Determining Labor and Equipment Costs of Logging Crews

by

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Small, independent logging contractors can benefit from cost control and cost planning. This report details the labor and equipment cost components of a logging crew. Records, both required and available for determining costs, are discussed. Recommended costing procedures are illustrated. Although the study took place in the Pacific Northwest, the principles apply to all logging companies.

Production records available to logging contractors are also described. These records determine the amount of volume removed from an area for a period of time. Cost and production for the same time period can be used to determine the unit cost of production.

An essential part of any logging operation is the maintenance of job quality and safety standards. This report describes the methods being used to insure that quality and safety standards are met.

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INTRODUCTION

PURPOSE OF PROJECT--The forest products industry has been under severe economic pressure for the past several years. Many companies have gone out of business while others have been forced to reduce portions of their operations. To combat these economic pressures, companies can implement better cost control. This report concentrates on independent logging contractors. It is intended as a comprehensive report of the labor and equipment cost components of a logging crew. Records both required and available for determining costs are discussed. Recommended costing procedures are illustrated. Although the study took place in the Pacific Northwest, the principles apply to all logging companies.

OBJECTIVES--Specific objectives of this report are:

1. Identify the components making up the labor cost.
   1a. Determine what records are available to track each component of the labor cost.
   1b. Show examples of tracking labor costs.
2. Identify the components making up the equipment cost.
   2a. Determine what records are available to track each

component of the equipment cost.

2b. Show examples of tracking equipment costs.

3. Identify what types of production records are available.
4. Identify weaknesses and strengths of existing records and their ease of use.
5. Determine the ease of combining production and cost for the same period of time.
6. Determine if existing cost and production records are adequate to implement monetary incentive programs.
7. Discuss ways to maintain quality and safety in logging operations.

USES OF COST AND PRODUCTION RECORDS--Cost and production records are valuable for:

1. Tracking the cost and production on current sales. This information can be used to determine if the actual rates exceed or fall below the bid rates. It should be possible to determine areas of high cost or low production and take action to improve these areas.
2. Estimating costs and production for future timber sale bids. Good cost and production records combined with timber sale unit characteristics can be valuable for setting the bid rate for future timber sales.
3. Estimating the optimum replacement age for logging

equipment. Complete equipment cost records are vital to determine the optimum replacement age of equipment.

4. Implementing monetary incentive systems. See Appendix F for a brief description of these systems.

SCOPE OF STUDY--To fully understand cost and production records and their availability, it was necessary to locate independent logging contractors who were willing to participate in such a study. Through a letter writing campaign followed by telephone calls, two independent logging contractors were located in southwest Oregon. Data was collected from June, 1986 to September, 1986, and analyzed during the fall of 1986 and the winter of 1986-1987. This section will describe the method used to collect the data, the company characteristics, and the crew and sale characteristics.

Method used to collect the data--Two separate methods were used to collect data during the course of the study. The first was concerned with collecting production and hours worked for three yarding and loading crews. This was necessary to determine how easy it would be for a small contractor to track the cost and production of an individual crew for a certain setting or time period. The contractor could also use this

information to determine current sale costs and production.

To collect the data, a shift-level form was prepared and one member of the crew (usually the loader operator) was responsible for supplying the required data. Information collected included sale identification, crew information, equipment information, production information, and miscellaneous information. Crew information included names, total hours worked and compliance hours worked (compliance hours are the hours spent by a crew member doing items such as brush piling, erosion control work, or streamcourse cleanout). Equipment information included operating hours, hours used for compliance work, an estimate of down-time hours, and an estimate of fuel consumption (if available). Production information included number of loads hauled during the day, load identification numbers, and an estimate of compliance work completed during the day (if any). Miscellaneous data included landing change time, skyline road change time and an estimate of skid trail and temporary road construction time.

The information collected on the shift-level form was used to compile a report that analyzed the logging contractor's operation. Other contractors may want to collect more (or less) information depending on the

depth of analysis they wish for their operation. An example of the shift-level form used during the study can be found in Appendix A. This form can be adapted to any logging operation.

The second method was concerned with determining the components of the labor and equipment costs, determining the availability of records for costs and production, and determining if the cost and production records could be used to implement and administer a monetary incentive program. To do this, interviews were held with office personnel of the two companies to get first-hand knowledge of what is available, and in what form it is available. When more detail was required on a particular component of a cost, interviews were set up with the appropriate organization such as Workers' Compensation, Unemployment Tax personnel, or logging supply companies. Finally, from the information gathered during the course of the summer, labor costs, equipment costs, and production rates were determined for the three crews analyzed.

Company characteristics--The two independent logging contractors who participated in the study supply logs to mills in the area. Rather than bidding on timber sales, both companies concentrate on bidding on logging jobs for a price per MBF for delivered logs. The two

companies studied will be referred to throughout this report as Company A and Company B.

Company A operates eight to nine logging sides simultaneously during the course of a logging season. Most of these sides are cable logged, however one to two ground-based sides do operate per year. The company is non-union, with 75 to 95 logging crew members employed during the peak logging season. Company A is a small corporation, pays its logging personnel on an hourly pay scale (siderods and road maintenance personnel are paid salary), and is presently not on any monetary incentive program. The company does have a computer, but presently its only use is to track company payroll.

Company B is much smaller than Company A, employing ten to twelve logging crew members while operating one to two ground-based sides per year. Company B is a non-union partnership, pays its logging personnel on an hourly pay scale (partners are paid bi-weekly draws), and is not presently on any monetary incentive program. The company does not own a computer, but future plans include the purchase of a personnal computer.

Crew and sale characteristics--The costs and production associated with three yarding and loading crews was collected during the course of the summer. Two of the crews worked for Company A. Both of these crews were on

cable sides, one an eight-person crew with a large slackline yarder and the other a seven-person crew with a running skyline yarder. Silvicultural systems varied from partial cuts to clearcuts. Company B had one ground-based side working during the summer. The crew consisted of six hourly employees and three partners. The partners were always present on the job site and are considered working members of the crew for this study. Silvicultural systems consisted of partial cuts, clearcuts, and one thinning unit. For more complete information on the crew and sale characteristics, see Appendix B.

THE LABOR COST COMPONENT

The labor cost component for this study is concerned with the employer's contribution to the total labor cost for logging crews. Employer's contributions to the total labor cost for the two logging companies studied are: wages, draws, salaries, Workers' Compensation insurance, state unemployment tax, federal unemployment tax, Social Security tax, and health insurance (if paid for by the employer). No description is given for employee deductions for federal income tax, state income tax, Social Security tax, or other employee contributions.

The components described will not cover all the possible employer contributions. Some additional contributions may be paid vacation, retirement plans, travel pay, and administrative cost for running a monetary incentive program. If these contributions are paid for by the employer, they must be included to arrive at an accurate labor cost. Table 1 shows the labor cost components and their relative percentages for Company A and Company B.

TABLE 1. THE LABOR COST COMPONENTS EXPRESSED AS A PERCENT OF TOTAL LABOR COST

Labor cost component	Company A	Company B
hourly wages	67.1%	53.4%
partner draws	0.0%	20.6%
salaried overhead	8.6%	0.0%
Workers' Compensation	14.7%	15.5%
Social Security tax	4.8%	5.3%
state unemployment tax	2.6%	2.2%
federal unemployment tax	0.5%	0.4%
health and/or life insurance	1.7%	2.6%
TOTAL	100.0%	100.0%

WAGES , DRAWS, AND SALARIES--Wages, draws, and salaries contributed 75.7% and 74% to the total labor cost for Company A and B respectively.

Wages--Wages can be described as a dollar per hour payment for services rendered, in this case the yarding and loading of logs. Wages can further be broken into regular wages and overtime wages. Regular wages are wages paid for the straight time portion of work, overtime wages are wages paid for the overtime portion of work (usually any time over 40 hours per week is considered overtime).

Calculation of total wage payment was done as follows: the total hours worked per week were determined for each employee. These total hours were multiplied by the regular dollar per hour wage to determine the total regular portion of the wage base. The hours worked over 40 in a week were multiplied by one-half the regular hourly wage. This amount was then added to the regular portion of the wage base to come up with the total wages earned for the week. For example, if employee "X" worked a total of 50 hours in one week and the base hourly wage paid was $10/hr then the total wages paid for the week would be: $10/hr X 50 hrs. + $5/hr X 10 hrs. = $550. This method allows the wage component to be broken into the regular portion ($500 in this example) and the overtime portion ($50 in this example). This method of determining wages simplifies the calculation of Workers' Compensation cost which will be shown in a later section. Wages contributed 67.1%

and 53.4% to the total labor cost for Company A and Company B respectively.

Draws--Draws are a predetermined amount of payment given to employees on a scheduled basis. In this study, draws were given to the partners in Company B on a regular basis (twice monthly). The partners were not paid on an hourly basis like the other employees, rather they split the profits at the end of the year in addition to collecting draws. The draws still must be considered in determining total labor cost when the partners work as active members of the logging crew. In this study the partners worked as active members, therefore excluding this cost would severely underestimate labor cost. Draws given to partners are not subject to the same employer contributions as are hourly wages given to employees of the company. This will be more fully discussed in the following sections. Draws contributed 20.6% to the total labor cost for Company B.

Salaries--Salaries are also a predetermined amount that is paid to permanent employees on a regular basis. However, salaried employees normally do not split the profits at the end of the year. Company A paid a salary to the siderods and the siderod superintendent. This amounted to 8.6% of the total labor cost of Company A.

Since siderods spend time on more than one logging side, it's important to accurately record the time spent on each logging side so that the proper amount of salary can be assigned.

