (29·38)
(iv) Maximum power (unballasted)												
1	14·0 (13·7)	1460 (3220)	2330	14·9	1·76 (7·83)	470 (1·050)	27 (81)	85 (185)	84 (183)	24 (75)	68	750 (29·53)
2	22·2 (21·9)	1480 (3270)	2310	15·1	2·42 (10·8)	344 (0·769)	33 (92)	85 (185)	84 (183)	25 (77)	58	750 (29·53)
3	38·0 (37·5)	1460 (3220)	2260	13·8	2·99 (13·4)	278 (0·622)	33 (92)	85 (185)	85 (185)	26 (79)	55	750 (29·53)
4	40·8 (40·3)	1100 (2430)	2260	8·5	3·19 (14·3)	260 (0·582)	34 (93)	87 (189)	86 (187)	27 (81)	53	750 (29·53)
5	40·6 (40·1)	680 (1500)	2240	3·9	3·19 (14·3)	260 (0·582)	37 (99)	90 (194)	87 (189)	29 (84)	48	750 (29·53)
6	36·0 (35·5)	340 (750)	2250	1·3	not rec.	not rec.	37 (99)	90 (194)	88 (190)	30 (86)	47	750 (29·53)

Total oil consumption during ten hours of tests (ii) and (iii): 44 g/h (0,095 lb/h)
* Test (iii) was carried out with additional ballast and the results for power and fuel consumption have no practical significance

Tractor RAKOVICA 60 - SPECIAL

Drawbar test on a tarmacadam track, with ballast



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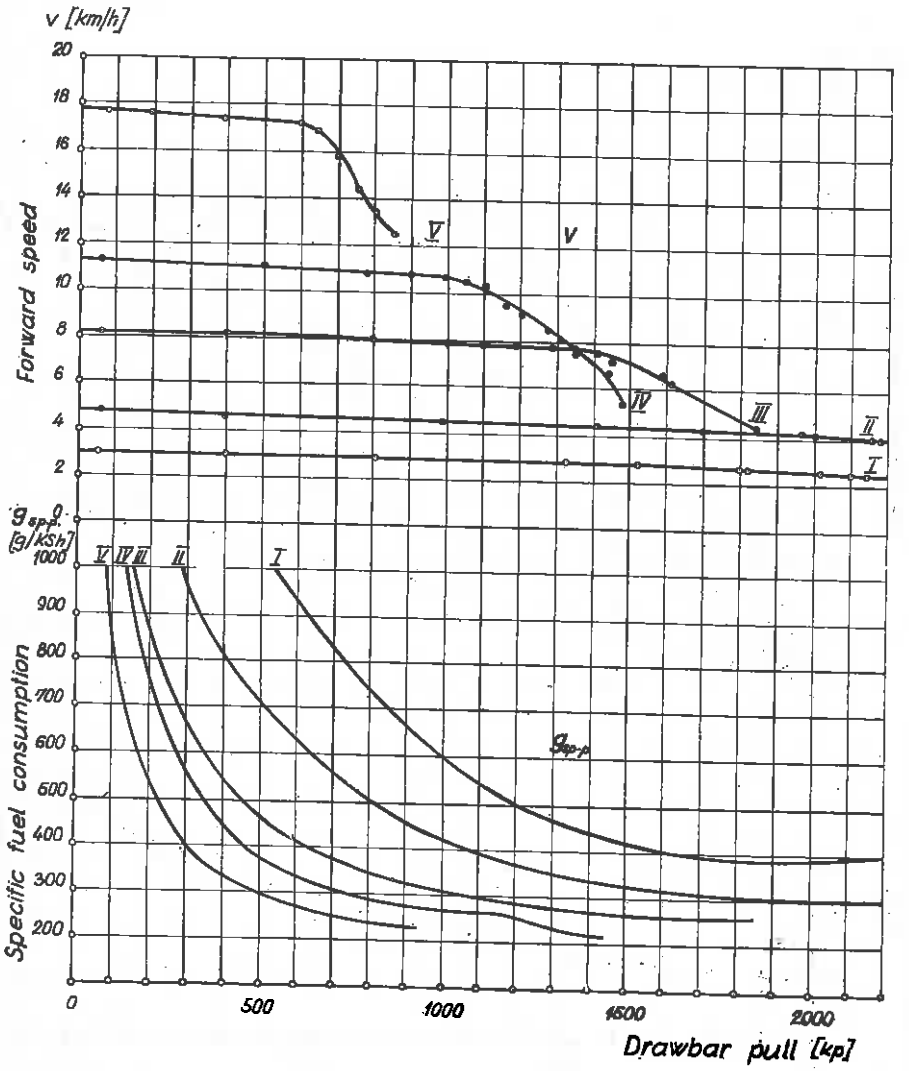

