

P O L I T E C N I C O   D I   T O R I N O  
ESAME DI STATO PER L'ABILITAZIONE ALLA PROFESSIONE DI INGEGNERE  
I SESSIONE - ANNO 1998

Ramo: MINERARIO / AMBIENTE E TERRITORIO

TEMA N. 2

Nella planimetria di fig. 1 è raffigurata la situazione morfologica di una area in cui è stata, in passato, attuata un'attività estrattiva che ora si intende riattivare operando nei limiti territoriali riportati nella stessa figura.

La massa scavata è costituita da un giacimento di roccia porfirica profondamente alterata, che si presenta come uno scisto argilloso-marnoso varicolori, con abbondanti inclusioni di argilla caolinica. Tale materiale è destinato all'impiego nell'industria ceramica.

Date le caratteristiche di resistenza della roccia utile, la coltivazione del giacimento sarà condotta con mezzi meccanici. Una valutazione della cubatura del giacimento ha suggerito di programmare la coltivazione per non più di 5 anni, con una produzione di 40.000 m<sup>3</sup>/annui (volume di scavo).

Si chiede al candidato di:

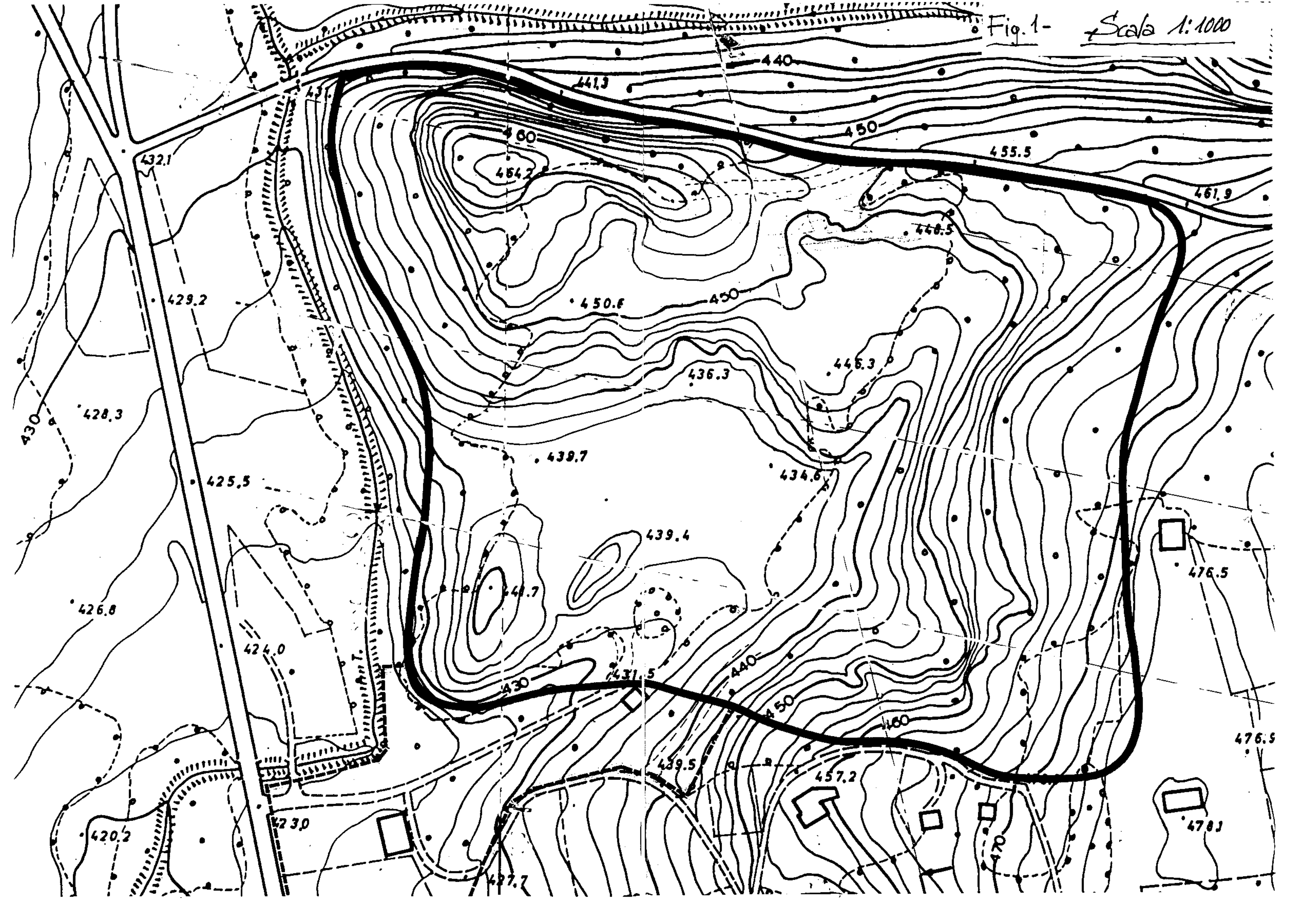
- raffigurare in planimetria e sezioni (in scala opportuna) il cantiere di scavo nella fase iniziale, nella fase finale e in una fase intermedia.
- nell'ipotesi di eseguire la coltivazione mediante dozer, pala caricatrice e un mezzo di trasporto, scegliere tra i modelli descritti nella documentazione allegata quelli che si ritiene adatti al livello di produzione previsto, supponendo di lavorare su un turno giornaliero di 8 ore per 220 giorni all'anno.

Si chiede inoltre al candidato di trattare uno dei due seguenti argomenti:

- A) Eseguire un'analisi di stabilità del fronte di scavo (fronte globale e gradone di coltivazione), servendosi della soluzione basata sull'abaco di fig. 2, e attribuendo al materiale roccioso scavato valori ragionevolmente stimati delle caratteristiche fisico-meccaniche.
- B) Nell'ipotesi che al termine del quinquennio di coltivazione il giacimento possa considerarsi esaurito, si prenda in considerazione la possibilità di utilizzare l'area scavata per realizzare una discarica di rifiuti solidi urbani.

Si illustrino pertanto i principali aspetti tecnici che caratterizzeranno tale opera (volumetria, geometria globale, sistemi di isolamento, estrazione del biogas e del percolato), completando l'esposizione verbale con opportuni schizzi grafici.