Availability of payroll records--Payroll records were readily available for both companies studied. Company A had a computerized payroll which tracked regular pay, overtime pay, and salaries. In addition to a total company payroll, reports for individual sales (and logging sides) were also generated. This is a very convenient report, since Company A had up to nine sides operating at one time. Company B did not have a computer and kept payroll records similar to a ledger system used by accountants. In either case, payroll records were readily available and easy to access and use. Wages paid to the crews were easy to determine from the payroll records.

WORKERS' COMPENSATION--Under Oregon's Workers' Compensation Law, subject workers are entitled to compensation and medical benefits for any accidental injury or occupational disease resulting from employment. Death benefits for survivors are also covered under this law. Subject workers are any person who furnish services for payment. Only the regular

portion of wages is subject to Workers' Compensation premiums. The overtime portion of overtime pay is not subject to premiums. Monetary incentive pay is subject to Workers' Compensation premiums. Partners and corporate officers are not considered subject workers under the law but may elect coverage. If partners elect coverage, they are subject to an assumed monthly wage even if the monthly draw they receive is less than this assumed wage. Workers' Compensation insurance relieves employers of the liability required by the law, but a high price is paid. Workers' Compensation is second only to wages, draws, and salaries as a percentage of total labor cost. For the two companies studied, Workers' Compensation insurance payments contributed 14.7% and 15.5% to the total labor cost for Company A and Company B respectively.

Workers' Compensation premium rates differ by industry classification. In Oregon there are over 600 industry classifications, at least seven apply to the logging industry. Table 2 shows the major logging industry classifications and their associated rates.

Table 2. WORKERS' COMPENSATION RATES, OREGON LOGGING CLASSIFICATION (1986 RATES).

CLASSIFICATION	JOBS COVERED	*RATE ($/$100 of payroll)
2702	all logging positions falling and bucking (hand and mechanical) mechanics (while on the logging site) road, landing, and skid trail construction (during logging)	27.50
2703	mechanics (at repair shop)	6.40
5511	road, landing, and skid trail construction (prior to logging)	12.15
0124	brush piling (hand and mechanical) slash burning streamcourse cleanout	27.98
9310	log truck drivers	15.60
9309	fire watch	8.75
8810	clerical (must be in separate office area)	0.56

*These rates subject to variation among individual insurance carriers and change annually. Preferred rates, if applicable, can be up to 10% less than rates shown.

The rates shown in Table 2 can be thought of as the "manual" rate of the insurance carrier. However, the rate the insured pays is not the manual rate. The manual rate goes through four adjustments before a final premium is reached. These four adjustments are: an adjustment for experience modification, a premium

discount, a Workers' Compensation Department (WCD) tax, and a workday tax. A dicussion of these four adjustments plus an overview of the Workers' Compensation system can be found in Appendix G.

Availability of Workers' Compensation premium records--Most logging companies pay Workers' Compensation on a monthly basis. An employer payroll report is prepared by the insurance company and sent to the insured at the end of each month. This report includes the report period, the payroll description, the job classification codes and their rates, the experience modification factor, and the WCD tax rate. The insured is responsible for filling in the payroll for each job classification and calculating the net premium and the total premium including required taxes.

Payroll for logging companies includes base pay for time worked (including salary), overtime pay--only at the straight-time rate, assumed wages for partners (if any) and monetary incentive pay. Other items such as holiday pay, sick leave pay, and the value of lodging and meals would be added to payroll if provided by the company. The employer's payroll report is prepared in duplicate and the original along with the premium payment is sent to the insurance company. Although payroll for job classifications are shown separately,

the employer's payroll report is intended to show the premium required for the entire company payroll for the month. Only one report per month is sent to a company.

Simplified formula to determine Workers' Compensation payments for individual logging crews--To determine the amount of Workers' Compensation premium to charge against a crew, a simplified formula could be used to compute a Workers' Compensation premium factor:

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(logging classification rate / 100)
X (experience modification)
X (1 - premium discount)
X (1 + WCD tax rate)
+ 0.0012 for workday tax
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= Workers' Compensation premium factor
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The payroll subject to the logging classification rate would be multiplied by this factor. This payroll is the same as discussed above, except that the assumed wage of partners may have to be prorated if the partners allocated their time to more than one job classification. Note that the workday tax has been converted to a ratio of $.0012 of tax per $1 of payroll. This can be adjusted to fit individual situations if necessary.

An example calculation demonstrates the use of this factor.

Given:

logging classification rate	= $27.50 / $100 of subject payroll
experience modification	= 0.95
premium discount	= 10% (.10)
WCD tax rate	= 12% (.12)
workday tax	= $.12/day or $.0012/$1 of payroll
subject payroll (hourly plus salaried)	= $9,000
assumed wages subject (prorated partners)	= $1,000

Calculation of factor:

(27.50 / 100)	:logging classification rate
X (0.95)	:experience modification
X (1 - 0.10)	:premium discount
X (1 + 0.12)	:WCD tax
+ 0.0012	:workday tax

= 0.2645	:Workers' Compensation premium factor

Calculation of amount of Workers' Compensation premium:

($9,000 + $1,000) X 0.2645 = $2,645

Limitations of using the Workers' Compensation simplified formula--There are several shortcomings to be aware of when using the formula discussed above to determine the amount of Workers' Compensation premium to apply to a crew. Only the regular portion of overtime pay is subject to Workers' Compensation premiums. If the overtime portion of overtime pay is multiplied by the Workers' Compensation factor, premium cost will be overestimated. Also, the workday tax calculated will

not be exact since the tax rate is being converted from a dollar per day figure to a ratio of workday tax paid per dollar of payroll. However, this amount is usually small and should not make a large difference in the labor cost. Finally, the first $2,500 (1986 figure) of annual premium is not subjected to a premium discount. The formula to calculate the Workers' Compensation factor does not take this into account.

Most companies tracking labor cost will not need to consider these shortcomings when calculating a Workers' Compensation factor. If this is the case, a company should calculate a Workers' Compensation factor using the simplified formula described above and use this factor for the entire premium period.

SOCIAL SECURITY TAX--Social Security is a plan for old-age pensions, survivors' benefits, and health or disability insurance administered by the U.S. government and maintained by federal funds of certain groups of employers and their employees. Logging employees, including partners and salaried employees, are subject to Social Security tax. The social security rates are set yearly by Congress and take effect on January 1. For 1986, the tax rate is 15.30% of gross wages to an upper limit of $42,000 per employee. If an employee makes more than $42,000 in gross wages during the

calendar year, no Social Security tax would be paid on the amount over $42,000. Social Security tax is split 50%-50% between the employer and employee. This means that for 1986 the employer contributed 7.15% to the Social Security tax while the employee contributed the other 7.15%. The employer contribution to Social Security tax is required to be paid within three banking days after payday. Monetary incentive pay is subject to Social Security tax. However, Social Security tax is paid only if wages plus incentive pay remains below $42,000. Social Security tax contributed 4.8% and 5.3% to the total labor cost for Company A and Company B respectively.

Availability of Social Security tax records--Although Social Security tax payments are due by the employer within three banking days of payday, a report is filed quarterly to the Social Security agency. This is Federal Form 941 and it shows the amount of total company payroll, the amount of payroll subject to Social Security tax, and the employer contribution to Social Security tax. An employer could determine the exact ratio of Social Security payment to total wages by dividing total Social Security tax paid for the year by total company wages paid for the same year. For logging crews it would be easier to multiply the total crew

wages by the non-adjusted Social Security tax rate (employer's contribution) to determine total cost of Social Security. This method can be justified since very few logging personnel make over $42,000 in gross wages during a year.

STATE UNEMPLOYMENT TAX--State unemployment taxes are wholly an employer contribution. The unemployment tax rate (for the state of Oregon) is determined as follows. A "benefit ratio" for an employer is calculated by dividing the benefits charged to an employer by the taxable payroll. "Taxable payroll" includes payroll for a maximum of 12 calendar quarters preceeding July 1 of the previous year. Taxable payroll for unemployment tax purposes is set at an upper limit of gross wages per employee. For example, for 1985 the taxable payroll was set at an upper limit of $13,000 per employee. In 1986, the taxable payroll limit was raised to $14,000 per employee. "Benefit charges" are the benefits paid out and charged to an employer's account. The benefit charges used for the calculation of the benefit ratio are for the same time period as the taxable payroll. The unemployment tax rate is determined by the benefit ratio--the higher the ratio, the higher the tax rate. For 1986, Oregon's unemployment tax rates varied from a low of 2.2% of subject wages (the first $14,000 of gross

wages per employee) to a high of 5.4% of subject wages.

An example calculation of the unemployment tax rate for an employer follows:

Tax year: 1986

Base period used to calculate the 1986 tax rate:
July 1, 1982 to June 30, 1985

Total benefits charged during base period	:	$7,000
Total taxable payroll of company during base period	:	$92,000
Benefit ratio: $7,000 / $92,000	=	.076090

Unemployment tax rate for 1986 = 4.0% of subject wages (based on a benefit ratio of .076090)

Calculations similar to these are made by the State Unemployment Tax Agency yearly and are sent to the employer around November 15. The tax rate takes effect on January 1 of the following year and remains in effect until December 31 of the same year. For 1986, the first $14,000 of an employee's wages is subject to unemployment tax. Incentive pay is considered wages. Payments to legally registered general partners are not subject to unemployment tax. Therefore, the partners of Company B did not pay state unemployment tax. State unemployment tax contributed 2.6% and 2.2% to the total labor cost for Company A and Company B respectively.

