

Determination of Construction Equipment Rental Rates in Force Account Operations for Federal and State Government Agencies

JENNIFER JORGE AND ZOHAR HERBSMAN

Construction equipment rental rates vary widely according to factors such as type and age of the equipment, capacity, estimated operating costs, availability, and the geographic and climatic conditions at the job site. In 1986, the Florida Department of Transportation retained the services of the Engineering and Industrial Experiment Station at the University of Florida for the purpose of developing a model method for the determination of construction equipment rental rates for the state of Florida. Research of the cost factors involved in the determination of equipment rental rates was conducted in the form of a nationwide survey of state departments of transportation and of several federal government agencies, analysis of the methodology used by rental rate guides, and a study of federal guidelines concerning equipment cost reimbursement. The method thus developed, if implemented, would establish compensation rates for equipment force account work. This method could replace both the negotiation process—which may lead to inequitable compensation for the same equipment services—and the use of nationwide guides of average rates in which the user has no control over the costs and formulas applied. Research clearly indicates that the use of the developed method could result in considerable cost and time savings and in fewer claim disputes by providing standard, realistic, and equitable compensation to contractors for their use of construction equipment in force account work for governmental agencies.

Competitive bidding is the method most commonly used by state departments of transportation (DOTs) for the purpose of awarding construction contracts. In this case, the contractor is paid by a lump sum fee or by a unit price agreement. In both instances, the government agency pays a flat fee, without requiring specific invoices of all the components involved in the calculation of fees. However, there are many cases in which government agencies award noncompetitive construction contracts and pay contractors for actual costs incurred in the execution of contractual operations. Work so awarded is commonly known as force account work when it can be placed under any of the following three categories:

1. Payment based on a cost-plus system, used for small projects, emergency operations, and other cases to which competitive bidding does not apply.
2. Payment for supplemental agreements, for additional necessary work beyond the scope of the original project.
3. Payments for claims obtained by contractors through some judicial procedure. This type of arrangement involves a reimbursement method similar to the cost-plus method.

Department of Civil Engineering, College of Engineering, University of Florida, Gainesville, Fla. 32611.

The common denominator in these three categories is that, in each case, government agencies reimburse contractors for actual costs of labor, materials, and equipment. Cost control for labor and materials is a relatively simple matter of book-keeping; however, equipment costs are decidedly more difficult to determine. Construction equipment rental rates represent a considerable portion of the costs incurred by contractors when they submit claims for force account work to DOTs. Most DOTs use rental rate manuals to determine equipment reimbursement. Past records show that depending on the manual used, the rental cost for the same piece of equipment can vary from 10 percent to well over 400 percent and that such large variances occur for practically all types of equipment.

RESEARCH PROGRAM DEVELOPMENT

The purpose of this research was to specify the necessary parameters and to recommend a method for determining rental rates for construction equipment for the Florida Department of Transportation (FDOT). The objectives of the research program were as follows:

1. To evaluate the cost components involved in the calculation of construction equipment rental rates.
2. To review FDOT procedures for determining construction equipment rental rates.
3. To conduct a nationwide survey of the methods currently used by departments of transportation in all states.
4. To investigate the methods used by other governmental organizations such as the FHWA, the U.S. Army Corps of Engineers, and the U.S. Navy; and private organizations such as equipment dealers and large construction companies.
5. To develop guidelines and recommendations for the determination of rental rates for equipment used in FDOT force account projects. These guidelines would serve as the basis for the development of an analytical model that would determine equipment rental rates according to ownership costs, operation and maintenance costs, operating hours, equipment overhead, and profit. The result would be a rental rates guide for the FDOT that could be updated on a regular basis to reflect changes in policy and actual market conditions.

Equipment cost is the major cost item in many construction projects. Because the problem of setting equitable and real-

istic compensation for the use of construction equipment is common to most DOTs and to some federal government agencies, the results of this research should be of significant value to all of these organizations.

COST COMPONENTS OF RENTAL RATES

There are three categories of cost components used in deriving equipment rental rates: ownership costs, operation costs, and miscellaneous costs.

Ownership Costs

Ownership costs (C_{own}) cover all the expenses involved in the acquisition of a particular piece of equipment. C_{own} are based on the total purchase price, the economic life period, and the estimated salvage value of the equipment at the end of that period. The cost items under C_{own} are depreciation, return on investment, applicable taxes, and other costs such as insurance, storage, and replacement escalation.