Fig. 1- *Scala 1:1000*

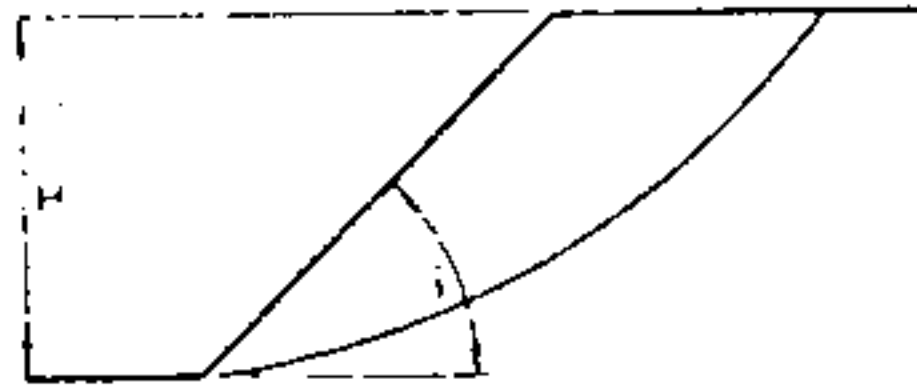
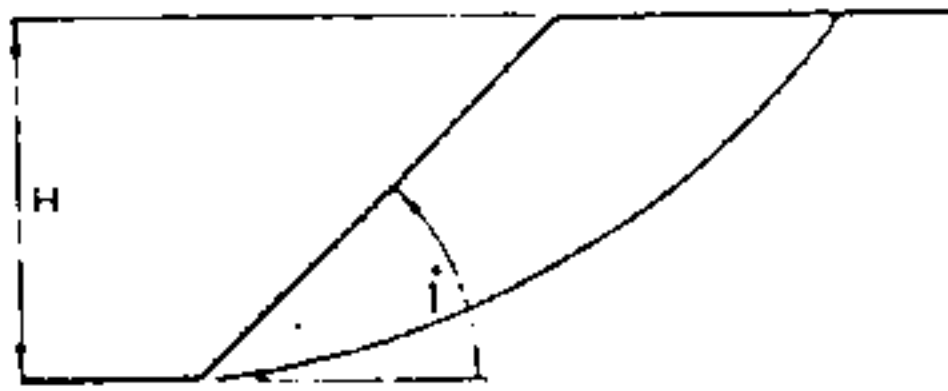


Slope angle function X

Slope height function Y

A - drained slope

B - no tension crack

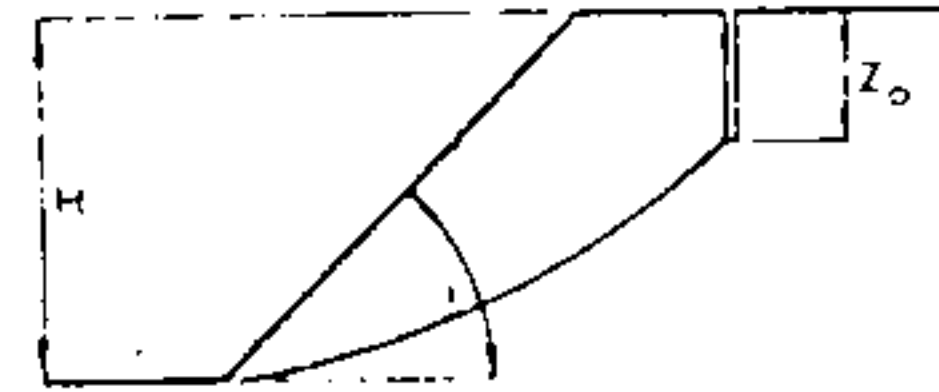
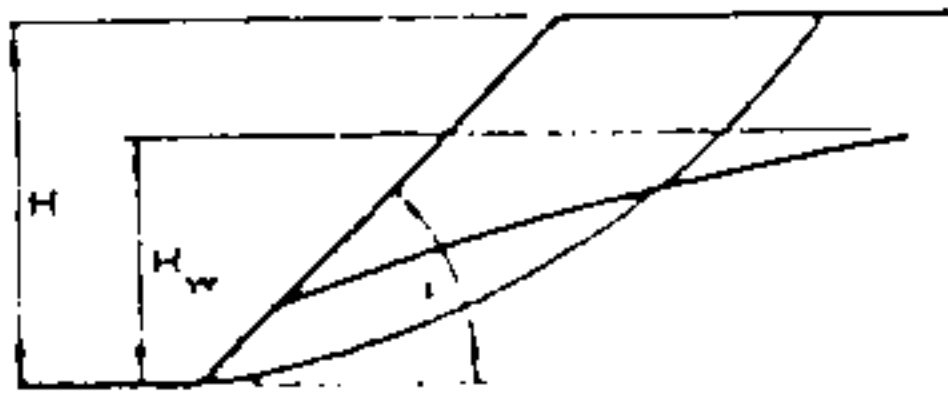


$$X = i - 12\phi$$

$$Y = YH/c$$

C - normal drawdown

D - dry tension crack



$$X = i - \phi \left[ 12 - 0.3 \frac{H_w}{H} \right]$$

$$Y = \left[ 1 + \left( \frac{i - 25}{100} \right) \frac{Z_o}{H} \right] \frac{YH}{c}$$

E - horizontal water flow

F - water-filled tension crack



$$X = i - \phi \left[ 12 - 0.5 \frac{H_w}{H} \right]$$

$$Y = \left[ 1 + \left( \frac{i - 10}{100} \right) \frac{Z_e}{H} \right] \frac{YH}{c}$$

