ESTIMATING OWNING & OPERATING COSTS

Owning & Operating (O&O) Baseline Cost Estimate Solutions

The O&O web site provides information related to O&O baseline cost estimate development for both commercial engine products and machines. Approved O&O baseline cost estimate ranges for machines, and links related to O&O baseline cost development are also available. **NOTE:** Access to the web sites indicated below is restricted to Caterpillar and Cat dealer personnel.

For information about O&O costs, enter the appropriate link for your location.

For Asia Pacific Division (APD): http://apdnet.cat.com
Select "Product Support," "Equipment Management Solutions," "Owning and Operating Costs."

For Corporate Global Mining (CGM): http://catminer.cat.com
Select "Product Support," "Equipment Management," "MARCs," "BUILDER Downloads."

For Europe, Africa, Middle East (EAME): (O&O link not supported).

For Latin America Commercial Division (LACD): http://lacd.cat.com
Select "Product Support," "Equipment Management Solutions," "Owning and Operating Costs."

For North American Commercial Division (NACD): https://nacd.cat.com/infocast/frames/home
Select "Product Support Service Fulfillment (Parts and Service)," "Equipment Management Solutions," "Owning and Operating Cost Information," "Link to O&O Baseline Cost Estimate Solutions."

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General

Machine users must balance productivity and costs to achieve optimum performance ... that is, achieve the desired production at the lowest possible cost. The approach most often used to measure machine performance is this simple equation:

$$\frac{\textit{Lowest Possible Hourly Costs}}{\textit{Highest Possible Hourly Productivity}} = \textit{Top Machine Performance}$$

Most sections of this Handbook deal with the productivity of Cat machines. This section considers the cost aspect of performance.

Hourly Owning and Operating Costs for a given machine can vary widely because they are influenced by many factors: the type of work the machine does, the ownership period, local prices of fuel and labor, the repair and maintenance costs, shipping costs from the factory, interest rates, etc. No attempt is made in this handbook to provide precise hourly costs for each model. Users must be able to estimate with a reasonable degree of accuracy what a machine will cost per hour to own and operate in a given application and locality. Therefore, this section provides a suggested method of estimating hourly owning and operating costs. When this method is coupled with local conditions and dealer input, it will result in reasonable estimates.

The method suggested follows several basic principles:

- Repair and Planned Maintenance cost per hour are developed jointly by the customer and local Cat dealer.
- In the examples, labor is assumed @ $60.00 per hour, fuel @ $1.25 per gallon. For reliable estimates, these costs must always be obtained locally.
- Because of different standards of comparison, what may seem a high application to one machine owner may appear only medium to another.
- Unless otherwise specified, the word "hour" when used in this section means clock or operating hours, not Service Meter Units.

HOURLY OWNING AND OPERATING COST ESTIMATE

DATE _____

	Estimate #1	Estimate #2
A–Machine Designation	_____	_____
B–Estimated Ownership Period (Years)	_____	_____
C–Estimated Usage (Hours/Year)	_____	_____
D–Ownership Usage (Total Hours)(B × C)	_____	_____

OWNING COSTS

1. a. Delivered Price (P), to the Customer (including attachments) . . _____ _____
   b. Less Tire Replacement Cost if desired . . . . . _____ _____
   c. Delivered Price Less Tires . . . . . _____ _____
2. Less Residual Value at Replacement (S) . . . . . (___%) _____ (___%) _____
   (See subsection 2A on back)
3. a. Net Value to be recovered through work . . . . . _____ _____
   (line 1c less line 2)
   b. Cost Per Hour:
   $\frac{\text{Net Value}}{\text{Total Hours}}$ (1) _____ (2) _____ . . . . . _____ _____
4. Interest Costs $\frac{P(N+1)+S(N-1)}{2N} \times \text{Simple Int. \% Rate} = \frac{}{\text{Hours/Year}}$
   N = No. Yrs.
   (1) $\frac{+1}{}$ + $\frac{-1}{}$ × ___ % (2) $\frac{+1}{}$ + $\frac{-1}{}$ × ___ %
   _____ = _____ = _____ _____
   _____ Hours/Yr. _____ Hours/Yr.
5. Insurance $\frac{P(N+1)+S(N-1)}{2N} \times \text{Insurance \% Rate} = \frac{}{\text{Hours/Year}}$
   N = No. Yrs.
   (1) $\frac{+1}{}$ + $\frac{-1}{}$ × ___ % (2) $\frac{+1}{}$ + $\frac{-1}{}$ × ___ %
   _____ = _____ = _____ _____
   _____ Hours/Yr. _____ Hours/Yr.

   (Optional method when Insurance cost per year is known)

   Ins. $ _____ Per Yr. ÷ _____ Hours/Yr. =

	Estimate #1	Estimate #2
6. Property Tax $\frac{P(N+1)+S(N-1)}{2N} \times$ Tax Rate % / Hours/Year =		
N = No. Yrs.		
(1) ___+1___ + ___−1___ × ___ % (2) ___+1___ + ___−1___ × ___ %		
_____ = _____ =		
_____ Hours/Yr. _____ Hours/Yr.		
(Optional method when Property Tax cost per year is known)		
Property Tax $ _____ Per Yr. ÷ _____ Hours/Yr. =		
7. TOTAL HOURLY OWNING COST (add lines 3b, 4, 5 and 6)		

OPERATING COSTS

8. Fuel: Unit Price × Consumption		
(1) _____ × _____ =		
(2) _____ × _____ =		
9. Planned Maintenance (PM)-Lube Oils, Filters, Grease, Labor: (contact your local Cat dealer)		
10. a. Tires: Replacement Cost ÷ Life in Hours		
$\frac{\text{Cost}}{\text{Life}}$ (1) _____ (2) _____		
b. Undercarriage (Impact + Abrasiveness + Z Factor) × Basic Factor		
(1) (_____ + _____ + _____) = _____ × _____ =		
(2) (_____ + _____ + _____) = _____ (Total) × _____ (Factor) =		
11. Repair Cost (Per Hour) (contact your local Cat dealer)		
12. Special Wear Items: Cost ÷ Life . . . . . (See subsection 12A on back)		
13. TOTAL OPERATING COSTS (add lines 8, 9, 10a (or 10b), 11 and 12)		
14. MACHINE OWNING PLUS OPERATING (add lines 7 and 13)		
15. OPERATOR'S HOURLY WAGE (include fringes)		
16. TOTAL OWNING AND OPERATING COST		

SUBSECTION 2A: Residual Value at Replacement

Gross Selling Price	(est. #1) (___%) _____		(est. #2) (___%) _____	
Less: a. Commission	_____		_____	
b. Make-ready costs	_____		_____	
c. Inflation during ownership period*	_____		_____	
Net Residual Value (Enter on line 2)	_____	(___%)	_____	(___%) of original delivered price

*When used equipment auction prices are used to estimate residual value, the effect of inflation during the ownership period should be removed to show in constant value what part of the asset must be recovered through work.

SUBSECTION 12A: Special Items
(cutting edges, ground engaging tools, bucket teeth, etc.)

(1) Cost ÷ Life = Cost/Hour	(2)
1. _____ ÷ _____ = _____	1. _____ ÷ _____ = _____
2. _____ ÷ _____ = _____	2. _____ ÷ _____ = _____
3. _____ ÷ _____ = _____	3. _____ ÷ _____ = _____
4. _____ ÷ _____ = _____	4. _____ ÷ _____ = _____
5. _____ ÷ _____ = _____	5. _____ ÷ _____ = _____
6. _____ ÷ _____ = _____	6. _____ ÷ _____ = _____
Total (1) _____	(2) _____

(Enter total on line 12)

1-7 ESTIMATING OWNING COSTS

(Line Items 1 through 7)

To protect their equipment investment and be able to replace it, the machine owner must recover over the ownership period an amount equal to the loss in resale value plus the other costs of owning the equipment including interest, insurance and taxes.

The machine owner, for accounting purposes, estimates resale value loss in advance, and recovers his original equipment investment by establishing depreciation schedules according to the various uses of the equipment. Proper financial and tax assistance is highly recommended when establishing depreciation schedules.

Considering today's economic conditions worldwide and the trend toward larger, more expensive equipment, many users choose to keep these units on the job well after they have been fully depreciated for tax purposes. On the other hand, tax incentives in many areas may favor trading a machine well before that occurs.

The ownership period in years, the hours per year, and the total number of hours on a machine, are significant factors in determining O&O costs. Additionally, since the ownership period and machine hours can vary widely for different customers for a given model, it is not practical to calculate O&O costs using an assumed ownership period. The customer must provide that information for each situation.

These same factors will be used to develop the Repair costs and Planned Maintenance costs by your local Cat dealer.

The machine depreciation method suggested in this handbook is not based on or related to any tax considerations, but rather is a simple straight line write-off based solely on the number of years and hours the owner expects to use during the ownership period.

Accordingly, it is imperative that careful consideration be given the selection of depreciation periods, and that for owning and operating cost calculations they be based on actual ownership periods and hours on the machine rather than tax write-off life.

Typical Application Descriptions

The following tables show typical descriptions for work performed by each product family for three different application levels. It is only a guide and can be used along with the fuel and tire charts to help determine fuel and tire cost factors. Additionally, many times the ownership period and the number of hours per year a machine is used, is related to application.

1 DELIVERED PRICE TO CUSTOMER

(Line Item 1a, b and c)

Delivered price should include all costs of putting a machine on the user's job including transportation and any applicable sales taxes.

On rubber tired machines, tires are considered a wear item and covered as an operating expense. Accordingly, some users may wish to deduct tire costs from the delivered price particularly for larger machines.

2 RESIDUAL VALUE AT REPLACEMENT

(Line Item 2 and Subsection 2A)

Any piece of earthmoving machinery will have some residual value at trade-in. While many owners prefer to depreciate their equipment to zero value, others recognize the residual resale or trade-in value. This is at the estimator's option, but as in the discussion of depreciation, today's higher equipment costs almost dictate that resale value be considered in determining the net depreciable investment. And if machines are traded early for tax incentive purposes, resale value becomes even more significant.

For many owners, potential resale or trade-in value is a key factor in their purchasing decisions, since this is a means of reducing the investment they must recover through depreciation charges. The high resale value of Caterpillar built machines can reduce hourly depreciation charges, lower total hourly owning costs and improve the owner's competitive position.

When resale or trade-in value is used in estimating hourly owning and operating costs, local conditions must be considered, as used equipment values vary widely around the world. However, in any given used equipment business, factors which have greatest influence on resale or trade-in value are: age of machine (years), the number of hours on the machine at the time of sale or trade, the type of jobs and operating conditions in which it worked, and the physical condition of the machine. Your local Cat dealer is your best source for determining current used equipment values.

Subsection 2A can be used to calculate the estimated residual value. If recent auction prices for used machines are used as a guide, then the value (or percentage) should be adjusted downward to remove the effect of inflation. Governmental indices on construction equipment costs or Dealer price records can be used to calculate the amount of inflation for the appropriate useful life. Another way to estimate residual value is comparing the current used machine value to the current new machine price provided major product changes haven't occurred.

3 VALUE TO BE RECOVERED THROUGH WORK

(Line Item 3a and b)

The delivered price (P) less the estimated residual value (S) results in the value to be recovered through work, divided by the total usage hours, gives the hourly cost to protect the asset's value.

4 INTEREST

(Line Item 4)

Many owners charge interest as part of hourly owning and operating costs, others consider it as general overhead in their overall operation. When charged to specific machines, interest is usually based on the owner's average annual investment in the unit.

Interest is considered to be the cost of using capital. The interest on capital used to purchase a machine must be considered, whether the machine is purchased outright or financed.

If the machine will be used for N years (where N is the number of years of use), calculate the average annual investment during the use period and apply the interest rate and expected annual usage:

$$\frac{\left[\dfrac{P(N+1)+S(N-1)}{2N}\right] \times \text{Simple Int. \% Rate}}{\text{Hours/Year}}$$

5-6 INSURANCE AND TAXES

(Line Items 5 and 6)

Insurance cost and property taxes can be calculated in one of two ways. If the specific annual cost is known, this figure should be divided by the estimated usage (hours/years) and used. However, when the specific interest and tax costs for each machine are not known, the following formulas can be applied:

$$\frac{\dfrac{\text{Insurance}}{\text{N = No. Years}}}{\text{Hours/Year}} \left[\frac{P(N+1)+S(N-1)}{2N}\right] \times \text{Insurance \% Rate}$$

$$\frac{\dfrac{\text{Property Tax}}{\text{N = No. Years}}}{\text{Hours/Year}} \left[\frac{P(N+1)+S(N-1)}{2N}\right] \times \text{Tax Rate \%}$$

8-13 ESTIMATING OPERATING COSTS

(Line Items 8 through 13)

8 FUEL CONSUMPTION

(Line Item 8)

Actual fuel consumption should be measured in the field. However, if no opportunity exists to do this, consumption can be estimated when the machine application is known.

Application determines engine load factor and engine fuel consumption. Engine load factor refers to the instantaneous loading of the engine relative to its maximum capability. An engine continuously producing full rated horsepower is operating at a load factor of 100%. Earthmoving machines may reach a 100% load factor intermittently, but seldom operate at this level for extended periods of time. Periods spent at idle, dozer and pusher travel in reverse, haul units traveling empty, close maneuvering at part throttle and operating downhill are examples of conditions which reduce load factor.

The following tables provide hourly fuel consumption estimates at various load factors. Engine load factors are to be used as a general guide and will vary by model and application. Since machine uses vary, application guides are also provided to aid in estimating load factor.

To estimate hourly fuel cost, select the load factor based on application and find hourly consumption. Then:

Hourly consumption × Local Unit Price of Fuel = Hourly Fuel Cost

When using these tables, keep in mind the many variables which can affect fuel consumption. Two operators of different temperament or attitude operating identical machines side by side in the same material can have as much as 10-12% difference in their consumption rates. Actual results may vary from the ranges shown because they are created to cover a wide spectrum of operating conditions. Your Cat dealer representative can help select the most reasonable estimate for your specific situation; we suggest you call on him.

Keep in mind also that a fuel consumption study measured over a short period of operation will give higher fuel consumption than shown here because: (1) the study will be at 100% productivity, without breaks or idle time, and (2) the operators will know they're being measured and therefore may not use their normal operating techniques. On the other hand, these tables allow for "normal" inefficiencies in the working cycle and will more closely relate to "normal" day to day operation.