Depreciation

Depreciation is a non-cash flow accounting method for determining the loss in value of an investment over a period of time. It is a function of time and use, and it is caused by unrepaired wear, deterioration, obsolescence, and reduced demand (I). The method used depends on the purposes of the depreciation. For internal accounting, the straight-line method—which depreciates the cost into equal portions throughout the life of the equipment—is commonly used. For tax purposes, most companies will use an accelerated depreciation method, since it would provide for a larger share of the cost to be written off in the earlier years of equipment ownership. Common accelerated depreciation methods include the declining balance, the sum-of-the-years-digits, the accelerated cost recovery system (ACRS), and the modified accelerated cost recovery system (MACRS). The latter two are schedules of allowable yearly percentages of depreciation published by the U.S. Internal Revenue Service. These two purposes are divergent and result in two different methods of

depreciation used on the same capital item. This double accounting procedure is legal and used openly in the construction industry. However, true depreciation can be measured only by determining the market value of the equipment at a particular point in time.

The following are formulas to calculate depreciation amounts:

- Straight-line method (SL):

$$P - SV/N \tag{1}$$

- Declining balance (DB):

$$P \times (Factor/N) \tag{2}$$

- Sum-of-the-year's digits (SOYD):

$$P - SV \times (D/SOYD) \tag{3}$$

where

- P = present value;
- SV = salvage value;
- N = useful life;
- $Factor$ = 1 for declining balance, 2 for double declining balance;
- D = that year's digit; and
- $SOYD$ = sum-of-the-year's digits.

Table 1 and Figure 1 show a comparison of depreciation methods for equipment valued at \$200,000, with a useful life of 5 years and a salvage value of \$50,000.

Return on Investment

The purchase of equipment is normally considered an investment venture. As such, it is made on the premise that the investment will ultimately yield a rate of return high enough to compensate for the risk of the undertaking. Thus, interest is charged on the capital used for purchasing the equipment, whether the purchase is financed by an institution or paid for with company funds. In the latter case, the allowance of interest charged is made to compensate the company for the rate of return that its funds would obtain if deposited in a banking

TABLE 1 COMPARISON OF DEPRECIATION METHODS ON A 5-YR SCHEDULE

	Straight Line		Double Declining Balance		Sum of the Years' Digits	
	Value @ Year Digit	Year's Depreciation End of Year	Value @ End of Year	Year's Depreciation	Value @ End of Year	Year's Depreciation
1	\$200,00	\$30,000	\$200,000	\$80,000	\$200,000	\$50,000
2	170,000	30,000	120,000	48,000	150,000	40,000
3	140,000	30,000	72,000	22,000 ^a	110,000	30,000
4	110,000	30,000	50,000	0	80,000	20,000
5	80,000	30,000	50,000	0	60,000	10,000
6	50,000	-----	50,000	-----	50,000	-----
TOTAL						
Depreciation		\$150,000		\$150,000		\$150,000

^a Depreciation for the year must be adjusted so that it will not decrease the salvage value of \$50,000.

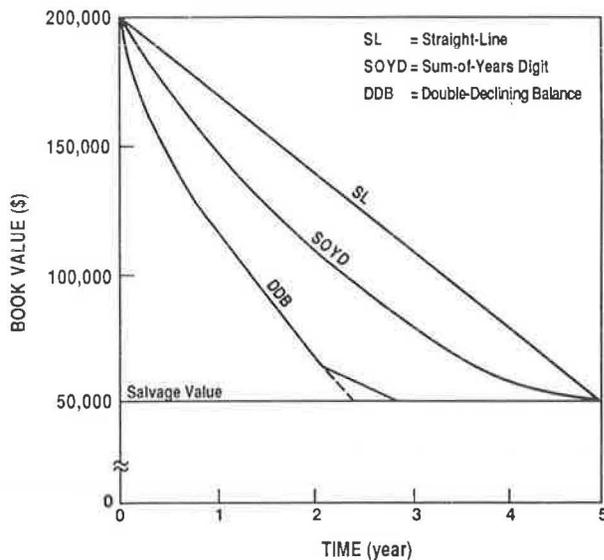


FIGURE 1 Comparison of depreciation methods.

institution or if used for another investment that would yield an acceptable rate of return. Although there are several methods for calculating the actual cost of investment, the most common one is the amortization method, which is used by most financial institutions. The general formula for the amortization method is

$$A = P [i(1 + i)^N] / [(1 + i)^N - 1] \quad (4)$$

where

- A = periodic amount to be paid to amortize debt,
- i = interest rate per time period,
- N = number of time periods in amortization schedule, and
- P = present cost of equipment.

Taxes

Several forms of taxation enter the calculation of equipment costs. Sales taxes, income taxes, property taxes and any investment tax credits allowable under law should all be considered.