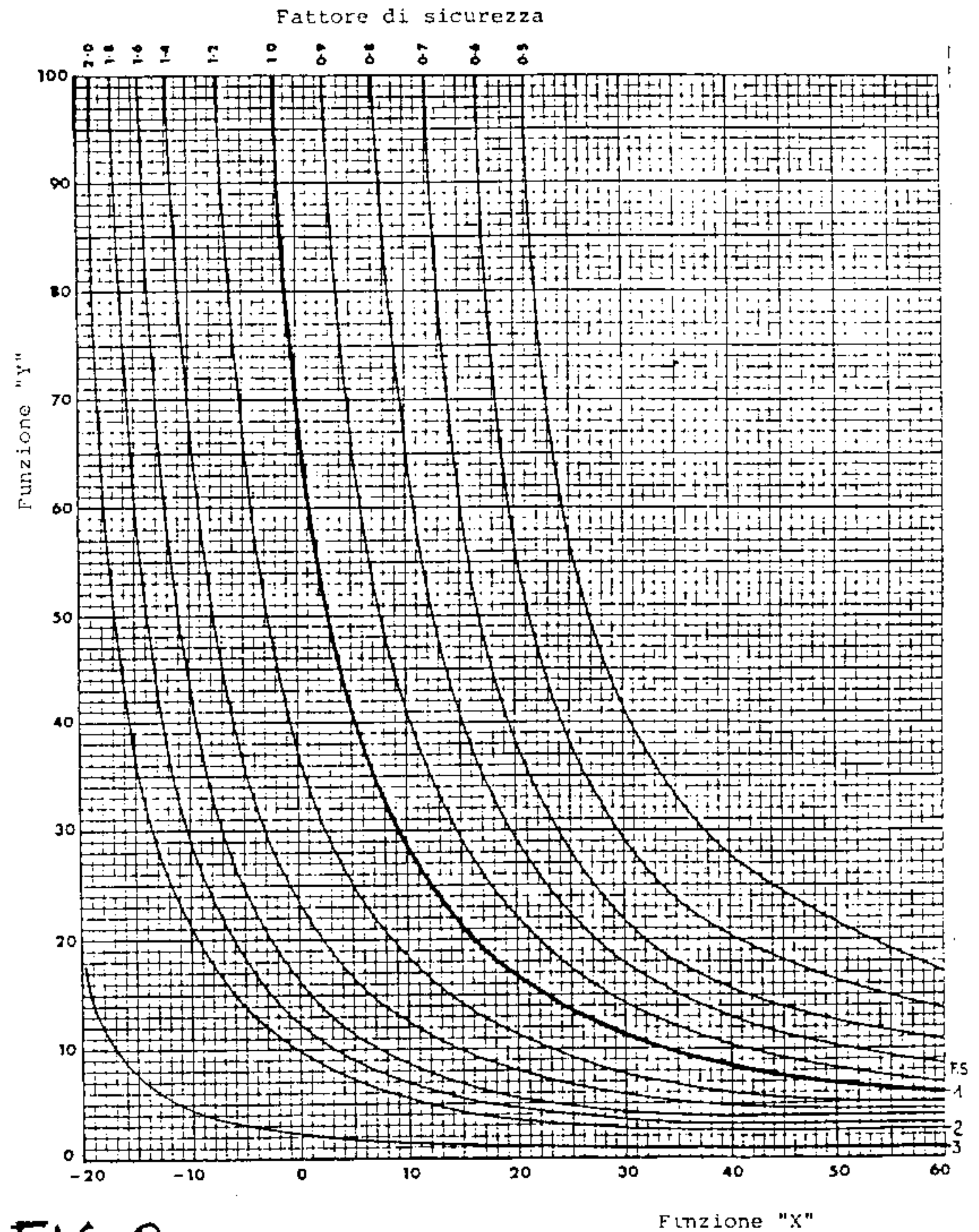


FIG. 2





MODEL	D3B		D4E		D5B		D6D		D7G	
Flywheel Power	48 kW	65 HP	60 kW	80 HP	78 kW	105 HP	104 kW	140 HP	149 kW	200 HP
Operating Weight* (Power Shift) (Direct Drive)	6711 kg	14,795 lb	9090 kg	20,040 lb	12 355 kg	27,240 lb	14 900 kg	32,850 lb	20 520 kg	45,340 lb
Engine Model	3204		3304		3306		3306		3306	
Rated Engine RPM	2400		2000***		1750		1900		2000	
No. of Cylinders	4		4		6		6		6	
Bore	114 mm	4.5"	121 mm	4.75"	121 mm	4.75"	121 mm	4.75"	121 mm	4.75"
Stroke	127 mm	5"	152 mm	6"	152 mm	6"	152 mm	6"	152 mm	6"
Displacement	5.2 L	318 in <sup>3</sup>	7 L	425 in <sup>3</sup>	10.5 L	638 in <sup>3</sup>	10.5 L	638 in <sup>3</sup>	10.5 L	638 in <sup>3</sup>
Track Rollers (each side)	5		5		6		6		6	
Width of Standard Track Shoe	305 mm	12"	330 mm	13"	406 mm	16"	457 mm	18"	510 mm	20"
Length of Track on Ground	1.82 m	5'11.8"	1.83 m	6'0"	2.21 m	7'3"	2.36 m	7'9"	2.70 m	8'11"
Ground Contact Area (w/std. shoe)	1.11 m <sup>2</sup>	1723 in <sup>2</sup>	1.21 m <sup>2</sup>	1872 in <sup>2</sup>	1.79 m <sup>2</sup>	2784 in <sup>2</sup>	2.16 m <sup>2</sup>	3348 in <sup>2</sup>	2.76 m <sup>2</sup>	4280 in <sup>2</sup>
Track Gauge	1.42 m	4'8"	1.52 m	5'0"	1.88 m	6'2"	1.88 m	6'2"	1.98 m	6'6"
GENERAL DIMENSIONS:										
Height (stripped top)**	1.69 m	5'6.5"	1.73 m	5'8"	1.95 m	6'5"	2.08 m	6'10"	2.27 m	7'5"
Height (to top of ROPS)	2.66 m	8'8.7"	2.71 m	8'11"	2.77 m	9'1"	2.87 m	9'5"	3.20 m	10'6"
Overall Length (with S blade)	3.70 m	12'2"	3.86 m	12'8"	4.60 m	15'1"	4.80 m	15'9"	5.28 m	17'4"
(without blade)	2.75 m	9'0"	3.20 m	10'6"	3.63 m	11'11"	3.73 m	12'3"	4.19 m	13'9"
Width (with Standard Shoe)	1.79 m	5'10"	1.98 m	6'6"	2.36 m	7'9"	2.36 m	7'9"	2.55 m	8'5"
Ground Clearance	290 mm	11.4"	357 mm	14"	279 mm	11"	310 mm	12.2"	347 mm	13.7"
Blade Types and Widths:										
Straight	—		2.44 m	8'0"	3.15 m	10'4"	3.20 m	10'6"	3.66 m	12'
Angle	—		3.12 m	10'3"	3.63 m	11'11"	3.89 m	12'9"	4.27 m	14'
Universal	—		—		—		—		3.81 m	12'6"
Power Angle & Tilt	2.41 m	7'11"	—		—		—		—	
Cushion	—		—		—		—		—	
Fuel Tank Refill Capacity	114 L	30 gal	146 L	38.6 gal	246 L	65 gal	295 L	78 gal	435 L	115 gal

\* Operating Weight includes lubricants, coolant, full fuel tank, straight bulldozer, hydraulic controls and fluids, ROPS canopy, and operator. D3B has 3F-3R transmission and power angle and tilt blade.

\*\* Height (stripped top) — without ROPS, exhaust, seat back or other easily removed encumbrances

\*\*\* D4E with direct drive has a rated engine RPM of 1900.

Note: D4E with long undercarriage: length of track on ground 2.22 m (7'3"); ground contact area 1.46 m<sup>2</sup> (2262 in<sup>2</sup>)