FUEL CONSUMPTION TABLES AND LOAD FACTOR GUIDES

TRACK-TYPE TRACTORS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
D3K	—	**—**	7.9	**2.1**	—	**—**
D4K	—	**—**	8.6	**2.3**	—	**—**
D5K	—	**—**	9.0	**2.4**	—	**—**
D5N	6.5-11.5	**1.5-3.5**	11.5-16.0	**3.5-4.5**	13.75-18.5	**3.75-5.0**
D6G	12.0-17.0	**3.2-4.5**	17.0-22.0	**4.5-5.8**	22.0-27.6	**5.8-7.3**
D6K	9.9-14.9	**2.6-3.9**	14.9-21.5	**3.9-5.7**	19.8-26.4	**5.2-7.0**
D6N	12.1-16.5	**3.2-4.3**	13.8-21.4	**3.6-5.6**	18.7-26.4	**4.9-6.9**
D6R Series 3 (138 kW/**185 hp**)	13.6-19.7	**3.6-5.2**	19.7-25.7	**5.2-6.8**	25.7-31.4	**6.8-8.3**
D6R Series 3 (149 kW/**200 hp**)	15.5-22.3	**4.1-5.9**	22.3-29.1	**5.9-7.7**	29.1-35.6	**7.7-9.4**
D6T (138 kW/**185 hp**)	15.5-22.3	**4.1-5.9**	22.3-28.8	**5.9-7.6**	28.8-35.6	**7.6-9.4**
D6T (149 kW/**200 hp**)	15.9-22.7	**4.2-6.0**	22.7-29.5	**6.0-7.8**	29.5-36.3	**7.8-9.6**
D7E	14.8-20.8	**3.9-5.5**	20.8-27.2	**5.5-7.2**	27.2-34.5	**7.2-9.1**
D7G	16.0-22.5	**4.5-6.0**	22.5-29.0	**6.0-8.0**	29.0-35.5	**8.0-9.5**
D7R Series 2	—	**—**	24.6-31.4	**6.5-8.3**	31.4-39.0	**8.3-10.3**
D8R	22.5-32.0	**6.0-8.5**	32.0-41.5	**8.5-11.0**	41.5-51.0	**11.0-13.5**
D8T Tier 3	23.5-33.7	**6.2-8.9**	33.7-43.5	**8.9-11.5**	43.9-53.7	**11.6-14.2**
D9T Tier 3	30.3-43.1	**8.0-11.4**	43.1-56.4	**11.4-14.9**	56.4-69.3	**14.9-18.3**
D10T	42.8-60.1	**11.3-16.1**	60.1-79.5	**16.1-21.0**	79.5-97.7	**21.0-25.8**
D11R	61.0-87.0	**16.5-23.0**	87.0-113.0	**23.0-30.0**	113.0-139.5	**30.0-37.0**
D11T	59.0-84.4	**15.6-22.3**	84.4-109.8	**22.3-29.0**	109.8-135.1	**29.0-35.7**

*D7G fuel consumption data is based on a precombustion chamber equipped engine. Fuel consumption for a direct injection equipped D7G should be approximately 10% less.

Typical Application Description
(relative to work application)

Low — Pulling scrapers, most agricultural drawbar, stockpile, coal pile and finish grade applications. No impact. Intermittent full throttle operation.

Medium — Production dozing in clays, sands, gravels. Push loading scrapers, borrow pit ripping, most land clearing applications. Medium impact conditions. Production landfill work.

High — Heavy rock ripping. Push loading and dozing in hard rock. Working on rock surfaces. Continuous high impact conditions.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

Product Link Information — Product link measured over hundreds of Track-Type Tractors shows that more than 90% of the machines experience an average fuel consumption equal to or lower than those shown in the Medium Application profile.

MOTOR GRADERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
120K	9.0-12.9	**2.4-3.4**	12.9-16.7	**3.4-4.4**	16.7-20.6	**4.4-5.4**
120M	10.2-14.6	**2.7-3.9**	14.6-19.0	**3.9-5.0**	19.0-23.3	**5.0-6.2**
12K	10.9-15.2	**2.9-4.1**	15.5-20.2	**4.1-5.3**	20.2-24.8	**5.3-6.6**
12M	11.0-15.7	**2.9-4.2**	15.7-20.4	**4.2-5.4**	20.4-25.1	**5.4-6.6**
140K	12.3-17.6	**3.3-4.7**	17.6-23.0	**4.7-6.1**	23.0-28.2	**6.1-7.5**
140M	13.5-16.4	**3.6-4.3**	16.4-21.3	**4.3-5.6**	21.3-30.9	**5.6-8.2**
160K	14.0-20.0	**3.7-5.3**	20.0-26.0	**5.3-6.9**	26.0-32.0	**6.9-8.5**
160M	14.6-17.8	**3.9-4.7**	17.8-23.1	**4.7-6.1**	23.1-33.5	**6.1-8.8**
14M	15.7-22.4	**4.1-5.9**	22.4-29.1	**5.9-7.7**	29.1-39.8	**7.7-10.5**
16M	20.4-29.1	**5.4-7.7**	29.1-37.9	**7.7-10.0**	37.9-46.6	**10.0-12.3**
24M	36.0-49.2	**9.5-13.0**	49.2-68.1	**13.0-18.0**	68.1-83.3	**18.0-22.0**

Typical Application Description
(relative to work application)

Low — Light road maintenance. Finish grading. Plant and road mix work. Large amounts of traveling. Light snow plowing.

Medium — Haul road maintenance. Average road maintenance, road mix work, scarifying. Road construction, ditching, loose fill spreading. Land forming, land leveling and elevating grader use. Medium to heavy snow removal.

High — Heavy maintenance of hard packed roads with embedded rock. Heavy fill spreading, base material spreading and ditching. Ripping/scarifying of asphalt or concrete. Continuous high load factor. High impact. Heavy snow plowing.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

SKID STEER LOADERS, MULTI TERRAIN LOADERS AND COMPACT TRACK LOADERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
216B2	3.98-5.69	**1.05-1.50**	5.69-7.40	**1.50-1.95**	7.40-9.11	**1.95-2.41**
226B2	5.89-8.42	**1.56-2.22**	8.42-10.94	**2.22-2.89**	10.94-13.47	**2.89-3.56**
232B2	5.89-8.42	**1.56-2.22**	8.42-10.94	**2.22-2.89**	10.94-13.47	**2.89-3.56**
236B2	5.59-7.98	**1.48-2.11**	7.98-10.37	**2.11-2.74**	10.37-12.77	**2.74-3.37**
242B2	5.89-8.42	**1.56-2.22**	8.42-10.94	**2.22-2.89**	10.94-13.47	**2.89-3.56**
246C	5.59-7.98	**1.48-2.11**	7.98-10.37	**2.11-2.74**	10.37-12.77	**2.74-3.37**
247B2	5.89-8.42	**1.56-2.22**	8.42-10.94	**2.22-2.89**	10.94-13.47	**2.89-3.56**
256C	6.12-8.74	**1.62-2.31**	8.74-11.36	**2.31-3.00**	11.36-13.98	**3.00-3.69**
257B2	5.89-8.42	**1.56-2.22**	8.42-10.94	**2.22-2.89**	10.94-13.47	**2.89-3.56**
262C	6.12-8.74	**1.62-2.31**	8.74-11.36	**2.31-3.00**	11.36-13.98	**3.00-3.69**
272C	6.78-9.69	**1.79-2.56**	9.69-12.59	**2.56-3.33**	12.59-15.50	**3.33-4.09**
277C	6.12-8.74	**1.62-2.31**	8.74-11.36	**2.31-3.00**	11.36-13.98	**3.00-3.69**
279C	6.12-8.74	**1.62-2.31**	8.74-11.36	**2.31-3.00**	11.36-13.98	**3.00-3.69**
287C	6.12-8.74	**1.62-2.31**	8.74-11.36	**2.31-3.00**	11.36-13.98	**3.00-3.69**
289C	6.12-8.74	**1.62-2.31**	8.74-11.36	**2.31-3.00**	11.36-13.98	**3.00-3.69**
297C	6.78-9.69	**1.79-2.56**	9.69-12.59	**2.56-3.33**	12.59-15.50	**3.33-4.09**
299C	6.78-9.69	**1.79-2.56**	9.69-12.59	**2.56-3.33**	12.59-15.50	**3.33-4.09**

Typical Application Description
(relative to work application)

Low — Light utility, construction, nursery and landscaping applications. Load and carry of free flowing, low density materials on firm, smooth surfaces for short distances with minimal grades. Light snow removal.

Medium — Industrial and construction job site applications. Loading from bank or load and carry of low to medium density materials on normal surfaces with low to medium rolling resistance and slight adverse grades. Occasional use of various attachments under normal loading conditions.

High — Continuous industrial, construction and batch plant applications. Loading from tight banks or load and carry of high density materials on rough or very soft surfaces with high rolling resistance and adverse grades. Maximum use of high flow attachments under high loading conditions.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

ARTICULATED TRUCKS (Underground)

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
AD30	27.0-38.0	**7.1-10.0**	38.0-45.0	**10.0-11.9**	45.0-56.0	**11.9-14.8**
AD45B	35.0–45.0	**9.2-11.9**	45.0-55.0	**11.9-14.5**	55.0-65.0	**14.5-17.2**
AD55B	45.0-55.0	**11.9-14.5**	55.0-65.0	**14.5-17.2**	65.0-80.0	**17.2-21.1**

Typical Application Description
(relative to work application)

Low Continuous operation at <80% of maximum recommended gross weight. Short to medium haul distances: 300-1000 m **(990-3300 feet)**. Well maintained, level haul roads. Considerable amount of idling. Very few tray impacts. Low load factor.

Medium Intermittent operation at less than maximum recommended gross weight. Medium to longer haul distances: 1000-5000 m **(3300-16,000 feet)**. Varying haul road conditions with some adverse grades. Occasional tray impacts. Medium load factor.

High Continuous operation at maximum recommended gross weight. Long haul distances: >5000 m **(>16,000 feet)**. Poor haul road conditions with adverse/steep grades. Frequent tray impacts. High load factor.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-40%
Medium 40%-60%
High 60%-80%

LOAD HAUL DUMP UNITS (LHD'S) (Underground)

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
R1300G	11.3-15.1	**3.0-4.0**	15.1-18.9	**4.0-5.0**	18.9-30.2	**5.0-6.0**
R1600G	15.1-22.7	**4.0-6.0**	22.7-28.3	**6.0-7.5**	28.3-39.7	**7.5-10.5**
R1700G	22.7-26.4	**6.0-7.0**	26.4-34.0	**7.0-9.0**	34.0-45.4	**9.0-12.0**
R2900G	30.2-37.8	**8.0-10.0**	37.8-45.4	**10.0-12.0**	45.4-56.7	**12.0-15.0**
R2900G XTRA	33.0-40.0	**8.7-10.5**	40.0-47.0	**10.5-12.4**	47.0-59.0	**12.4-15.6**

Typical Application Description
(relative to work application)

Low Dig and carry operation from stockpiles to ground level transfer station. Low density, free flowing ore and waste. Excellent draw point floor surfaces. Short haul distances: 25-100 m **(80-330 feet)**. Level roads with good surface conditions. Low load factor.

Medium Intermittent development/production loading into trucks/transfer station. Good digging with well shot, low to medium density ore and waste. Average draw point floor surfaces. Medium haul distances: 100-200 m **(330-660 feet)**. Poor road surfaces with slightly adverse grades. Medium load factor.

High Continuous production loading of trucks at or near maximum load height. Difficult digging. Loading haul trucks. Rough draw point surfaces. Long haul distances: 200-300 m **(660-990 feet)**. Poor haul roads with adverse grades. High load factor.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-40%
Medium 40%-60%
High 60%-80%