Insurance

Insurance costs include coverage for fire, theft, comprehensive liability, and damage to the equipment.

Storage

Storage expenses include the rent and maintenance of space (storage yard, warehouse, etc.), handling of equipment in and out of storage, and any security—security guard, mechanical security systems—needed.

Replacement Escalation

Historically, construction equipment prices have increased about 5 percent per year for the past 20 years. This escalation in price is because of factors such as inflation, new technology, market conditions, and changes in taxation laws. Although an estimate of the escalation amount can be found, it is almost impossible to predict escalation with any amount of certainty. As of this writing, the FHWA does not allow replacement escalation costs to be paid as part of the costs of rental construction equipment for work subsidized by the U.S. federal government.

Operation Costs

Operation costs (C_{oper}) are those costs associated with use of the equipment. They include the costs of maintenance, repairs, fuel, and lubrication. The type of equipment, the conditions under which it is used, and the location of the project are all factors that will influence the cost of operation.

Maintenance and Repair

Maintenance repair costs (C_{rep}) include scheduled services of a preventive nature and repairs caused by unforeseen mechanical breakdowns. The estimation of maintenance costs can, therefore, be made more accurately than for repair costs. The best way to estimate future maintenance and repair costs is to use past records as a guide whenever available. The expenses under this category are the costs of parts, sales taxes, labor, fringe benefits, shop overhead, any supporting facilities, and any maintenance equipment required. The annual C_{rep} may be expressed as a percentage of the annual cost of depreciation. For example, it has been established that for cranes, the average annual C_{rep} ranges from 40 to 50 percent of the annual straight-line depreciation of the equipment. For draglines and clamshells, the range is 60 to 70 percent (2). When accelerated depreciation is used, tables for typical total lifetime costs of operation can be used and C_{rep} may be calculated by the following equation (2):

$$C_{rep} = ((D/SOYD) \times TC_{rep}) / m \quad (5)$$

where

- C_{rep} = hourly cost of maintenance and repair for year D ,
- D = that year's digit,
- $SOYD$ = sum-of-the-year's digits,
- TC_{rep} = typical total lifetime for equipment life maintenance and repair cost, and
- m = operating hours in that year.

Fuel

Under standard conditions (barometric pressure of 29.9 in. of mercury at a temperature of 60°F) a gasoline engine will consume approximately 0.06 gal of fuel per flywheel-horsepower-hour (fwhp-hr). A diesel engine will consume 0.04 gal per fwhp-hr. Under severe conditions, the consumption of fuel can increase by up to 30 percent (3). Engines that seldom

operate at the rated output or at a constant output for long periods have a reduced fuel demand because of time and operation factors. The hourly cost of fuel (C_{fuel}) may then be calculated by

$$C_{fuel} = \text{operating factor} \times \text{time factor} \times \text{rated fwhp} \times (\text{gal of fuel/fwhp-hr}) \times \text{cost per gal} \quad (6)$$

Lubrication Oil

The quantity of oil used by an engine depends on the engine size, the capacity of the crankcase, the condition of the piston rings, and the number of hours between oil changes. When past records for a particular type of equipment are not available, the hourly cost of oil (C_{oil}) can be calculated in one of two ways:

$$C_{oil} = [(fwhp \times f \times n)/r] + c/t \quad (7)$$

where

- $fwhp$ = rated flywheel horsepower of engine,
- f = operating factor,
- n = 0.006 lb of oil,
- c = gal capacity of crankcase, and
- r = 7.4 lb/gal.

A simplified way to calculate the hourly cost of lubrication oil is to consider it as a percentage—between 10 and 30 percent—of fuel cost.

Miscellaneous Costs

Several other cost items can be considered under miscellaneous costs. Among these are mobilization to the jobsite,

required safety inspections, and other expenses that may apply depending on the type of equipment and the particular contract under which the equipment is operating.

A summary of all the components involved in the calculation of rental rates is shown in Figure 2.

SURVEY OF CURRENT PRACTICES

A written survey on current construction equipment rental practices was sent to all 50 state departments of transportation and to organizations such as the FHWA and the U.S. Navy.

Departments of Transportation

The survey findings in Table 2 show that 38 states use the *Rental Rate Blue Book* (Blue Book) by Dataquest, Inc. (4), as indicated in the standard specifications for their state. Many states arbitrarily adjust the rates on the *Blue Book*. As examples, Nebraska, Wyoming, and Mississippi use 77, 68, and 80 percent, respectively, of the blue book rates. For most of the states the *Blue Book* rates are used in lieu of negotiation. The states of Colorado and Illinois have developed their own rental rates guides. As of this writing, only the state of Massachusetts has adopted the use of the *Construction Equipment Ownership and Operating Expense Schedule* published by the U.S. Army Corps of Engineers. The state of Florida currently uses 1/176th of the monthly *Blue Book* rental rate as the hourly rate.