Availability of state unemployment tax records--In Oregon, state unemployment taxes are paid quarterly by the employer. All subject wages, including advances, are reportable when paid to the employee. For example, if the wages were earned for the period March 15 to March 30 but paid on April 5, the wages would be recorded in the second quarter (April-June). State form 136, a quarterly reporting form, is completed by the employer and sent to the Oregon Employment Division. This report contains the following information: number of covered workers for each month of the quarter; the total wages paid to covered workers for the quarter; the excess wages, or amount of wages paid during the quarter in excess of the taxable wage base; and the taxable wages, calculated by subtracting the excess wages from the total wages. Also required on this report is a listing of all employees that are being reported. This listing includes Social Security number, name, number of weeks worked during the quarter, and total wages paid during the quarter.

Determining the proper state unemployment tax rate to charge logging crews--Since the upper limit of subject wages is relatively low ($14,000 for 1986), it is safe to assume that many members of the crew will reach this limit while others may not. This means that the

unemployment tax rate for the company decreases as more employees reach the upper payroll limits. To compensate for this, a company can calculate a prorated unemployment tax rate by dividing the total state unemployment tax paid for all members of the crew by the total wages paid to the same crew members for the same time period (usually one year). The neccessary dollar amounts can be obtained from the unemployment tax records. This prorated tax rate must be calculated at least once a year due to potential annual changes in the upper limits of subject wages.

FEDERAL UNEMPLOYMENT TAX--Federal unemployment tax is used by the federal government to supplement unemployment benefits to workers. The tax is wholly an employer contribution. The tax rate is set by Congress and remains in effect for the entire year. For 1986, the federal unemployment tax rate was 0.8% of gross wages to an upper subject wage limit of $7000. Monetary incentive pay is considered wages. Payments to legally registered partners are not subject to federal unemployment tax. Federal unemployment tax contributed 0.5% and 0.4% to the total labor cost for Company A and Company B respectively.

Availability of federal unemployment tax records--Federal unemployment taxes are paid quarterly by the employer. Federal Form 940 is used. The form shows total wages paid, excess wages paid, and federal unemployment tax due. There is no provision to list individual employees on the federal unemployment tax form as there is on the state form. Payment is due within one month of the end of the quarter.

Determining the proper federal unemployment tax rate to charge logging crews--Since the upper limit of subject wages is relatively low ($7,000 for 1986), it is safe to assume that most crew members will reach this upper limit while a few may not. This means that the federal unemployment tax rate for a company will decrease as more crew members reach the upper limit. The options to solving this problem are the same as those for state unemployment tax.

HEALTH INSURANCE--The portion of health insurance premiums that are paid for by the employer must be considered as part of the total employer labor cost. Company A had a health insurance plan for the members of the logging crews. Premiums were paid monthly, however an employee had to be employed by the company for three months before being covered by the insurance plan.

Records for the monthly premium and employees covered were easily obtained from the insurance company. Company B had a health and life insurance plan for the three partners. Only one hourly employee was covered by a company health insurance plan. Records for Company B were also easy to obtain. Health insurance contributed 1.7% to the total labor cost for Company A. Health and life insurance contributed 2.6% to the total labor cost for Company B.

Determining the proper health and/or life insurance rate to charge logging crews--The proper amount to charge logging crews for health insurance is complicated when some employees are covered by the plan while others are not. Company A tracked the insurance cost of each individual employee by assigning a daily rate for insurance and multiplying this rate by the number of days an employee worked on a particular crew. This was done manually and was very time consuming.

An easier way to track health and life insurance cost is to determine the amount of insurance premiums paid for each dollar of total wages. Cost of insurance premiums for the logging labor force of a company for an entire year would be determined from insurance records. This amount would then be divided by the total wages for the logging labor force for the same time period. It

may be necessary to determine a separate rate for partners versus hourly employees as was the case for Company B. In either case, monetary incentive pay would not be subject to the rates developed for health and/or life insurance.

DEVELOPING A LABOR BURDEN FACTOR--The discussion above described the labor cost components as a percentage of the total labor cost. There is another way of expressing labor cost that is frequently used. This is known as a labor loading, labor burden cost, or simply labor burden. Labor burden can be described as the amount of additional cost incurred above wages to operate a crew. Labor burden is normally expressed as a percent or ratio of wages.

Some contractors may wish to include salaried employees along with the hourly wage employees when determining labor burden cost. There would be no errors in doing this as long as the same labor burden factors applied to the salaried employees and hourly employees. Partner draws, on the other hand, should be handled with a separate labor burden factor since they are not subject to unemployment tax and may not be subject to Workers' Compensation charges. As a basic example, assume that the following rates apply to a logging contractor:

LABOR BURDEN FACTOR: HOURLY AND SALARIED EMPLOYEES

Workers' Compensation factor ($25/$100 of wages)	or	$0.2500 / $1 of wages
Social Security tax (7.15% rate)	or	$0.0715 / $1 of wages
State Unemployment tax (5.00% rate)	or	$0.0500 / $1 of wages
Federal Unemployment tax (0.80% rate)	or	$0.0080 / $1 of wages
Health and/or Life Insurance:		$0.0250 / $1 of wages
TOTAL LABOR BURDEN FACTOR:		$0.4045 / $1 of wages

(Note that this labor burden factor is expressed as a ratio of wages. It could also be expressed as 40.45% of wages.)

LABOR BURDEN FACTOR: PARTNER DRAWS

Social Security tax (7.15% rate)	or	$0.0715 / $1 of draws
Health and/or Life Insurance:		$0.1250 / $1 of draws
TOTAL LABOR BURDEN FACTOR:		$0.1965 / $1 of draws

(This labor burden factor can also be expressed as 19.65% of draws.)

In this simple example, the total hourly plus salaried employee wages would be multiplied by one labor burden factor and any partner draws (assigned to the logging crew) would be multiplied by another labor burden factor. The total wages, draws, and labor burden cost would be added together to come up with a total labor cost for the crew. An example helps illustrate this:

Total wages plus salary:		$10,000
times burden factor	:	X 0.4045
TOTAL BURDEN COST	:	$4,045
Total partner draws	:	$3,000
times burden factor	:	X 0.1965
TOTAL BURDEN COST	:	$590

TOTAL LABOR COST =	$10,000	:wages plus salary
	+ $4,045	:labor burden cost
	+ $3,000	:partner draws
	+ $590	:labor burden cost
	$17,635	:total labor cost

This labor cost can be divided by the amount of MBF produced in the same time period to determine a cost per unit ($/MBF) for labor.

Labor burden factors calculated for the companies studied--Table 3 shows the labor burden rates for Company A and Company B. These rates are for 1986 and should only be used as a guideline for developing a labor burden factor.

Table 3. LABOR BURDEN FACTOR FOR COMPANY A AND COMPANY B EXPRESSED AS A PERCENT OF WAGES.

	COMPANY A	COMPANY B	
		W/O PARTNERS	W/PARTNERS
WORKERS' COMPENSATION	21.51%	29.10%	21.00%
SOCIAL SECURITY	7.15%	7.15%	7.15%
STATE UNEMPLOYMENT	3.90%	4.20%	3.03%
FEDERAL UNEMPLOYMENT	0.80%	0.80%	0.58%
HEALTH INSURANCE	2.50%	0.28%	3.53%
	35.94%	41.53%	35.29%

These rates do not use a prorated state unemployment nor federal unemployment tax rate. Actual labor burden may be lower if a prorated tax rate were used.

Strengths of using the labor burden factor--The labor burden factor described above is relatively simple to calculate and use. Computers are not required for its use. The factors needed to derive the labor burden factor are available from existing records. Health and/or life insurance is the most difficult factor to derive since some calculation is required to determine the proper amount of premium and total wages to use. Total wages can be multiplied by the labor burden factor (care must be taken if partner draws are being considered) to come up with a total labor burden cost. Labor burden cost and all wages, draws, and salary are added together to give an estimate of the total labor cost.

Weaknesses of using the labor burden factor--There are several weaknesses to using the labor burden factor as described above, especially if the labor burden cost is to be charged against a crew on monetary incentives. Multiplying total wages by a labor burden factor subjects any overtime portion of overtime pay to Workers' Compensation. Since the overtime portion of overtime pay should not be charged for Workers' Compensation premiums, this can overestimate a crew's labor cost. Second, some inaccuracies in the calculation of unemployment tax and possibly Social Security tax will result since the prorated tax rates used in calculating the labor burden may not be the actual rates paid.

Recommendations in using the labor burden factor--If a logging contractor wished to use the labor burden factor simply to track labor cost for planning purposes, the use of an "unadjusted" labor burden factor may be appropriate, especially if a minor amount of overtime is worked during the season. However, if overtime is frequently worked, only the wages subject to Workers' Compensation (straight-time wages and the straight-time portion of overtime wages) should be multiplied by the Workers' Compensation factor. The total wages would be

multiplied by the remaining labor burden factor to calculate the remaining labor cost.

If the labor cost is being charged against a crew on a monetary incentive program then it may be desirable to calculate the labor cost as accurately as possible. This means charging the proper rate for all components of the labor cost.

Regardless of which method to calculate the labor burden is chosen, the limitations must be fully understood. This becomes more important when crews are on monetary incentives.

Some examples will help to illustrate the differences in using the labor burden factor. Example 1 shows the effects of charging an unadjusted labor burden factor against total wages. Example 2 adjusts the labor burden factor for state and federal unemployment tax and charges Workers' Compensation against only the straight-time portion of wages. Example 3 shows a precise method for tracking the actual labor cost for a logging crew.

Example 1. This example shows the use of an unadjusted labor burden factor and multiplies total wages by the Workers' Compensation rate. Also, state and federal unemployment rates are not prorated.