EXCAVATORS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
301.5	2.1-2.5	**0.55-0.66**	2.5-2.9	**0.66-0.77**	2.9-3.3	**0.77-0.87**
301.6C	0.9-1.4	**0.24-0.35**	1.4-1.8	**0.35-0.47**	1.8-2.3	**0.47-0.59**
301.8C	0.9-1.4	**0.24-0.35**	1.4-1.8	**0.35-0.47**	1.8-2.3	**0.47-0.59**
302.5C	1.2-1.8	**0.31-0.47**	1.8-2.4	**0.47-0.62**	2.4-3.0	**0.62-0.78**
303 CR/SR	3.4-4.0	**0.89-1.07**	4.0-4.7	**1.07-1.24**	4.7-5.4	**1.2-1.42**
304 CR	4.0-4.8	**1.06-1.28**	4.8-5.6	**1.28-1.49**	5.6-6.4	**1.49-1.7**
305 CR/SR	4.7-5.7	**1.24-1.49**	5.7-6.6	**1.49-1.74**	6.6-7.5	**1.74-1.99**
307D	2.5-3.7	**0.7-1.0**	3.7-4.9	**1.0-1.3**	4.9-6.2	**1.3-1.6**
308D CR	2.5-3.7	**0.7-1.0**	3.7-4.9	**1.0-1.3**	4.9-6.2	**1.3-1.6**
311D RR (Tier 3)	3.5-6.5	**0.9-1.7**	6.5-9.5	**1.7-2.5**	9.5-12.8	**2.5-3.4**
312D (Tier 3)	4.0-7.5	**1.1-2.0**	7.5-11.5	**2.0-3.0**	11.5-15.2	**3.0-4.0**
314D CR (Tier 3)	4.0-7.5	**1.1-2.0**	7.5-11.5	**2.0-3.0**	11.5-15.2	**3.0-4.0**
315D (Tier 3)	5.0-9.5	**1.3-2.5**	9.5-14.5	**2.5-3.8**	14.5-19.2	**3.8-5.1**
319D (Tier 3)	5.5-10.5	**1.5-2.8**	10.5-15.5	**2.8-4.1**	15.5-21.0	**4.1-5.5**
320D (STD Tier 3)	6.0-12.0	**1.6-3.2**	12.0-18.0	**3.2-4.8**	18.0-24.0	**4.8-6.3**
320D (HHP Tier 3)	6.5-12.5	**1.7-3.3**	12.5-18.5	**3.3-4.9**	18.5-24.8	**4.9-6.6**
321D CR (STD Tier 3)	6.0-12.0	**1.6-3.2**	12.0-18.0	**3.2-4.8**	18.0-24.0	**4.8-6.3**
321D CR (HHP Tier 3)	6.5-12.5	**1.7-3.3**	12.5-18.5	**3.3-4.9**	18.5-24.8	**4.9-6.6**
323D (Tier 3)	6.5-12.5	**1.7-3.3**	12.5-18.5	**3.3-4.9**	18.5-24.8	**4.9-6.6**
324D (STD Tier 3)	7.0-14.0	**1.8-3.7**	14.0-21.0	**3.7-5.5**	21.0-28.0	**5.5-7.4**
324D (HHP Tier 3)	8.0-16.0	**2.1-4.2**	16.0-24.0	**4.2-6.3**	24.0-32.0	**6.3-8.5**
324D (STD Tier 2)	6.5-13.5	**1.7-3.6**	13.5-20.0	**3.6-5.3**	20.0-26.6	**5.3-7.0**
324D (HHP Tier 2)	7.5-15.5	**2.0-4.1**	15.5-23.0	**4.1-6.1**	23.0-30.4	**6.1-8.0**
328D CR (Tier 3)	8.5-17.5	**2.2-4.6**	17.5-26.0	**4.6-6.9**	26.0-34.5	**6.9-9.1**
329D (STD Tier 3)	8.0-16.0	**2.1-4.2**	16.0-24.0	**4.2-6.3**	24.0-32.0	**6.3-8.5**
329D (HHP Tier 3)	8.5-17.5	**2.2-4.6**	17.5-26.0	**4.6-6.9**	26.0-34.5	**6.9-9.1**
329D (STD Tier 2)	7.5-15.5	**2.0-4.1**	15.5-23.0	**4.1-6.1**	23.0-30.5	**6.1-8.1**
329D (HHP Tier 2)	8.5-16.5	**2.2-4.4**	16.5-24.5	**4.4-6.5**	24.5-33.0	**6.5-8.7**
336D (Tier 3)	11.5-23.0	**3.0-6.1**	23.0-34.5	**6.1-9.1**	34.5-45.5	**9.1-12.0**
336D (Tier 2)	11.0-21.5	**2.9-5.7**	21.5-32.5	**5.7-8.6**	32.5-43.5	**8.6-11.5**
345D (Tier 3)	15.5-30.5	**4.1-8.1**	30.5-45.6	**8.1-12.0**	45.6-61.0	**12.0-16.1**
345D (Tier 2)	14.5-29.0	**3.8-7.7**	29.0-43.3	**7.7-11.4**	43.3-58.0	**11.4-15.3**
365C (Tier 3)	16.5-33.0	**4.4-8.7**	33.0-49.2	**8.7-13.0**	49.2-65.5	**13.0-17.3**
365C (Tier 2)	15.5-31.0	**4.1-8.2**	31.0-46.7	**8.2-12.3**	46.7-62.5	**12.3-16.5**
374D (Tier 3)	19.0-37.5	**5.0-9.9**	37.5-56.4	**9.9-14.9**	56.4-75.5	**14.9-19.9**
374D (Tier 2)	18.0-35.5	**4.8-9.4**	35.5-53.6	**9.4-14.2**	53.6-71.5	**14.2-18.9**
385C (Tier 3)	20.5-41.0	**5.4-10.8**	41.1-61.0	**10.8-16.1**	61.0-81.5	**16.1-21.5**
385C (Tier 2)	19.5-39.0	**5.2-10.3**	39.0-58.0	**10.3-15.3**	58.0-77.5	**15.3-20.5**
M313D	8.0-12.0	**2.1-3.2**	12.0-16.0	**3.2-4.2**	16.0-19.0	**4.2-5.0**
M315D	9.0-13.0	**2.4-3.4**	13.0-18.0	**3.4-4.8**	18.0-21.0	**4.8-5.5**
M316D	8.0-12.0	**2.1-3.2**	12.0-17.0	**3.2-4.5**	17.0-20.0	**4.5-5.3**
M318D	9.0-13.0	**2.4-3.4**	13.0-18.0	**3.4-4.8**	18.0-22.0	**4.8-5.8**
M322D	11.0-17.0	**2.9-4.5**	17.0-23.0	**4.5-6.1**	23.0-26.0	**6.0-6.9**
M325C MH*	12.9-15.9	**3.4-4.2**	20.8-23.8	**5.5-6.3**	23.8-27.6	**6.3-7.3**
M325C L MH*	14.0-19.0	**3.7-5.0**	23.0-27.0	**6.1-7.1**	27.0-32.0	**7.1-8.5**
W330B MH*	19.0-24.0	**5.0-6.3**	29.0-33.0	**7.7-8.7**	34.0-39.0	**9.0-10.3**
W345B MH*	25.0-30.0	**6.6-7.9**	38.0-42.0	**10.0-11.1**	45.0-50.0	**11.9-13.2**

*If the application of these machines is to be used for scrap handling, the LOW hourly fuel consumption rate would typically apply.
NOTE: Fuel consumption rates for 320D through 385C include machine at idle per load factor definition.

Mini HEX
Typical Application Description
(relative to work application)

Low — Mostly shallow depth urban utility construction where excavator sets pipe and digs in sandy loam or free flowing, low density material. Little traveling and little or no impact.

Medium — Most residential pipeline and cabling applications. Continuous mass excavation and trenching in natural bed clay soils. Some traveling and steady, full throttle operation.

High — Continuous trenching or truck loading in rock or shot rock soils. Most pipeline applications in hard rocky material. Large amount of travel over rough ground. Constant high load factor and high impact.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-40%
Medium 40%-60%
High 60%-80%

300 Series
Typical Application Description
(relative to work application)

Low — Mostly shallow depth urban utility construction where excavator sets pipe and digs less than 50% of the daily work schedule. Sandy loam, free flowing, low density material. Most scrap handling applications. Little traveling and little or no impact.

Medium — Most residential sewer applications. Continuous mass excavation and trenching in natural bed clay soils. Digging 60-85% of the daily work schedule. Most log loading applications. Some traveling and steady, full throttle operation.

High — Continuous trenching or truck loading in rock or shot rock soils. Most pipeline applications in hard rocky material. Digging 90-95% of the daily work schedule. Large amount of travel over rough ground. Working on rock floor with constant high load factor and high impact.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-40%
Medium 40%-60%
High 60%-80%

M Series
Typical Application Description
(relative to work application)

Low — Urban utility construction application in sandy loam, low density material. Digging less than 50% of the daily work schedule. Rehandling and scrap handling applications.

Medium — Residential sewer applications in natural bed clay. Continuous digging in sandy clay/gravel. Digging 60-85% of the daily work schedule. Site development and lumber yard applications. Most logging applications.

High — Pipeline applications in hard rocky material. Continuous digging in rock/natural bed clay. Digging 90-95% of the daily work schedule. High impact, using hammer, working in forests and quarries.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-40%
Medium 40%-60%
High 60%-80%

FRONT SHOVELS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
5090	43.0-48.0	**11.4-12.7**	62.0-68.0	**16.4-18.0**	71.0-78.0	**18.8-20.6**
5130B (Tier 1)	—	**—**	120.2	**31.6**	160.3	**42.2**
5230B (Tier 1)	—	**—**	232.5	**61.2**	310.0	**81.6**

Typical Application Description
(relative to work application)

Low Continuous loading in loose banks or stockpile. Light, easy work with, considerable idling. Good underfoot conditions.

Medium Continuous loading in well-shot rock or fairly tight bank. Steady cycling with frequent periods of idle. Good underfoot conditions; dry floor, little impact or sliding on undercarriage. Minimal travel time (3%-6%).

High Continuous loading in poorly-shot rock, virgin or lightly-blasted tight banks. Steady cycling in hard to dig material. Adverse underfoot conditions; rough floors, high impact and/or sliding on undercarriage.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-50%
Medium 50%-80%
High 80%-100%

PIPELAYERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
PL61	5.7-11.7	**1.5-3.0**	9.7-15.1	**2.5-4.0**	13.2-18.9	**3.5-5.0**
572R Series 2	8.5-12.3	**2.2-3.3**	12.3-15.7	**3.3-4.2**	15.7-19.5	**4.2-5.2**
583T	11.8-16.9	**3.1-4.5**	16.9-21.8	**4.5-5.8**	21.8-26.8	**5.8-7.1**
587R	11.8-16.0	**3.1-4.2**	16.0-20.8	**4.2-5.5**	20.8-25.5	**5.5-6.8**
587T	15.3-21.9	**4.0-5.8**	21.9-28.3	**5.8-7.5**	28.3-34.9	**7.5-9.2**

Typical Application Description
(relative to work application)

Low Little or no use in mud, water or on rock. Use on level, regular surfaces.

Medium Typical pipelayer use in operating conditions ranging from very good to severe.

High Continuous use in deep mud or water or on rock surfaces.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

WHEEL TRACTOR-SCRAPERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
613G Tier 3	15.0-19.0	**4.0-5.0**	21.0-25.0	**5.5-6.5**	27.5-34.0	**7.3-9.0**
621G Tier 3	26.3-37.6	**6.9-9.9**	37.6-48.8	**9.9-12.9**	48.8-60.1	**12.9-15.9**
623G Tier 3	30.1-41.3	**8.0-10.9**	41.3-52.6	**10.9-13.9**	52.6-66.1	**13.9-17.5**
627G Tier 3	40.2-59.9	**10.6-15.8**	59.9-79.5	**15.8-21.0**	79.5-104.7	**21.0-27.7**
631G Tier 3	33.9-48.5	**9.0-12.8**	48.5-63.0	**12.8-16.6**	63.0-77.5	**16.6-20.5**
637G Tier 3	48.8-72.4	**12.9-19.1**	72.4-95.9	**19.1-25.3**	95.9-125.3	**25.3-33.1**
657G Tier 3	66.3-98.6	**17.6-26.1**	98.6-130.9	**26.1-34.6**	130.9-163.3	**34.6-43.1**

Typical Application Description
(relative to work application)

Low — Level or favorable grades on good haul roads and low rolling resistance. Easy-loading materials, partial loads. No impact. Average use, but with considerable idling.

Medium — Adverse and favorable grades with varying loading and haul road conditions. Long and short hauls, near full. Some impact. Typical road building use.

High — Rough haul roads. Loading heavy clay, continuous high total resistance conditions with steady cycling. Overloading. High impact conditions, such as loading ripped rock.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

BACKHOE LOADERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
416D (NA)	6.4-8.3	**1.7-2.2**	8.3-10.2	**2.2-2.7**	10.2-12.1	**2.7-3.2**
416D (T)	7.6-9.5	**2.0-2.5**	9.5-11.4	**2.5-3.0**	11.4-13.2	**3.0-3.5**
416E	7.6-9.5	**2.0-2.5**	9.5-11.4	**2.5-3.0**	11.4-13.2	**3.0-3.5**
420E (T)	7.0	**1.8**	11.0	**2.9**	18.1	**4.8**
422E (T)	6.4-8.3	**1.7-2.2**	8.3-10.2	**2.2-2.7**	10.2-12.1	**2.7-3.2**
424D (NA)	6.4-8.3	**1.7-2.2**	8.3-10.2	**2.2-2.7**	10.2-12.1	**2.7-3.2**
428E (T)	7.6-9.5	**2.0-2.5**	9.5-11.4	**2.5-3.0**	11.4-13.2	**3.0-3.5**
430E (T)	7.7	**2.0**	12.8	**3.4**	20.4	**5.4**
432E (T)	8.1-10.0	**2.1-2.6**	10.0-11.9	**2.6-3.1**	11.9-14.2	**3.1-3.8**
434E (T)	8.1-10.0	**2.1-2.6**	10.0-11.9	**2.6-3.1**	11.9-14.2	**3.1-3.8**
438D	8.9-11.2	**2.4-3.0**	11.2-13.1	**3.0-3.5**	13.1-15.3	**3.5-4.0**
442E (T)	8.9-11.2	**2.4-3.0**	11.2-13.1	**3.0-3.5**	13.1-15.3	**3.5-4.0**
444E (T)	8.9-11.2	**2.4-3.0**	11.2-13.1	**3.0-3.5**	13.1-15.3	**3.5-4.0**
446D (T)	10.6-12.9	**2.8-3.4**	12.9-15.1	**3.4-4.0**	15.1-17.4	**4.0-4.6**
450E	17.0	**4.5**	17.0	**4.5**	21.9	**5.8**

NA = Naturally Aspirated
T = Turbocharged

Backhoe Loaders
Typical Application Description
(relative to work application)

Low — Light duty utility applications with intermittent cycles in light to medium soil. Trenching depths less than 1.83 m **(6 feet)**.

Medium — General utility applications with regular cycles in medium to heavy soil. Dig depths to 3.05 m **(10 feet)**. Occasional use of constant flow implements.

High — Production applications or digging in rock. Dig depths over 3.05 m **(10 feet)**. Long cycle times or regular use of constant flow implements.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-30%
Medium 30%-40%
High 40%-50%

FOREST PRODUCTS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
FOREST MACHINES						
320D FM	11.5-14.0	**3.0-3.7**	17.0-19.0	**4.5-5.0**	20.5-22.5	**5.4-6.0**
322C LL	25.0-28.0	**6.5-7.5**	26.0-29.0	**7.0-7.5**	27.0-30.0	**7.5-8.0**
324D FM	14.0-19.0	**3.7-5.1**	23.0-27.0	**6.1-7.1**	27.0-32.0	**7.2-8.5**
325C LL	26.0-29.0	**7.0-7.5**	27.0-30.0	**7.0-8.0**	29.0-32.0	**7.5-8.5**
325D FM	14.0-19.0	**3.7-5.1**	23.0-27.0	**6.1-7.1**	27.0-32.0	**7.2-8.5**
330C LL	36.0-40.0	**9.5-10.5**	37.0-41.0	**10.0-11.0**	38.0-42.0	**10.0-11.0**
330D FM	19.0-24.0	**5.0-6.3**	29.0-33.0	**7.7-8.7**	34.0-39.0	**9.0-10.3**
FELLER BUNCHERS						
511 (2290)	25.0-28.0	**6.5-7.5**	28.0-34.0	**7.5-9.0**	36.0-42.0	**9.5-11.0**
521 (2390)	27.0-33.0	**7.0-8.5**	33.0-36.0	**8.5-9.5**	36.0-44.0	**9.5-11.5**
522 (2391)	27.0-33.0	**7.0-8.5**	33.0-36.0	**8.5-9.5**	36.0-44.0	**9.5-11.5**
532 (2491)	28.0-34.0	**7.5-9.0**	34.0-38.0	**9.0-10.0**	38.0-45.0	**10.0-12.0**
541 (2590)	28.0-34.0	**7.5-9.0**	34.0-38.0	**9.0-10.0**	38.0-45.0	**10.0-12.0**
551	28.0-34.0	**7.5-9.0**	34.0-38.0	**9.0-10.0**	38.0-45.0	**10.0-12.0**
552	30.0-34.0	**8.0-9.0**	34.0-40.0	**9.0-10.5**	40.0-49.0	**10.5-13.0**
TRACK SKIDDERS						
517	5.7-13.2	**1.5-3.5**	13.2-18.9	**3.5-5.0**	15.0-22.7	**4.0-6.0**
527	13.2-18.9	**3.5-5.0**	18.9-23.6	**5.0-6.25**	23.6-32.2	**6.25-8.5**
WHEEL SKIDDERS						
525B	10.4-15.1	**2.75-4.0**	15.1-20.8	**4.0-5.5**	20.8-32.2	**5.5-8.5**
535B	10.4-15.1	**2.75-4.0**	15.1-22.7	**4.0-6.0**	22.7-34.0	**6.0-9.0**
545	10.4-15.1	**2.75-4.0**	15.1-24.6	**4.0-6.5**	24.6-37.8	**6.5-10.0**
KNUCKLEBOOM LOADERS						
539	26.0-29.0	**6.87-7.66**	27.0-30.0	**7.13-7.93**	29.0-32.0	**7.66-8.45**
HARVESTERS						
550	*	*	*	*	*	*
570	*	*	*	*	*	*
580	*	*	*	*	*	*
FORWARDERS						
554	*	*	*	*	*	*
574	*	*	*	*	*	*
584	12.0	**3.18**	14.0	**3.70**	16.0	**4.24**

*Insufficient data.

