

# MINE AND MILL EQUIPMENT COSTS

*AN ESTIMATOR'S GUIDE*

2006

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## INTRODUCTION

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The Mine and Mill Equipment Cost Guide provides estimators with an exhaustive list of the capital and hourly costs associated with owning and operating equipment typically used in mining and mineral processing operations. Unit commodity prices and capital costs found in the Guide are determined by annual surveys of equipment manufacturers and distributors; fuel, energy, tire, and lubricant suppliers; and U.S. mining companies. Most of the capital costs in the manual are list or budgeting prices for specific standard-equipped models. The models are identified by specifications only, without mention of manufacturers' names. This approach prevents utilization of the manual for promotional purposes and also prevents conflicts between buyers and sellers of items listed in the manual. Our purpose in publishing these values is to provide information for estimating purposes only, not to establish market values for the items.

Hourly costs are determined by established computational procedures suitable for preliminary engineering estimates. These procedures are described in more detail below. Additional specification and productivity information for some of the equipment is provided in the appendices following each section.

Equipment operating costs can vary considerable from mine to mine, and should be adjusted for local conditions. The paragraphs that follow provide some guidance for doing this. If the operating costs are to be used for contract bid estimates, company overhead and profit must be added to the hourly costs listed in the Guide.

InfoMine maintains a continuing data collection program to increase the statistical basis for the factors used to estimate the operating costs. Users are encouraged to submit relevant data from their own operating experience or to submit comments about any part of the manual to InfoMine. A self-mailer form is provided with each copy of the Guide for this purpose. We also welcome calls (509-328-8023), faxes (509-328-2028) or email messages (western.mine@westernmine.com).

## COST ESTIMATING METHODOLOGY - *How to Use This Book*

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This manual is designed for mine cost estimators. It provides the equipment capital and operating cost information necessary for a discounted cash flow approach to making investment decisions. Equipment purchase prices are listed separately so that they can be treated appropriately with respect to the timing of the purchase. Depreciation, and replacement (*Capital Recovery*) costs are presented on an hourly basis, as are the ownership expenses associated with insurance, storage, and record keeping.

Equipment purchase prices, if used, should be totaled separately in the year accrued. Evaluators using this approach should take care not to double account for the equipment capital costs by including the *Capital Recovery* value. This value should only be used in analyses where capital expenditures are not listed separately, or where the operation establishes a sinking fund used to replace spent equipment.

Generally, the *Total* operating cost value (the far right column) is applied directly to the estimated equipment use (hours). Individual cost categories are listed so that the total may be adjusted for conditions specific to the operation. The use requirements to which the hourly *operating costs* are applied must be determined by the evaluator. Use requirements should represent the actual time that the machine operates, not the hourly schedule of the proposed mine or mill. For instance, during an 8-hour shift, an excavator may work for only 6½ hours,

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with the remaining time allotted to operator breaks or scheduled maintenance. The hourly use per shift of some equipment (such as drills and service vehicles) is more difficult to estimate since many other tasks are interspersed with machine operation. However, stationary equipment operates on a more predictable schedule. Ventilation fans often operate 24 hours per day, 7 days a week, as do many of the machines used in mineral processing.

In some cases, hourly ownership costs (which are *not* included in the *Total* column) can be included in the analysis if they are not considered elsewhere in the estimate. If, however, equipment purchase costs are included separately, i.e. as capital cost items in a cash flow analysis, then the *Capital Recover* amount should be included only to account for equipment replacement anticipated at some time in the future and only if purchase costs for these replacements are not included separately. Similarly, hourly overhead costs should not be included if insurance, licensing and record keeping costs are included in a separate estimate of administrative costs.

## DATA ITEM DESCRIPTIONS

### Column Headings

Repair Labor	\$23.81 per hour	Natural Gas	\$3.808 per MCF	
DieselFuel	\$0.535 per gallon	Electric Power	\$0.049 per KWH	<b>1</b>
Gasoline	\$0.556 per gallon	Lube Oil	\$3.050 per gallon	

SPECIFICATION					Capital Cost
Description	Weight (lbs.)	Motor Type/Incl.	HP		
<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	

CAPITAL RECOVERY	HOURLY OPERATING COSTS									
	OVERHEAD	OVERHAUL		MAINTENANCE		FUEL/			WEAR	TOTAL
		PARTS	LABOR	PARTS	LABOR	POWER	LUBE	TIRES	PARTS	
<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>