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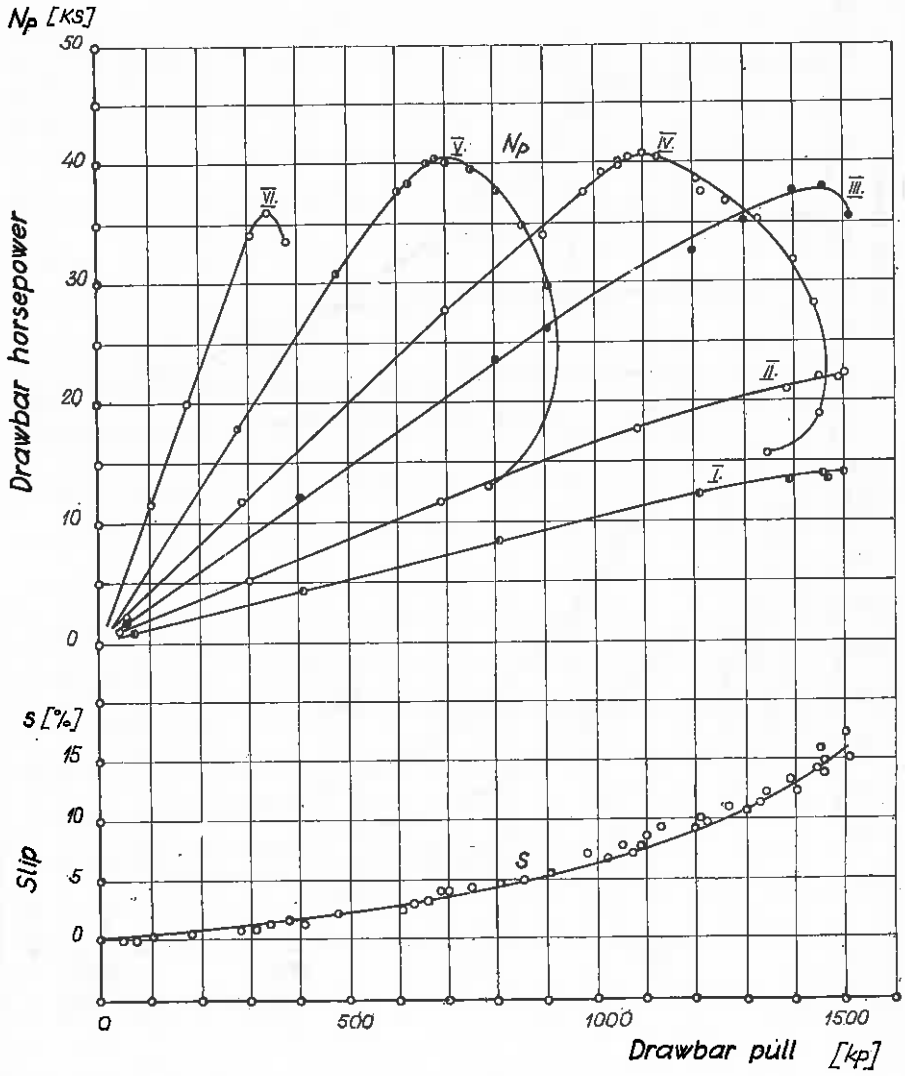
Drawbar test on a tarmacadam track, without ballast