FHWA

The FHWA has issued a policy guidance to ensure that predetermined equipment rental rate used by state highway agencies comply with federal cost principles whenever force account

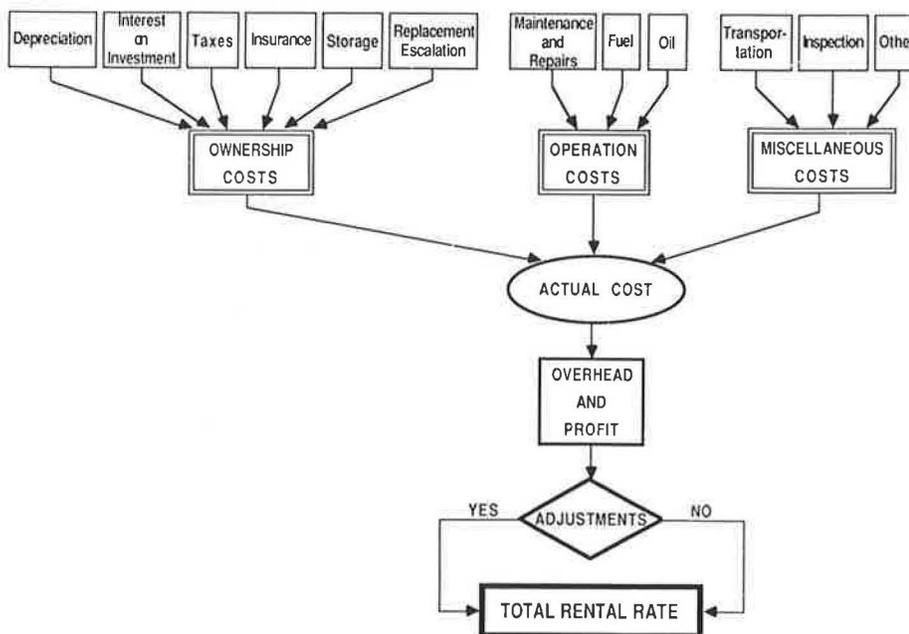


FIGURE 2 Rental cost components.

TABLE 2 TABULATION OF STATE DEPARTMENTS OF TRANSPORTATION RESPONSES

State	Blue Book	COE	AED	DOT	State	Blue Book	COE	AED	DOT
Alabama	X		X		Montana	X			
Alaska	X				Nebraska	X			
Arizona	X				Nevada	X			
Arkansas	X				New Hampshire	X			
California	X			X	New Jersey	X			
Colorado				X	New Mexico	X			
Connecticut	X				New York	X			
Delaware	X				North Carolina	X			
Florida	X				North Dakota	X			
Georgia	X				Ohio	X			
Hawaii	X				Oklahoma				X
Idaho	X				Oregon	X			
Illinois				X	Pennsylvania	X			
Indiana			X		Rhode Island	X			
Iowa	X				South Carolina				X
Kansas	X				*South Dakota				X
Kentucky	X				Tennessee	X			
Louisiana				X	Texas				
Maine	X				Utah	X			
Maryland	X				Vermont	X			
Massachusetts			X		Virginia	X			
Michigan				X	Washington	X			
Minnesota	X				West Virginia	X			
Mississippi	X				Wisconsin	X			
Missouri	X				Wyoming	X			

AED = Association of Equipment Distributors
COE = Corps of Engineers

DOT = Department's Own method
a = Uses Colorado's method

work is necessary. Federal policy requires that actual costs be used to determine extra work payments. However, since actual equipment costs may not be readily available, the FHWA permits the use of predetermined rental rates guides, as long as they are modified to exclude costs that are ineligible for federal reimbursement. The ineligible costs are those of contingency expenses and of replacement escalation. Contingency factors are not allowed under Circular A-87, Attachment B, Part D-2 (Standards for Selected Items of Cost) of the Office of Management and Budget (OMB). Replacement escalation costs are not allowed under OMB Circular A-87, Attachment B, Section B-11, which states that the computation of depreciation or use allowance is to be based on original acquisition costs.

