

# TABLES

## SWELL — VOIDS — LOAD FACTORS

SWELL (%)	VOIDS (%)	LOAD FACTOR
5	4.8	.952
10	9.1	.909
15	13.0	.870
20	16.7	.833
25	20.0	.800
30	23.1	.769
35	25.9	.741
40	28.6	.714
45	31.0	.690
50	33.3	.667
55	35.5	.645
60	37.5	.625
65	39.4	.606
70	41.2	.588
75	42.9	.571
80	44.4	.556
85	45.9	.541
90	47.4	.526
95	48.7	.513
100	50.0	.500

## BUCKET FILL FACTORS

Loose Material	Fill Factor
Mixed Moist Aggregates	95-100%
Uniform Aggregates up to 3 mm (1/8")	95-100
3 mm-9 mm (1/8"-3/8")	90-95
12 mm-20 mm (1/2"-3/4")	85-90
24 mm (1") and over	85-90
<b>Blasted Rock</b>	
Well Blasted	80-95%
Average Blasted	75-90
Poorly Blasted	60-75
<b>Other</b>	
Rock Dirt Mixtures	100-120%
Moist Loam	100-110
Soil, Boulders, Roots	80-100
Cemented Materials	85-95

**NOTE:** Loader bucket fill factors are affected by bucket penetration, breakout force, rackback angle, bucket profile and ground engaging tools such as bucket teeth or bolt-on replaceable cutting edges.

**NOTE:** For bucket fill factors for hydraulic excavators, see bucket payloads in the hydraulic excavator section.

## TYPICAL ROLLING RESISTANCE FACTORS

Various tire sizes and inflation pressures will greatly reduce or increase the rolling resistance. The values in this table are approximate, particularly for the track and track + tire machines. These values can be used for estimating purposes when specific performance information on particular equipment and given soil conditions is not available. See Mining and Earthmoving Section for more detail.

UNDERFOOTING	ROLLING RESISTANCE, PERCENT*			
	Tires Bias	Tires Radial	Track **	Track +Tires
A very hard, smooth roadway, concrete, cold asphalt or dirt surface, no penetration or flexing . . . . .	1.5%*	1.2%	0%	1.0%
A hard, smooth, stabilized surfaced roadway without penetration under load, watered, maintained . . . . .	2.0%	1.7%	0%	1.2%
A firm, smooth, rolling roadway with dirt or light surfacing, flexing slightly under load or undulating, maintained fairly regularly, watered . . . . .	3.0%	2.5%	0%	1.8%
A dirt roadway, rutted or flexing under load, little maintenance, no water, 25 mm (1") tire penetration or flexing . . . . .	4.0%	4.0%	0%	2.4%
A dirt roadway, rutted or flexing under load, little maintenance, no water, 50 mm (2") tire penetration or flexing . . . . .	5.0%	5.0%	0%	3.0%
Rutted dirt roadway, soft under travel, no maintenance, no stabilization, 100 mm (4") tire penetration or flexing . . . . .	8.0%	8.0%	0%	4.8%
Loose sand or gravel . . . . .	10.0%	10.0%	2%	7.0%
Rutted dirt roadway, soft under travel, no maintenance, no stabilization, 200 mm (8") tire penetration and flexing . . . . .	14.0%	14.0%	5%	10.0%
Very soft, muddy, rutted roadway, 300 mm (12") tire penetration, no flexing . . . . .	20.0%	20.0%	8%	15.0%

\*Percent of combined machine weight.

\*\*Assumes drag load has been subtracted to give Drawbar Pull for good to moderate conditions. Some resistance added for very soft conditions.

## ANGLE OF REPOSE OF VARIOUS MATERIALS

MATERIAL	ANGLE BETWEEN HORIZONTAL AND SLOPE OF HEAPED PILE	
	Ratio	Degrees
Coal, industrial . . . . .	1.4:1—1.3:1	35-38
Common earth, Dry . . . . .	2.8:1—1.0:1	20-45
Moist . . . . .	2.1:1—1.0:1	25-45
Wet . . . . .	2.1:1—1.7:1	25-30
Gravel, Round to angular . . . . .	1.7:1—0.9:1	30-50
Sand & clay . . . . .	2.8:1—1.4:1	20-35
Sand, Dry . . . . .	2.8:1—1.7:1	20-30
Moist . . . . .	1.8:1—1.0:1	30-45
Wet . . . . .	2.8:1—1.0:1	20-45

# Tables

## ROUND REINFORCED CONCRETE PIPE APPROXIMATE WEIGHT PER FOOT

INSIDE DIAMETER		WEIGHT PER FT.	
mm	ft/in	kg	lb
305	12"	42	93
380	15"	58	127
460	18"	76	168
530	1'9"	97	214
610	2'0"	120	265
685	2'3"	146	322
760	2'6"	174	384
840	2'9"	205	452
915	3'0"	238	524
1070	3'6"	311	686
1220	4'0"	393	867
1370	4'6"	485	1069
1525	5'0"	588	1295
1675	5'6"	699	1542
1830	6'0"	821	1811
1980	6'6"	952	2100
2135	7'0"	1093	2409
2285	7'6"	1242	2740
2440	8'0"	1402	3090
2590	8'6"	1578	3480
2740	9'0"	1753	3865

NOTE: Table courtesy of American Concrete Pipe Assn.

## COEFFICIENT OF TRACTION FACTORS

MATERIAL	TRACTION FACTORS	
	Rubber Tires	Tracks
Concrete	.90	.45
Clay loam, dry	.55	.90
Clay loam, wet	.45	.70
Rutted clay loam	.40	.70
Dry sand	.20	.30
Wet sand	.40	.50
Quarry pit	.65	.55
Gravel road (loose not hard)	.36	.50
Packed snow	.20	.27
Ice	.12	.12
Semi-skeleton shoes		
Firm earth	.55	.90
Loose earth	.45	.60
Coal, stockpiled	.45	.60

NOTE: The elevated sprocket design Track-type Tractors (D11T, D10R, D9R and D8R), with their suspended undercarriage, provide up to 15% more efficient tractive effort than rigid tracked Track-type Tractors.