HOURLY EMPLOYEES

Wages	
straight time portion	$27,500
overtime portion	$2,000
Total wages	$29,500
Labor Burden	
Workers' Compensation	$0.2500 / $1 of wages
Social Security tax	$0.0715 / $1 of wages
state unemployment tax	$0.0500 / $1 of wages
federal unemployment tax	$0.0080 / $1 of wages
health and/or life insurance	$0.0250 / $1 of wages
BURDEN FACTOR	$0.4045 / $1 of wages

PARTNER DRAWS

Draws	
straight time portion	$5,000
overtime portion	$0
Labor Burden	
Social Security tax	$0.0715 / $1 of draws
health and/or life insurance	$0.1250 / $1 of draws
BURDEN FACTOR	$0.1965 / $1 of draws

TOTAL LABOR COST = Total wages plus salary
+ Labor burden cost (hourly plus salaried)
+ Total partner draws
+ Labor burden cost (partners)

TOTAL LABOR COST =	$29,500	= $29,500
+	($29,500 X 0.4045)	= $11,933
+	$5,000	= $5,000
+	($5,000 X 0.1965)	= $983
		=======
		$47,416

Example 2. This example shows the use of the labor burden factor, but multiplies only the straight-time portion of wages by the Workers' Compensation factor. Also, assumed prorated state and federal unemployment tax rates are used.

HOURLY EMPLOYEES

Wages	
straight time portion	$27,500
overtime portion	$2,000
Total wages	$29,500
Labor Burden	
Workers' Compensation	$0.2500 / $1 of wages
Social Security tax	$0.0715 / $1 of wages
state unemployment tax	$0.0350 / $1 of wages
federal unemployment tax	$0.0028 / $1 of wages
health and/or life insurance	$0.0250 / $1 of wages
BURDEN FACTOR FOR WORKERS' COMP.	$0.2500 / $1 of wages
BURDEN FACTOR FOR REMAINING ITEMS	$0.1343 / $1 of wages

PARTNER DRAWS

Draws	
straight time portion	$5,000
overtime portion	$0
Labor Burden	
Social Security tax	$0.0715 / $1 of draws
health and/or life insurance	$0.1250 / $1 of draws
TOTAL BURDEN FACTOR	$0.1965 / $1 of draws

TOTAL LABOR COST = Total wages plus salary
+ Workers' Compensation burden
+ Remaining labor burden (hourly plus salary)
+ Partner draws
+ Labor burden (partner)

TOTAL LABOR COST =	$29,500	= $29,500
+	($27,500 X 0.2500)	= $6,875
+	($29,500 X 0.1343)	= $3,962
+	$5,000	= $5,000
+	($5,000 X 0.1965)	= $983
		=======
		$46,320

The difference in labor cost between example 1 and example 2 is $1,096.

Example 3. This example shows the calculation of labor cost using exact figures except for health and life insurance which is expressed as a $ / $1 of wages.

Scenario: The partner cost will be the same as example 1 and example 2, or $5983 total. To keep the hourly employee wages the same as the previous examples, assume the following:

4 employees paid $10/hr. for straight time, $5/hr. for overtime. Each employee worked 70 days on this job. Total days = 280.

EMPLOYEE	TOTAL HOURS	OVERTIME HOURS	STRAIGHT-TIME WAGES	OVERTIME WAGES	TOTAL WAGES
1	687.5	100	$6875	$500	$7375
2	687.5	100	$6875	$500	$7375
3	687.5	100	$6875	$500	$7375
4	687.5	100	$6875	$500	$7375
TOTAL			$27,500	$2,000	$29,500

EMPLOYEE	TOTAL WAGES AT START OF JOB	TOTAL WAGES AT END OF JOB	W.C. WAGES	SUTA WAGES	FUTA WAGES
1	$6000	$13375	$6875	$7375	$1000
2	$9000	$16375	$6875	$5000	$0
3	$11000	$18375	$6875	$3000	$0
4	$0	$7375	$6875	$7375	$7000
TOTAL			$27500	$22750	$8000

W.C. = Workers' Compensation
SUTA = State Unemployment tax
FUTA = Federal Unemployment tax

Burden factors

W.C. w/o workday tax	$0.2488 / $1 of wages
W.C. workday tax	$0.12 / day
Social Security tax	$0.0715 / $1 of wages
state unemployment tax	$0.0500 / $1 of wages
federal unemployment tax	$0.0080 / $1 of wages
health and/or life insurance	$0.0250 / $1 of wages

EXAMPLE 3 CONTINUED

TOTAL LABOR COST = Total wages plus salary
+ Workers' Compensation cost
+ Workers' Compensation workday tax
+ Social Security tax
+ Health and/or life insurance cost
+ SUTA tax
+ FUTA tax
+ Partner cost

TOTAL LABOR COST =	$29,500	= $29,500
+	($27,500 X 0.2488)	= $6,842
+	($0.12/DAY X 280 days)	= $33.40
+	($29,500 X 0.0715)	= $2,109.25
+	($29,500 X 0.0250)	= $737.50
+	($22,750 X 0.0500)	= $1,137.50
+	($8,000 X 0.0080)	= $64.00
+	$5,983	= $5,983
		==========
		$46,407
		(rounded)

The labor cost in example 3 is $1,009 less than that in example 1 and $87 more than that in example 2.

These examples illustrate the differences in labor cost calculated using three different levels of the labor burden factor. Example 1, multiplying the total wages by an unadjusted labor burden factor, would be acceptable for timber sale planning purposes. Example 2, which multiplies only the straight-time portion of wages by the Workers' Compensation factor and which uses prorated tax rates for state and federal unemployment tax, would be acceptable to use in monetary incentives. This method fairly represents the labor burden cost if recalculated yearly. Example 3 is the most precise method of calculating the labor cost of a crew but is also the most difficult to compute.

THE EQUIPMENT COST COMPONENT

Standard equipment cost calculations include allowances for both ownership and operating costs. The ownership portion of equipment cost includes purchase price (new or used), salvage or residual value, depreciation, property tax, insurance premiums, lost opportunity cost (interest foregone), and any fees required for license and storage of the equipment. Operating costs include fuel, lube and oil, repair and maintenance, track or tire replacement, and wire rope replacement. These cost components are used in standard engineering formulas such as average annual cost to determine the cost which must be recovered for a piece of equipment to break even. This is also the cost which would be charged against a crew on monetary incentives for use of the particular piece of equipment.

This report identifies the equipment cost components that a logging contractor needs to track, what cost records are available, and identifies areas where better records must be kept. There is also some discussion on the use of standard equipment cost formulas such as the Average Annual Investment (AAI) and marginal cost (next year's actual cost). A thorough discussion and derivation of the AAI method of equipment cost calculation can be found in Appendix C. Sample

calculations of equipment cost using both the average annual cost method and the marginal cost method can also be found in Appendix C.

OWNERSHIP COSTS--Ownership costs consist of depreciation, property tax, insurance cost, lost opportunity cost, and storage and license fees. Ownership costs are also known as fixed costs and occur whether the piece of equipment is being operated or sitting idle. Ownership costs are expressed on an annual cost basis or more commonly on a dollar per yearly scheduled machine hour basis (scheduled machine hours per year can be described as the number of shifts per year a machine is expected to work multiplied by the average hours per shift). Each component is described and the availability and use of existing records is discussed for each component.

Depreciation--Depreciation is the decrease in worth of an asset over time. Depreciation of logging equipment is brought about by the everyday wear and tear of operation gradually lessening the capability of the piece of equipment to perform its intended function. To a lesser extent, depreciation of logging equipment can be brought about by technological advances which makes a current piece of equipment obsolete.

Depreciation is recovered by subtracting the salvage value from the purchase price and dividing the result by the estimated useful life in years of the equipment. Normally, purchase price is reduced by the cost of track, tire, or wire rope replacement. If the scheduled machine hours per year are known an hourly cost is calculated. An example for a crawler tractor would be as follows:

```
$150,000  (purchase price plus tax and freight)
- 10,000  (track replacement cost)
========
$140,000
- 30,000  (salvage value)
========
$110,000  (depreciable amount)
```

If the estimated useful life is 8 years and the scheduled machine hours (SMH) per year are estimated to be 1600 (200 days/year X 8 hours/shift), then the depreciation cost becomes:

$110,000 / 8 years = $13,750 / year
[$13,750 / year] / [1600 SMH / year] = $8.59 / SMH

The method used above to calculate depreciation is the Straight-Line method and is normally used in equipment cost calculations due to its compatability with the AAI formula and its ease of use.

Availability of records needed to compute depreciation cost--In order for a logging contractor to estimate

depreciation cost, five values must be known: purchase price, track, tire, or line replacement costs, salvage value, estimated useful life in years for the piece of equipment, and scheduled machine hours of use per year for the piece of equipment. It is relatively easy to get purchase prices and track, tire, and line replacement cost from an equipment dealer, but the remaining figures are not always so easy to obtain. For example, salvage value of a piece of equipment can range anywhere from 0% to 30% of original purchase price.

Useful life and scheduled hours per year are estimates and often change. If a company kept records on similar pieces of equipment, then salvage value and life can be more accurately predicted. Neither Company A nor Company B kept records of this sort. The Caterpillar Performance Handbook is a good reference for estimating total ownership hours for a piece of equipment based on application and operating conditions. See Appendix D for an adaptation of this guide.