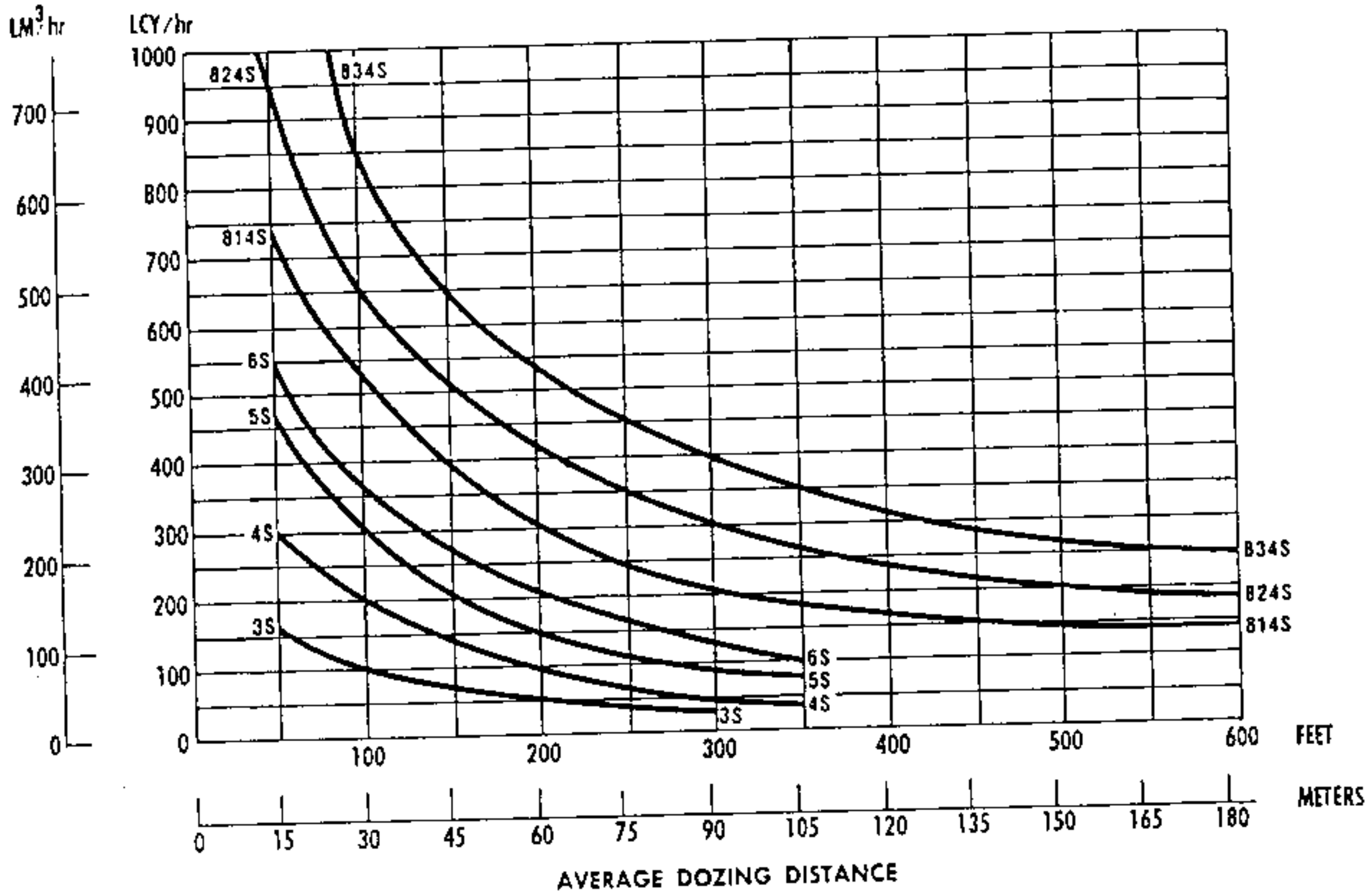
MODEL	D8L		D9L		D10	
Flywheel Power	250 kW	335 HP	343 kW	460 HP	522 kW	700 HP
Operating Weight* (Power Shift) (Direct Drive)	37 170 kg	81,950 lb	52 007 kg	114,853 lb	79 020 kg	174,200 lb
Engine Model	3408		3412		D348	
Rated Engine RPM	1900		1900		1800	
No. of Cylinders	8		12		12	
Bore	137 mm	5.4"	137 mm	5.4"	137 mm	5.4"
Stroke	152 mm	6"	152 mm	6"	165 mm	6.5"
Displacement	18 L	1099 in <sup>3</sup>	27 L	1649 in <sup>3</sup>	29.3 L	1788 in <sup>3</sup>
Track Rollers (each side)	8		8		8	
Width of Standard Track Shoe	560 mm	22"	610 mm	24"	711 mm	28"
Length of Track on Ground	3.213 m	10'6.5"	3.55 m	11'7.5"	3.91 m	12'10"
Ground Contact Area (w/std. shoe)	3.59 m <sup>2</sup>	5588 in <sup>2</sup>	4.320 m <sup>2</sup>	6696 in <sup>2</sup>	5.56 m <sup>2</sup>	8624 in <sup>2</sup>
Track Gauge	2.200 m	7'3"	2.50 m	8'2"	2.89 m	9'6"
GENERAL DIMENSIONS:						
Height (stripped top)**	2.895 m	9'7"	3.17 m	10'5"	3.48 m	11'5"
Height (to top of ROPS)	3.874 m	12'9"	4.213 m	13'10"	4.52 m	14'10"
Overall Length (with S blade)	6.227 m	20'4"	7.08 m	22'11"	7.57 m	24'8"
(without blade)	4.950 m	16'2"	5.32 m	17'5"	5.92 m	19'8"
Width (with Standard Shoe)	2.759 m	9'0"	3.19 m	10'5"	3.61 m	11'11.5"
Ground Clearance	513 mm	20.2"	610 mm	24"	701 mm	27.6"
Blade Types and Widths:						
Straight	4.172 m	13'10"	4.54 m	14'11"	5.49 m	18'
Angle	4.851 m	15'11"	—		—	
Universal	4.503 m	14'9"	4.97 m	16'4"	6.00 m	19'8"
Power Angle & Tilt	—		—		—	
Cushion	—		3.31 m	10'11"	3.81 m	12'6"
Fuel Tank Refill Capacity	776 L	205 gal	965 L	255 gal	1450 L	383 gal

\* Operating Weight includes lubricants, coolant, full fuel tank, straight bulldozer, hydraulic controls and fluid, ROPS canopy, and operator.

\*\* Height (stripped top) — without ROPS, exhaust, seat back or other easily removed encumbrances