## SPEED CONVERSION

km/h Equivalents in m/min				MPH Equivalents in FPM			
km/h	m/min	km/h	m/min	mph	fpm	mph	fpm
1	16.7	21	350.0	1	88	21	1848
2	33.3	22	366.7	2	176	22	1936
3	50.0	23	383.3	3	264	23	2024
4	66.7	24	400.0	4	352	24	2112
5	83.3	25	416.7	5	440	25	2200
6	100.0	26	433.3	6	528	26	2288
7	116.7	27	450.0	7	616	27	2376
8	133.3	28	466.7	8	704	28	2464
9	150.0	29	483.3	9	792	29	2552
10	166.7	30	500.0	10	880	30	2640
11	183.3	31	516.7	11	968	31	2728
12	200.0	32	533.3	12	1056	32	2816
13	216.7	33	550.0	13	1144	33	2904
14	233.3	34	566.7	14	1232	34	2992
15	250.0	35	583.3	15	1320	35	3080
16	266.7	36	600.0	16	1408	36	3168
17	283.3	37	616.7	17	1496	37	3256
18	300.0	38	633.3	18	1584	38	3344
19	316.7	39	650.0	19	1672	39	3432
20	333.3	40	666.7	20	1760	40	3520

NOTE: Since 1 km/h equals 16.7 m/min (1000 ÷ 60), to interpolate add 1.67 m/min for each 0.1 km/h.

NOTE: Since 1 mph equals 88 fpm (5280 ÷ 60), to interpolate add 8.8 fpm for every 0.1 mph.

1 mph = 26.9 m/min.

## BEARING POWERS

MATERIAL	BEARING POWER			
	Bar	lb/in <sup>2</sup>	Metric t/m <sup>2</sup>	U.S. tons/ft <sup>2</sup>
Rock (semi-shattered)	4.8	70	50	5
Rock (solid)	24.1	350	240	24
Clay, dry	3.8	55	40	4
medium dry	1.9	27	20	2
soft	1.0	14	10	1
Gravel, cemented	7.6	110	80	8
Sand, compact dry	3.8	55	40	4
clean dry	1.9	27	20	2
Quicksand & alluvial soil	0.5	7	5	0.5

## AGRICULTURAL COMMODITIES CONVERSION FACTORS

	lb	kg	Metric Ton
1 Bushel of Corn*	56	25.40	0.02540
1 Bushel of Soybean*	60	27.22	0.02721
1 Bushel of Oats*	32	14.51	0.01451
1 Bushel of Wheat*	60	27.22	0.02721
1 Bale of Cotton	478	216.81	0.21681

1 metric ton of Corn	39.37 Bushels*
1 metric ton of Soybean	36.75 Bushels*
1 metric ton of Oats	68.92 Bushels*
1 metric ton of Wheat	36.75 Bushels*
1 metric ton of Cotton	4.61 Bales

\*Bushel is a volume measurement, 1 Bushel = 35.24 liters = 9.31 U.S. Gallons. In the agricultural mercantile exchange, the Bushel is widely used for grains as weight. For the above weights, the market assumes a standard density for each type of grain.

### CURVE SUPERELEVATION IN PERCENT GRADE, TO PROVIDE NO LATERAL TIRE FORCE

Negotiating curves can generate high lateral tire forces. These forces contribute to high tire wear and ply separation. Superelevating the curve helps eliminate these forces. The amount of superelevation depends on the curve's radius and the speed at which it is negotiated.

The following table is a guide for providing the superelevation necessary to eliminate lateral forces.

Superelevated turns present a danger when slippery. For this reason, curves superelevated over 10% should be used with caution. Unless the proper speed is maintained, matching the elevation of the curve, a vehicle may slide off of the lower edge of the roadway. Superelevated curves should be maintained in good tractive conditions.

TURN RADIUS		Speed	Speed	Speed	Speed	Speed	Speed	Speed	Speed
m	ft	16 km/h 10 mph	24 km/h 15 mph	32 km/h 20 mph	40 km/h 25 mph	48 km/h 30 mph	56 km/h 35 mph	64 km/h 40 mph	72 km/h 45 mph
15.2	<b>50</b>	13%	30%	—	—	—	—	—	—
30.5	<b>100</b>	7%	15%	27%	—	—	—	—	—
45.7	<b>150</b>	4%	10%	18%	28%	—	—	—	—
61.0	<b>200</b>	3%	8%	13%	21%	30%	—	—	—
91.5	<b>300</b>	2%	5%	9%	14%	20%	27%	—	—
152.4	<b>500</b>	1%	3%	5%	8%	12%	16%	21%	27%
213.4	<b>700</b>	1%	2%	4%	6%	9%	12%	15%	19%
304.9	<b>1000</b>	1%	2%	3%	4%	6%	8%	11%	14%

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### MAXIMUM SPEED ON CURVES FOR VARIOUS SUPERELEVATION GRADES WITH A 0.20 LATERAL COEFFICIENT OF TRACTION

Another approach to superelevated curves is to determine the safe speed for negotiating a turn at a certain lateral tire force. In general, a 20% lateral coefficient of traction is safe for all but slippery conditions. The following table shows maximum speed with various superelevations to maintain a 0.20 lateral coefficient of traction.

TURN RADIUS		Flat Curve		5% Super-elevation		10% Super-elevation	
m	ft	km/h	mph	km/h	mph	km/h	mph
7.6	<b>25</b>	14	<b>9</b>	16	<b>10</b>	17	<b>11</b>
15.2	<b>50</b>	20	<b>12</b>	22	<b>14</b>	24	<b>15</b>
30.5	<b>100</b>	28	<b>17</b>	31	<b>19</b>	34	<b>21</b>
45.7	<b>150</b>	34	<b>21</b>	38	<b>24</b>	42	<b>26</b>
61.0	<b>200</b>	39	<b>24</b>	44	<b>27</b>	48	<b>30</b>
91.5	<b>300</b>	48	<b>30</b>	54	<b>34</b>	59	<b>37</b>
152	<b>500</b>	62	<b>39</b>	70	<b>43</b>	76	<b>47</b>
213	<b>700</b>	74	<b>46</b>	—	—	—	—

A transition "spiral" may be necessary at higher speeds when entering or departing from a superelevated turn.