U.S. Navy

The U.S. Navy follows the guidelines set by the Federal Acquisition Regulations 31.15, which applies to direct government procurements. This regulation identifies the U.S. Army Corps of Engineers as an acceptable source of equip-

ment rental rates but does not require its use. Thus, the U.S. Navy does not have a standard method for establishing equipment rental rates on force account work. Rather, it is left to the individual divisions to negotiate or use a published rental rates guide, as long as the rates on the guide are adjusted to comply with federal regulations.

CURRENT RENTAL RATES SOURCES

Rental Rate Blue Book

The *Rental Rate Blue Book* has been published since 1960 by Dataquest, Inc., a company of the Dun & Bradstreet Corporation. Its introduction states that "The rates in this manual are intended as guidelines paralleling amounts an equipment owner should charge during rental or contractual periods to recover equipment related costs" (4, Section A, p. 1). Volume 1 is a comprehensive cost recovery guide for equipment manufactured during the past 5 years, volume 2 is for equipment that is from 6 to 10 years old, and volume 3 is for equipment that is 11 to 20 years old. The rates published in the *Blue*

Book are calculated from cost formulas and factors developed from Dataquest research. Although some general formulas used are shown in the introduction section, it is not clear how Dataquest actually calculates all the cost factors involved. Direct inquiries to Dataquest failed to clarify their methodology. Survey responses indicate that many states feel the rates in the *Blue Book* are too high and not representative of actual costs, and that is why adjustments to decrease these rates have been implemented. The disadvantages of using private publications in general is that the user has no control over the methods and formulas used and that the costs of overhead and profit may be incorporated within individual components, thus compounding these factors and making it difficult to identify actual costs.

U.S. Army Corps of Engineers

The Construction Equipment Ownership and Operating Expense Schedule was developed by the U.S. Army Corps of Engineers in 1979. It establishes predetermined equipment ownership and operating expense hourly rates for use in the preparation of estimates and in the pricing of negotiated procurements requiring independent government estimates. This guide shows in detail how each cost component is calculated. No allowances are made for operating labor, mobilization costs, overhead, or profit (5). The advantage of using this guide is that it fully complies with Federal Acquisition Regulations. However, the general consensus of highway agencies is that the rates in this schedule are considered too low, especially when compared to the most commonly used guide, which is the *Blue Book*.

Colorado Department of Highways

The Colorado Department of Highways (CDOH), and the Colorado Contractors Association, through a joint committee, have reached agreement on the procedures to determine rental rates for equipment used in force account work. These procedures are incorporated into the *Construction Equipment Rental Rate Schedule* published by the CDOH (6). The current version of this schedule is based on the 1974 publication of the *Contractor's Equipment Ownership Expense Schedule* by the Associated General Contractors organization. Modifications are made to update for costs of fuel, oil, grease, and filters. "This schedule was then computerized and is in use today. The committee agrees that the 1974 data would appear obsolete, however, the repair and ownership percentages are considered applicable to today's equipment values" (G.W. Fritts, Colorado Department of Highways, personal correspondence to Z. Herbsman, 1987). The rates on this schedule do not compensate for operator wages, fringe benefits, or profit. Replacement escalation factors are also excluded, and interest rates are revised annually to reflect market conditions.

Conclusions on Current Practices

Table 3 shows several published rental rates for comparison purposes only. From this table it can be seen that rental rates for the same piece of equipment may vary from 10 to over 400 percent, depending on the rental rates guide used. At present, the majority of state highway agencies (76 percent) use the *Blue Book* of nationwide averages of rental rates as

TABLE 3 COMPARISON OF PUBLISHED 1986 RENTAL RATES^a

Description	Hourly Rates (\$) including operating Costs				
	Blue Book (Jan 1986)		U.S. Army Corps (June 1986)	Colorado (May 1986)	Illinois (Jan 1986)
	Unadjusted Hourly Rate	As adjusted by FDOT			
1. P&H Self-Propelled Hydraulic Crane Model Omega 115, 15 tons, diesel powered	79.10	40.71	21.66	39.55	57.75
2. Caterpillar Wheel Loader, Model 992C, 13.5 c.y., diesel powered	467.30	206.99	152.51	304.85	340.73
3. Caterpillar Motor Grader, Model 16-G, 250 HP, diesel powered	106.95	82.35	49.82	105.00	123.75
4. MKT Pile Driving Hammer, Model DE-70B/50B, 30,000 ft.-lbs., diesel powered	87.30	32.72	18.61	48.40	53.90

^a 1986 rates used for demonstration purposes only

standard reference for compensation of force account work. Many of these states arbitrarily adjust the published rates because of the inherent diversities in geographical working conditions throughout the country, and the distinct policies of highway agencies, which may not be the same as those used by the rental rates guide.