## 1 Unit Prices

Some of the hourly operating costs are based on these unit prices. Tire prices are listed separately in the appendices for the Surface Mine Equipment and Underground Mine Equipment sections. The repair labor rate is the average wage for mechanics working at U.S. coal, metal, and industrial mineral mines, as determined by the latest *Mining Cost Service* survey. Appropriate burden factors are included in the wage rates. The gasoline and diesel fuel prices are the average prices for sales to end-users in U.S. Petroleum Administration for Defense District No. IV, which includes the states of Colorado, Idaho, Montana, Utah, and Wyoming. Motor fuel taxes, which normally apply for on-road use only, are not included in these prices. The natural gas rate is a typical rate for the Denver area, and the electric power rate is an average for the Rocky Mountain region. The electric

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power and natural gas rates include appropriate demand and service charges as well as energy charges. The lube oil price represents a typical charge for bulk crankcase oil for off-road diesel equipment. (See "Adjustment of Operating Costs" to learn how to adjust costs for other unit prices).

### **2 Description**

Most of the item descriptions describe actual equipment models. Sufficient capacity and specification information is provided to help guide the estimator in selecting the appropriate unit for his or her proposed equipment fleet. Further specification and productivity information for many of the items is listed in the appendix following each section.

### **3 Weight**

The weights listed here are provided by the manufacturers of the described items. They may represent either a working weight or a shipping weight, but are intended for use in estimating the cost of shipping the item to the project site.

### **4 Motor**

An entry in the "Motor Type" column indicates that a motor or engine is required by this unit. The type of motor or engine is indicated by: *d* = diesel, *e* = electric, or *g* = gasoline. A "y" in the "Motor Included" column indicates that the cost of purchasing and operating the motor is included in the capital and operating cost amount. An "n" in the "Motor Included" column indicates that a motor is required, but has not been included in the capital or operating costs. In this case an appropriate motor should be selected from the Miscellaneous Section of the manual and both its capital and operating costs added to the estimate.

### **5 HP (Horsepower)**

This entry indicates the size of the motors or engines included with the unit or required by the unit. The listed horsepower value is used in the equations for computing hourly fuel, or electric power costs.

### **6 Capital Cost**

The values listed here are list or budget prices for the described equipment item. They are listed for estimating purposes only and should not be considered representative of actual market value. Large disparities can exist between prices listed here and those actually charged to a specific buyer. Disparities can result from differences in specifications, from options added, from the results of price negotiations, and from changing market conditions.

Selling prices are commonly discounted to some degree from list prices. The discount offered by a manufacturer will depend on such factors as the number of units ordered and how well the model is selling at the moment. A model that is selling poorly will be discounted more than one that is selling well. When market conditions are generally depressed or when large inventories of competing used equipment are available, discounts tend to be higher. In specific instances, a manufacturer may offer a high discount to make the first sale in a particular area, in a particular segment of the industry, or at a particular mine.

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Discounts for large mobile equipment, such as trucks, shovels, and loaders, typically range from 5% to 40%. Discounts for smaller equipment such as motors and pumps may be higher, often as much as 50% to 55%.

Prices throughout the manual are for U.S. sales in U.S. dollars. Unless otherwise stated, sales taxes, transportation from the distribution center to the minesite, and installation charges are not included, nor are the costs of optional accessory items not considered to be standard equipment. Information helpful in estimating sales taxes and transportation costs can be found in *Mining Cost Service* published by InfoMine USA, Inc. Installation or set-up costs vary dramatically. Small mobile units are essentially service-ready upon delivery. Larger mobile units may require some set-up costs. The costs of the labor and materials required for installing stationary equipment generally average between 38% and 145%, but can be as high as 300%, of the purchase price, depending primarily on the degree of foundation, electrical, and piping work required in relation to the purchase price of the machine.

Our own philosophy in using these prices is to assume the actual cost will be less than the price listed because of discounting, but the discount will be at least partially offset by the cost of added options. The prices listed in the manual therefore tend to be on the high side, but are sufficiently accurate for a conservative preliminary estimate.