# Tables

WEIGHT* OF MATERIALS	LOOSE		BANK		LOAD FACTORS
	kg/m <sup>3</sup>	lb/yd <sup>3</sup>	kg/m <sup>3</sup>	lb/yd <sup>3</sup>	
Basalt	1960	3300	2970	5000	.67
Bauxite, Kaolin	1420	2400	1900	3200	.75
Caliche	1250	2100	2260	3800	.55
Carnotite, uranium ore	1630	2750	2200	3700	.74
Cinders	560	950	860	1450	.66
Clay — Natural bed	1660	2800	2020	3400	.82
Dry	1480	2500	1840	3100	.81
Wet	1660	2800	2080	3500	.80
Clay & gravel — Dry	1420	2400	1660	2800	.85
Wet	1540	2600	1840	3100	.85
Coal — Anthracite, Raw	1190	2000	1600	2700	.74
Washed	1100	1850			.74
Ash, Bituminous Coal	530-650	900-1100	590-890	1000-1500	.93
Bituminous, Raw	950	1600	1280	2150	.74
Washed	830	1400			.74
Decomposed rock —					
75% Rock, 25% Earth	1960	3300	2790	4700	.70
50% Rock, 50% Earth	1720	2900	2280	3850	.75
25% Rock, 75% Earth	1570	2650	1960	3300	.80
Earth — Dry packed	1510	2550	1900	3200	.80
Wet excavated	1600	2700	2020	3400	.79
Loam	1250	2100	1540	2600	.81
Granite — Broken	1660	2800	2730	4600	.61
Gravel — Pitrun	1930	3250	2170	3650	.89
Dry	1510	2550	1690	2850	.89
Dry 6-50 mm (1/4"-2")	1690	2850	1900	3200	.89
Wet 6-50 mm (1/4"-2")	2020	3400	2260	3800	.89
Gypsum — Broken	1810	3050	3170	5350	.57
Crushed	1600	2700	2790	4700	.57
Hematite, iron ore, high grade	1810-2450	4000-5400	2130-2900	4700-6400	.85
Limestone — Broken	1540	2600	2610	4400	.59
Crushed	1540	2600	—	—	—
Magnetite, iron ore	2790	4700	3260	5500	.85
Pyrite, iron ore	2580	4350	3030	5100	.85
Sand — Dry, loose	1420	2400	1600	2700	.89
Damp	1690	2850	1900	3200	.89
Wet	1840	3100	2080	3500	.89
Sand & clay — Loose	1600	2700	2020	3400	.79
Compacted	2400	4050			
Sand & gravel — Dry	1720	2900	1930	3250	.89
Wet	2020	3400	2230	3750	.91
Sandstone	1510	2550	2520	4250	.60
Shale	1250	2100	1660	2800	.75
Slag — Broken	1750	2950	2940	4950	.60
Snow — Dry	130	220			
Wet	520	860			
Stone — Crushed	1600	2700	2670	4500	.60
Taconite	1630-1900	3600-4200	2360-2700	5200-6100	.58
Top Soil	950	1600	1370	2300	.70
Taprock — Broken	1750	2950	2610	4400	.67
Wood Chips**	—	—	—	—	—

\*Varies with moisture content, grain size, degree of compaction, etc. Tests must be made to determine exact material characteristics.

\*\*Weights of commercially important wood species can be found in the last pages of the Logging & Forest Products section. To obtain wood weights use the following equations: lb/yd<sup>3</sup> = (lb/ft<sup>3</sup>) × .4 × 27  
kg/m<sup>3</sup> = (kg/m<sup>3</sup>) × .4

## ALTITUDE DERATION

PERCENT FLYWHEEL HORSEPOWER  
AVAILABLE AT SPECIFIED ALTITUDES

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
D3K XL	100	100	100	100	88	85
D3K LGP	100	100	100	100	88	85
D4K XL	100	100	100	100	88	85
D4K LGP	100	100	100	100	88	85
D5K XL	100	100	100	100	88	85
D5K LGP	100	100	100	100	88	85
D5N XL & LGP	100	100	100	100	100	100
D6K XL & LGP	100	100	100	100	N/A	N/A
D6N XL & LGP	100	100	100	100	N/A	N/A
D6N XL & LGP**	100	100	100	100	100	100
D6G	100	100	100	100	94	87
D6G Series 2 XL	100	100	100	94	87	80
D6G Series 2 LGP	100	100	100	94	87	80
D6R Series 3 (All)	100	100	100	100	92	84
D7G	100*	100*	100*	94	86	80
D7G Series 2	100	100	100	100	100	94
D7R Series 2 (All)	100	100	100	100	100	96
D8R	100	100	100	93	85	77
D8T	100	100	100	100	100	93
D9R	100	100	100	93	85	77
D9T	100	100	100	100	100	93
D10T	100	100	100	100	97	89
D11T/D11T CD	100	100	100	93	85	77
120H STD	100	100	100	100	100	100
120M	100	100	100	100	95	88
135H STD	100	100	100	100	100	98
12H STD	100	89	83	77	71	65
12M	100	100	100	100	95	88
140H STD	100	100	100	100	97	89
140M	100	100	100	100	**	**
160H STD	100	100	100	97	89	82
160M	100	100	100	100	**	**
14M	100	100	100	100	100	**
16M	100	100	100	100	100	100
24M	100	100	100	100	**	**

\*Refer to "Captive Vehicle Engine Fuel Specifications" microfiche at your local dealer.

\*\*Information not available at time of printing.