It is recommended that highway agencies that are currently modifying rental rates guides establish their own fair policies and standard guidelines regarding allowable equipment costs in force account work. The rental rates calculated by using the established criteria would ensure that the policies of the user agency are being enforced.

RECOMMENDATIONS FOR CALCULATING CONSTRUCTION EQUIPMENT RENTAL RATES

Outlined below are specific recommendations for the calculation of the necessary costs needed to establish rental rates for construction equipment.

Ownership Costs

It is recommended that the items under C_{own} be calculated as one total number. The major cost items are depreciation and interest on investment. The other C_{own} components (taxes, insurance, storage, and replacement escalation) can be grouped together as an added percentage above that used for calculating the interest on investment. The following formula can be used to calculate the hourly cost of ownership.

$$C_{own} = \{P [i(1+i)^N / (1+i)^N - 1] - SV/N\} / m \quad (8)$$

where

- P = purchase price of the equipment,
- i = percentage rate for interest, taxes, insurance, storage, and replacement escalation,
- N = useful life (in years), and
- m = operating hours in a year.

Depreciation

- The initial cost of any construction equipment should include the costs of the basic machinery, of necessary accessories to make the equipment operational, and any applicable sales taxes, transportation, inspection, and assembly costs. These costs can be obtained from industry sources, such as the manufacturer's list price, or from guides such as the *Cost Reference Guide for Construction Equipment* (7), which publishes list prices.

- Research data indicated that a list price discount rate of between 5 and 15 percent is commonly applied to construction equipment; therefore, a discount percentage should be taken into account when establishing rental rates.

- Straight-line is the recommended method of depreciation for equipment in regular use. For excessive wear and tear, it may be necessary to use an accelerated depreciation schedule.

Salvage value

- Depending on the type of equipment, the average salvage value at the end of the economic life can range from 10 to 35 percent. However, lower and higher values can be encountered, depending on the conditions of the equipment as well as the predominant market conditions. It is best to use up-to-date publications such as the *Green Guide* (8).

- Because of the unpredictable state of the economy, it is not possible to estimate with certainty the present value of a future sum, as is the salvage value. It is, therefore, recommended that no provisions be made for inflation and deflation, since these will be better reflected in the current resale values published.

Return on investment

- It is suggested that the interest rate used be the monthly equivalent of the sum of the current yearly cost of money rate as determined by the U.S. Department of Treasury plus 2 percent per year to account for fluctuations in the treasury rate. Depending on the policy of each agency, a varying percent allowance may be added to compensate for the inherent risk of investing in construction equipment. The cost of capital is a major expense and should, therefore, be adjusted periodically to reflect actual economic conditions.

- The amortization method with a monthly schedule is the most accurate method for determining the cost of interest on investment, since it is the method preferred by financial institutions.

Cost of taxes, insurance, storage and replacement escalation

- If the investment tax credit is reinstated by the federal government, it should be considered as an added discount on the original purchase price.

- Income taxes are not considered an expense, but are part of the distribution of total profits of the company (9). As such, it is recommended that no allowance be made for these taxes.

- The cost of sales taxes is part of the original purchase price and should be included as part of the total purchase price of the equipment.
- Property taxes are also considered indirect costs of the company and as such should not be included under rental rate costs.
- The cost of insurance can generally range between 1 and 5 percent of the equipment value. This range can vary due to the type of equipment as well as the history of the individual contractor.
- The cost of storage fluctuates depending on the location of the work area but generally can be considered to be a yearly 1 percent of the equipment value.
- Replacement escalation costs are not allowed under FHWA regulations (10). It is recommended that no allowance for this expense be provided, because this cost can be recovered when the new equipment is depreciated.

Operation Costs

Operation costs can be subdivided into two categories: maintenance and repair costs and fuel and oil costs.

Maintenance and Repair Costs

Maintenance and repair costs are a major component of any rental rate. If past records are not available, it is suggested that this item be calculated with tables of typical lifetime repair costs as percentages of the initial price. These tables can be found in construction equipment textbooks (2). Manufacturers and equipment dealers also have maintenance and repair data for specific types of equipment.