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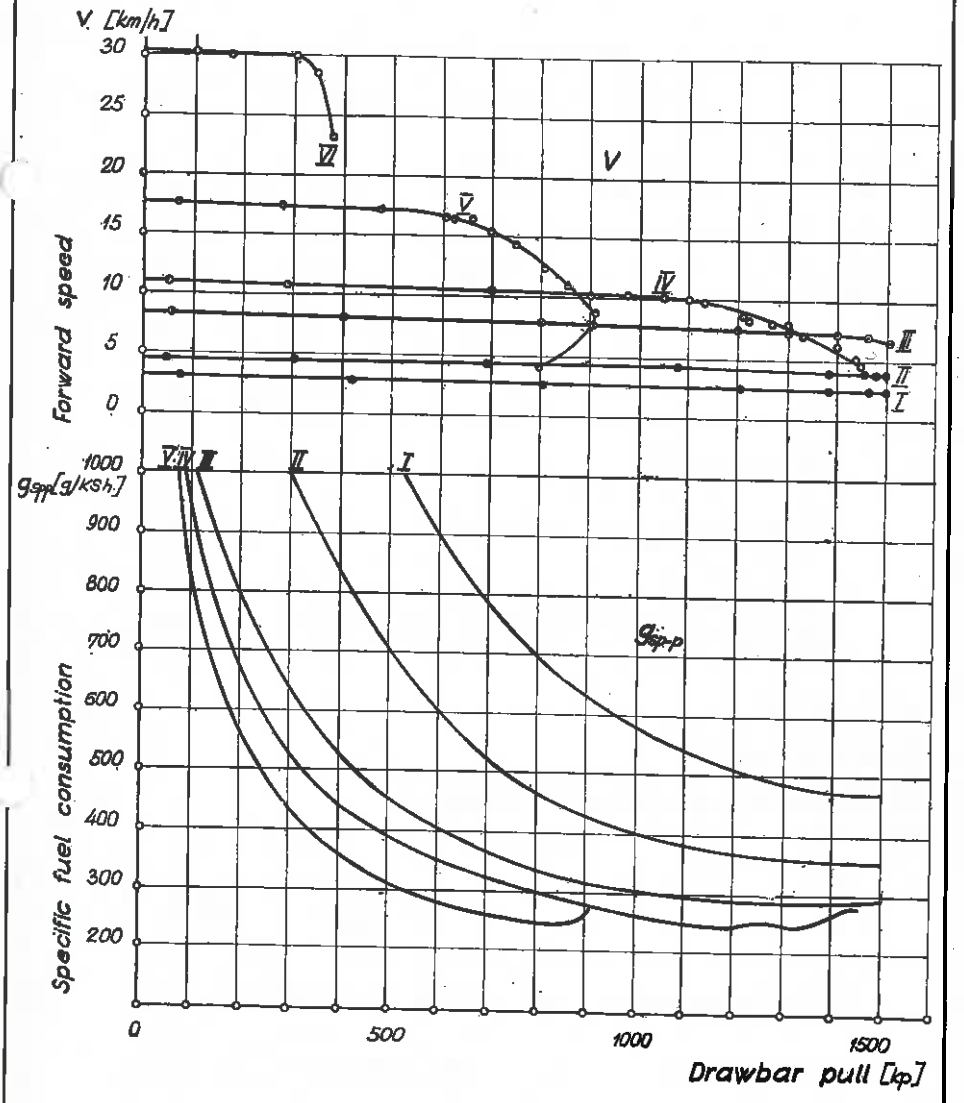

(3 and 4) TURNING SPACE AND TURNING CIRCLE

Wheel equipment: front — 6·50-20 TR 6 ply, without ballast
rear — 14-30 TP 6 ply, without ballast

Track of wheels: front — 1470 mm (57·7 in)
rear — 1490 mm (58·6 in)

	With brakes		Without brakes	
	Right hand	Left hand	Right hand	Left hand
Radius of turning space	3·50 m (11 ft 6 in)	3·46 m (11 ft 4 in)	3·95 m (11 ft 4 in)	3·72 m (12 ft 4 in)
Radius of turning circle	3·44 m (11 ft 2 in)	3·40 m (12 ft 2 in)	3·69 m (12 ft 2 in)	3·66 m (12 ft 0 in)