# Tables

## ALTITUDE DERATION (Continued)

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
216B2	100	89	81	72	61	52
226B2	100	97	95	91	87	83
232B2	100	97	95	91	87	83
236B2	100	97	95	91	87	83
242B2	100	97	95	91	87	83
246C	100	97	95	91	87	83
247B2	100	97	95	91	87	83
256C	100	97	95	91	87	83
257B2	100	97	95	91	87	83
262C	100	97	95	91	87	83
272C	100	97	95	91	87	83
277C	100	97	95	91	87	83
279C	100	97	95	91	87	83
287C	100	97	95	91	87	83
289C	100	97	95	91	87	83
297C	100	97	95	91	87	83
299C	100	97	95	91	87	83
301.5	95	89	81	71	N/A	N/A
301.6	95	89	81	71	N/A	N/A
301.8	95	89	81	71	N/A	N/A
302.5	95	89	81	71	N/A	N/A
303 SR/CR	93	85	78	N/A	N/A	N/A
304 CR	94	87	80	N/A	N/A	N/A
305 SR/CR	96	91	86	N/A	N/A	N/A
307C (4M40)	100	100	*	*	*	*
308C SR/CR	100	100	*	*	*	*
311D LRR	100	100	100	*	*	*
312D/312D L**	100	100	100	*	*	*
312D/312D L***	97	95	92	*	*	*
313C SR/CR	100	100	100	83	78	73
314D CR/314D LCR	100	100	100	*	*	*
315D L**	100	100	100	*	*	*
315D L***	97	95	92	*	*	*
319D L/319 D LN	97	95	92	*	*	*
M313C	100	97	95	91	N/A	N/A
M315C	100	97	95	91	N/A	N/A
M316C	*	*	*	*	*	*
M318C	100	100	97	95	N/A	N/A
M322C	100	100	97	95	N/A	N/A
M313D	*	*	*	*	*	*
M315D	*	*	*	*	*	*
M316D	100	100	100	100	100	98.9
M318D	100	100	100	100	96.6	91.8
M322D	100	100	100	100	96.1	91.9

\*Information not available at time of printing.

\*\*Japan Sourced.

\*\*\*France Sourced.

ALTITUDE DERATION (Continued)

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
320D/320D RRR/323D	100	100	90	87	83	*
320D L/320D LRR/323D L	100	100	90	87	83	*
320C N	100	100	90	87	83	*
320C FM	100	100	90	87	83	*
321D LCR	100	100	90	87	83	*
322C	100	100	100	100	100	97
324D L	100	100	100	100	100	100-96
322C LN	100	100	100	100	100	97
322C FM	100	100	100	100	100	97
325C	100	100	100	100	100	100
325C FM	100	100	100	100	100	100
328D LCR	100	100	100	100	100-96	96-92
329D L	100	100	100	100	100-96	96-92
329D LN	100	100	100	100	100	100
330C	100	100	100	100	100	100
330C FM	100	100	100	100	100	100
336D L	100	100	100	100	100-93	93-86
336D LN	100	100	100	100	100	100
345D	100	100-96	96	96-89	89-82	82-74
345D L	100	100-96	96	96-89	89-82	82-74
365C L	100	100	100	100	95	88
385C/385C L	100	100	100	100	100	97
385C FS	100	100	100	100	100	97
416E/422E (NA)	100†	89	81	71	N/A	N/A
416E/422E (Turbo)	100	100	100	100	N/A	N/A
420E/420E IT	100	100	100	100	N/A	N/A
428E	99	97	95	91	N/A	N/A
430E/430E IT	100	100	100	100	N/A	N/A
432E	99	97	95	91	N/A	N/A
434E	99	97	95	91	N/A	N/A
442E	99	97	95	91	N/A	N/A
444E	99	97	95	91	N/A	N/A
450E	100	100	100	100	N/A	N/A
Forest Products:						
525B	*	*	*	*	*	*
535B	*	*	*	*	*	*
545	*	*	*	*	*	*
517	100	100	100	99	95	87
527	100	100	100	100	99	91
320C FM	*	*	*	*	*	*
322C FM	*	*	*	*	*	*
325C FM	*	*	*	*	*	*
330C FM	*	*	*	*	*	*

\*Information not available at time of printing.

†Up to 600 m (1968 ft).

# Tables

## ALTITUDE DERATION (Continued)

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
PL61	100	100	100	100	N/A	N/A
572R Series 2	100*	100*	100*	94	86	80
583R	100	100	100	100	94	87
587R/T	100	100	94	87	80	73
621G◄	100	100	100	100	97	90
631G◄	100	100	100	100	97	90
627G Tractor◄	100	100	100	100	97	90
Scraper◄	100*	100*	100*	92	85	79*
637G Tractor◄	100	100	100	100	97	90
Scraper◄	100*	100*	100	95	87	80
657G Tractor◄	100	100	100	94	88	81
Scraper◄	100	100	100	95	90	84
613G	100	100	100	100	95	87
623G◄	100	100	100	100	97	90
770◄	100	100	100	100-96	96-87	87-79
772◄	100	100	100	100-98	98-87	87-77
773F◄	100	100	100	100-97.9	97.9-94.7	94.7-91.7
775F◄	100	100	100	100	100	100-98.6
777D◄	100	100	100-99.5	99.5-94	94-90	90-85
777F◄	100	100	100	100	100-99.5	99.5-91*
785C◄	100	100	100	100	100-93	93-85
785D◄	100	100	100	100	100	100-97
789C◄	100	100	100	100-92.5	92.5-85	85-77.5
789C HAA◄	100	100	100	100	100	100-98.5
793D◄	100	100	100	100-95.5	95.5-88	88-80.5
793D HAA◄	100	100	100	100	100-98.5	98.5-91
793F◄	100	100	100	100	100-93.3	93.3-80
793F HAA◄	100	100	100	100	100	100
797F◄	100	100	100-98.5	98.5-91.2	91.2-85.1	85.1-79.3
797F HAA◄	100	100	100	100	100	100
725	100	100	100	100	100	100
730	100	100	100	90	80	66
730 Ejector	100	100	100	90	80	66
735	100	100	96	82	60	39
740	100	100	96	82	60	39
740 Ejector	100	100	96	82	60	39
814F2	**	**	**	**	**	**
824H	**	**	**	**	**	**
834H	**	**	**	**	**	**
844H	100	100	100	98	93	83
854K	100	100	100	98	93	79

\*Refer to "Captive Vehicle Engine Fuel Specifications" microfiche at your local dealer.

\*\*Information not available at time of printing.

†At 4572 m (15,000 ft).

◄EUI engine — Automatic altitude deration.

**NOTE:** Contact factory for deration estimates based upon site specific temperatures and altitudes for altitude range of 3800 to 4600 m (12,500 to 15,000 ft).