Wheel Skidders
Typical Application Description
(relative to work application)

Low — Intermittent skidding for short distances, no decking. Good underfoot conditions; dry floor, few if any stumps, flat/level terrain with low skidding resistance.

Medium — Continuous turning, steady skidding for medium distances with moderate decking. Good underfoot conditions; dry floor with few stumps, gradual rolling/moderate terrain with medium skidding resistance.

High — Continuous turning, steady skidding for long distances with frequent decking. Poor underfoot conditions; wet floor, numerous stumps, steep terrain with high skidding resistance.

Load Factor Guide — 517

Low — Skidding loads less than 4536 kg **(10,000 lb)** in flat terrain (0-8% grade) with low skidding resistance.

Medium — Skidding loads up to 4536 kg **(10,000 lb)** in moderate terrain (8-30% grade) with medium skidding resistance.

High — Skidding loads over 4536 kg **(10,000 lb)** in steep terrain (over 30% grade) with high skidding resistance.

Load Factor Guide — 525B

Low — Skidding loads less than 4500 kg **(10,000 lb)** in flat terrain (0-5% grade) with low skidding resistance.

Medium — Skidding loads up to 6800 kg **(15,000 lb)** in moderate terrain (5-10% grade) with average skidding resistance

High — Skidding loads over 6800 kg **(15,000 lb)** in steep terrain (over 10% grade) with high skidding resistance.

Load Factor Guide — 527

Low — Skidding loads less than 6360 kg **(14,000 lb)** in flat terrain (0-8% grade) with low skidding resistance.

Medium — Skidding loads up to 6360 kg **(14,000 lb)** in moderate terrain (8-30% grade) with medium skidding resistance.

High — Skidding loads over 6360 kg **(14,000 lb)** in steep terrain (over 30% grade) with high skidding resistance.

Feller Bunchers
Typical Application Description
(relative to work application)

Low — Harvesting application or intermittent felling and stacking in good underfoot conditions. Flat ground, uniform trees below 255 mm **(10 inches)**.

Medium — Harvesting or hot saw application in medium underfoot conditions. Rolling terrain, some trees up to 457 mm **(18 inches)** or some hardwoods.

High — High cycling in poor underfoot conditions, steep terrain, over stumps or fallen trees. Multiple small diameter trees or larger trees 508 mm **(20 inches)** or larger hardwoods.

Load Factor Guide
(average engine load factor based on application description for each range)

Low — 45%-65%

Medium — 66%-85%

High — 86%-98%

Forwarders
Typical Application Description
(relative to work application)

Low — Loading and hauling application in good conditions. Flat ground, concentrated log bunches, single tier log lengths, short haul distances

Medium — Loading and hauling application in medium conditions. Rolling terrain, medium spacing of log bunches, single and two tier log lengths.

High — Loading and hauling application in poor conditions, steep or rocky terrain, scattered log bunches, two tier log lengths, long haul distances.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 15%-25%
Medium 25%-35%
High 35%-45%

OFF HIGHWAY TRUCKS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
770	20.4-30.6	**5.4-8.1**	30.6-40.8	**8.1-10.8**	40.8-51.0	**10.8-13.5**
772	23.6-35.3	**6.2-9.3**	35.3-47.1	**9.3-12.4**	47.1-58.9	**12.4-15.6**
773E	27.4-41.2	**7.2-10.9**	41.2-54.9	**10.9-14.5**	54.9-68.6	**14.5-18.1**
773F	28.3-42.5	**7.5-11.2**	42.5-56.6	**11.2-15.0**	56.6-70.8	**15.0-18.7**
775F	28.7-43.1	**7.6-11.4**	43.1-57.4	**11.4-15.2**	57.4-71.8	**15.2-19.0**
777D	37.5-56.3	**9.9-14.9**	56.3-75.0	**14.9-19.8**	75.0-93.8	**19.8-24.8**
777F	37.1-55.7	**9.8-14.7**	55.7-74.2	**14.7-19.6**	74.2-92.8	**19.6-24.5**
785C	53.7-80.6	**14.2-21.3**	80.6-107.5	**21.3-28.4**	107.5-134.4	**28.4-35.5**
785D	54.2-81.4	**14.3-21.5**	81.4-108.5	**21.5-28.7**	108.5-135.6	**28.7-35.8**
789C	70.6-105.9	**18.7-28.0**	105.9-141.2	**28.0-37.3**	141.2-176.5	**37.3-46.6**
793D	90.8-136.2	**24.0-36.0**	136.2-181.6	**36.0-48.0**	181.6-227.0	**48.0-60.0**
793F	96.7-145.0	**25.5-38.3**	145.0-193.3	**38.3-51.1**	193.3-241.7	**51.1-63.9**
797F	146.8-220.3	**38.8-58.2**	220.3-293.7	**58.2-77.6**	293.7-367.1	**77.6-97.0**

NOTE: Load factors above 50% may be experienced in many applications.

Typical Application Description
(relative to work application)

Low — Continuous operation at an average gross weight less than recommended. Excellent haul roads. No overloading, low load factor.

Medium — Continuous operation at an average gross weight approaching recommended. Minimal overloading, good haul roads, moderate load factor.

High — Continuous operation at or above maximum recommended gross weight. Overloading, poor haul roads, high load factor.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-30%
Medium 30%-40%
High 40%-50%

ARTICULATED TRUCKS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
725	10.6-14.8	**2.8-3.9**	14.8-20.8	**3.9-5.5**	20.8-30.1	**5.5-8.0**
730 Ejector	12.3-17.1	**3.3-4.5**	17.1-24.5	**4.5-6.4**	24.2-34.9	**6.4-9.2**
730	11.7-16.3	**3.1-4.3**	16.3-23.0	**4.3-6.1**	23.0-33.2	**6.1-8.8**
735	16.6-23.1	**4.4-6.1**	23.1-32.4	**6.1-8.6**	32.4-46.8	**8.6-12.4**
740	16.7-23.2	**4.4-6.1**	23.2-32.6	**6.1-8.6**	32.6-47.1	**8.6-12.5**
740 Ejector	17.5-24.4	**4.6-6.4**	24.4-34.2	**6.4-8.6**	34.2-49.5	**9.0-13.1**

Typical Application Description
(relative to work application)

Low — Earthmoving and stockpile use with well matched loading equipment, free flowing material. Large amount of idling, short to medium haul distances on well-maintained level haul roads. Minimum total resistance, few impact loads.

Medium — Typical use in road-building, dam construction, open-pit mining, etc. Normal load and haul times, varying haul road conditions with some adverse grades. Some impact loads.

High — Poorly-matched loading equipment with continuous overloading. Long haul time and continuous use on very poorly maintained haul roads with frequent adverse grades. High rolling resistance, poor traction, high impact loads.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 20%-30%
Medium 30%-40%
High 40%-50%

TELEHANDLERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
TH210	5.1-6.8	**1.3-1.8**	8.5-10.1	**2.2-2.6**	11.8-13.5	**3.1-3.5**
TH215	5.1-6.8	**1.3-1.8**	8.5-10.1	**2.2-2.6**	11.8-13.5	**3.1-3.5**
TH220B (59-74 kW/**80-99 hp**)	5.0-7.0	**1.3-1.8**	10.0-14.0	**2.6-3.7**	13.0-17.0	**3.4-4.5**
TH220B (92 kW/**123 hp**)	5.0-8.0	**1.3-2.1**	10.0-16.0	**2.6-4.2**	13.0-20.0	**3.4-5.3**
TH330B (59-74 kW/**80-99 hp**)	5.0-7.0	**1.3-1.8**	10.0-14.0	**2.6-3.7**	13.0-17.0	**3.4-4.5**
TH330B (92 kW/**123 hp**)	5.0-8.0	**1.3-2.1**	10.0-16.0	**2.6-4.2**	13.0-20.0	**3.4-5.3**
TH340B	5.0-7.0	**1.3-1.8**	10.0-14.0	**2.6-3.7**	13.0-17.0	**3.4-4.5**
TH350B	5.0-7.0	**1.3-1.8**	10.0-14.0	**2.6-3.7**	13.0-17.0	**3.4-4.5**
TH355B	5.0-7.0	**1.3-1.8**	10.0-14.0	**2.6-3.7**	13.0-17.0	**3.4-4.5**
TH360B	5.0-7.0	**1.3-1.8**	10.0-14.0	**2.6-3.7**	13.0-17.0	**3.4-4.5**
TH460B	5.0-7.0	**1.3-1.8**	10.0-14.0	**2.6-3.7**	13.0-17.0	**3.4-4.5**
TH560B (59-74 kW/**80-99 hp**)	5.0-9.0	**1.3-2.4**	10.0-15.0	**2.6-4.0**	13.0-17.5	**3.4-4.6**
TH560B (92 kW/**123 hp**)	5.0-9.0	**1.3-2.4**	10.0-17.0	**2.6-4.5**	13.0-21.0	**3.4-5.5**
TH580B	5.0-6.0	**1.3-1.6**	9.0-10.7	**2.4-2.8**	16.0-18.3	**4.2-4.8**

Typical Application Description
(relative to work application)
Low Light to moderate, intermittent, utility applications with frequent periods of idling and limited travel.
Medium General construction applications with moderate amounts of travel.
High Continuous production applications with near capacity loading and extended lifts.

Load Factor Guide
(average engine load factor based on application description for each range)
Low 20%-30%
Medium 30%-40%
High 40%-50%

WHEEL DOZERS/SOIL COMPACTORS/LANDFILL COMPACTORS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
814F	21.0-25.0	**5.5-6.5**	26.0-30.0	**7.0-8.0**	36.0-40.0	**9.5-10.5**
815F	26.0-30.0	**7.0-8.0**	36.0-42.0	**9.5-11.0**	44.0-47.0	**11.5-12.5**
816F	26.0-30.0	**7.0-8.0**	36.0-42.0	**9.5-11.0**	44.0-47.0	**11.5-12.5**
824H	28.9-33.8	**7.9-8.9**	39.8-45.8	**10.5-12.1**	53.7-59.7	**14.2-15.8**
825H	37.8-43.8	**10.0-11.6**	53.7-67.3	**14.2-17.8**	63.7-69.7	**16.8-18.4**
826H	34.0-35.8	**8.4-9.4**	39.8-43.8	**10.5-11.6**	47.8-51.7	**12.6-13.6**
834H	34.6-43.4	**9.1-11.4**	48.2-52.2	**12.7-13.8**	67.6-74.0	**17.8-19.5**
836H	39.8-43.8	**10.5-11.6**	47.8-51.7	**12.6-14.0**	55.7-59.7	**14.7-18.0**
844	42.0-50.0	**11.0-13.0**	54.0-62.0	**14.0-16.0**	65.0-73.0	**17.0-19.0**
854G	53.0-61.0	**14.0-16.0**	68.0-76.0	**18.0-20.0**	83.0-91.0	**22.0-24.0**

Wheel Dozers
Typical Application Description
(relative to work application)

Low — Light utility and stockpile work. Pulling compactors. Dozing loose fill. Considerable idling or travel with no load and no impact.

Medium — Production dozing, push loading in clays, sands, silts, loose gravels. Shovel clean-up. Normal compaction.

High — Heavy production dozing in rock. Push-loading in rocky, bouldery borrow pits. Heavy landfill compactor work. High impact conditions.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

Soil Compactors/Landfill Compactors
Typical Application Description
(relative to work application)

Low — No dozing or very light spreading on a flat or downhill surface. Machine has support equipment dozing and spreading trash while compactor simply travels over flat surface multiple times.

Medium — Compactor primary use is compacting already spread material. Compactor assists in dozing and spreading during peak periods of day and possibly working slopes of no steeper than a 4:1.