Weaknesses of using depreciation cost in monetary incentives--Although depreciation is a major component of equipment cost and is essential for cost control and planning, there are several weaknesses when applying it to monetary incentives. First, the estimates used for salvage value, years of life, and scheduled hours of use

can severely overcharge or undercharge a crew. As a simple example, assume that the depreciable amount calculated above ($110,000) is correct, the actual hours worked during the year is close to 1600, but the life of the machine turns out to be nine years instead of the estimated eight years. The actual yearly cost of depreciation would be $12,222 for nine years as compared to $13,750 for eight years. Actual hourly cost would be $7.64 for nine years compared to $8.59 for eight years. This means that the crew could be overcharged $0.95 in depreciation charges alone for each hour the machine is used. On the other hand, if the life of the machine turns out to be only seven years, then the contractor would be undercharging the crew $1.23 (an hourly cost of $9.82 for a seven-year life versus an hourly cost of $8.59 for an eight-year life).

Opportunity Cost--Opportunity cost is the amount of money a logging contractor foregoes by investing in a particular piece of equipment. If capital was borrowed to purchase the piece of equipment, the interest rate is established by the lender. The yearly opportunity cost becomes the amount of interest paid per year. If cash was used to purchase the equipment, the opportunity cost is the amount of money, or return, the contractor would like to receive if his money was invested elsewhere.

Typical rates of return range from 10% to 15%. In the AAI method of equipment costing, the yearly rate of return (expressed as a decimal), is multiplied by the AAI to determine the total amount of revenue needed to recover the opportunity cost. This cost is converted to a dollar per hour basis by dividing the total yearly opportunity cost by the scheduled machine hours for the year.

Availability of records for calculating an opportunity cost--There is no standard formula available for calculating a rate of return for an opportunity cost. If the equipment is financed, the rate of return used is the interest rate set by the lending institution. If the equipment is financed with company funds, a good starting point for a rate of return is the going interest rate given on loans for equipment purchase. A company could use this rate or raise or lower it as they feel necessary. If the company has a rate of return they are willing to accept for invested income, then this rate should be used in the calculation of opportunity cost.

Opportunity cost is a difficult concept for many contractors to understand and many do not have an established rate of return for company investments. Neither Company A nor Company B had a rate of return for

invested income. The opportunity cost is a major component of the equipment cost and the selection of a realistic rate of return greatly influences the dollar per hour ownership cost for a piece of equipment. See Appendix C for an example calculation of the opportunity cost.

Property Tax--Property tax is charged against the market value of a piece of equipment assessed at the start of the year. The rates vary depending on where the equipment is located as of January 1 of the year. Company A, for instance, had equipment located in several counties and school districts on the first of the year. As a result, Company A had approximately five different property tax rates assessed for varying amounts of equipment market values. To simplify this problem, a weighted average property tax rate should be calculated and applied against each piece of equipment. Property tax is not assessed against licensed and registered pickup trucks or crew vehicles.

Availability of property tax records--Property tax records are readily available and relatively easy to use. An individual billing is sent to the owner of the property for each tax base area. The bill includes the tax rate expressed in dollars per one thousand dollars

of market value and the total market value of the equipment at the tax base location. Individual pieces of equipment are not identified. The property tax for an individual piece of equipment can be determined by expressing the weighted average property tax rate as a ratio of market value and multiplying the AAI by this ratio. For example, if the property tax rate is $13.50 / $1000 of market value, the ratio of property tax to market value is $0.0135 / $1 of market value. Since the AAI represents the average annual investment or average market value, an estimate of the hourly charge for property tax for this example is:

(AAI X 0.0135) / scheduled machine hours = $/hr. charge

Since the property tax rate is based on the true cash market value of a piece of property, the method shown above is only valid when an average annual tax payment is desired. It will not be the actual yearly property tax payment for a piece of equipment. The true annual tax payment will be higher or lower depending on the age and market value of the piece of equipment being costed. However, for planning purposes or monetary incentives, an average annual payment may be used.

Insurance--Most logging contractors will carry insurance

on their logging equipment and vehicles to cover the cost of any loss due to fire, theft, or other damage. This cost must also be recovered when calculating the hourly rate to own a piece of equipment. For both Company A and Company B, insurance rates for logging equipment were determined on a dollar per thousand dollar of market value much the same as property tax. The market value the insurance company used was the same value used for property tax assessment. This makes the calculation of insurance charges very simple.

Availability of insurance records--The rates charged for insurance on a piece of equipment are readily available from the insurance policy or by contacting the insurance agent. Both Company A and Company B had a blanket policy with insurance rates in the area of $8.00 / $1000 of market value regardless of the age of the equipment. The method used to calculate the yearly insurance charge for logging equipment is the same method used to calculte the property tax charge. Vehicles such as pickups used for crew travel are not charged the same rate as other logging equipment. Typically, these vehicles are charged a monthly policy premium. The total yearly insurance payment is easily calculated from these monthly payments.

Storage Fees--If there is a charge for storage of a piece of logging equipment, this charge must be reflected in the dollar per hour rate calculated for the ownership cost. Neither Company A nor Company B had any fees charged for storage of equipment. Both companies either kept the equipment on job sites during the year or stored it at their own shop location. If storage is being charged, it can be treated as a percent of AAI much like property tax or insurance, or the actual rate can be determined by dividing the annual storage charge by the scheduled machine hours for the year.

License Fees--Logging equipment including fire trucks is not subject to licensing fees. Trucks used for highway travel do have a license fee. The yearly license fee must be divided by the yearly scheduled machine hours to determine the dollar per hour charge. Another option is to treat the license fees as a percent of AAI.

Handling inflation in ownership costs--Since the costs calculated by the AAI method are for a base year, the effect of inflation should be taken into account. Multiplying the current ownership cost by the annual rate of inflation adjusts for the effects of inflation. For example, if the calculated ownership cost is $20.00/hour in the base year (1987), and the inflation

rate for 1988 is estimated to be 5%, then the ownership cost for 1988 would be recalculated to be: $20.00/hour X 1.05 = $21.00/hour.

This method assumes that all components of the ownership cost are inflating at the same rate. An example of inflating ownership costs can be found in Appendix C. The bottom line when dealing with inflation is to realize that the costs calculated in the base year will not be high enough to cover the same costs in future years due to the effects of inflation.

When to use the AAI method or the marginal cost method for calculating ownership costs--As discussed in Appendix C, the AAI method calculates the average capital invested in a piece of equipment during its estimated useful life. If a piece of equipment is used beyond its estimated useful life, it is technically incorrect to use the AAI method to estimate ownership costs. This is because the estimated life of the equipment (from a calculation standpoint) is now zero years and the average capital invested in the piece of equipment is now the current market value. This current market value may not be the same as the salvage value used in the AAI calculation.

It is neccessary to switch to a marginal cost (next year's actual cost) if a piece of equipment is used

beyond its useful life. The opportunity cost, property tax, insurance costs, and, if applicable, license fees and storage, should be expressed as a ratio of current market value. Depreciation charges are no longer calculated since these charges have been recovered. Ownership costs using the marginal cost method should be calculated yearly due to flucuations in market value for a piece of equipment. These ownership costs will be much less than those estimated using the AAI method but more accurately portray the true ownership costs. Inflation will be taken into account if ownership costs are calculated yearly using the marginal cost method. A sample calculation using the marginal cost method for ownership cost is found in Appendix C.

OPERATING COSTS--Operating costs include fuel and lube costs, tire, track, and wire rope replacement costs, and repair and maintenance costs. Operating costs are also known as variable costs and are the result of operating a piece of equipment. Operating costs are converted to a cost per scheduled machine hour so that they can be added to ownership costs to arrive at a total cost per scheduled machine hour. This report describes each component of the operating cost. In addition, the records available to a logging contractor to track these costs and the ease of using these records is evaluated.

Where available, standard formulas, guidelines, and references are given to allow a contractor to estimate operating costs when records are lacking.

Fuel and Lube-- Company A did not measure fuel or lube consumption but rather gave an estimate of the amount of fuel used per machine hour (a machine hour is 60 minutes of machine work) for each piece of equipment studied. Company B purchased a fuel meter at the start of the study and tracked fuel consumption and machine hours of use for each piece of equipment studied. Use of lubricants was not tracked.

It's important to convert fuel and lubricant consumption based on machine hours to fuel and lubricant consumption based on scheduled machine hours. For example, if a piece of equipment uses 4.0 gallons of fuel for each machine hour it works but only works 6 machine hours out of a scheduled eight hour shift, then fuel consumption per scheduled machine hour becomes:

$$\frac{4.0 \text{ gallons}}{\text{machine hour}} \times \frac{6 \text{ machine hours}}{8 \text{ scheduled machine hours}} = 3.0 \text{ gallons/SMH}$$

This 3.0 gallons per hour figure can be multiplied by the dollar per gallon cost for fuel to determine the cost per hour for fuel consumption:

3.0 gallon / SMH X $0.80 / gallon = $2.40 / gallon

Availability of fuel and lubricant records--Fuel and lubricant records are available to logging contractors. In many instances, fuel and lube is delivered to the job site. The receipt for the fuel and lube usually shows the amount and type delivered and the unit cost for each. In order for a contractor to calculate an accurate average fuel and lube cost it is necessary to analyze fuel and lube records for a fairly long period of time, perhaps for a year or longer. A weighted average cost for a gallon of diesel and gasoline can be calculated from the fuel records. The total cost for lubricants for a period of time can be divided by the total cost of diesel and gasoline for the same time period to determine a prorated cost of lubricants for each dollar of fuel.

Another option a logging contractor has is to use the current cost of fuel and lubricants and update these costs when major price changes occur. This option has the advantage of being easy to use but does require good estimates of both fuel and lubricant consumption.