ALTITUDE DERATION (Continued)

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
815F2	***	***	***	***	***	***
825H	***	***	***	***	***	***
816F2	***	***	***	***	***	***
826H	***	***	***	***	***	***
836H	***	***	***	***	***	***
906	95	89	81	71	N/A	N/A
907	95	89	81	71	N/A	N/A
908	99	97	95	91	N/A	N/A
914G/IT14G	99	97	95	91	N/A	N/A
924H/924Hz	100	100	100	100	97	89
928Hz	100	100	100	100	92	85
930H	100	100	100	100	92	85
938H/IT38H	100	100	100	100	N/A	N/A
950H	100	100	100	100	100	N/A
962H/IT62H	100	100	100	100	100	N/A
966H	100	100	100	100	100	100
972H	100	100	100	100	100	100
980H	100	100	100	100	100-93	93-84
988H	100	100	100	95	85	75
990H	100	100	100	98	93	83
992K	100	100	100	98	93	79
993K	100	100	100	99	93	89
994D	100	100	100	100	**	**
994F	100	100	100	100	**	**
939C	100	100	100	100	*	*
953D	100	100	100	100	N/A	N/A
963D	100	100	100	100	N/A	N/A
973C	100	100	100	100	100	98
TH220B	99	97	95	91	N/A	N/A
TH330B	99	97	95	91	N/A	N/A
TH360B	99	97	95	91	N/A	N/A
TH560B	99	97	95	91	N/A	N/A
TH580B	99	97	95	91	N/A	N/A
PM-565B	100	100	100	*	*	*
RM-250C	100	100	100	100	100	100
RM-350B	100	100	100	*	*	*
AP-800C	99	97	95	91	N/A	N/A
AP-900B	*	*	*	*	*	*
AP-1000B	100	100	100-97	97-93	93-89	89-83
AP-650B	100	100	100	97-93	93-89	89-83
AP-655C	100	100	100	100	*	*
AP-1050B	100	100	100-97	97-93	93-89	89-83
AP-1055B	100	100	100-97	97-93	93-89	89-83

\*Information not available at time of printing.  
 \*\*Automatically derates 3%/300 m (1000 ft) above 3000 m (10,000 ft).  
 \*\*\*Information not available at time of printing.

# Tables

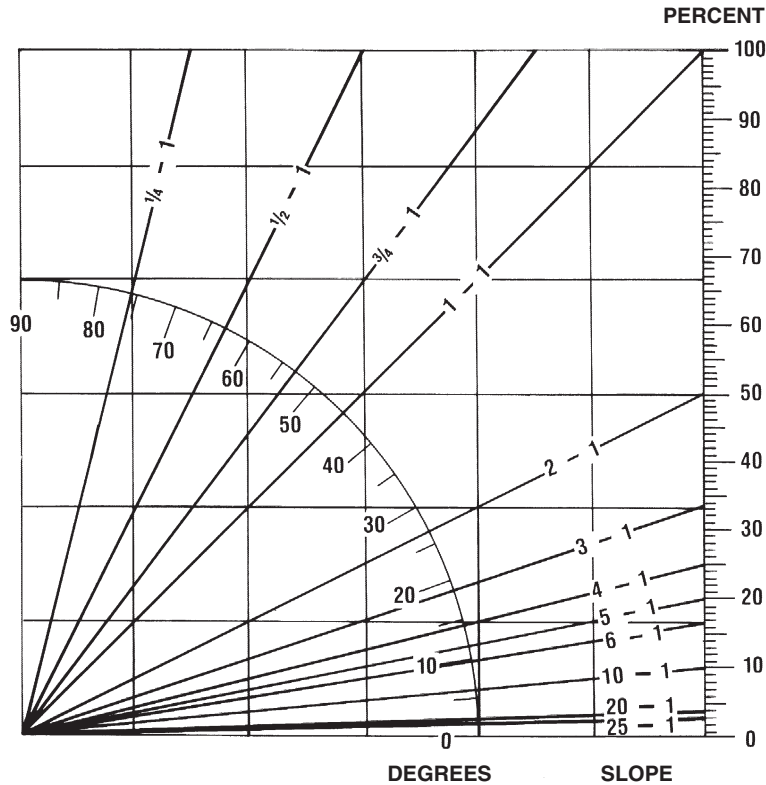
## ALTITUDE DERATION (Continued)

MODEL	0-760 m (0-2500')	760-1500 m (2500-5000')	1500-2300 m (5000-7500')	2300-3000 m (7500-10,000')	3000-3800 m (10,000-12,500')	3800-4600 m (12,500-15,000')
BG-230	99	97	95	91	N/A	N/A
BG-240C	100	100	100-97	97-93	93-89	89-83
BG-260C	100	100	100-97	97-93	93-89	89-83
BG-225C	99	97	95	91	N/A	N/A
BG-245C	100	100	100-97	97-93	93-89	89-83
BG-2455C	100	100	100-97	97-93	93-89	89-83
BG-650	99	97	95	91	N/A	N/A
CS-323C	95	89	81	71	N/A	N/A
CS-423E	100	100-93	93-85	85-77	77-64	64-53
CS-433E	100	100	100	99-96	96-91	91-85
CS-533E	100	100	100-97	97-93	93-89	89-83
CS-563E	100	100	100	100	100	100
CS-573E	100	100	100	100	100	100
CS-583E	100	100	100	100	100	100
CS-663E	100	100	100	100	*	*
CS-683E	100-99	99-97	97-95	95-93	93-89	89-83
CP-323C	100	100-90	90-83	83-73	73-62	62-52
CP-433E	100	100	100-99	99-96	96-91	91-85
CP-533E	100	100	100-97	97-93	93-89	100
CP-563E	100	100	100	100	100	89-83
CP-573E	100	100	100	100	100	100
CP-583E	100	100	100	100	100	100
CP-663E	100	100	100	100	*	*
CB-214E	95	90	82	72	62	51
CB-224E/CB-225E	95	90	82	72	62	51
CB-334E	95	90	82	72	62	51
CB-335E	95	90	82	72	62	51
CB-434D	95	89	81	71	N/A	N/A
CB-534D/CB-534D XW	100	100	100	100	100	100
CB-634D	100	100	100-97	97-93	93-89	89-83
PS-150C	95	89	81	71	N/A	N/A
PS-360B	99	97	95	91	N/A	N/A
PF-300B	99	97	95	91	N/A	N/A
PS-300B	99	97	95	91	N/A	N/A
R1300G II	*	*	*	*	*	*
R1600G	*	*	*	*	*	*
R1700G	*	*	*	*	*	*
R2900G	*	*	*	*	*	*
R2900G Extra	*	*	*	*	*	*
AD30	*	*	*	*	*	*
AD45B	*	*	*	*	*	*
AD55	*	*	*	*	*	*
AD55B	**	**	**	**	**	**

\*\*Information not available at time of printing.