High — Compactor is possibly only machine for operation. Machine will doze and spread material alone and then compact it with multiple passes working on steep slopes and possibly uphill.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

COMPACTION EQUIPMENT

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
CP-323C	8.0-13.0	**2.0-3.5**	11.0-15.0	**3.0-4.0**	11.0-19.0	**3.0-5.0**
CS-323C	8.0-13.0	**2.0-3.5**	11.0-15.0	**3.0-4.0**	11.0-19.0	**3.0-5.0**
CS-423E	11.0-13.0	**3.0-3.5**	11.0-17.0	**3.0-4.5**	13.0-19.0	**3.5-5.0**
CS-431C	8.0-11.0	**2.0-3.0**	11.0-13.0	**3.0-3.5**	11.0-15.0	**3.0-4.0**
CP-44	5.8-7.8	**1.5-2.1**	7.8-11.9	**2.1-3.1**	11.9-15.7	**3.1-4.2**
CS-44	5.8-7.8	**1.5-2.1**	7.8-11.9	**2.1-3.1**	11.9-15.7	**3.1-4.2**
CS-531D	11.0-13.0	**3.0-3.4**	12.0-14.0	**3.2-3.7**	13.0-16.0	**3.4-4.2**
CP-533E	10.0-12.0	**2.64-3.17**	11.0-13.0	**2.9-3.4**	12.0-15.0	**3.2-4.0**
CS-533E	10.0-12.0	**2.64-3.17**	11.0-13.0	**2.9-3.4**	12.0-15.0	**3.2-4.0**
CP-563E	12.0-14.0	**3.2-3.7**	14.0-17.0	**3.7-4.5**	17.0-20.0	**4.5-5.3**
CS-563E	12.0-14.0	**3.2-3.7**	14.0-17.0	**3.7-4.5**	17.0-20.0	**4.5-5.3**
CP-573E	12.0-15.0	**3.2-4.0**	14.0-18.0	**3.7-4.8**	17.0-21.0	**4.5-5.6**
CS-573E	12.0-15.0	**3.2-4.0**	14.0-18.0	**3.7-4.8**	17.0-21.0	**4.5-5.6**
CS-583E	15.0-17.0	**4.0-4.5**	17.0-19.0	**4.5-5.0**	19.0-23.0	**5.0-6.0**
CP-663E	15.0-17.0	**4.0-4.5**	17.0-19.0	**4.5-5.0**	21.0-22.5	**5.5-6.0**
CS-663E	15.0-17.0	**4.0-4.5**	17.0-19.0	**4.5-5.0**	21.0-22.5	**5.5-6.0**
CS-683E	17.0-19.0	**4.5-5.0**	19.0-21.0	**5.0-5.5**	22.5-24.5	**6.0-6.5**
CB-214D	2.0-3.0	**0.5-1.0**	2.5-3.5	**0.5-1.0**	3.0-4.0	**1.0-1.5**
CB-224D	2.0-4.0	**0.5-1.0**	3.0-4.0	**0.5-1.0**	3.5-4.5	**1.0-1.5**
CB-225D	2.0-3.0	**0.5-1.0**	2.5-3.5	**0.5-1.0**	3.0-4.0	**1.0-1.5**
CB-334E	3.8-5.7	**1.0-1.5**	5.7-7.0	**1.5-1.8**	7.0-10.0	**1.8-2.6**
CB-335E	3.5-5.5	**0.9-1.4**	5.5-6.5	**1.4-1.7**	6.5-9.0	**1.7-2.4**
CB-434C	11.0-13.0	**3.0-3.5**	13.0-17.0	**3.5-4.5**	17.0-19.0	**4.5-5.0**
CB-434D	5.7-7.6	**1.5-2.0**	7.6-11.4	**2.0-3.0**	11.4-15.2	**3.0-4.0**
CB-534D	5.7-7.6	**1.5-2.0**	7.6-11.4	**2.0-3.0**	11.4-15.2	**3.0-4.0**
CB-54	8.5	**2.2**	9.4	**2.5**	11.0	**2.9**
CB-562D	5.7-7.6	**1.5-2.0**	7.6-11.4	**2.0-3.0**	11.4-15.2	**3.0-4.0**
CB-564D	8.55	**2.26**	10.45	**2.76**	13.3	**3.51**
CB-64	8.5	**2.2**	9.4	**2.5**	11.0	**2.9**
CB-634C	13.0	**3.5-4.0**	15.0-19.0	**4.0-5.0**	19.0-21.0	**5.0-5.5**
PS-150C	8.0-11.0	**2.0-3.0**	11.0-13.0	**3.0-3.5**	13.0-15.0	**3.5-4.0**
PS-200B	11.0	**3.0**	11.0-13.0	**3.0-3.5**	13.0-15.0	**3.5-4.0**
PF-300C	13.0	**3.5**	15.0-17.0	**4.0-4.5**	17.0-23.0	**4.5-6.0**
PS-300C	13.0	**3.5**	15.0-17.0	**4.0-4.5**	17.0-23.0	**4.5-6.0**
PS-360C	17.4-9.8	**1.9-2.6**	9.8-12.4	**2.6-3.3**	12.4-14.5	**3.3-4.6**

Asphalt Compactors
Typical Application Description
(relative to work application)
Low Asphalt mix, 25-50 mm **(1-2 inch)** lifts. Static finish rolling, all lifts.
Medium Asphalt mix, 51-100 mm **(2-4 inch)** lifts.
High Asphalt mix, 101-150 mm **(4-6 inch)** lifts. Prepare granular base lifts.

Vibratory Soil Compactors
Typical Application Description
(relative to work application)
Low Granular soil not compacted to high density (<95 Proctor). Residential street work with lift thicknesses from 51-100 mm **(2-4 inch)** working the initial compaction. Level ground, minimal slopes and intermittent periods of waiting for base work completion or material delivery. Speeds in the middle of the low range (2-3 km/h [1-2 mph]). Minimal start and stop of the vibe function.
Medium Granular soil compacted to density (>95 Proctor). Cohesive soils with padded drum and low/normal moisture content, blading <25%. Continuous operation on thicker lifts 101-200 mm **(4-8 inch)** or doing the final passes on stiffer materials or working at the top end of the low speed range. Working on slopes greater than 5% or rapid directional changes combined with start and stop of the vibe function.
High Cohesive soil with padded drum and high moisture content. Combined high load factors from the medium duty application. Working on thick lifts 201-300 mm **(8-12 inch)**, slopes greater than 15%, or applications requiring significant blade work. An example would be trench work with backfilling.

Load Factor Guide
(average engine load factor based on application description for each range)
Low Vibration 20-40%
Medium Vibration 40-60%
High Vibration 60-100%

Pneumatic Compactors
Typical Application Description
(relative to work application)
Low Asphalt mix, all lifts. Intermediate or finish rolling, chip seal. Level ground.
Medium Asphalt mix, all lifts. Intermediate or finish rolling. Granular base breakdown <100 mm **(<4 inch)**. Moderate grade.
High Granular base or cold in place breakdown roller >100 mm **(4 inch)** lifts. Intermediate or finish rolling. Steep grades.

Load Factor Guide
(average engine load factor based on application description for each range)
Low Vibration 30%-50%
Medium Vibration 50%-80%
High Vibration 80%-100%

COMPACTION EQUIPMENT — UTILITY COMPACTORS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
CB14	1.6	**0.42**	2.0	**0.53**	2.3	**0.61**
CB22	4.0	**1.06**	5.5	**1.45**	7.0	**1.85**
CB24, CB24 XT	4.0	**1.06**	5.5	**1.45**	7.0	**1.85**
CC24	3.0	**0.79**	5.0	**1.32**	7.0	**1.85**
CB32	4.0	**1.06**	5.5	**1.45**	7.0	**1.85**
CB34, CB34 XW	2.0-3.2	**0.53-0.83**	3.2-4.5	**0.83-1.19**	4.5-6.0	**1.19-1.59**
CC34	2.0-3.2	**0.53-0.83**	3.2-4.5	**0.83-1.19**	4.5-6.0	**1.19-1.59**

Utility Compactors — CB14, CB22, CB24, CB32, CC24
Typical Application Description
(relative to work application)
Low Asphalt mix, 25-50 mm **(1-2 inch)** lifts. Static finish rolling, all lifts.
Medium Asphalt mix, 25-50 mm **(1-2 inch)** lifts. Normal working conditions with vibe and static.
High Asphalt mix, 25-50 mm **(1-2 inch)** lifts. May include some soil compaction.

Load Factor Guide
(average engine load factor based on application description for each range)
Low Vibration 10-30%
Medium Vibration 30-60%
High Vibration 60-85%

Utility Compactors — CB34, CC34
Typical Application Description
(relative to work application)
Low Asphalt mix, 25-50 mm **(1-2 inch)** lifts. Static finish rolling, all lifts.
Medium Asphalt mix, 51-100 mm **(2-4 inch)** lifts
High Asphalt mix, 101-150 mm **(4-6 inch)** lifts. Prepare granular base lifts

Load Factor Guide
(average engine load factor based on application description for each range)
Low Vibration 20-40%
Medium Vibration 40-70%
High Vibration 80-100%

ASPHALT PAVERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
AP-650B (97 kW/**130 hp**)	20.8-24.6	**5.5-6.5**	24.6-28.4	**6.5-7.5**	32.2-36.0	**8.5-9.5**
AP-800D (97 kW/**130 hp**)	20.8-24.6	**5.5-6.5**	24.6-28.4	**6.5-7.5**	32.2-36.0	**8.5-9.5**
AP-500E (106 kW/**142 hp**)	9.0-14.0	**2.4-3.7**	14.0-19.0	**3.7-5.0**	19.0-25.0	**5.0-6.6**
AP-555E (106 kW/**142 hp**)	9.0-14.0	**2.4-3.7**	14.0-19.0	**3.7-5.0**	19.0-25.0	**5.0-6.6**
AP-600D (129 kW/**174 hp**)	13.3-19.0	**3.5-5.0**	19.0-24.7	**5.0-6.5**	32.2-36.0	**8.5-9.5**
AP-655D (129 kW/**174 hp**)	13.3-19.0	**3.5-5.0**	19.0-24.7	**5.0-6.5**	32.2-36.0	**8.5-9.5**
AP-1050B (129 kW/**174 hp**)	19.0-22.5	**5.0-6.0**	26.5-30.0	**7.0-8.0**	34.0-38.0	**9.0-10.0**
AP-1000D (167 kW/**224 hp**)	20.8-24.6	**5.5-6.5**	24.6-28.4	**6.5-7.5**	32.2-36.0	**8.5-9.5**
AP-1055D (167 kW/**224 hp**)	20.8-24.6	**5.5-6.5**	24.6-28.4	**6.5-7.5**	32.2-36.0	**8.5-9.5**
BG-600D (129 kW/**174 hp**)	13.3-19.0	**3.5-5.0**	19.0-24.7	**5.0-6.5**	32.2-36.0	**8.5-9.5**
BG-655D (129 kW/**174 hp**)	13.3-19.0	**3.5-5.0**	19.0-24.7	**5.0-6.5**	32.2-36.0	**8.5-9.5**
BG-245C (129 kW/**174 hp**)	19.0-22.5	**5.0-6.0**	26.5-30.0	**7.0-8.0**	34.0-38.0	**9.0-10.0**
BG-260D (167 kW/**224 hp**)	20.8-24.6	**5.5-6.5**	24.6-28.4	**6.5-7.5**	32.2-36.0	**8.5-9.5**
BG-2455D (167 kW/**224 hp**)	20.8-24.6	**5.5-6.5**	24.6-28.4	**6.5-7.5**	32.2-36.0	**8.5-9.5**

Typical Application Description
(relative to work application)
Low Narrow width paving, low production.
Medium 3-4 m **(10-12 feet)** width, 50-75 mm **(2-3 inch)** lift.
High Wide width, deep lift paving.

Load Factor Guide
(average engine load factor based on application description for each range)
Low 20%-30%
Medium 30%-40%
High 40%-50%

COLD PLANERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
PM-201	45.5-60.6	**12.0-16.0**	60.6-83.4	**16.0-22.0**	83.4-106.1	**22.0-28.0**
PM-465	37.0-45.0	**10.0-12.0**	45.0-57.0	**12.0-15.0**	60.0-76.0	**16.0-20.0**
PM-565B	37.0-53.0	**10.0-14.0**	53.0-68.0	**14.0-18.0**	72.0-87.0	**19.0-23.0**

Typical Application Description
(relative to work application)
Low 50 mm **(2 inches)** or less cutting depth, 80% load cycle.
Medium 100 mm **(4 inches)** cutting depth.
High Steady, full depth.

Load Factor Guide
(average engine load factor based on application description for each range)
Low 35%-50%
Medium 50%-65%
High 65%-80%

ROAD RECLAIMERS/SOIL STABILIZERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
RM-250C	26.5-34.1	**7.0-9.0**	34.1-41.6	**9.0-11.0**	41.6-53.0	**11.0-14.0**
RM-300	26.5-34.1	**7.0-9.0**	34.1-41.6	**9.0-11.0**	41.6-53.0	**11.0-14.0**
RM-350B	53.1-68.2	**14.0-18.0**	68.2-83.4	**18.0-22.0**	83.4-94.8	**22.0-25.0**
RM-500	45.4-56.7	**12.0-15.0**	60.5-68.1	**16.0-18.0**	75.7-87.1	**20.0-23.0**

Typical Application Description
(relative to work application)
Low 150 mm **(6 inches)** soil/100 mm **(4 inches)** asphalt.
Medium 305 mm **(12 inches)** soil/150 mm **(6 inches)** asphalt.
High 457 mm **(18 inches)** soil/305 mm **(12 inches)** asphalt.

Load Factor Guide
(average engine load factor based on application description for each range)
Low 35%-60%
Medium 60%-80%
High 80%-90%

TRACK LOADERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
933C	9.0-11.0	**2.5-3.0**	11.0-13.0	**3.0-3.5**	13.0-15.0	**3.5-4.0**
939C	11.0-13.0	**3.0-3.5**	13.0-15.0	**3.5-4.0**	15.0-17.0	**4.0-4.5**
953D	12.2-19.1	**3.2 -5.1**	19.1-24.4	**5.1-6.4**	24.4-29.6	**6.4-7.8**
963D	15.7-22.5	**4.2-5.9**	24.7-29.2	**6.5-7.7**	29.2-36.0	**7.7-9.5**
973D	25.9-35.5	**6.8-9.4**	35.5-44.3	**9.4-11.7**	44.3-52.1	**11.7-13.8**

Typical Application Description
(relative to work application)

Low — Site clearing of small vegetation, stripping top soil, carrying to stockpile. Backfilling and grading. Intermittent truck loading from stockpile. Free flowing, low density materials with standard bucket. Large amounts of idling. No impact.

Medium — Bank excavation, bank or stockpile loading. Intermittent ripping, basement digging of natural bed clays, sands, silts, gravels. Load and carry. Steady full throttle operation.

High — Loading shot rock, cobbles, glacial till, caliche. Continuous work on rock surfaces. Continuous excavating and loading from bank. High density materials in standard bucket. Land clearing and steel mill work. Large amount of ripping in tight, rocky materials. High impact conditions.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

Product Link Information — Product Link measured over hundreds of Track-Type Loaders shows that more than 90% of the machines experience an average fuel consumption equal to or lower than those shown in the Low Application profile.