Once the fuel consumption per scheduled machine hour has been determined for a piece of equipment, the dollar per hour fuel cost can be calculated by multiplying the fuel consumption by the cost. Lubrication cost can be estimated by multiplying fuel cost by the prorated lube cost or by using actual lube

consumption and cost figures. For example, if diesel cost was determined to be $0.80 / gallon and lube was calculated to be $0.16 / $1 of fuel (prorated lube cost), then a realistic cost for fuel and lube consumption would be:

fuel consumption: 3.0 gal./scheduled machine hour (SMH)
fuel cost : 3.0 gal./SMH X $0.80/gal = $2.40 / SMH
lube cost : $0.16 / $1 of fuel or
0.16 X $2.40 / SMH = $0.38 / SMH

Estimating fuel and lube consumption--The Caterpillar Performance Handbook has several tables which show the hourly fuel consumption and the hourly consumption of lubricants for different classifications and uses of equipment. Another option is to use the following formula to estimate the gallons of fuel used per machine hour (adapted from Miyata, 1980):

$$GPMH = \frac{L \times FHP \times LF}{LPG}$$

Where GPMH is the gallons used per machine hour, L is the pounds of fuel used per horsepower-hour, FHP is the rated horsepower at the flywheel at governed engine rpm, LF is the load factor (the portion of full rated flywheel horsepower used during normal operations), and LPG is the weight of fuel in pounds per gallon. Typical values are given in Table 4.

Table 4. WEIGHTS, FUEL CONSUMPTION RATES, AND LOAD FACTORS FOR DIESEL AND GASOLINE ENGINES. (Adapted from Sessions and Miyata)

Engine type	Weight (LPG) lb / gallon	Fuel Consumption (L) lb / hp-hr	Load Factor (LF) Low	Med	High
Gasoline	6.0	0.46	0.40	0.55	0.70
Diesel	7.1	0.42	0.40	0.55	0.70

Lubricant consumption in gallons (GPMH) per machine hour can also be estimated by the following formulas (adapted from Sessions):

GPMH = 0.0002 x FHP (crankcase oil)
GPMH = 0.00007 x FHP (transmission oil)
GPMH = 0.00005 x FHP (final drives)
GPMH = 0.00002 x FHP (hydraulic controls)

These formulas include normal oil changes and no leaks. They should be increased 25 percent when operating in heavy dust, deep mud, or water. In machines with complex and high pressure hydraulic systems, such as forwarders, processors, and harvesters, the consumption of hydraulic fluids can be much greater. Another rule of thumb is that lubricants and grease cost five to fifteen percent the cost of fuel.

These estimates of fuel and lubricant consumption are calculated for a machine hour and must be converted to gallons per scheduled machine hour as discussed above. The cost per gallon for fuel or lubricants can then be multiplied by the gallons consumed per scheduled machine

hour to obtain a dollar per scheduled machine hour cost.

Tire, Track, or Wire Rope Replacement--Since tires, tracks, and wire rope usually do not have the same life as the piece of equipment, these items should be costed out separately. At the time of purchase, the cost of tire, track, or wire rope replacement should be determined. Labor should be included in this cost. An estimate of tire, track, or wire rope life needs to be made so that a dollar per hour cost can be determined.

Availability of records to determine tire, track, or wire rope replacement--Neither Company A nor Company B kept records to determine the life or cost of tire, track, or wire rope replacement. Replacement costs used in standard equipment cost formulas often assume new parts are used to replace the ones worn out. However, new parts are not always used to replace old ones. It is not uncommon to purchase used tracks or tires or to salvage these items from other machines. It is also not uncommon to do a partial replacement of tires or tracks. Estimates of tire, track, and wire rope life vary tremendously depending on operator, terrain, harvest conditions, and even weather.

A good record keeping system that tracks yearly replacement costs for individual pieces of equipment is desired for determining accurate costs. If records are

kept, a cummulative hourly cost can be derived by determining the total replacement cost and dividing this by the total scheduled machine hours during the same time period. For example, if for a three year period the total cost of track replacement was $10,000 and the total scheduled machine hours was 4800 hours, then the total cummulative hourly cost for track replacement becomes $10,000 / 4800 hours = $2.08 / hour.

Estimating tire, track, and wire rope life--There are few sources available that give estimates of tire, track, or wire rope life. Tire and track life are often expressed in hours while wire rope life is often expressed in total production achieved before replacement is required. Equipment dealers, manufacturers, and logging supply companies may be able to give an estimate of life. The Caterpillar Performance Handbook gives an estimate of tire life based on application zones. Zone A is where almost all tires actually wear through to the tread due to abrasion only. Zone B includes tires wearing out but others failing prematurely due to rock cuts, rips, and non-repairable punctures. Zone C has few if any tires ever wearing through the tread before having to be discarded, usually from rock cuts. Based on these application zones, the following tire life can be estimated.

TABLE 5. ESTIMATED TIRE LIFE BASED ON APPLICATION ZONE. (Adapted from the Caterpillar Performance Handbook)

Equipment	Tire Life, Hours		
	Zone A	Zone B	Zone C
Skidders	4000-6000	2000-4000	1000-2000
Wheel loaders	3000-6000	1000-3000	500-1000
Off-highway trucks	4000-6000	2000-4000	1000-2000

Note: The values found in this table are estimates of machine hours and must be converted to scheduled machine hours by the same method described in the section on fuel and lube consumption.

This table is based on the following assumptions:

1. New tires are run to destruction (this is not necessarily recommended).
2. Standard machine tires are used. Optional tires can be outside of these ranges.
3. Sudden failures due to exceeding tire rated loading is not considered, nor are premature failures due to punctures.

There is no known reference for estimating the life of tracks. Track life depends on operating conditions, terrain, and operator.

The U.S. Forest Service has developed a wire rope life guide (Table 6) for cable logging systems in the Pacific Northwest (McGonagill). This guide assumes the wire rope is properly maintained and used in accordance with manufacturer's recommendations.

TABLE 6. ESTIMATED WIRE ROPE LIFE BASED ON PRODUCTION. (McGonagill)

Logging System	Line Use	Line Size (Inches)	Line Life (MMBF)	Line Classification
Standing Skyline	Skyline	1 3/4	20 to 25	6 x 21
		1 1/2	15 to 25	6 x 21
		1 3/8	8 to 15	6 x 21
	Mainline	1	10 to 15	6 x 26
	Haulback	3/4	8 to 12	6 x 26
		7/8	8 to 12	6 x 26
Live Skyline	Skyline	1 1/2	10 to 20	6 x 21
		1 3/8	8 to 15	6 x 21
		1	6 to 10	6 x 26
	Mainline	1	10 to 15	6 x 26
		3/4	8 to 12	6 x 26
		5/8	8	6 x 26
	Haulback	7/8	8 to 12	6 x 26
		3/4	8 to 12	6 x 26
		1/2	6 to 10	6 x 26
	Slackpulling	7/16	5 to 8	6 x 26
Running Skyline	Mainline	1	8 to 12	6 x 26
	Haulback	3/4	4 to 8	6 x 26
High Lead	Mainline	1 3/8	8 to 15	6 x 26
		1 1/8	6 to 12	6 x 26
	Haulback	7/8	6 to 12	6 x 26
Strawline		3/8 to 7/16	5 to 8	6 x 19
Carriage	Skidding	1/2	.5	6 x 26
		7/8	3 to 5	6 x 26
Guylines			4 years	6 x 25
Skyline chokers		1/2 to 3/4	.2 to .3	6 x 25

Note: This table shows wire rope life based on total production. For an example of converting wire rope life to total hours from total production, see Appendix E.

Weaknesses of using tire, track, or wire rope replacement costs in a monetary incentive program--Unless records have been kept on similar pieces of equipment in similar operating conditions, the cost of tire, track, or wire rope replacement is an estimate that can severely overcharge or undercharge a crew on monetary incentives. As a simple example, suppose an estimate of tire replacement (at time of replacement) for a skidder was $1200 per tire plus $300 in labor. The estimated life due to the rough terrain was 1200 hours. Total cost for tire replacement would be estimated at $5100 or $5100 / 1200 hours = $4.25 / hour. If the tires actually lasted 1600 hours, this would reduce the replacement cost to $3.19 / hour, or $1.06 / hour less than originally estimated.

Repair and Maintenance--Repair and maintenance costs include everything from routine maintenance items to major overhauls of engines, transmissions, clutch, brakes, or other major components. Routine lube and oil changes are often covered under the lube and oil costs. Normally, parts and labor are included in repair and maintenance costs while shop and repair vehicles are included in administrative overhead.

Records available for repair and maintenance cost--Neither Company A nor Company B kept repair and

maintenance records on individual pieces of equipment. Parts and supplies were often lumped together under one expense account so that the cost of actual parts used in the repair of a piece of equipment was often impossible to determine. Each company had full-time mechanics employed so the total labor cost for repair and maintenance could be tracked. However, neither company tracked the labor cost. Company A made an estimate of the total repair and maintenance cost for each piece of equipment, but this would not have been accurate enough for a monetary incentive program. For Company B, a total repair and maintenance cost was determined and assigned to the timber sale that was operating. This also would not have been accurate enough to use in a monetary incentive program.

Repair and maintenance estimation techniques available for use--There are at least three repair and maintenance cost techniques available for use. The Caterpillar Performance Handbook (Edition 16) has a series of charts developed for different classes of equipment. An estimate of the dollar per hour cost for repair and maintenance for varying operating conditions can be read directly from the charts. An "extended-life multiplier" is used to correct the cost depending on total estimated hours of machine use. These costs are only averages and the Caterpillar Performance Handbook recommends talking

to a Caterpillar dealer for more accurate cost figures. These costs also do not include any increase for inflation and must be updated yearly. Also, any repair and maintenance required for the undercarriage is excluded from these charts and must be calculated separately.