\*\*For altitude capability, contact your local Global Marketing representative.

**GRADE COMPARISON CHART  
DEGREES — PERCENT — SLOPE**



**GRADE IN DEGREES  
AND PERCENTS**

DEGREES	PERCENT
1	1.8
2	3.5
3	5.2
4	7.0
5	8.8
6	10.5
7	12.3
8	14.0
9	15.8
10	17.6
11	19.4
12	21.3
13	23.1
14	24.9
15	26.8
16	28.7
17	30.6
18	32.5
19	34.4
20	36.4
21	38.4
22	40.4
23	42.4
24	44.5
25	46.6
26	48.8
27	51.0
28	53.2
29	55.4
30	57.7
31	60.0
32	62.5
33	64.9
34	67.4
35	70.0
36	72.7
37	75.4
38	78.1
39	81.0
40	83.9
41	86.9
42	90.0
43	93.3
44	96.6
45	100.0

# Tables

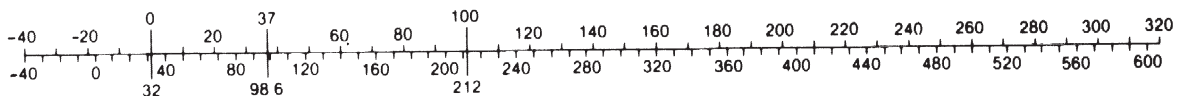
## CONVERSION FACTORS

Multiply Metric Unit	By	To Obtain English Unit	Multiply English Unit	By	To Obtain Metric Unit
kilometer (km)	.6214	mile	mile, statute (m)	1.609	kilometer
meter (m)	1.0936	yard	yard (yd)	.9144	meter
meter (m)	3.28	foot	foot (ft)	.3048	meter
centimeter (cm)	.0328	foot	inch (in)	25.4	millimeter
millimeter (mm)	.03937	inch	sq mile (mile <sup>2</sup> )	2.590	sq kilometer
sq kilometer (km <sup>2</sup> )	.3861	square mile	acre	.4047	hectare
hectare (ha)	2.471	acre	sq foot (ft <sup>2</sup> )	.0929	sq meter
sq meter (m <sup>2</sup> )	10.764	square foot	sq inch (in <sup>2</sup> )	.000645	sq meter
sq meter (m <sup>2</sup> )	1550	square inch	cu yard (yd <sup>3</sup> )	.7645	cu meter
sq centimeter (cm <sup>2</sup> )	.1550	square inch	cu inch (in <sup>3</sup> )	16.387	cu centimeter
cu centimeter (cm <sup>3</sup> )	.061	cubic inch	cu foot (ft <sup>3</sup> )	.0283	cu meter
cu meter (m <sup>3</sup> )	1.308	cubic yard	cu inch (in <sup>3</sup> )	.0164	liter
liter (L)	61.02	cubic inch	cubic yard (yd <sup>3</sup> )	764.55	liter
liter (L)	.001308	cubic yard	mph	1.61	km/h
km/h	.621	mph	Ton — mph	1.459	tkm/h
liter (L)	.2642	U.S. gallon	U.S. gallon (US Gal)	3.785	liter
liter (L)	.22	Imperial gallon	U.S. gallon	.833	Imperial gallon
metric ton (t)	.984	long ton	long ton (lg ton)	1.016	metric ton
metric ton (t)	1.102	short ton	short ton (sh ton)	.907	metric ton
kilogram (kg)	2.205	pound, avdp.	pound (lb)	.4536	kilogram
gram (g or gr)	.0353	ounce, avdp.	ounce (oz)	28.35	gram
kilonewton (kN)	225	pound (force)	pound (lb) (force)	.00445	kilonewton
newton (N)	.225	pound (force)	pound (lb) (force)	4.45	newton
cu centimeter (cm <sup>3</sup> )	.0338	fluid ounce	fluid oz (fl oz)	29.57	cu centimeter
kilograms/cu meter	1.686	pounds/cu yd	lb/cu ft (lb/ft <sup>3</sup> )	16.018	kg/cu meter
kilograms/cu meter	.062	pounds/cu ft	lb/cu yd (lb/yd <sup>3</sup> )	.5933	kg/cu meter
kilograms/sq cm (kg/cm <sup>2</sup> )	14.225	pounds/sq in	pounds/sq. in.	.0703	kilogram/sq cm
kilocalorie (kcal)	3.968	Btu	psi	.0689	bar
kilogram-meter (kg•m)	7.233	foot-pound	psi	6.89	kilopascal
meter-kilogram (m•kg)	7.233	pound-foot	Btu	.2520	kilogram-calorie
metric horsepower (CV)	.9863	hp	foot-pound (ft-lb)	.1383	kilogram-meter
kilowatt (kW)	1.341	hp	horsepower (hp)	1.014	metric horsepower
kilopascal (kPa)	.145	psi	horsepower (hp)	.7457	kilowatt
bar	14.5	psi	pounds/cu yd	.0005928	tons/m <sup>3</sup>
tons/m <sup>3</sup>	1692	pounds/cu yd	pounds (No. 2 diesel fuel)	.1413	U.S. gallon
decaliter	.283	bushel	bushel	3.524	decaliter

**NOTE:** Some of the above factors have been rounded for convenience. For exact conversion factors please consult International System of Units (SI) table.