Fuel and Oil Costs

If no past records of fuel and oil costs are available, a good approach would be to use validated formulas to calculate these

TABLE 4 EQUIPMENT DATA INPUT

EQUIPMENT DATA		
Agency:	Equipment Classification:	Date:
Model:	Galion 503L	
Year:	1986	
Description:	Motorgrader	
Horsepower:	74	
Fuel:	Gasoline	
List Price:	\$ 40,140	
Discount:	10%	
Transportation:	N/A	
State Sales Tax:	6%	
Equipment Life:	60 month (5 years)	
Work Hours:	145.83 hours/month (1750 hours/year)	
Salvage Value:	25% of Depreciable Amount	
Depreciation:	Straight Line Method	
Finance Method:	Amortization	
Finance Period:	Equipment Life	
Cost of Capital:	10 %	
Life Maintenance:	70% of Depreciable Amount	
Operator Wages:	N/A	
Fuel Price:	\$ 1.05/gallon	
Operating Factor:	85% of Full Load	
Time Factor:	50 min/hour = 0.833	
Fuel Consumption:	0.06 gal/hp-hr	
Lubrication Cost:	10% of Fuel Cost	
Insurance:	3% per year	
Storage:	1% per year	
Escalation:	N/A	
Equipment Overhead:	5% of Total Direct Costs	
Profit:	N/A	
Adjustment Factors:	10% more for Severe Conditions 15% less for Monthly Rental	

costs. Several formulas are found in current equipment literature, and they can be adjusted for operating and time factors, as well as the costs of fuel and oil. For the sake of simplification, oil consumption usually can be considered to be a percentage (between 10 and 30 percent) of fuel costs.

Miscellaneous Costs

When considering miscellaneous costs, the following are recommended:

- That the costs for mobilization to the job site be reimbursed as a lump sum; and
- That the costs of necessary inspections and any other miscellaneous costs directly related to the equipment in operation be reimbursed to the contractor.

Adjustments

The above recommendations are intended to be used for the calculation of the total actual cost of owning and operating a piece of equipment in a force account operation. To determine

TABLE 5 RENTAL RATE CALCULATIONS

Agency:	Model:	Galion 503L	Year:	1986
I. OWNERSHIP COST				
Net Price	=	\$ 40,140(1-0.10)	=	\$ 36,126
Sales Tax	=	\$ 36,126 x 0.06	=	\$ 2,167.56
Depreciable Amount	=		=	\$ 38,293.56
Salvage Value	=	\$ 38,293.56 x 0.25	=	\$ 9,573.39
Total Interest Rate	=	10% cost of capital 3% insurance 1% storage 14% per year equivalent to 1.1% per month		
		$\$ 38,293.56 \left[\frac{0.011(1 + 0.011)^{60}}{(1 + 0.011)^{60} - 1} \right]$		$\frac{\$ 9,573.39}{60}$
C_{own}	=		=	$\frac{145.83}{145.83}$
C_{own}	=		=	\$ 4.91/hr
II. OPERATION COST (C_{oper})				
A) Maintenance and Repairs (C_{rep})				
C_{rep}	=	$\frac{38,293.56 \times 0.70}{60 \text{ months} \times 145.83 \text{ hrs/month}}$	=	\$ 3.06/hour
B) Fuel (C_{fuel})				
C_{fuel}	=	$0.85 \times 0.833 \times 74 \text{hp} \times 0.06 \text{ gal/hp-hr} \times \$ 1.05/\text{gal}$	=	\$ 3.30/hour
C) Lubrication (C_{oil})				
C_{oil}	=	3.30×0.10	=	\$ 0.33/hour
C_{oper}	=	$3.06 + 3.30 + 0.33$	=	\$ 6.69/hour
III. TOTAL DIRECT COST (TDC)				
TDC	=	$C_{own} + C_{oper}$	=	\$ 4.91 + \$ 6.69 = \$ 11.60/hour
IV. ADJUSTMENTS				
A) $C_{overhead}$ = 11.60 x 0.05 = \$ 0.58/hour				
Total Rental Hourly Rate	=	$11.60 + 0.58$	=	\$ 12.18/hour
B) Severe Conditions				
$\$ 12.18 \times 1.10$	=		=	\$ 13.39/hour
C) Idle Time				
$\$ 12.18 - \$ 6.69$	=		=	\$ 5.49/hour
D) Long Term Rental				
$\$ 12.18 \times (1-0.15)$	=		=	\$ 10.35/hour

the rental rate of the equipment, overhead and profit (if allowable) should be considered. Certain job conditions and agency policies may also warrant adjustments on the calculated rental rate.

- To cover the project overhead directly related to the equipment, a 5 to 15% increase in the hourly rate is considered reasonable. Profit in force account work is usually calculated as a function of the total job cost and, as such, it should not be included in the calculation of rental rates, unless otherwise stipulated by policy of the agency.