A second method which is commonly used is to estimate repair and maintenance cost as a percentage of depreciation. Ranges typically given are shown in Table 7 (adapted from Sessions, McGonagill, Miyata).

TABLE 7. PERCENT OF DEPRECIATION COST TO USE TO ESTIMATE REPAIR AND MAINTENANCE COST.

EQUIPMENT	PERCENT RATE
chainsaw	90-100
crawler tractor	90-100
rubber-tired skidder (cable)	50-90
rubber-tired skidder (grapple)	60-100
cable yarder	50-65
mechanical skyline carriage	20
radio controlled carriage	100
radio signal systems	60
swingboom loaders (hydraulic)	50-80
swingboom loaders (cable)	30-60
rubber-tired front end loader	90
hydraulic felling shear	50-80

Example: If the depreciation cost for a cable yarder is $8.00 / SMH then repair and maintenance cost can be estimated at: $8.00 / SMH X 0.50 = $4.00 / SMH.

The repair and maintenance cost estimated with this technique will vary depending on life, hours of use per year, purchase price, and salvage value assigned to a piece of equipment. This technique should not be used

for anything other than an estimate of repair and maintenance. However, this technique is commonly used with the AAI method due to its simplicity.

The last technique is one that has been used by the Forest Engineering Research Institute of Canada (FERIC) but not in the United States. Research on more than 160 logging machines over a two year period was performed to determine the accumulated repair and maintenance cost (inflated to 1985 dollars) for different classes of logging equipment. Regression equations were then developed to determine accumulated repair and maintenance cost as a function of total hours of machine use. From this information, ratios of accumulated repair and maintenance cost at optimum equipment ages to purchase price of equipment were calculated. The ratios varied depending on operating conditions. This system is very accurate for the area and operations studied, and perhaps could be adapted to other areas by using adjusted ratios.

Handling inflation in operating costs--The effects of inflation in the operating costs are relatively easy to take into account if standard cost formulas are being used. The simplest way is to update the cost using current figures. For example, the current cost of fuel and lubricants would be used. Current costs of tire, track, or wire rope replacement would also be used. If

an estimate of repair and maintenance cost was made using a percent of depreciation, then this repair and maintenance cost must be inflated by the current inflation rate. If actual costs are tracked for tire, track, wire rope replacement, and repair and maintenance, then these costs should be inflated to reflect the current year's cost. Appendix C shows an example calculation of equipment cost taking inflation into account.

Using the marginal cost method and operating costs--When using the marginal cost method (next year's actual cost) fuel and lube costs should be calculated the same as the AAI method. Tire, track, and wire rope replacement cost can be reflected in an increase in market value and do not have to be costed out separately. As long as market values are determined yearly this method is appropriate. The actual annual repair and maintenance cost, estimated from records, would be used. To insure accurate costs, marginal costs should be updated yearly. See Appendix C for an example of cost calculation using the marginal cost method.

COLLECTING PRODUCTION DATA FROM EXISTING RECORDS

Production described in this report is the amount of volume that is hauled and scaled from a particular timber sale or unit in a designated period of time. The volume designation will be MBF although other units of measure such as cunits, tons, or cords may be applicable for other areas or timber sales. Three means of collecting and analyzing production data are addressed in this report: half reports, truck ticket tabulations, and tracking individual loads.

HALF REPORTS--Half reports are a record of volume hauled and scaled for a time period of one-half month. Most of the mills in southwest Oregon issue half reports to their logging contractors. Production figures that can be obtained directly from half reports include total net MBF, total gross MBF, adjusted gross MBF (adjusted gross MBF is the amount of usable utility cull or select cull), total loads hauled for the period, and total logs hauled for the period. Averages for MBF/day, MBF/load, logs/day, and logs/load can be derived from the half reports. Some half reports show more detail such as bureau scale ticket number, load receipt number (mill receipt number), delivery date, truck number, number of logs on the load, and a breakdown of the volume on the load.

Half reports are the basis of payment from the mill to the logging contractor. A contractor may have as the basis of payment total gross MBF, total net MBF, or a combination of gross MBF and adjusted gross MBF. Half reports are received by the logging contractor approximately ten days after the half ends.

Strengths of using half reports to track production-- Half reports are a concise report that are useful for tracking volume from a sale. They are good for a cummulative record of the volume being removed from a sale. A company that is interested in tracking production and costs on a sale basis can match up the volume figures on a half report to the costs incurred in the same time period.

Weaknesses of using half reports to track production-- There are several shortcomings to using half reports to track volume that is used as a basis of payment for a monetary incentive program. A half report may not show all volume actually hauled during the half. Some loads hauled on the last day of the half may carry over to the next half. This could cause a long delay in the settlement of a setting especially if the setting changes on the last day of the half. Half reports do not show the production of individual sides or crews. If more than one company crew is working on a timber

sale, the half report reflects the entire sale volume.

Cold decked volume is not reflected on the half reports. This could become a problem if cold decked volume is the result of more than one crew and the volume is hauled during the same half. Finally, it may be necessary to cross reference individual loads to the half report if discrepancies arise. Some half reports do not show individual loads which would make resolving any conflicts impossible. For an incentive program to be successful, individual loads must be tracked and cross referenced to some type of scale report. Truck ticket tabulations and individual scale tickets will do this.

TRUCK TICKET TABULATIONS--In southern Oregon, a truck ticket tabulation sheet is available from the log scaling and grading bureau. This sheet is a daily record of the amount of volume that is scaled for a particular sale. The following information is contained on the sheet: the source of the volume including purchaser, sale name, logging contractor, and brand identification number; the delivery point of the volume; the scaling location; the date scaled; the date the report is issued; the bureau scale ticket number; the load number (this is the U.S. Forest Service, Bureau of Land Management, or private landowner identification number); and a breakdown of volume for each load

including gross board feet, adjusted gross board feet, net board feet, and number of logs. The report also totals each of the volume figures. This report is received approximately three to five days after the scaling date.

Strengths of using truck ticket tabulations to track production--Truck ticket tabulations are a daily record of the volume that is removed from a timber sale. The reports are easy to understand and most of the data needed for a monetary incentive program is located on this report.

Weaknesses of using truck ticket tabulations to track production--Truck ticket tabulations track the daily volume hauled and scaled from a timber sale. If two or more crews are operating on one sale, the truck ticket tabulations will not break out individual crew production. Another weakness of truck ticket tabulations is that it is possible for a load hauled on one day to be reported on another day's tabulation sheet. Finally, truck ticket tabulation sheets do not record when crews switch from one unit to another. A change in an incentive payment unit would not be recorded if truck ticket tabulations were the only source of tracking production.

TRACKING INDIVIDUAL LOADS--There is a relatively simple means of tracking the volume that a yarding and loading crew produces from a setting. The loader operator or some other member of the crew should record the number of each load that leaves the landing on a daily basis. If the incentive payment unit changes during the day, this should be clearly noted on the form being used to record the load numbers. The load numbers recorded must be easy to cross reference to the truck ticket tabulation sheets or to individual load scale tickets. Individual scale tickets are available from the scaling bureau or mill to which the loads are delivered. The overall objective of tracking individual loads is to assign the proper volume from a designated unit to the proper yarding and loading crew.

MAINTAINING SAFETY AND QUALITY STANDARDS

A properly administered operation must have the means to maintain safety and quality standards at a desired level. Without control over these items the cost of the operation could increase as Workers' Compensation premiums rise due to an increased accident rate or as logging contracts become harder to obtain due to a reputation of a poor quality job. Quality involves both log quality (logs manufactured to purchasers' specifications) and contract compliance quality (proper utilization and environmental quality such as brush disposal and erosion control).

Most operations have little more than administrative means (training, disciplinary action, termination, etc.) to control infractions of quality or safety standards. Monetary incentives, however, can incorporate safety and quality into a well administered program. See Appendix H for a discussion of maintaining safety and quality in monetary incentive programs.

SUMMARY AND RECOMMENDATIONS

LABOR COST--Labor cost records are available and are relatively easy to use. The primary components of the labor cost for logging crews include wages, partner draws, Workers' Compensation, Social Security tax, and state and federal unemployment tax. These primary components are required by law and with the exception of Workers' Compensation can be influenced very little by crew activities. Workers' Compensation costs can be reduced if the company maintains a good safety record. Some additional labor costs which may have to be tracked include supervision, health insurance, travel pay, vacation and holiday pay, and retirement pay. For monetary incentive purposes, these additional costs should be separated from the primary costs. The crew may decide to eliminate some of these costs in order to increase the bonus payment.

It is recommended that a labor burden factor be calculated to simplify the tracking of labor costs. Since Social Security tax and unemployment tax have upper gross wage limits, an adjusted labor burden factor should be developed for these components based on actual annual tax paid. Workers' Compensation charges should only be made against regular wages and the regular portion of overtime wages. Partner draws should have a

separate labor burden factor developed. Inaccuracies in the labor cost will result if these guidelines are not followed. If an unadjusted labor burden factor is used, labor cost calculated will be higher than the actual cost. This variation may be substanial with respect to monetary incentive programs but minor for planning purposes. With care labor cost can be tracked accurately enough to be used in monetary incentive programs. One company did track their labor cost but did not use a labor burden factor.

EQUIPMENT COST--Equipment costs can be split into ownership costs and operating costs. In order to track accurate ownership costs purchase price, estimated years of life, salvage values, a company interest rate, property tax, insurance rates, and any fees for storage and license must be known. Operating costs include repair and maintenance, fuel and lube consumption, and tire, track, or wire rope replacement costs.