### Temperature conversion

#### Degree C



#### Degree F

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \div 1.8$$

$$^{\circ}\text{F} = (\text{C} \times 1.8) + 32$$

**METRIC UNIT EQUIVALENTS**

---

1 km	=	1000 m
1 m	=	100 cm
1 cm	=	10 mm
1 km <sup>2</sup>	=	100 ha
1 ha	=	10,000 m <sup>2</sup>
1 m <sup>2</sup>	=	10,000 cm <sup>2</sup>
1 cm <sup>2</sup>	=	100 mm <sup>2</sup>
1 m <sup>3</sup>	=	1000 liters
1 liter	=	1000 cm <sup>3</sup>
1 metric ton	=	1000 kg
1 quintal	=	100 kg
1 N	=	0.10197 kg•m/s <sup>2</sup>
1 kg	=	1000 g
1 g	=	1000 mg
1 bar	=	14.504 psi
1 cal	=	427 kg•m
	=	0.0016 cv•h
	=	0.00116 kw•h
torque unit		
1 CV	=	75 kg•m/s
1 kg/cm <sup>2</sup>	=	0.97 atmosph.

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**ENGLISH UNIT EQUIVALENTS**

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1 mile	=	1760 yd
1 yd	=	3 ft
1 ft	=	12 in
1 sq mile	=	640 acres
1 acre	=	43,560 sq ft
1 sq ft	=	144 sq in
1 cu ft	=	7.48 gal liq
1 gal	=	231 cu in
	=	4 quarts liq
1 quart	=	32 fl oz
1 fl oz	=	1.80 cu in
1 sh ton	=	2000 lb
1 lg ton	=	2240 lb
1 lb	=	16 oz, avdp
1 Btu	=	778 ft lb
	=	0.000393 hph
	=	0.000293 kwh
1 mechanical hp	=	550 ft-lb/sec
1 atmosph.	=	14.7 lb/in <sup>2</sup>

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**POWER UNIT EQUIVALENTS**

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kW	=	Kilowatt
hp	=	Mechanical Horsepower
CV	=	Cheval Vapeur (Steam Horsepower)
		French Designation For <b>Metric</b> Horsepower
PS	=	Pferdestärke (Horsepower)
		German Designation For <b>Metric</b> Horsepower
1 hp	=	1.014 CV = 1.014 PS
	=	0.7457 kW
1 PS	=	1 CV = 0.986 hp
	=	0.7355 kW
1 kW	=	1.341 hp
	=	1.36 CV
	=	1.36 PS

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## Tables

Engine Model and (Cylinders)	Machine	Aspiration	Fuel Injection System	Bore × Stroke		Displacement	
				mm	in	L	in <sup>3</sup>
Mitsubishi L3E (3)	301.6C, 301.8C	NA	DI	76 × 70	3 × 2.8	0.95	58.1
Mitsubishi S3L2 (3)	302.5C	NA	DI	78 × 92	3.1 × 3.6	1.3	80.4
Mitsubishi S3Q2 (3)	303C CR	NA	DI	88 × 103	3.5 × 4.1	1.9	115.9
	303.5C CR	T					
Mitsubishi S4Q2 (4)	304C CR	NA	DI	88 × 103	3.5 × 4.1	2.5	152.9
	305C CR	T					
3013C (3)	CB-214E, CB-224E, CB-225E	NA	DI	75 × 72	2.95 × 3.54	1.50	91.3
3014 (4)		NA	DI	75 × 72	2.95 × 3.54	2.0	122
3024C (4)	CB-334E, CB-335E, 902, 216B, 232B	NA	DI	84 × 100	3.31 × 3.94	2.22	135
	226B, 242B, 247B, 257B	T					
Mitsubishi 4M40EI (4)	307C, 307C SB, 308C CR	NA	DI	95 × 100	3.7 × 3.94	2.84	173
C3.4	906, 907, 908	T	DI	94 × 120	3.7 × 4.72	3.331	203.3
3044C	268B, 267B, 277B, 287B, 236B, 246B, 248B, 252B, 262B	T	DI	94 × 120	3.7 × 4.7	3.3	201
3054C		T		105 × 127	4.13 × 5.0	4.4	268
3054D		T	DI	105 × 127	4.13 × 5.0	4.4	268
3054C (I-4)	416E, 422E	NA	DI	105 × 127	4.13 × 5.0	4.4	268
	(416E), 420E, 420E IT, (422E), 428E, 430E, 430E IT, 432E, 434E, 442E, 444E	T (optional)					
3054E (I-4)	CB-434D, CS-323C, CS-423E, CP-323C, PS-150C	NA	DI	105 × 127	4.13 × 5.0	4.4	268
	AP-800C, BG-230, BG-650, 908, 914G, IT14G, PS-360B, PF-300B, PS-300B, CS-433E, CP-433E, CB-534C	T (optional)					
	M313C, M315C, AP-650B, 315C L**, BG-225C	TA					
3064 (I-4)	311C U, 312C, 314C CR/LCR, 313C SR/CR	T	DI	105 × 127	4.1 × 5.0	4.4	268
3114 (I-4)	446D	T	DI	105 × 127	4.13 × 5.0	4.4	268
3046 (I-6)		NA	DI	94 × 120	3.7 × 4.7	5.0	305
	D3G XL, D3G LGP, D4G XL, CS-533E, D4G LGP, D5G XL, D5G LGP, CP-533E, 315C/315C L*, 939C	T	DI				

\*Japan sourced.

\*\*France sourced.

DI — Direct Injection

T — Turbocharged

TA — Turbocharged and Aftercooled

NA — Naturally Aspirated

**NOTE:** Materials and specifications subject to change without notice. Component commonality of Cat Engines for all applications does not imply complete interchangeability. Contact your Cat dealer for specific information.