WHEEL LOADERS AND INTEGRATED TOOLCARRIERS

Model	Low		Medium		High	
	liter	U.S. gal	liter	U.S. gal	liter	U.S. gal
904H	4.4-6.3	**1.16-1.66**	6.3-8.2	**1.66-2.17**	8.2-10.1	**2.17-2.67**
906H	3.8	**1.01**	7.6	**2.01**	11.4	**3.02**
907H	3.8	**1.01**	7.6	**2.01**	11.4	**3.02**
908H	4.3	**1.14**	8.6	**2.28**	12.9	**3.42**
914G, IT14G	5.0-6.5	**1.0-2.0**	8.0-10.5	**2.0-2.5**	11.5-13.0	**3.0-3.5**
924H, 924Hz	3.5-5.8	**0.9-1.5**	5.8-8.1	**1.5-2.1**	8.1-15.0	**2.1-3.9**
928H, 928Hz	3.8-6.2	**1.0-1.6**	6.2-8.5	**1.6-2.2**	8.5-15.4	**2.2-4.0**
930H	3.8-6.2	**1.0-1.6**	6.2-8.5	**1.6-2.2**	8.5-15.4	**2.2-4.0**
938H, IT38H*	5.2-7.8	**1.4-2.0**	7.8-10.4	**2.0-2.7**	10.4-15.0	**2.7-4.0**
950H*	7.9-11.4	**2.1-3.0**	11.4-14.7	**3.0-3.9**	14.7-18.5	**3.9-4.9**
962H, IT62H*	9.4-12.0	**2.5-3.2**	12.0-15.1	**3.2-4.0**	15.1-19.2	**4.0-5.1**
966H*	9.1-13.4	**2.4-3.5**	13.4-16.9	**3.5-4.5**	16.9-20.5	**4.5-5.4**
972H*	12.3-17.1	**3.3-4.5**	17.1-21.0	**4.5-5.5**	21.0-25.5	**5.5-6.7**
980H*	15.6-20.6	**4.1-5.4**	20.6-26.0	**5.4-6.9**	26.0-32.9	**6.9-8.7**
988H	28.0-40.1	**7.4-10.6**	40.1-52.6	**10.6-13.9**	52.6-65.1	**13.9-17.2**
990H	42.0-58.3	**11.1-15.4**	58.3-75.0	**15.4-19.8**	75.0-91.6	**19.8-24.2**
992K	53.0-75.7	**14.0-20.0**	75.7-98.4	**20.0-26.0**	98.4-121.0	**26.0-32.0**
993K	61.3-87.4	**16.2-23.1**	87.4-113.6	**23.1-30.0**	113.6-140.0	**30.0-37.0**
994F	87.0-123.0	**23.0-32.5**	123.0-160.0	**32.5-42.2**	160.0-197.0	**42.2-52.0**

*The Medium Wheel Loader (i.e. 938H to 980H) hourly fuel rates are taken directly from customer machines registered on Product Link worldwide. Data from the top and bottom 5% of these customer machines has been excluded from the tables because it varies widely (15-60% from the extremes shown) and therefore is not considered representative of what the remaining 90% of customers experience. Hourly fuel consumption for the 90% of machines in the tables also varies depending upon geographical region, load factor variation between models, etc. Cat machines are often used in more demanding applications which can account for differences between competitive models used in lighter duty applications. Consult your local Cat dealer for ways to more accurately estimate hourly fuel consumption for specific applications.

Compact Wheel Loaders
Typical Application Description
(relative to work application)

Low — Light industrial or construction site duties. Moving light loads with bucket or pallet forks. Not continuous duty, considerable idle time. Machine could be working on average 2 hours or less per day.

Medium — Intermittent aggregate truck loading from stockpile, hopper charging or load and carry on firm, smooth surfaces for short distances with minimal grades. Free flowing, low density materials. Light utility, industrial and construction applications. Light snowplowing.

High — Continuous truck loading from stockpile and hopper charging. Loading from bank or load and carry on normal surfaces with low to medium rolling resistance and slight adverse grades. Low to medium density materials in properly sized bucket. Assumes normal travel distances associated with high productivity stockpile load-out and batch plant applications.

Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

Small, Medium and Large Wheel Loaders and Integrated Toolcarriers
Typical Application Description
(relative to work application)

Low — Intermittent aggregate truck loading from stockpile, hopper charging or load and carry on firm, smooth surfaces for short distances with minimal grades. Free flowing, low density materials. Light utility, industrial and construction applications. Light snowplowing. Most logging applications where there is considerable idling.

Medium — Continuous truck loading from stockpile and hopper charging. Loading from bank or load and carry on normal surfaces with low to medium rolling resistance and slight adverse grades. Low to medium density materials in properly sized bucket. Assumes normal travel distances associated with high productivity stockpile load-out and batch plant applications.

High — Loading shot rock (large loaders) from a face. Steady loading from very tight banks. Continuous work on rough or very soft surfaces with high rolling resistance. Load and carry in hard digging material with longer travel distances on poor surfaces with adverse grades. Handling high density materials with counterweighted machine.

Small and Large Wheel Loaders
Load Factor Guide
(average engine load factor based on application description for each range)

Low 35%-50%
Medium 50%-65%
High 65%-80%

Medium Wheel Loader and Integrated Toolcarrier
Load Factor Guide
(average engine load factor based on application description for each range)
Fuel rates can vary for a specific load factor depending on model and application, therefore some overlap is shown in the load factor table.

Low 15%-30%
Medium 25%-35%
High 30%-45%

9 PLANNED MAINTENANCE (PM) LUBE OILS, FILTERS, GREASE, LABOR

Planned Maintenance (PM) costs should be developed by the Cat dealer, with customer input for the specific application.

PM costs include the parts and labor at the intervals specified in the Operation and Maintenance Manuals provided for each machine. PM costs for each machine may vary slightly depending upon factors required or specified by the customer. See your local Cat dealer to develop the specific PM cost per hour estimate for your machine and application.

10a TIRES

(Line Item 10a)

Tire costs are an important part of the hourly cost of any wheel machine. Tire costs are also one of the most difficult to predict with many variables. The best estimate for tire costs are obtained when tire life estimates are based upon actual customer experience, and are used with prices the machine owner actually pays for the replacement tires.

For cases in which tire experience is not available, use the following tire life estimator curves.

Tire Life Estimators

- Curves do not allow for additional life from recapping. They assume new tires run to destruction, but this is not necessarily recommended.
- Based on standard machine tires. Optional tires will shift these curves either up or down.
- Sudden failure (blow out) due to exceeding Ton-MPH (tkm/h) limitations is not considered. Nor are premature failures due to puncture.
- Application Descriptions/Zones:

  Low/Zone A: almost all tires actually wear through the tread from abrasion.

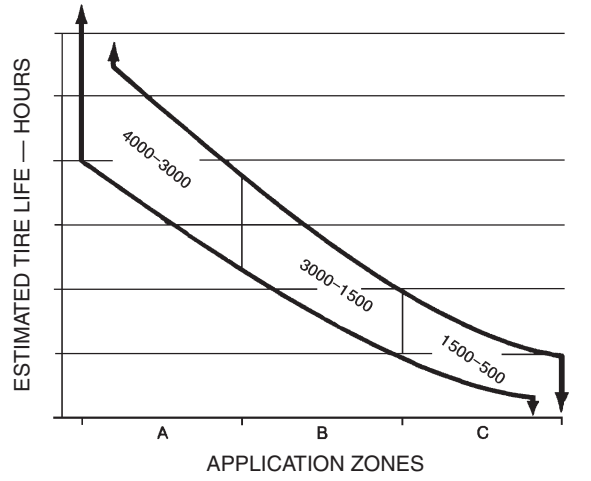
  Medium/Zone B: tires wear out normally but others fail prematurely due to rock cuts, impacts and non-repairable punctures.

  High/Zone C: few, if any, tires wear through the tread due to non-repairable damages, usually from rock cuts, impacts and continuous overloading.

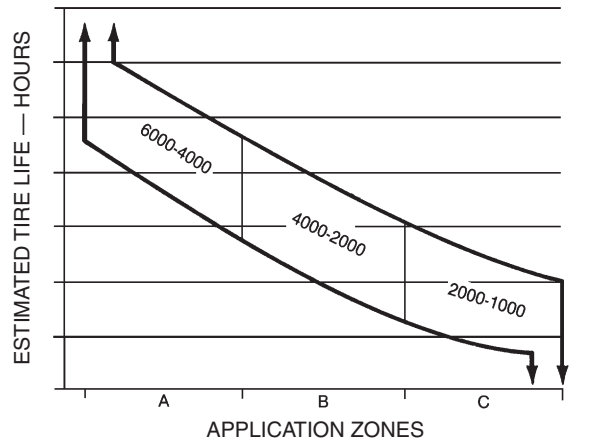
NOTE: Tire life can often be increased by using extra tread and extra deep tread tires.

NOTE: Premature failure could occur at any time due to puncture.

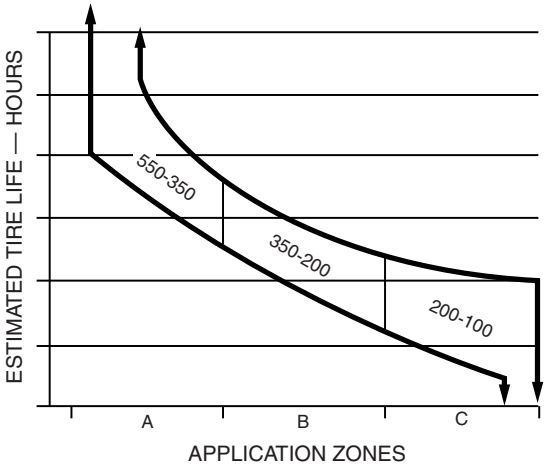
MOTOR GRADERS



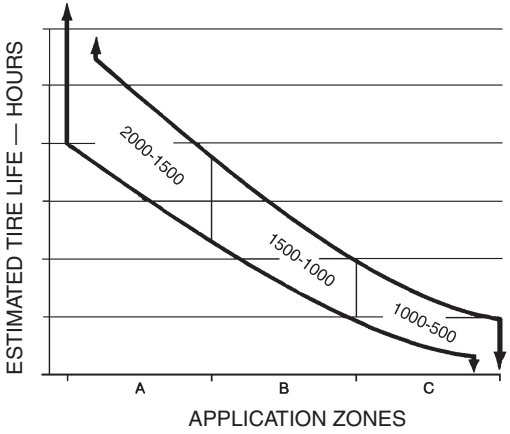
SKIDDERS



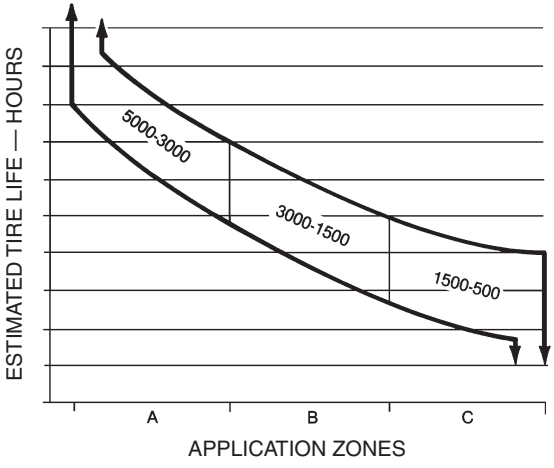
SKID STEER LOADERS



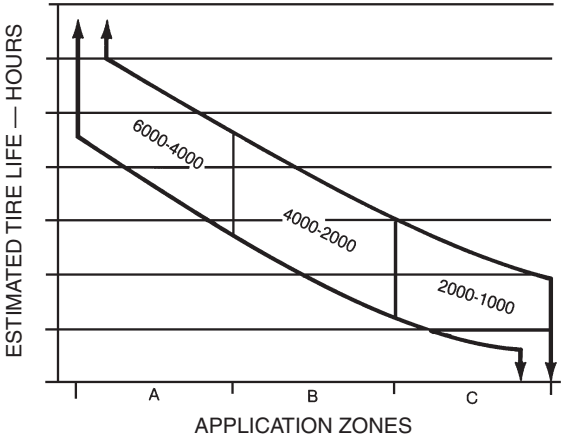
LOAD HAUL DUMP UNITS



WHEEL TRACTOR-SCRAPERS



CONSTRUCTION AND MINING TRUCKS



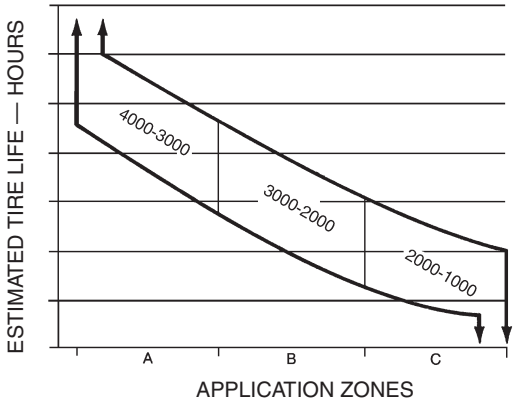
Key:

Zone A — Almost all tires actually wear through the tread due to abrasion.

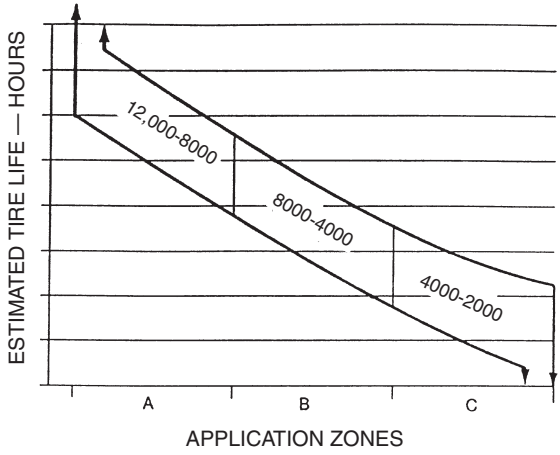
Zone B — Some tires wear out normally while others fail prematurely due to rock cuts, impacts and non-repairable punctures.

Zone C — Few, if any, tires wear through the tread because of non-repairable damages, usually from rock cuts, impacts or continuous overloading.

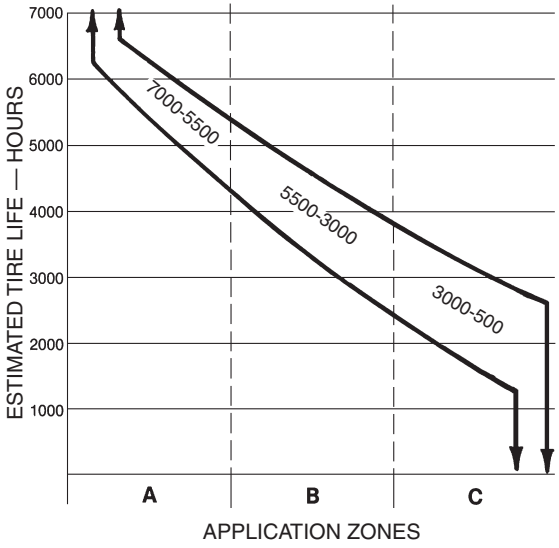
UNDERGROUND TRUCKS



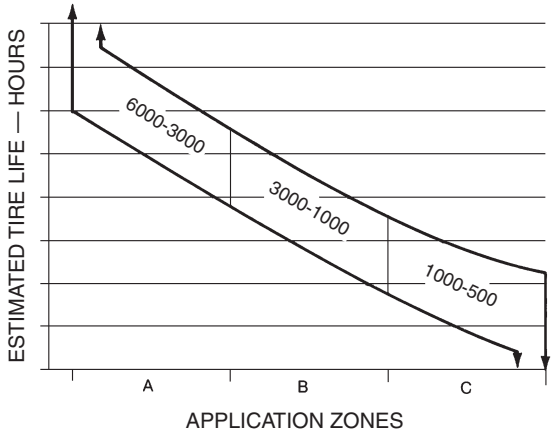
TRACTORS/WAGONS



ARTICULATED TRUCKS



WHEEL TRACTORS
WHEEL LOADERS



Key:

Zone A — Almost all tires actually wear through the tread due to abrasion.