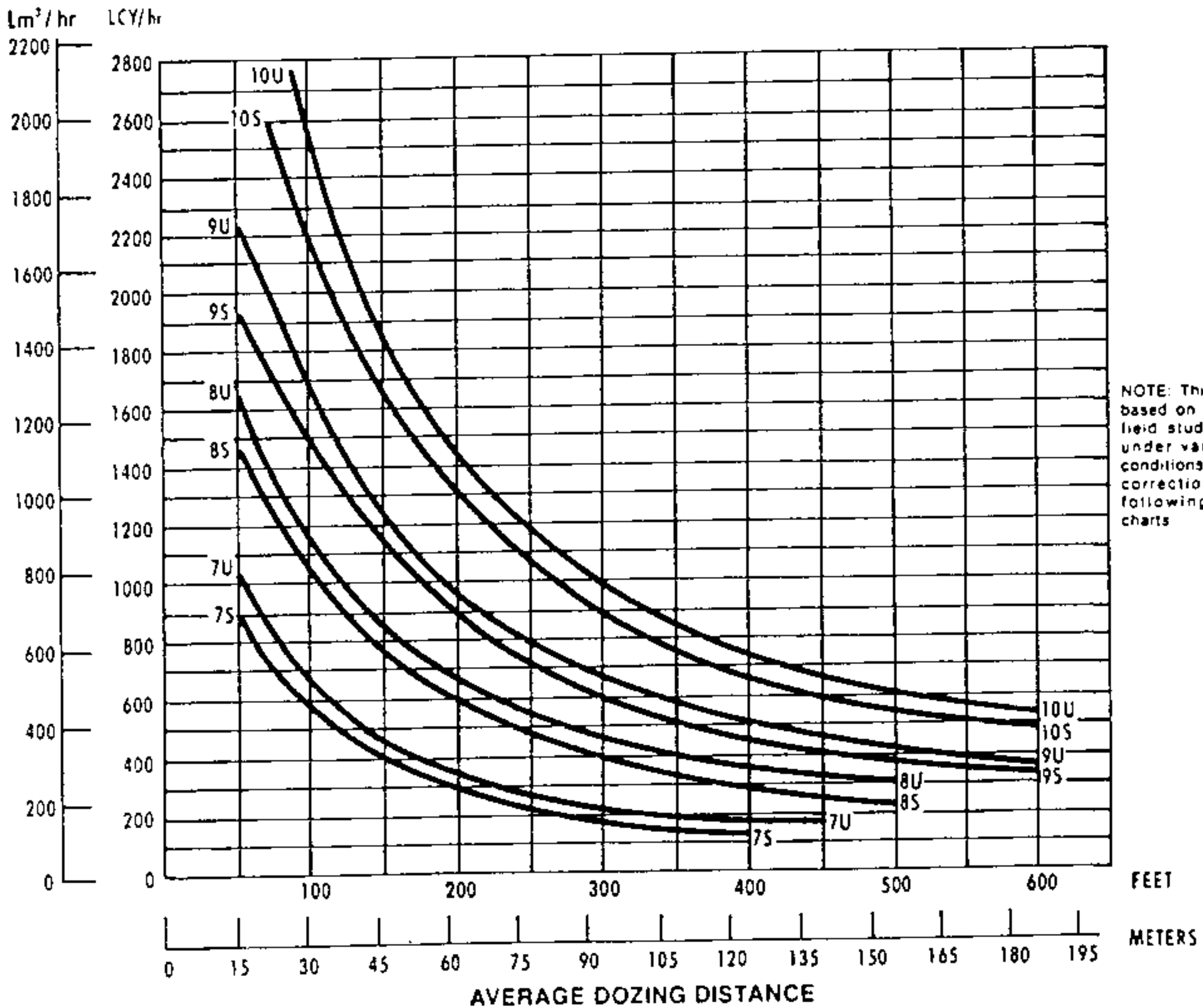
## ESTIMATED DOZING PRODUCTION

### Straight Blades • D3, D4, D5, D6, 814, 824, 834



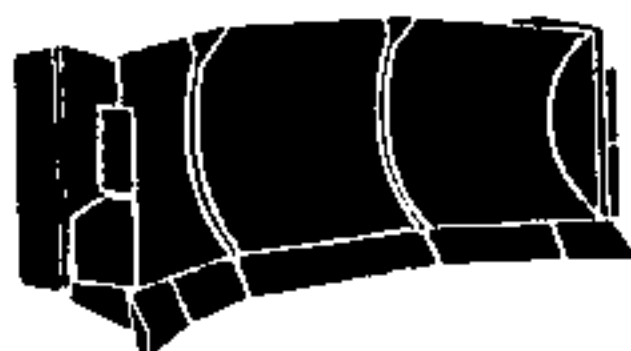
NOTE: This chart is based on numerous field studies made under varying job conditions. Refer to correction factors on the next page. The 3S represented is for the D3B LGP.

## ESTIMATED DOZING PRODUCTION • Universal and Straight Blades • D7 through D10



NOTE: This chart is based on numerous field studies made under varying job conditions. Refer to correction factors following these charts.

**PRODUCTION DOZING TOOLS**



"U"—Universal blade—the large wings on this blade make it efficient for moving big loads over long distances as in land reclamation, stockpile work, charging

hoppers and trapping for loaders. As this blade has a lower HP/foot (or kW/meter) of cutting edge than an "S", penetration should not be a prime objective. With a lower HP/LCY (or kW/Lm<sup>3</sup>) than an "S", this blade is best for lighter or relatively easily dozed material. Equipped with tilt cylinders (standard on D7, D8, D9 and D10), it has some of the versatility of the "S" blade. A tilt cylinder improves its ability to ditch, pry out, and level. This extends its use to many utility tasks.



"S" — The Straight blade is the most versatile bulldozer available. Its modified "U" design (available only on the D8, D9 and D10) makes it a good production

dozing tool. Since it is physically smaller than the "U" dozer, it is easier to maneuver and can handle a wider range of materials. It has a higher HP/foot of cutting edge than the "U" blade; consequently, the "S" is more aggressive in penetrating and obtaining a blade load. A tilt cylinder (standard on D7, D8, D9 and D10) increases both the productivity and versatility of this dozer. With a high HP/LCY, the "S" blade can handle heavy material easily. Equipped with a push plate, it is effectively used for push loading scrapers.

**SPECIAL APPLICATION DOZING TOOLS**

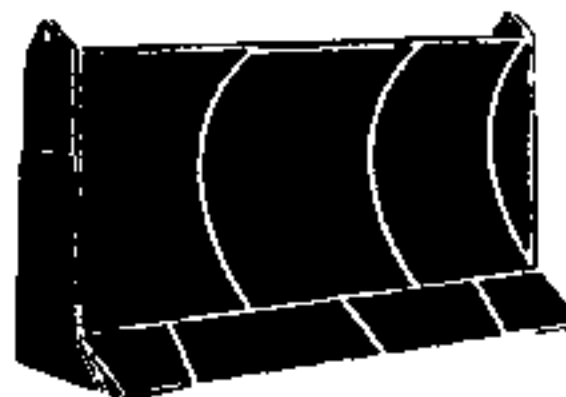
Caterpillar and other blade manufacturers provide specialty bulldozers for specific applications. The

blades are designed to increase production while performing certain tasks. However, specialization may reduce the blade versatility. Following are the most popular special application blades.



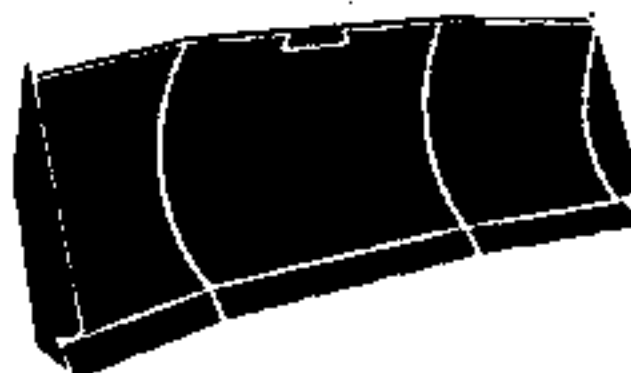
"A" — Or Angling blade can be positioned straight or angled 25 degrees to either side. It is designed for side-casting, pioneering roads, backfilling, cutting

ditches and other similar tasks. It can reduce the amount of maneuvering required to do these jobs. Its "C" frame can be used for attachments such as pushing, land clearing, or snow removal tools.



"C" — The Cushion blade is used on the D9 and D10 for on-the-go push-loading. Rubber cushions allow the dozer to absorb the impact of contacting a scraper push

block. When not push-loading, the dozer can be used for cut maintenance and other general dozing jobs. The narrow width of the "C" dozer increases machine maneuverability in congested cuts and reduces the possibility of cutting tires associated with "S" & "U" blades.