Engine Model and (Cylinders)	Machine	Aspiration	Fuel Injection System	Bore × Stroke		Displacement	
				mm	in	L	in <sup>3</sup>
3056 (I-6)	CS-563E, CS-573E, CS-583E, CS-663E, AP-655C, CS-683E, CP-563E, CP-573E, CP-583E, CP-663E, M316C, M318C, M322C	ATAAC	DI	100 × 127	3.94 × 5.0	6.0	365
3066 (I-6)	320C, 320C L, 320C LN, 320C S, 321C LCR	T	DI	102 × 130	4.0 × 5.1	6.4	391
3116 (I-6)	CB-634D, BG-240C, AP-900B	T	DI	105 × 127	4.13 × 5.0	6.6	402
	BG-260C, BG-245C, AP-1050B, AP-1055B, 120H STD, 135H STD, BG-2455C, AP-1000B	TA	DI				
3304 (I-4)	527, 517	TA	DI	121 × 152	4.75 × 6.0	7.0	425
3126 (I-6)	D5**, D6N**, 561N, 953C, 963C	T	DI	110 × 127	4.33 × 5.0	7.2	442
	525B, 535B	TA					
	325C LN	ATAAC					
C4.2 ACERT	311D, 311D LRR, 312D, 312D L, 314D CR, 314D LCR, 315D L, 319D	ATAAC	DI	102 × 130	4.02 × 5.12	4.2	259
C4.4 ACERT	D3K, D4K, D5K, 450E	T	DI	105 × 127	4.13 × 5.0	4.4	269
C6.4 ACERT	320D, 320D L, 320D RR, 320D LRR, 321D LCR, 323D L	ATAAC	DI	102 × 130	4.0 × 5.1	6.4	389
C6.6	R1300G II, 924Hz, 924H, 928Hz, 930H	ATAAC	DI	105 × 127	4.13 × 5.0	6.6	402
C6.6 ACERT	D6K, D6N, 953D, 963D, 120M, 12M, PL61, 613G, 938H, IT38H	TA	DI	105 × 127	4.13 × 5.0	6.6	402
C7 ACERT (I-6)	324D L, 328D LCR, 329D L, 950H, 962H, IT62H	ATAAC	DI	110 × 127	4.33 × 5.0	7.2	442
C9 ACERT (I-6)	336D L, 814F II, 815F II	ATAAC	DI	112 × 149	4.4 × 5.9	8.8	537
C9 ACERT (I-6)	160M, D6T, 336D, 336D L, 336D LN, 627G Sc., 637G Sc., 973C	TA	DI	112 × 149	4.4 × 5.9	8.8	537
3176 (I-6)	572R Series 2, R1600G, 345B L Series II, D7R Series 2 (All), 814F, 815F, 816F	ATAAC	DI	125 × 140	4.92 × 5.5	10.2	629

\*France sourced.

\*\*Not sold in U.S., Canada or Europe.

DI — Direct Injection

T — Turbocharged

TA — Turbocharged and Aftercooled

ATAAC — Air/Air Aftercooled

**NOTE:** Materials and specifications subject to change without notice. Component commonality of Cat Engines for all applications does not imply complete interchangeability. Contact your Cat dealer for specific information.

## Tables

Engine Model and (Cylinders)	Machine	Aspiration	Fuel Injection System	Bore × Stroke		Displacement	
				mm	in	L	in <sup>3</sup>
3306 (I-6)	R1300G, 12H STD, D6G, 140H STD, 160H STD	T	DI	121 × 152	4.75 × 6.0	10.5	638
	D7G	TA	DI				
	545, R1300G	ATAAC	DI				
3196 (I-6)	365B L Series II	ATAAC	DI	130 × 150	5.1 × 5.9	12.0	732
3406 (I-6)	RM-250C, RM-350B, 583R, 587R, D8R, D8R LGP	TA	DI	137 × 165	5.4 × 6.5	14.6	893
	826G Series II, 825G Series II, 824G Series II, AD30	ATAAC	DI				
C11 (I-6)	725, 730, 730 Ejector	ATAAC	DI	130 × 140	5.1 × 5.5	11.2	680
C11 ACERT (I-6)	R1700G, 14M, 966H	TA	DI	130 × 140	5.12 × 5.51	11.1	680
		ATAAC					
C13 ACERT (I-6)	16M, 345D L, 972H	TA	DI	130 × 157	5.12 × 6.18	12.5	763
C15 ACERT (I-6)	D8T, D8T LGP, 587T, 621G, 623G, 627G Tr., 657G Sc., 770	TA	DI	137 × 172	5.4 × 6.75	15.2	928
	R2900G, AD30, 735, 740, 740 Ejector, 824H, 825H, 826H, 980H	ATAAC	DI	137 × 171.5	5.4 × 6.75	15.2	928
3456 (I-6)	834G, 836G, 385B, 385B L, 5090B	ATAAC	DI	140 × 171	5.5 × 6.75	15.8	966
3408 (V-8)	D9R, 589, PM-565B	TA	DI	137 × 152	5.4 × 6.0	18.0	1099
		ATAAC					
C18 (I-6)		TA	DI	145 × 185	5.7 × 7.3	18.1	1104
C18 ACERT	AD45B, AD55, D9T, 631G, 637G Tr., 657G Tr., 988H, 772, 834H, 836H	TA	DI	145 × 185	5.7 × 7.3	18.1	1104
C27 ACERT (V-12)	D10T, 773F, 775F, 990H, 844H	TA	DI	137 × 152	5.4 × 6.0	27.0	1648
3412 (V-12)	D10R, 5110B	TA	DI	137 × 152	5.4 × 6.0	27.0	1649
	844	ATAAC	DI				
3508 (V-8)	D11R, 5130B, 992K, 854G, 777D	TA	DI	170 × 190	6.7 × 7.5	34.5	2105
3512 (V-12)	785C	TA	DI	170 × 190	6.7 × 7.5	51.8	3158
	785D	ATAAC					
3516 (V-16)	789C, 793D, 994D, 5230B, 994F	TA	DI	170 × 190	6.7 × 7.5	69.1	4211
C32 ACERT	777F, 854K, 992K, 993K, D11T, D11T CD	TA	DI	145 × 162	5.7 × 6.4	32.1	1959
C175-16 (V-16)	793F	ATAAC	DI	175 × 220	6.9 × 8.7	84.7	5169
C175-20 (V-20)	797F	ATAAC	DI	175 × 220	6.9 × 8.7	105.8	6456

DI — Direct Injection

T — Turbocharged

TA — Turbocharged and Aftercooled

ATAAC — Air/Air Aftercooled

**NOTE:** Materials and specifications subject to change without notice. Component commonality of Cat Engines for all applications does not imply complete interchangeability. Contact your Cat dealer for specific information.