Zone B — Some tires wear out normally, others fail prematurely due to rock cuts, impacts, and non-repairable punctures.

Zone C — Few, if any, tires wear through the tread because of non-repairable damages, usually from rock cuts, impacts, or continuous overloading.

Application Tire Life	Tires Cost Per Hour — Basic Factors		
	Zone A 8000-5000	Zone B 5000-2500	Zone C 2500-500
Model 990 II 992G 994D	$20-$40	$30-$80	$60-$400

GOODYEAR LIFE ESTIMATING SYSTEM

As an additional assist in estimating *hauling unit* tire life, Goodyear Tire and Rubber Co. has furnished the following information which is included here with their permission. READ THE PREAMBLE CAREFULLY.

"… at present, there is no completely accurate, fool-proof method of forecasting tire life. Tire engineers have many theoretical methods … but these generally are so involved and time consuming that they are impractical for field use.

"However, the tire industry has made many surveys of tire performance and arrived at a system which can give rough *estimates* of tire life. Studies done by the major tire companies and by at least two major equipment manufacturers are in close agreement.

"The table [which follows] shows how to apply this system …"

ESTIMATED TIRE SERVICE LIFE OF HAULING UNITS (Trucks and Scrapers)

No.	Condition	Factor
I	**Maintenance**	
	Excellent	1.090
	Average	0.981
	Poor	0.763
II	**Speeds (Maximum)**	
	16 km/h ~ **10 mph**	1.090
	32 km/h ~ **20 mph**	0.872
	48 km/h ~ **30 mph**	0.763
III	**Surface Conditions**	
	Soft Earth — No Rock	1.090
	Soft Earth — Some Rock	0.981
	Well Maintained — Gravel Road	0.981
	Poorly Maintained — Gravel Road	0.763
	Blasted — Sharp Rock	0.654
IV	**Wheel Positions**	
	Trailing	1.090
	Front	0.981
	Driver (Rear Dump)	0.872
	(Bottom Dump)	0.763
	(Self Propelled Scraper)	0.654
V	**Loads** (See No. VIII note)	
	T&RA/ETRTO* Recommended Loading	1.090
	20% Overload	0.872
	40% Overload	0.545
VI	**Curves**	
	None	1.090
	Medium	0.981
	Severe	0.872
VII	**Grades** (Drive Tires Only)	
	Level	1.090
	5% Max.	0.981
	15% Max.	0.763
VIII	**Other Miscellaneous Combinations** (See note below)	
	None	1.090
	Medium	0.981
	Severe	0.872
	Condition VIII is to be used when overloading is present in combination with one or more of the primary conditions of maintenance, speeds, surface conditions and curves. The combination of severe levels in these conditions, together with an overload, will create a new and more serious condition which will contribute to early tire failure to a larger extent than will the individual factors of each condition.	

*Tire and Rim Association/European Tire and Rim Technical Organization.

Type of Tire	Base Average Life Hours	km	Miles
E-3 Std. Bias Tread	2510	40 400	**25,100**
E-4 Bias Xtra Tread	3510	56 500	**35,100**
E-4 Radial Xtra Tread	4200	67 600	**42,000**

Using Base Hours (or Miles), multiply by the appropriate factor for *each* condition to obtain approximate estimated hours (or miles) as the final product.

Example: An off-highway truck equipped with E-4 drive tires running on a well maintained haul road having easy curves and minimum grades and receiving "average" tire maintenance attention but being 20% overloaded:

Condition: I II III IV V VI VII VIII

Factor: $0.981 \times 0.872 \times 0.981 \times 0.872 \times 0.872 \times 0.981 \times 0.981 \times 0.981 \times 3510$ base hours = 2114 hours (say 2100 hours)

As can be seen, this system requires the careful application of strictly subjective judgments, and can be expected to result in conservative estimates. Keep in mind, however, **that the system is offered only as an aid in estimating and not as a rigid set of rules.**

On the other hand, if tire life on a given job is considered less than satisfactory, an analysis of these factors may point to conditions which can be improved to the betterment of tire life.

Replacement tire prices should always be obtained from local tire company sources.

Since tires are considered a wear item in this method of estimating owning and operating costs, total tire replacement cost is deducted from machine delivered price to arrive at a net figure for depreciation purposes. Outlay for tires is then included as an item in operating costs:

$$\text{Hourly Tire Cost} = \frac{\text{Replacement Cost of Tires}}{\text{Estimating Tire Life in Hours}}$$

Recapping can sometimes lower hourly tire cost. Considerations are availability of molds, local recapping costs, and experience with recap life.

10b UNDERCARRIAGE

(Line Item 10b)

Undercarriage expense can be a major portion of the operating costs for track-type machines, and these costs can vary *independently* of basic machine costs. That is, the undercarriage can be employed in an extremely abrasive, high-wear environment while the basic machine may be in an essentially easy application, and vice-versa. For that reason, it is recommended that the hourly cost of undercarriage be calculated separately as a wear item rather than being included in the repair costs for the basic machine.

Three primary conditions affect probable life-expectancy of track-type undercarriage:

1. **Impact.** The most measurable effect of impact is structural — that is bending, chipping, cracking, spalling, roll-over, etc., and problems with hardware and pin and bushing retention.

   Impact ratings:

   High — Non-penetrable hard surfaces with 150 mm (6") or higher bumps.

   Moderate — Partially penetrable surfaces and bumps of 75-150 mm (3-6") height.

   Low — Completely penetrable surfaces (which provide full shoe plate support) with few bumps.

2. **Abrasiveness.** The tendency of the underfoot materials to grind away the wear surfaces of track components.

   Abrasiveness ratings:

   High — Saturated wet soils containing a high proportion of hard, angular or sharp sand or rock particles.

   Moderate — Slightly or intermittently damp soils containing a low proportion of hard, angular or sharp particles.

   Low — Dry soils or rock containing a low proportion of hard, angular or sharp sand or rock chip particles.

   Impact and abrasiveness in combination can accelerate wear rates beyond their individual effects when considered alone, thus further reducing component life. This should be taken into account in determining impact and abrasiveness ratings or, if preferred, the combination can be included in selecting the "Z" factor.

3. **"Z" factor.** Represents the combined effect on component life of the many intangible environmental, operational and maintenance considerations on a given job.

   Environment and Terrain. Earth which may not be abrasive itself can pack in sprocket teeth, causing mis-match and high stress as the teeth engage the bushings. Corrosive chemicals in the materials being moved or in the natural soil can affect wear rates, while moisture and temperature can exaggerate the effect. Temperature alone can play its own role — hot slag and hard-frozen soils being but the extremes. Constant sidehill work can increase wear on the sides of components.

Operation. Some operator practices tend to increase track wear and cost if not controlled on the job. Such practices include high-speed operation, particularly in reverse; tight turns or constant corrections in direction; and stalling the tractor under load forcing the tracks to slip.

Maintenance. Good maintenance — proper track tension, daily cleaning when working in sticky materials, etc. — combined with periodic wear measurement and timely attention to recommended services (CTS) can extend component life and lower costs by minimizing the effects of these and other adverse conditions.

While impact and abrasion should not be too difficult to judge, selection of the proper "Z" factor will require careful analysis of job conditions such as weather, tendency for soil packing, side-hill loading, corrosive environment, etc.; operational factors such as high-speed reverse, amount of travel, tight turns, track slippage under overload, etc.; and maintenance considerations such as proper tensioning, use of Custom Track Service, etc.

Selection of the "Z" multiplier is strictly a matter of judgement and common sense, but its effect on cost can be the difference between profit on a controlled job and heavy loss where control is allowed to slip. To assist in arriving at an appropriate value for the "Z" factor, consider that proper maintenance — or the lack thereof — will represent about 50% of its effect, environment and terrain 30%, and operator practices 20%. For large excavators the amount of travel is the critical part of the "Z" factor. A good operator working under good field conditions can be counterbalanced by poor maintenance practices to yield a fairly high "Z" factor. On the other hand, close attention to maintenance, tension and alignment can more than offset a bad underfoot condition resulting in severe sprocket packing, and lead to selection of a moderate to low "Z" factor. Obviously, flexibility in selection of a "Z" factor has been built into the system, and use of this flexibility is encouraged. Further, a considerable measure of control can be maintained over the "Z" factor, and any reduction of its effects is money in the bank. Your Cat dealer CTS man can be invaluable in this endeavor as well as helping you establish a comprehensive undercarriage cost control program.

Estimating Undercarriage Cost

The guide below gives a basic factor for the various track-type machines and a series of conditions multipliers to modify the basic cost according to the anticipated impact, abrasive and miscellaneous ("Z") conditions under which the unit will be operating.

Step 1. Select machine and its corresponding basic factor.

Step 2. Determine range for impact, abrasiveness and "Z" conditions.

Step 3. *Add* selected conditions multipliers and apply sum to basic factor.

The result will be the estimated hourly cost for undercarriage in that application.

Undercarriage Basic Factors

Model	Basic Factor
5230B	28.2
D11T	26.1
5130B	20.4
D10T	16.2
5110B	13.6
D9T	10.9
D8T	9.6
973D, 587T, 589, D7R Series 2 LGP, D7E LGP	11.2
D7R Series 2, 963D, 583T, D6T LGP, D7R XR Series 2, D7E	9.1
385C, 5090B	7.2
D6T, 953D, 572R, 527	7.0
365C Tier 2	6.8
345D	5.9
D5N LGP, D6K, D6N XL, 517	5.6
336D	5.0
D3K (All), D4K (All), D5K (All), 939C, PL61	4.1
329D	3.9
314D, 315D, 319D, 323D	3.4
320D	2.9
307D, 308D, 311D, 312D	2.4

Conditions Multipliers

	Impact	Abrasiveness	"Z"
High	0.3	0.4	1.0
Moderate	0.2	0.2	0.5
Low	0.1	0.1	0.2

Example: D10T in high impact, non-abrasive material with a moderate "Z" factor.

D10T Basic Factor = 16.2
Multipliers: I = 0.3
A = 0.1
Z = 0.5

U.C. cost = 16.2 (0.3 + 0.1 + 0.5) = **$14.58/hour**

NOTE: 1. Conditions Multipliers may be selected in any combination. Thus, a multiplier of 0.4 (all low-range multipliers) represents the best of the best, while 1.7 (all high range multipliers) would be the worst of the worst conditions.

2. The hourly undercarriage cost estimate resulting from this method will be made up of *approximately* 70% parts cost and 30% labor charges. The cost of undercarriage components is based on published U.S. Consumers List Prices and may be adjusted as needed for import duties, exchange rates, etc. outside the United States. Labor has been figured at $60.00 (U.S.) per shop hour.

3. For further information and guidance, refer to the current issue of the Caterpillar Custom Track Service Handbook.

4. This formula for estimating undercarriage cost should not be used for tractors working in stockpile coal handling applications. Undercarriage costs are nominal in stockpile coal handling, and using this formula will result in estimating cost substantially above actual costs.

(11) REPAIR COSTS

(Line Item 11)

Repair cost per hour should be developed by the Cat dealer, with customer input for the specific machine application and requirements.

As with PM cost per hour, repair costs are significantly affected by the specific application and situation. Several important variables must be provided by the customer and the local Cat dealer. This will enable a calculated cost per hour that is specific to the machine conditions and customer needs.

Machine applications, operating conditions, ownership periods, component life, and maintenance attention determine repair costs. In any specific application, actual cost experience on similar machines and applications provides the best basis for establishing the hourly repair cost.

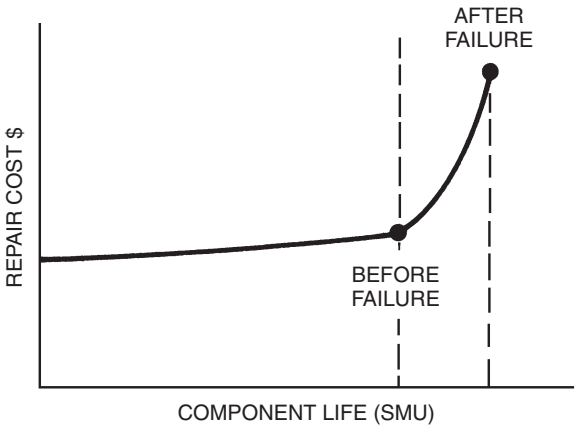
Repairs and component lives are normally the largest single item in operating costs and include all parts and direct labor (except operator's wages) chargeable to the machine. Shop overhead can be absorbed in general overhead or charged to machines as a percent of direct labor cost, whichever is the owner's normal practice.

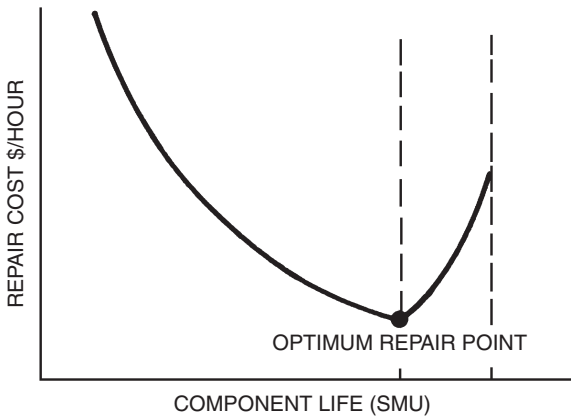
Hourly repair costs for a single machine normally follow an upward stairstep pattern since major outlays for repairs usually come in spurts. However, when broad averages are considered, the stairstep becomes a smooth, upward curve. Since this hourly repair cost curve starts low and gradually rises over time, hourly operating costs must be adjusted upward as the unit ages. Alternatively an average repair cost can be used which provides a straight line graph. Most owners prefer the average method, and it is the one suggested here.