(5) LOCATION OF CENTRE OF GRAVITY

	mm	(in)
Height above ground	850	(33·5)
Distance from the median plane parallel to the longi-axis of the rear wheels	748	(29·5)
Distance from the median plane parallel to the longitudinal axis of the tractor bisecting the track — to the right hand	4	(0·2)

(6) BRAKING

Date of tests: 16 Mai 1969
Type of track: tarmacadam
Type of decelerometer: Nr. RB 74 Moto Meter Recorder
Travelling speed of tractor: 26·6 km/h (16·5 mile/h)

Cold brakes

			Tractor without ballast	Tractor ballasted
Maximum deceleration,	m/s^2	(ft/s^2)	3·9 (12·8)	4·0 (13·1)
Stopping distance,	m	(ft)	10·90 (35·7)	13·1 (43·0)
Force on brake pedal,	kp	(lb)	50 (110)	52 (115)

Brake fade characteristics (hot tests, tractor without ballast)

Maximum deceleration:	hot/cold: 95%
Stopping distance:	cold/hot: 85%
Force on pedal:	cold/hot: 90%
Efficiency of parking latch:	Satisfactory hot and cold
Efficiency of hand brake:	Satisfactory hot and cold
Pull on hand brake:	46 kp (101·5 lb)

(7) MEASUREMENT OF AMBIENT NOISE EMITTED BY THE TRACTOR

Date of test:	7th August 1968
Type of sound level meter:	General Radio Company, Concord (Mass.) type 1551-c
Type of track:	Concrete
Results of test:	gear: 6th travelling speed before acceleration: 18·3 km/h (11·4 mile/h) sund level: 88 dBA

(8) NOISE MEASUREMENTS AT THE DRIVER'S EAR LEVEL

Date of test:	21st August 1968
Type of sound level meter and octave filter:	General Radio Company, Concord (Mass.), type 1551-c with octave band noise analyzer type 1550-A
Type of track:	Concrete
Type of frequency analyser:	Octave filter with eight bands width 37·5 to 9 600 Hz

Results of test:

Gear	Travelling speed, km/h	(mile/h)	Loudness, sones
3rd	7·1	(4·42)	110

(9) POWER LIFT AND HYDRAULIC PUMP PERFORMANCE

Date and location of test: 9th October 1968, Zagreb
Hydraulic fluid: make and type: INA HIDRAOL 90
viscosity: 9°E/50°C
viscosity index: 100

POWER LIFT

	Total vertical movement mm (in)	Maximum force exerted through full lift range kp (lb)	Pressure of hydraulic oil kp/cm² (lb/in²)	Lifting force at front axle load=0 kp kp (lb)
At lower hitch points (height above ground in down position 135 mm (5·3 in)	440 (17)	1200 (2650)	195 (2775)	Greater than maximum lifting force
On the frame	660 (26)	920 (2030)	195 (2775)	1150 (3210)

Linkage arrangement has only one position possible of the tie rods on the lower links

Type of linkage lock for transport: Implement position control lever
Opening pressure of the cylinder over pressure relief valve (manufacturer's figure): 210—260 kp/cm² (2990—3700 lb/in²)

PUMP CHARACTERISTICS

(i) Opening pressure of relief valve: 200 kp/cm² (2840 lb/in²)
Sustained pressure by the open relief valve: 195 kp/cm² (2775 lb/in²)

Pump delivery rate at external tapping:
(ii) at minimum pressure: 36·1 l/min (7·95 gal/min)
(iii) at maximum hydraulic power: 31·6 l/min (6·95 gal/min)
delivery pressure: 140 kp/cm² (1990 lb/in²)
power: 9·8 hp (9·6 hp)

Test Engineer: D. KRPAN
Officer in charge: V. OBELIĆ
Director: I. TODORIĆ
Date: 26th Mai 1969

TISAK: GRAFIČKI ZAVOD HRVATSKE, ZAGREB