"AEM U-Blades" — Balderson and Beales offer a variety of U-blades for use in a wide range of applications. They provide high volume movement of light

non-cohesive materials such as coal and woodchips. Heavier U-blades are also offered for production dozing and reclamation work.

# Off-Highway Trucks Specifications

4



MODEL	769C		773B		777	
Flywheel Power	336 kW	450 HP	485 kW	650 HP	649 kW	870 HP
Operating Weight (Empty)*	30 845 kg	68,000 lb	38 885 kg	85,730 lb	58 580 kg	129,150 lb
Top Speed (Loaded)	69 km/h	43 mph	61 km/h	38 mph	60 km/h	37 mph
GVW — Gross Vehicle Weight	62 595 kg	138,000 lb	84 285 kg	185,730 lb	135 690 kg	299,150 lb
Distribution: Empty:						
Front		49.6%		47.3%		46.2%
Rear		50.4%		52.7%		53.8%
Distribution: Loaded:						
Front		33.3%		33.3%		33.3%
Rear		66.7%		66.7%		66.7%
Capacity, Tons (standard body)	31.8 t	35 T	45.4 t	50 T	77.1 t	85 T
Cubic Yards —						
Struck (SAE)	17.4 m <sup>3</sup>	22.8 yd <sup>3</sup>	26.0 m <sup>3</sup>	34.0 yd <sup>3</sup>	36.3 m <sup>3</sup>	47.5 yd <sup>3</sup>
Heaped (3:1)	21.6 m <sup>3</sup>	28.2 yd <sup>3</sup>	31.4 m <sup>3</sup>	41.1 yd <sup>3</sup>	46.4 m <sup>3</sup>	60.7 yd <sup>3</sup>
Heaped (2:1) (SAE)	23.5 m <sup>3</sup>	30.8 yd <sup>3</sup>	34.1 m <sup>3</sup>	44.6 yd <sup>3</sup>	51.3 m <sup>3</sup>	67.1 yd <sup>3</sup>
Heaped (1:1)	29.4 m <sup>3</sup>	38.5 yd <sup>3</sup>	41.7 m <sup>3</sup>	54.6 yd <sup>3</sup>	65.4 m <sup>3</sup>	85.6 yd <sup>3</sup>
Engine Model	3408		3412		D348	
No. Cylinders	8		12		12	
Bore	137 mm	5.4"	137 mm	5.4"	137 mm	5.4"
Stroke	152 mm	6.0"	152 mm	6.0"	165 mm	6.5"
Displacement	18 L	1099 in <sup>3</sup>	27 L	1649 in <sup>3</sup>	29.3 L	1786 in <sup>3</sup>
Standard Tires, Front & Dual Rear	18.00-33, 28 PR (E-3)		21.00-35, 32 PR (E-3)		24.00-49, 42 PR (E-3)	
Vehicular Clearance Turning Circle	18.5 m	60' 8"	23.5 m	77' 0"	26.8 m	88'
Fuel Tank Refill Capacity	530 lit	140 gal	700 lit	185 gal	946 lit	250 gal
<b>GENERAL DIMENSIONS (Empty):</b>						
Height to Canopy Rock Guard Rail	3.94 m	12' 11"	4.23 m	13' 10.5"	4.90 m	16' 1"
Wheel Base	3.71 m	12' 2"	4.19 m	13' 9"	4.57 m	15'
Overall Length	8.19 m	26' 10"	9.27 m	30' 5"	9.78 m	32' 1"
Loading Height (empty)	3.22 m	10' 7"	3.69 m	12' 1"	4.14 m**	13' 7"***
Height at Full Dump	7.70 m	25' 3"	8.66 m	28' 5"	9.33 m	30' 8"
Body Length	5.31 m	17' 5"	6.43 m	21' 1"	6.86 m	22' 6"
Width (operating)	4.514 m	14' 10"	4.654 m	15' 3"	5.463 m	17' 11"
Width (shipping)***	3.64 m	11' 11"	3.79 m	12' 5"	3.51 m†	11' 6"†
Front Tire Tread	3.10 m	10' 2"	3.18 m	10' 5"	3.96 m	13'

\*Weights include lubricants, coolant, full fuel tank, operator and standard body. †3.65 m (12' 0") Sub Assembled Body.  
 \*\*Loading Height for 777 high density body is 12' 11" (3937 mm). ‡4.88 m (16' 0") Assembled Machine Catwalk Removed.  
 \*\*\*Disassembled. ††Includes catwalk protrusion beyond front bumper on 769C and 773B.



MODEL	966D		980C		988B		992C	
Flywheel Power	149 kW	200 HP	201 kW	270 HP	280 kW	375 HP	515 kW	690 HP
Engine Model	3306		3406		3408		3412	
Rated Engine RPM	2200		2100		2200		2200	
Bore	121 mm	4.75"	137 mm	5.4"	137 mm	5.4"	137 mm	5.4"
Stroke	152 mm	6"	165 mm	6.5"	152 mm	6"	152 mm	6"
No. Cylinders	6		6		8		12	
Displacement	10.5 L	638 in <sup>3</sup>	14.6 L	893 in <sup>3</sup>	18 L	1099 in <sup>3</sup>	27 L	1649 in <sup>3</sup>
Speeds Forward,	km/h	MPH	km/h	MPH	km/h	MPH	km/h	MPH
1st	6.6	4.1	6.5	4.0	6.4	4.0	6.8	4.2
2nd	11.7	7.2	11.4	7.1	11.5	7.2	12.1	7.5
3rd	20.3	12.6	20.0	12.4	20.4	12.7	20.9	13.0
4th	34.3	21.3	34.6	21.5	36.2	22.5	—	—
Speeds Reverse,								
1st	7.5	4.7	7.4	4.6	7.4	4.6	7.5	4.7
2nd	13.2	8.2	13.0	8.1	13.2	8.2	13.2	8.2
3rd	22.8	14.2	22.8	14.2	23.3	14.5	23.3	14.5
4th	38.1	23.7	39.6	24.6	41.4	25.7	—	—
Hydraulic Cycle Time, rated load in bucket:	Seconds		Seconds		Seconds		Seconds	
Raise	6.3		7.3		8.8		11.4	
Dump	2.0		2.0		2.7		2.8	
Lower (empty, float down)	3.0		3.4		4.4		4.0	
Total	11.3		12.7		15.9		18.2	
Fuel Tank Refill Capacity	308 L	81 gal	400 L	105 gal	632 L	167 gal	1136 L	300 gal
Hydraulic System Refill Capacity	240 L	63 gal	208 L	55 gal	295 L	78 gal	541 L	143 gal