### **7 Capital Recovery**

Capital recovery costs are included to provide an indication of the funds necessary to purchase or replace the machine. They are determined by the following relationship:

$$\text{Capital Recovery Cost} = \text{Capital Cost} \div R$$

*Where:* R = estimated replacement life

The anticipated replacement life is, of course, highly variable and is dependent upon operating conditions and company maintenance and replacement policies. Equipment lives used to determine the *Capital Recovery* values are listed below. No, overhauls are included in these estimated lives, and no adjustment has been made for any residual value at the end of the useful life.

Compressors	-	12,000 hours
Conveyors	-	10, 000 hours
Crushers	-	26,000 to 52,000 hours
Draglines	-	45,000 to 65,000 hours
Drills	-	12,000 to 18,000 hours
Excavators	-	10,000 to 14,000 hours
Flotation cells/Thickeners	-	26,000 to 52,000 hours
Grinding mills	-	52,000 to 104,000 hours
Mechanical shovels	-	25,000 hours
Pumps	-	12,000 hours
Trucks	-	37,500 hours

The capital recovery costs do not include interest, inflation, or escalation.

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### 8 Overhead

The overhead charges listed here are indirect administrative costs associated with machine ownership. They include insurance, license, and maintenance and record keeping charges. They are determined by the following relationship:

$$\text{Overhead} = C_R \times F$$

Where:  $C_R$  = capital recovery cost (dollars per hour)  
F = experience-based factor

Property and sales taxes, profit, and company and project overhead charges are not included. Taxes are specific to project location and can be estimated with the aid of information contained in *Mining Cost Service*. Charges associated with profit and corporate overhead should be added if appropriate.

### OPERATING COSTS

Hourly operating costs are considered variable and are directly related to daily use. They should be applied to daily use requirements, regardless of ownership period. The operating costs assume the equipment is working a full operating hour under average operating conditions. Suggestions for adjusting these values for other conditions or for other price situations are given in the "Adjustment of Operating Cost" paragraphs below. The cost of operator's time is not included. It must be added separately.

### 9 Overhaul Parts

Overhaul parts costs for mobile equipment are those associated with scheduled reconstruction and/or replacement of major components such as engines and transmissions. For stationary processing equipment, the costs are for scheduled refurbishing or replacement of major wear components such as drives, support frames, and vessels. The value is based upon the following relationship:

$$\text{Hourly Overhaul Parts Cost} = (\text{Capital Cost} \times F) \div H$$

Where: F = experience-based factor  
H = typical annual operating hours

### 10 Overhaul Labor

Overhaul labor costs for mobile equipment are those associated with scheduled reconstruction and/or replacement of major components such as engines and transmissions. For stationary processing equipment, the costs are for scheduled refurbishing or replacement of major wear components such as drives, support frames, and vessels. The value is based upon the following relationship:

$$\text{Hourly Overhaul Labor Cost} = \text{Overhaul Parts Cost} \times F \times L$$

Where: F = experience-based factor  
L = overhaul labor hourly wage plus benefits (dollars per hour)

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### 11 Maintenance Parts

This item represents those costs associated with both unscheduled repairs and scheduled servicing of both minor and major components, excluding overhaul activities. These include all aspects of machine maintenance exclusive of fueling, lubrication, tire replacement, and maintenance and replacement of those parts used directly to impart energy (*see wear parts*). The value is based upon the following relationship:

$$\text{Hourly Maintenance Parts Cost} = (\text{Capital Cost} \times F) \div H$$

Where: F = experience-based factor  
H = typical annual operating hours

### 12 Maintenance Labor

This item represents a typical charge per hour of operation to cover mechanics' time to perform maintenance and repair functions, exclusive of overhaul work. The value is estimated by the following relationship:

$$\text{Hourly Maintenance Labor Cost} = \text{Maintenance Parts Cost} \times F \times L$$

Where: F = experience-based factor  
L = repair labor hourly wage plus benefits (dollars per hour)

### 13 Fuel/Power

This item lists the cost of diesel fuel, gasoline, electric power, or natural gas as appropriate for the equipment specified. Care should be taken to note whether an “n” or a “y” is listed in the “Motor Included” column. If an “n” is listed, a motor is required, but the costs to operate it are not included here. In this case an appropriate motor should be selected from the Miscellaneous Section of the manual and both its capital and operating costs added to the estimate. Costs for each fuel type are determined by the following relationships:

#### Diesel Fuel

The hourly cost of diesel fuel required to operate the equipment under average conditions is estimated by the following relationship:

$$\text{Hourly Diesel Fuel Cost} = \text{Engine Horsepower} \times F \times D$$

Where: F = experience-based factor  
D = diesel fuel price (dollars per gallon)