Since repair costs are low initially and rise gradually, averaging them produces extra funds at first which are reserved to cover future higher costs.

Your Cat dealer has the ability to make more accurate repair cost estimates and we suggest you use their experience and expertise if you need help in estimating operating costs.

As stated, repair costs are affected by application, operating conditions, ownership period, maintenance, and age of the equipment. The most significant effects on cost will be those factors affecting major component life. A second significant factor is whether the repair is performed before or after catastrophic failure. Repair before a major component fails can be one-third of an after failure repair with only a moderate sacrifice in life (see graphs). Oil analysis and other diagnostic tools, maintenance inspections and indicators, and operator notes are vital to determine the optimum repair point and thereby achieving lower hourly repair costs. Maintenance practices are significant because they affect component longevity and the percentage of scheduled, before failure repairs.





12 SPECIAL WEAR ITEMS

(Line Item 12 and Subsection 12A)

All costs for high-wear items such as cutting edges, ripper tips, bucket teeth, body liners, router bits, etc., and welding costs on booms and sticks should be included here. These costs will vary widely depending on applications, materials and operating techniques. Consult your Cat dealer Parts Department for estimated life under your job conditions.

15 OPERATOR'S HOURLY WAGE

(Line Item 15)

This item should be based on local wage scales and should include the hourly cost of fringe benefits.

EXAMPLES OF FIGURING OWNING AND OPERATING COSTS

(The following two examples are for illustrative purposes only. The intent is to show how the worksheets could be filled out. The PM and Repair costs should be developed by your local Cat dealer.)

Example I: ESTIMATING HOURLY OWNING AND OPERATING COSTS OF A TRACK-TYPE TRACTOR

Assume a power shift track-type tractor with straight bulldozer, hydraulic control, tilt cylinder and three-shank ripper, is purchased by a contractor for $135,000, delivered price at job site.

Application will be production dozing of bank gravel. Minimal ripping will be required to loosen material.

In the following calculations, refer as necessary to the source material already reviewed.

OWNING COSTS —

To Determine Residual Value at Replacement

Enter delivered price, $135,000, in space (A). (See example form at end of this discussion.) Since the machine being considered is a track-type tractor, no tires are involved. This particular owner's experience is that at trade-in time, the tractor will be worth approximately 35% of its original value. This $47,250 trade-in value is entered in space (B) leaving a net of $87,750 to be recovered through work.

Enter the net value to be recovered through work in space (C).

Indicated ownership period is 7 years with annual usage of 1200 hours per year or 8400 hours of total ownership usage.

Divide the Net Value from space (C), $87,750, by Ownership Usage, 8400 hours, and enter result $10.45 in space (D).

Interest, Insurance, Taxes

In this example, local rates are assumed as follows:

Interest	16%
Insurance	1%
Taxes	1%
	18%

Using the following formula:

N = 7:

$$\frac{\left[\dfrac{135{,}000\ (7+1) + 47{,}250\ (7-1)}{2 \times 7}\right] \times 0.16}{1200} = 12.99$$

Enter $12.99 in space (E).

Insurance and property taxes can also be calculated using the same formula as shown for the interest cost, and entering them on lines 5 and 6.

Items 3b, 4, 5 and 6 can now be added and the result, $25.06 entered in space (H) Total Hourly Owning Costs.

OPERATING COSTS —

Fuel

See fuel consumption tables. The intended application, production dozing, indicates a medium load factor. Assume that the estimated fuel consumption from the table is 17 liter/hr (4.5 U.S. gal/hr.). Cost of fuel in this locality is $0.34/liter ($1.25/U.S. gal.).

Consumption		Unit Cost		Total
17 liter/hr	×	$0.34 liter	=	$5.78
4.5 gal/hr	×	$1.25 gal.	=	$5.63

Enter this figure in space (I).

Planned Maintenance (PM) Cost per Hour

Use PM cost per hour estimate developed by your local Cat dealer. (For this example assume cost per hour is $2.30) Enter this figure in space (J) on line 9.

Tires

Since this example considers a track-type tractor, space (K) is left blank.

Undercarriage

Our estimating reference gives an undercarriage cost Basic Factor of 6.6 for this tractor. It is anticipated that with some ripping on the job, impact loading of track components will be medium, indicating an "I" multiplier of 0.2. The gravel-sand mix in the bank, being dry, should be only moderately abrasive for an "A" multiplier of 0.2. In analyzing the miscellaneous conditions: there is enough clay in the bank to produce some packing of the sprockets; the operator is careful, but is forced into some tight turns because of space limitations; there is good drainage in the pit; track tension is checked weekly; and all track-type equipment on the job is enrolled in the Custom Track Service program. Accordingly, the "Z" multiplier is judged to be somewhat greater than low level — 0.3 in this case.

It should be noted that in applying particularly the "Z" factor, rather wide flexibility is provided and was used in the above example. Such flexibility is intended and its use encouraged.

Then:

Cost per hour = Basic Factor × (I + A + Z)
Basic Factor = 6.6
Conditions Multipliers: I = 0.2
A = 0.2
Z = 0.3
Cost per hour 6.6 (0.2 + 0.2 + 0.3) = $4.62 which is entered in space (L).

Repair Cost per Hour

Use the Repair cost per hour estimate developed by your local Cat dealer. (For this example assume cost per hour is $6.12) Enter this figure in space (M) on line 11.

Special Items

Assuming the tractor is equipped with a three-shank ripper and an "S" dozer, allowance must be made for ripper tips, shank protectors, and dozer cutting edges.

Assume your knowledge of the operation indicates the ripper will be used only about 20% of total tractor operating time. Estimated tip life while in use is 30 hours. Therefore, tips will be replaced:

$$\frac{30 \text{ Hours}}{0.20} = \text{each 150 hours of tractor operation}$$

Shank protector life is estimated at three times tip life or 450 hours of tractor operation.

Cutting edge life is estimated to be 500 hours.

Using local prices for these items, hourly costs are estimated as follows:

$$\text{Tips: } \frac{3 \text{ @ } \$35.00 \text{ ea.}}{150 \text{ hr.}} = \$0.70 \text{ per hour}$$

$$\text{Shank Protectors: } \frac{3 \text{ @ } \$55.00 \text{ ea.}}{450 \text{ hr.}} = \$0.37 \text{ per hour}$$

$$\text{Cutting Edges: } \frac{\$125 \text{ per set}}{500 \text{ hr.}} = \$0.25 \text{ per hour}$$

The total of these, $1.32; is entered in space (N).

Items 8, 9, 10b, 11 and 12 can now be added and the result, $19.99, is entered in space (O), Total Hourly Operating Costs.

Operator's Hourly Wage

Assume this is $25.00 including fringe benefits. This figure is entered in space (P).

Total Owning Costs, Total Operating Costs and Operator's Hourly Wage are now added together and the result, $67.01, is entered in space (Q). The itemized estimate of Hourly Owning and Operating Costs is now complete.

Example II: ESTIMATING HOURLY OWNING AND OPERATING COSTS OF A WHEELED VEHICLE

With only a few simple changes, owning and operating costs for a wheeled vehicle are calculated using the same format as that used for the Track-Type Tractor. Only the differences will be explained as we look at example calculations for a wheel loader.

OWNING COSTS —

To Determine Residual Value at Replacement

Enter delivered price in space (A). The cost of tires is deducted since they will be treated as a wear item. For purposes of illustration, the Wheel Loader is estimated to have a potential 48% trade-in value (B) at the end of the 5 year/7500 hour ownership usage, leaving a net value to be recovered through work of $34,320 (C).

Interest, Insurance, Taxes

Refer to the formulas using the same rates as before and 1500 operating hours per year. The result $4.22 is applied to the interest cost (E).

Insurance and property taxes can also be calculated using the same formula as shown for the interest cost.

The sum of lines 3b, 4, 5 and 6 gives the total hourly owning cost, line 7.

OPERATING COSTS —

Fuel

See the fuel consumption tables and apply the actual cost of purchasing fuel in the project area (I).

Planned Maintenance (PM) Cost per Hour

Use PM cost per hour estimate developed by your local Cat dealer. (For this example assume cost per hour is $2.10.) Enter this figure in space (J) on line 9.

Tires

Use the tire replacement cost and the best estimate of tire life based on experience and anticipated job conditions.

Repair Cost per Hour

Use the Repair cost per hour estimate developed by your local Cat dealer. (For this example assume cost per hour is $3.39.) Enter this figure in space (M) on line 11.

Special Items

Ground engaging tools, welding, etc. are covered here. Use current costs for cutting edges and similar items. Use your best estimate of the hours of life which can be expected from them based on previous experience in like materials. Enter the total on line 12.

The total of lines 8 through 13 represents hourly operating costs.

Operator's Hourly Wage

To give a true picture of operator cost, include fringe benefits as well as direct hourly wages (line 15).

TOTAL O&O

The total of lines 7, 13 and 15 is the total hourly owning and operating cost of the machine. Keep in mind that this is an estimate and can change radically from project to project. For the greatest accuracy, the hourly cost reflected in actual on-the-job cost records should be used.

HOURLY OWNING AND OPERATING COST ESTIMATE

DATE _____

	Estimate #1	Estimate #2
A–Machine Designation	Track-type Tractor	Wheel Loader
B–Estimated Ownership Period (Years)	7	5
C–Estimated Usage (Hours/Year)	1200	1500
D–Ownership Usage (Total Hours)(B × C)	8400	7500
OWNING COSTS	(1)	(2)
1. a. Delivered Price (P), to the Customer (including attachments)	135,000 (A)	70,000
b. Less Tire Replacement Cost if desired	N/A	4000
c. Delivered Price Less Tires	135,000	66,000
2. Less Residual Value at Replacement (S) (See subsection 2A on back)	(35 %) 47,250 (B)	(48 %) 31,680
3. a. Net Value to be recovered through work (line 1c less line 2)	87,750 (C)	34,320
b. Cost Per Hour: Net Value / Total Hours (1) 87,750 / 8400 (2) 34,320 / 7500	10.45 (D)	4.58
4. Interest Costs N = No. Yrs. $\frac{\frac{P(N+1)+S(N-1)}{2N} \times \text{Simple Int. \% Rate}}{\text{Hours/Year}}$ =		
(1) $\frac{[135{,}000\ (7+1)] + \frac{[47{,}250\ (7-1)]}{2\times 7} \times 0.16}{1200\ \text{Hours/Yr.}}$ = (2) $\frac{[66{,}000\ (5+1)] + \frac{[31{,}680\ (5-1)]}{2\times 5} \times 0.16}{1500\ \text{Hours/Yr.}}$ =	12.99 (E)	5.58
5. Insurance N = No. Yrs. $\frac{\frac{P(N+1)+S(N-1)}{2N} \times \text{Insurance \% Rate}}{\text{Hours/Year}}$ =		
(1) $\frac{[135{,}000\ (7+1)] + \frac{[47{,}250\ (7-1)]}{2\times 7} \times 0.01}{1200\ \text{Hours/Yr.}}$ = (2) $\frac{[66{,}000\ (5+1)] + \frac{[31{,}680\ (5-1)]}{2\times 5} \times 0.01}{1500\ \text{Hours/Yr.}}$ =	0.81 (F)	0.35

(Optional method when Insurance cost per year is known)

Ins. $ _____ Per Yr. ÷ _____ Hours/Yr. =

Estimating form continues next page

	Estimate #1	Estimate #2
6. Property Tax $\frac{P(N+1)+S(N-1)}{2N} \times$ Tax Rate % / Hours/Year =		
(1) $\frac{[135{,}000\ (7+1)] + \frac{[47{,}250\ (7-1)]}{2 \times 7} \times 0.01}{1200}$ Hours/Yr. =	0.81 (G)	0.35
(2) $\frac{[66{,}000\ (5+1)] + \frac{[31{,}680\ (5-1)]}{2 \times 5} \times 0.01}{1500}$ Hours/Yr. =		
(Optional method when Property Tax cost per year is known) Property Tax $ _____ Per Yr. ÷ _____ Hours/Yr. =		
7. TOTAL HOURLY OWNING COST (add lines 3b, 4, 5 and 6)	25.06 (H)	10.86
OPERATING COSTS		
8. Fuel: Unit Price × Consumption		
(1) 1.25 × 4.50 =	5.63 (I)	2.50
(2) 1.25 × _____ =		
9. Planned Maintenance (PM)-Lube Oils, Filters, Grease, Labor: (contact your local Cat dealer)	2.30 (J)	2.10
10. a. Tires: Replacement Cost ÷ Life in Hours		
Cost / Life (1) N/A (2) 4000 / 3500	(K)	1.14
b. Undercarriage (Impact + Abrasiveness + Z Factor) × Basic Factor		
(1) (0.2 + 0.2 + 0.3) = 0.7 × 6.6 =	4.62 (L)	
(2) (_____ + _____ + _____) = _____ (Total) × _____ (Factor) =		
11. Repair Cost (Per Hour) (contact your local Cat dealer)	6.12 (M)	3.39
12. Special Wear Items: Cost ÷ Life . . . . . (See subsection 12A on back)	1.32 (N)	0.60
13. TOTAL OPERATING COSTS (add lines 8, 9, 10a (or 10b), 11 and 12)	19.99 (O)	9.73
14. MACHINE OWNING PLUS OPERATING (add lines 7 and 13)	45.05	20.59
15. OPERATOR'S HOURLY WAGE (include fringes)	25.00 (P)	25.00
16. TOTAL OWNING AND OPERATING COST	70.05(Q)	45.59

SUBSECTION 2A: Residual Value at Replacement

Gross Selling Price	(est. #1) (___%)		(est. #2) (___%)	
Less: a. Commission				
b. Make-ready costs				
c. Inflation during ownership period*				
Net Residual Value (Enter on line 2)		47,250 (35 %)		31,680 (48 %) of original delivered price

*When used equipment auction prices are used to estimate residual value, the effect of inflation during the ownership period should be removed to show in constant value what part of the asset must be recovered through work.

SUBSECTION 12A: Special Items
(cutting edges, ground engaging tools, bucket teeth, etc.)

(1)	Cost		Life		Cost/Hour	(2)				
1.	105	÷	150	=	0.70	1.	120	÷	200	= 0.60
2.	165	÷	450	=	0.37	2.		÷		=
3.	125	÷	500	=	0.25	3.		÷		=
4.		÷		=		4.		÷		=
5.		÷		=		5.		÷		=
6.		÷		=		6.		÷		=
			Total	(1)	1.32	(2)	0.60			

(Enter total on line 12)

Notes —