Wheel Loaders | 966D Performance Data

BUCKET:	General Purpose				Rock			
	EXCAVATING		LOOSE MATERIAL		V-EDGE (no teeth)		V-EDGE (with teeth)	
Rated Load	5440 kg	12,000 lb	5440 kg	12,000 lb	5440 kg	12,000 lb	5440 kg	12,000 lb
Capacity, Rated (nominal heaped)	3.1 m <sup>3</sup>	4.0 yd <sup>3</sup>	3.5 m <sup>3</sup>	4.5 yd <sup>3</sup>	3.1 m <sup>3</sup>	4.0 yd <sup>3</sup>	3.1 m <sup>3</sup>	4.0 yd <sup>3</sup>
Capacity, Struck	2.6 m <sup>3</sup>	3.4 yd <sup>3</sup>	3.0 m <sup>3</sup>	3.9 yd <sup>3</sup>	2.7 m <sup>3</sup>	3.5 yd <sup>3</sup>	2.7 m <sup>3</sup>	3.5 yd <sup>3</sup>
Cutting edge: Type	Straight		Straight		V-edge		V-edge	
Bucket Width ←	3040 mm	119.7"	3040 mm	120"	3085 mm	121"	3085 mm	121"
Dump clearance at full lift and 45° discharge	3.018 m	9' 11"	2.869 m	9' 5"	2.739 m	9' 0"	2.692 m	8' 10"
Reach at 45° discharge angle and 2130 mm (7' 0") clearance	1.664 m	5' 5"	1.701 m	5' 7"	1.743 m	5' 9"	1.829 m	6' 0"
Reach at full lift and 45° discharge	1.090 m	3' 7"	1.149 m	3' 9"	1.235 m	4' 0"	1.416 m	4' 7"
Digging depth	77 mm	3.03"	69 mm	2.72"	77 mm	3.03"	77 mm	3.03"
Overall length	7.814 m	25' 8"	7.889 m	25' 11"	8.019 m	26' 4"	8.275 m	27' 2"
Overall height	5.433 m	17' 10"	5.558 m	17' 3"	5.468 m	17' 1"	5.468 m	17' 1"
Loader clearance circle (bucket in carry position)	14.640 m	48'	14.718 m	48' 2"	14.806 m	48' 7"	14.806 m	48' 7"
Static tipping load**								
Straight	13 774 kg	30,372 lb	13 260 kg	29,238 lb	13 650 kg	30,098 lb	13 362 kg	29,463 lb
Full 35° turn	12 677 kg	27,953 lb	12 165 kg	26,824 lb	12 551 kg	27,675 lb	12 263 kg	27,040 lb
Breakout force*	216 kN	48,536 lb	199 kN	44,737 lb	183 kN	41,048 lb	181 kN	40,656 lb
Operating weight**	19 505 kg	43,008 lb	19 877 kg	43,829 lb	19 659 kg	43,809 lb	19 868 kg	43,809 lb

← Bolt-on teeth increase bucket width by 63.8 mm (2.5").

Bolt-on cutting edge increases bucket width by 19 mm (.75").

\* Breakout force is measured 102 mm (4") behind tip of cutting edge with bucket hinge pin as pivot point. In accordance with SAE J732c (1969)

\*\* Static tipping load and operating weight include lubricants, coolant, full fuel tank, 23.5-25, 16 PR (L2) tires, ROPS cab, operator, and 1170 kg (2,580 lb) 75% CaCl<sub>2</sub> solution in rear tires. Machine stability is affected by the tire size, tire ballast and attachments. For selected items, add/subtract the following to/from machine operating weight and static tipping load:

	change in operating weight		change in articulated static tipping load	
	kg	lb	kg	lb
Remove cab only	- 230	- 500	- 190	- 420
Remove ROPS canopy only	- 560	- 1,230	- 560	- 1,240
23.5-25, 16 PR (L3) with 75% CaCl <sub>2</sub>	+ 265	+ 580	+ 350	+ 775
26.5-25, 14 PR (L2) with 75% CaCl <sub>2</sub>	+ 825	+ 1,820	+ 1110	+ 2,450
Counterweight in place of ballast with 23.5-25 tires	- 400	- 890	- 10	- 25
Counterweight in place of ballast with 26.5-25 tires	+ 110	+ 250	+ 180	+ 400



General Purpose

Rock

BUCKET:	General Purpose				Rock			
	EXCAVATING		LOOSE MATERIAL		V-EDGE (no teeth)		V-EDGE (with teeth)	
Rated Load	7000 kg	15,400 lb	7000 kg	15,400 lb	7000 kg	15,400 lb	7000 kg	15,400 lb
Capacity, Heaped	4.0 m <sup>3</sup>	5.25 yd <sup>3</sup>	4.4 m <sup>3</sup>	5.75 yd <sup>3</sup>	4.0 m <sup>3</sup>	5.25 yd <sup>3</sup>	4.0 m <sup>3</sup>	5.25 yd <sup>3</sup>
Struck	3.45 m <sup>3</sup>	4.5 yd <sup>3</sup>	3.83 m <sup>3</sup>	5.0 yd <sup>3</sup>	3.4 m <sup>3</sup>	4.4 yd <sup>3</sup>	3.4 m <sup>3</sup>	4.4 yd <sup>3</sup>
Bucket Width ◀	3.35 m	11'0"	3.35 m	11'0"	3.35 m	11'0"	3.35 m	11'0"
Dump clearance at full lift and 45° discharge	3.17 m	10'4"	3.03 m	9'11"	3.01 m	9'10"	2.77 m	9'1"
Reach at full lift and 45° discharge	1.32 m	4'4"	1.41 m	4'7"	1.48 m	4'10"	1.62 m	5'4"
Reach at 45° discharge angle and 2130 mm (7'0") clearance	1.93 m	6'4"	1.98 m	6'6"	2.03 m	6'6"	2.06 m	6'9"
Reach with lift arms horizontal and bucket level	2.67 m	8'9"	2.84 m	9'4"	2.90 m	9'6"	3.17 m	10'5"
Digging depth	75 mm	2.95"	106 mm	4.17"	75 mm	2.95"	75 mm	2.95"
Overall length	8.62 m	28'3"	8.81 m	28'11"	8.84 m	29'0"	9.12 m	29'11"
Overall height (bucket at full raise)	5.80 m	19'0"	5.92 m	19'5"	6.11 m	20'0"	6.11 m	20'0"
Loader clearance circle (bucket in carry position)	15.6 m	51'1"	15.7 m	51'2"	15.5 m	51'0"	15.7 m	51'2"
Static tipping load**								
Straight	18 490 kg	40,760 lb	17 810 kg	39,260 lb	18 060 kg	39,815 lb	17 755 kg	39,140 lb
Full 35° turn	16 945 kg	37,355 lb	16 270 kg	35,865 lb	16 520 kg	36,415 lb	16 210 kg	35,735 lb
Breakout force*	262 kN	58,880 lb	225 kN	50,815 lb	219 kN	49,270 lb	217 kN	48,775 lb
Operating weight**	26 310 kg	58,000 lb	26 815 kg	59,115 lb	26 680 kg	58,815 lb	26 925 kg	59,335 lb

◀ Bolt-on teeth increase bucket width by 58.8 mm (2.3").

Bolt-on cutting edge increases bucket width by 34 mm (1.3").

\* Breakout force is measured 102 mm (4") behind tip of cutting edge with bucket hinge pin as pivot point.