- The length of rental should affect the rate paid for construction equipment. Rental rate guides such as the *Blue Book* by Dataquest, Inc., have an hourly rate that is up to 50 percent more than the hourly rate calculated from their monthly rates for the same machinery. The decrease in rates for extended use is because of the continuous productivity derived from such use.

- If the government organization decides to classify work conditions as normal or severe, then a rate increase of 10 to 20 percent is recommended for use of equipment in severe conditions.

- Idle time that is not the fault of the contractor (such as heavy rain) should be compensated at the regular rental rate minus the operating costs. Downtime should not be compensated.

RENTAL RATES GUIDE: SAMPLE CALCULATIONS

The calculations of rental rates for any type of equipment must comply with the policies adopted by the user agency.

Tables 4 and 5 show the data and calculations necessary for the determination of a rental rate for a sample piece of equipment. It must be noted that the assumptions and formulas used were chosen arbitrarily and in reality would be dictated by the policies adopted by the particular government agency. Equipment rental rates shown in Table 6 were calculated in the same manner.

SUMMARY AND CONCLUSIONS

When outside sources of rental rates are used to compensate force account operations, the user has little or no influence over how the information is gathered and what cost parameters are used and, therefore, cannot control how the rates are determined. The companies that publish these guides have their own policies and objectives that may or may not comply with federal and/or state guidelines on rental construction equipment cost accounting and reimbursement.

Most states that use percent adjustments of the *Blue Book* have had difficulty correlating their chosen adjustment to factual data. The disadvantages of using arbitrarily adjusted rental rates is that the adjustment is applied across the board to all types of equipment and the result may be arbitrarily inadequate compensation. Given the success of states such as Colorado and Illinois in implementing their own methods for determining equipment rental rates, and given the variable and unpredictable nature of privately published rental rates guides, it is recommended that each highway agency establish its own specific policies and standard guidelines to deal with construction equipment reimbursement in force account work, in a manner that is fair to contractors.

Once criteria for equipment rental rates have been estab-

TABLE 6 SAMPLE PAGE OF FUTURE RENTAL RATES GUIDE

CONSTRUCTION EQUIPMENT RENTAL RATES								
Equipment	HP	List Price (\$)	Economic Life (hrs)	Ownership Cost (\$/hr)	Operation & Maintenance Cost (\$/hr)	Miscellaneous Cost (\$/hr)	Hourly Rental Rate	
							Average Conditions (\$/hr) ^a	Severe Conditions (\$/hr) ^a
MOTORGRADERS								
<u>Gasoline Powered</u>								
BASIC 601A (1978)	23	10,500	8,750	1.28	1.93	0.16	3.40	3.70
GALION 503L (1986)	74	40,410	8,750	4.91	6.69	0.58	12.20	13.40
HUBER M-800 (1976)	65	23,495	8,750	2.87	4.98	0.39	8.25	9.05
<u>Diesel Powered</u>								
ALLAT SG-100 (1982)	60	43,191	8,750	5.28	5.26	0.53	11.05	12.20
ATHEY AB-6905(1986)	75	38,095	8,750	4.66	5.36	0.50	10.50	11.60
BASIC 701A (1986)	52	23,137	8,750	2.83	3.47	0.31	6.60	7.30
BLADEMOR 727 (1986)	35	18,930	8,750	2.31	2.58	0.25	5.15	5.65
BLADEMOR 747 (1986)	60	38,100	8,750	4.66	4.87	0.48	10.00	11.00
BOWER								
ROADRUNNER (1982)	36	18,900	8,750	2.31	2.62	0.25	5.20	5.70

^a Rounded off to nearest \$0.05

Note: For long-term rental discounts, idle time and other conditions, see section on adjustment recommendations.

lished, a software and data base system should be developed and specifically tailored to comply with the guidelines and policy requirements of the government organization. The program thus developed should be flexible enough to be updated and accept necessary changes in cost parameter calculations. The costs of developing, implementing, and updating this system would be readily offset by the savings in equipment rental rates paid by the organization, and, on a smaller scale, by the revenues obtained by selling the rental rates guide to contractors and other interested organizations.

There may be instances in which various states have similar policies regarding force account work. In these cases, the best approach would be to determine policies through a joint effort and to develop a rental rates guide to be used in that region.

The rental rate system thus developed could become part of the Standard Specifications of the government agencies and could be used in conjunction with, or could even replace, negotiation.

A final analysis of the research data indicates that rental rates for construction equipment depend on the cost policies applied to the calculation variables. The recommendations and model of calculations presented can be modified by government organizations to more closely resemble actual costs in their areas and, depending on the policies adopted, could result in sizable savings in the cost construction equipment used in force account work.

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