#### Gasoline

The hourly cost of gasoline required to operate the equipment under average conditions is estimated by the following relationship:

$$\text{Hourly Gasoline Cost} = \text{Engine Horsepower} \times F \times G$$

Where: F = experience-based factor  
G = gasoline price (dollars per gallon)

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## **Electric Power**

The hourly cost of electric power required to operate the equipment under average conditions is estimated by the following relationship:

$$\text{Hourly Electric Power Cost} = \text{Motor Horsepower} \times F \times 0.746 \text{ kW per horsepower} \times E$$

*Where:* F = average electric power draw (%)  
E = electric power price (dollars per kWh)

The electric power price (E) includes demand and service charges as well as energy charges.

## **Natural Gas**

The cost of natural gas required to operate the equipment is determined by the following relationship:

$$\text{Hourly Natural Gas Cost} = (E \div 1,040,000 \text{ btu's/MCF}) \times N$$

*Where:* E = Energy requirement (btu's per hour)  
N = natural gas price (dollars per MCF)

## **14 Lube**

The hourly cost of crankcase oil and other lubricants required to operate the equipment is estimated by the following relationship:

$$\text{Hourly Lube Cost} = (\text{Capital Cost} \div F_l) + (((\text{Engine HP} \div F_c) \times L) \div I)$$

*Where:* F<sub>l</sub> = experience-based equipment lubrication factor  
F<sub>c</sub> = experience-based crankcase oil factor  
L = lube price (dollars per gallon)  
I = lube change interval (hours)

## **15 Tires**

Tire costs assume that each tire will be retreaded two times before being replaced with a new tire. The cost of a retread is assumed to be 75% the cost of a new tire, and the life expectancy about nine percent less. The hourly cost of tires is calculated by the following relationship:

$$\text{Hourly Tire Cost} = ((N \text{ tires} \times T) + (2 \text{ retreads} \times (0.75 \times T \times N \text{ tires}))) \div (L \text{ hours} + ((2 \text{ retreads} \times L \text{ hours}) \div 1.1))$$

*Where:* N = number of tires required by the vehicle  
T = tire price (see appendices for surface mining and underground mining sections for tire prices)  
L = expected tire life

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### 16 Wear Parts

Values listed here typically refer to the costs of parts which directly engage the rock and impart some form of energy designed to change the condition of that rock. These include items such as drill bits, dozer blades, excavator teeth, crusher and impactor liners, and grinding media. Hourly wear rates are highly variable (depending on the nature of the rock) and can be adjusted accordingly. Wear rates assumed here are considered average for hard-rock mining and mineral processing operations. The relationships used to provide the Wear Parts values are specific to the machine and take the form:

$$\text{Wear Part Cost} = P_c \times H_c$$

Where:  $P_c$  = cost of the parts (drill bits, grinding balls, bucket teeth)  
 $H_c$  = parts consumed per hour

### 17 Total

The total operating cost comprises the sum of the eight items listed. It does not include depreciation, overhead, insurance, or cost of facilities capital. Nor does it include the cost of operators.

## ADJUSTMENT OF OPERATING COSTS

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The hourly operating costs can be adjusted for variations in working conditions, unit prices, or wages. For some of the equipment types, sophisticated methods are available for estimating the cost of operating under various conditions. These methods are described in a variety of technical references. For preliminary estimating purposes, the hourly operating costs may be adjusted by multiplying them by an appropriate factor. Operating costs can be expected to vary from between 30% below the listed cost for extremely favorable conditions to 35% above for adverse conditions.

With the exception of parts, adjustment of the costs for variations in unit commodity prices is simply a matter of multiplying the cost by a factor determined by dividing the desired unit price by the unit price listed at the top of the operating cost page:

$$\text{Cost B} = \text{Cost A} \times \text{Unit Price B/Unit Price A}$$

Where: Cost B = adjusted cost  
Cost A = cost listed in the estimator's guide  
Unit Price B = desired unit commodity price  
Unit Price A = unit commodity price from the top of the operating cost page

Part costs are not derived from a unit commodity price, but rather from the equipment capital cost. To adjust for an atypical cost situation, simply increase or decrease the hourly repair part cost by the percentage that you expect your repair part prices to be higher or lower than average.

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