\*\* Static tipping load and operating weight shown include sound-suppressed cab and ROPS, 26.5-25, 20 PR (L-3) tires with 1378 kg (3,038 lb) 75% CaCl<sub>2</sub> solution in rear tires, full fuel tank and operator.

Machine stability and operating weight are affected by counterweight, larger tires and other attachments (use tire ballast or counterweight, not both). Add/subtract the following to/from operating weight and static tipping load:

	change in operating weight		change in articulated static tipping load	
	kg	lb	kg	lb
Remove cab only	-220	-500	-180	-400
Remove ROPS canopy only	-720	-1,600	-700	-1,540
26.5-25 20 PR (L4) with 75% CaCl <sub>2</sub>	+540	+1,200	+410	+900
26.5-25 20 PR (L5) with 75% CaCl <sub>2</sub>	+880	+1,950	+700	+1,550
29.5-25 22 PR (L3) with 75% CaCl <sub>2</sub>	+1090	+2,400	+1120	+2,470
Counterweight in place of ballast with 26.5-25 tires	-650	-1,440	-720	-1,600
Counterweight in place of ballast with 29.5-25 tires	-770	-1,700	-800	-1,800

900

BUCKET:	V-Edge						Straight Edge					
	ROCK		ROCK WITH TEETH		ROCK MODULOK		ROCK		ROCK WITH TEETH		LOOSE MATERIAL	
	9600 kg	21,200 lb	9600 kg	21,200 lb	9600 kg	21,200 lb	9600 kg	21,200 lb	9600 kg	21,200 lb	9600 kg	21,200 lb
Rated Load	5.4 m <sup>3</sup>	7.0 yd <sup>3</sup>	5.4 m <sup>3</sup>	7.0 yd <sup>3</sup>	5.4 m <sup>3</sup>	7.0 yd <sup>3</sup>	5.4 m <sup>3</sup>	7.0 yd <sup>3</sup>	5.4 m <sup>3</sup>	7.0 yd <sup>3</sup>	5.2 m <sup>3</sup>	6.8 yd <sup>3</sup>
Capacity, Heaped	4.6 m <sup>3</sup>	6.0 yd <sup>3</sup>	4.6 m <sup>3</sup>	6.0 yd <sup>3</sup>	4.6 m <sup>3</sup>	6.0 yd <sup>3</sup>	4.6 m <sup>3</sup>	6.0 yd <sup>3</sup>	4.6 m <sup>3</sup>	6.0 yd <sup>3</sup>	3.64 m	11'11.5"
Capacity, Struck	3.64 m	11'11.5"	3.64 m	11'11.5"	3.64 m	11'11.5"	3.64 m	11'11.5"	3.64 m	11'11.5"	3.64 m	11'11.5"
Bucket Width	3.46 m	11'4"	3.18 m	10'5.4"	3.26 m	10'9"	3.72 m	12'2.5"	3.49 m	11'5.5"	3.55 m	11'7.7"
Dump clearance at full lift and 45° discharge	1.95 m	6'5"	2.12 m	6'11.3"	2.08 m	6'10"	1.69 m	5'6.4"	1.91 m	6'3"	1.82 m	5'11.7"
Reach at full lift and 45° discharge	2.67 m	8'9"	2.77 m	9'1.2"	2.73 m	8'11"	2.47 m	8'1.3"	2.63 m	8'7.7"	2.56 m	8'4.9"
Reach at 45° discharge angle and 2130 mm (7'0") clearance	3.51 m	11'6.2"	3.84 m	12'7.3"	3.74 m	12'3.3"	3.14 m	10'3.4"	3.45 m	11'4"	3.35 m	10'11.9"
Reach with lift arms horizontal and bucket level	72 mm	2.8"	72 mm	2.8"	72 mm	2.8"	72 mm	2.8"	72 mm	2.8"	100 mm	3.9"
Digging depth	10.40 m	34'1.3"	10.73 m	35'2.4"	10.75 m	35'3"	10.02 m	32'10.5"	10.34 m	33'11"	10.23 m	33'6.9"
Overall length	6.95 m	22'9.7"	6.95 m	22'9.7"	6.95 m	22'9.7"	6.52 m	21'4.7"	6.52 m	21'4.7"	6.75 m	22'1.9"
Overall height	17.05 m	55'11"	17.22 m	56'6"	17.22 m	56'6"	17.06 m	55'11.5"	17.21 m	56'5.5"	17.18 m	56'4.5"
Loader clearance circle (bucket in carry position)	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
Static tipping load**	22 805	50,171	22 411	49,304	21 376	47,027	23 489	51,676	23 175	50,985	23 074	50,763
Straight	20 629	45,384	20 234	44,515	19 569	43,052	21 364	47,001	20 968	46,130	20 881	45,938
Full 35° turn	kN	lb	kN	lb	kN	lb	kN	lb	kN	lb	kN	lb
Breakout force*	360	81,000	357	80,325	378	85,050	463	104,175	461	103,725	394	88,650
Operating weight**	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
	40 811	89,784	41 077	90,369	41 520	91,344	40 536	89,179	40 765	89,683	40 565	89,243
<b>With steel shoe Beadless Tires:</b>												
Static tipping load.	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
Straight	25 395	55,869	25 001	55,002	24 315	53,493	26 119	57,462	25 805	56,771	25 688	56,514
Full 35° turn	22 970	50,534	22 575	49,665	21 900	48,180	23 659	52,050	23 345	51,359	23 244	51,137
Breakout force*	kN	lb	kN	lb	kN	lb	kN	lb	kN	lb	kN	lb
	362	81,450	359	80,775	380	85,500	466	104,850	464	104,400	397	89,325
Operating weight	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
	44 529	97,964	44 795	98,549	45 238	99,524	44 254	97,359	44 483	97,863	44 283	97,423

\* Breakout force is measured 102 mm (4") behind tip of cutting edge with bucket hinge pin as pivot point.

\*\* Static tipping load and operating weight shown include sound suppressed cab and ROPS with air conditioner, 35/65-33, 24 PR (L-4) tires, full fuel tank and operator. Machine stability and operating weight are affected by tire ballast and attachments. For additional static tipping load capacity (use tire ballast or counterweight, not both), add/subtract the following to/from machine operating weight and static tipping load:

	change in operating weight		change in articulated static tipping load	
	kg	lb	kg	lb
Remove cab only	-300	-660	-205	-450
Remove ROPS canopy only	-895	-1,975	-730	-1,610
Add counterweight	+1535	+3,385	+2965	+6,535
35/65-33, 24 PR (L-4) tires with 75% CaCl <sub>2</sub>	+2680	+5,910	+3305	+7,285
35/65-33, 24 PR (L-5) tires	+980	+2,160	+605	+1,330
35/65 R33 (L-5) equivalent tires	+575	+1,265	+355	+780
35/65-33, 24 PR (L-5) tires with 75% CaCl <sub>2</sub>	+3290	+7,255	+3455	+7,615
35/65 R33 (L-4) equivalent tires with 75% CaCl <sub>2</sub>	+2875	+6,335	+3535	+7,795
35/65 R33 (L-5) equivalent tires with 75% CaCl <sub>2</sub>	+3065	+6,755	+3425	+7,550