Determining realistic equipment costs to charge logging crews is difficult at best. Purchase prices (new or used), property tax rates, and insurance rates can be easily determined from available records. Salvage values, estimated years of life, and determining a company interest rate are more difficult. The AAI method of equipment costing was illustrated in this

report. This method combines straight-line depreciation with the additional annual costs to determine a total annual ownership cost.

Records to determine the operating portion of equipment cost were non-existant for both companies. Fuel and lube receipts were available but no records of fuel or lube consumption was being kept for individual pieces of equipment. No records were available for tire, track, or wire rope replacement life or cost of replacement. Repair and maintenance records are not being kept by the two companies studied. Each company employed full-time mechanics. Parts and supplies were recorded into one account. This made the approximation of total labor cost and total parts and supplies cost possible but individual equipment repair and maintenance cost impossible. There are several operating cost guidelines available, especially in the area of repair and maintenance. These may have some value in estimating total operating cost, but would not be valuable for use in a monetary incentive program.

Any method used to determine equipment costs must be fully understood with respect to limitations and sensitivity to flucuations in costs, salvage values, and equipment life. It would be best for a company to standardize equipment costing by using a method such as the AAI. Equipment costs should be inflated yearly.

Also, if a piece of equipment is being used beyond the estimated life used in the calculation of equipment cost, then switching to another method such as the marginal cost will show a decrease in the ownership portion of costs.

PRODUCTION RECORDS--There are several types of production records available for a contractor to use. Half reports are an excellent way to track the volume being removed from a timber sale. However, they will not track unit volume nor individual crew volume if more than one crew operates on a sale. Also, half reports are normally received ten days after the half ends which could cause delays in the incentive unit settlement. Truck ticket tabulation reports are available in southern Oregon from the log scaling and grading bureau. These reports are a concise record of individual loads hauled from a sale on a daily basis. Load identification numbers are located on the report. Truck ticket tabulations are normally obtained at the option of the contractor for a fee. The shortcomings of using truck ticket tabulations are a lack of tracking production from an individual crew and an occasional load being hauled on one day and reported on another's day truck ticket tabulation report. Truck ticket tabulation reports are normally received three to five days after scaling.

If a contractor is interested in tracking individual crew volume, individual loads must be tracked at the landing. The easiest way to do this would be to have the loader operator record the load identification number of each load leaving the landing. The date, unit identification, and an identification number that can be crossed referenced with a volume report such as truck ticket tabulations or individual scale tickets must be recorded.

In summary, adequate production records are available to track sale volume, unit volume, and individual truck load volume. The amount of record keeping necessary to track volume will depend on the intended end use of the volume figures. Monetary incentive programs will require accurate production records to be kept. It should be possible to track cost and production records for the same time period to determine the unit cost of production.

MAINTAINING SAFETY AND QUALITY STANDARDS--Most logging operations have little more than administrative means to control infractions of safety or quality standards. Monetary incentives can incorporate safety and quality into a well administered program. As discussed in Appendix H, current methods being used in monetary incentive programs to maintain safety and log quality

can be adapted to incentive programs implemented by independent logging contractors. Most importantly, the price or production rate negotiated for an incentive unit must allow for safe operation and log quality to desired specifications.

Incorporating compliance work quality into an incentive program for cable logging crews is desirable. Cable logging crews normally have a minor amount of compliance work, such as yarding unutilized material or a minor amount of streamcourse cleanout. These items should be included in the negotiated rate set for the incentive unit. These items would then be required to be completed prior to settlement of the incentive unit.

The question of including compliance items in an incentive program for ground-based logging crews becomes more involved when items such as machine brush piling are involved. It would be best if all compliance items are included in the negotiated rate set for the incentive unit and final settlement made upon completion of the unit. Another option would be to include some items, such as yarding of unmerchantable material, in the negotiated rate. Other compliance work, such as brush piling, would be treated as a separate job and would not affect the skidding crew.

RECOMMENDATIONS--From the research completed, several

recommendations can be made concerning future projects:

1. Develop cost collection and record keeping systems for logging contractors. These systems must be able to track individual crew costs and production. The entire program could possibly be tied in with the crew payroll. A computer software package would be best, but a manual method should also be considered. A users' guide would be an integral part of any record keeping system developed.

2. Educate logging contractors as to what cost components must be tracked. The limitations of equipment cost calculations, such as those inherent to the AAI method, should be fully understood. This can take place through publications, seminars, and the extension branch of Oregon State University.

3. Develop a data base for equipment cost with special emphasis on the operating component. Perhaps a study of manufacturers, equipment dealers, mechanics, and logging contractors could be conducted to determine a regional average for repair and maintenance costs. These costs could then be expressed in regression equations, tables, or as a ratio of repair and maintenance cost to new equipment purchase price.

APPENDICES

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APPENDIX A

1. SHIFT-LEVEL DATA COLLECTION FORM

DAILY PRODUCTION AND COMPLIANCE WORK REPORT

IDENTIFICATION
SALE NAME: UNIT NUMBER _____

DATE _____ DAY OF WEEK S M T W TH F S

TYPE OF COMPLIANCE WORK (IF ANY) _____

CREW INFORMATION NAME	HOURS (TOTAL)	COMPLIANCE WORK HRS.
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____
CREW MEMBER_____	_____	_____

EQUIPMENT INFORMATION

EQUIPMENT ID	HOURS TOTAL	HOURS COMPLIANCE	DOWN TIME/REASON	FUEL
_____	_____	_____	_____	____
_____	_____	_____	_____	____
_____	_____	_____	_____	____
_____	_____	_____	_____	____
_____	_____	_____	_____	____
_____	_____	_____	_____	____

PRODUCTION

NO. OF TRUCKS LOADED AT LANDING _____

LOAD ID NUMBERS: FROM _____ TO _____
FROM _____ TO _____

ESTIMATE OF COMPLIANCE WORK COMPLETED (ACRES, STATIONS) _____

MISCELLANEOUS
LANDING CHANGE TIME _____ TEMP. RD AND SKID TRAIL
COMMENTS: CONSTRUCTION TIME_____

FORM FILLED OUT BY: _____

APPENDIX B

1. CREW AND SALE CHARACTERISTICS

COMPANY A, SALE 1

CREW	EQUIPMENT
Hooktender	Skookum Tyee Slackline Yarder
Yarder Engineer	SC-40 Danebo Yarder
Loader Operator	Lorrain Loader (Hydraulic)
Chaser	Landing Crawler Tractor
Rigging Slinger	Rubber-tire Skidder
Choker Setter	Fire Truck
Choker Setter	Fuel Truck
Choker Setter	Crew Van
	Side Rod Pickup
	Chain Saws (2)

UNIT SUMMARY

Unit Number	Acres	Type of Cut	Loads Hauled
1	42	partial	151
2	25	partial	24

COMPANY A, SALE 2

CREW	EQUIPMENT
Hooktender	Skagit GT-3 Running Skyline Yarder
Yarder Engineer	W / Danebo MSP Carriage
Loader Operator	Northwest Cable Loader
Chaser	Landing Crawler Tractor
Second Chaser	Fire Truck
Rigging Slinger	Fuel Truck
Choker Setter	Crew Van
	Side Rod Pickup

UNIT SUMMARY

Unit Number	Acres	Type of Cut	Loads Hauled
1	22	clearcut	29
2	23	partial	185
3	13	clearcut	36

COMPANY B, SALE 1

CREW

Loader Operator (Partner)
Crawler Operator/Loader Operator (Partner)
Crawler Operator
Rubber-tired skidder Operator
Chaser (Partner)
Chaser
Choker Setter
Crawler Operator (Brush Crawler)
Laborer (W / Brush Crawler)

EQUIPMENT

Cable Loader
Cable Loader
Rubber-tire Skidder
Crawler w/grapple
Crawler
Crawler
Crawler (brush)
Crew Van
Partner Pickups (3)
Fire Trucks (2)
Chain Saws
FM Radios

UNIT SUMMARIES

Unit Number	Acres	Type of Cut	Loads Hauled
1	22	partial	115
2	13	partial	75
3	26	partial	131
4	3	partial	5
5	14	partial	5
6	14	clearcut	30
7	20	clearcut	115
8	45	thinning	175
9	12	partial	180
10	10	clearcut	190

APPENDIX C

1. DERIVATION OF THE AVERAGE ANNUAL INVESTMENT (AAI) METHOD

2. EXAMPLE CALCULATION OF EQUIPMENT COST USING THE AAI METHOD

3. EXAMPLE CALCULATION OF EQUIPMENT COST USING THE MARGINAL COST (NEXT YEAR'S ACTUAL COST) METHOD

4. EXAMPLE OF INFLATING EQUIPMENT COST

1. DERIVATION OF THE AVERAGE ANNUAL INVESTMENT

The Average Annual Investment Method for equipment ownership cost was originally known as the Straight-Line Depreciation plus Average Interest Method. It was originally used to determine equal annual costs of depreciation plus interest (lost opportunity cost). It has now been adapted to determine equal annual costs for depreciation, interest, property tax, insurance, storage, and license fees. The earliest derivation of this method can be found in Taylor, G.A., 1966, "Managerial and Engineering Economy". So that the user will understand this method more fully, it is derived here.

The formulation assumes that the recovery of capital is on a straight-line basis, that is, an equal amount is recovered each year. It also assumes that the value of the investment drops at the end of the year, as shown in Figure 1. It must be noted that because the investment decreases each year by (P-S)/N, the annual depreciation charges are equal, but the remaining costs are not. For example, the interest charges at the end of year one will be much higher then those at the end of the equipment life. Since we want to compute *equal* annual costs we must use the average annual amount of capital invested in a piece of equipment over its estimated useful life.

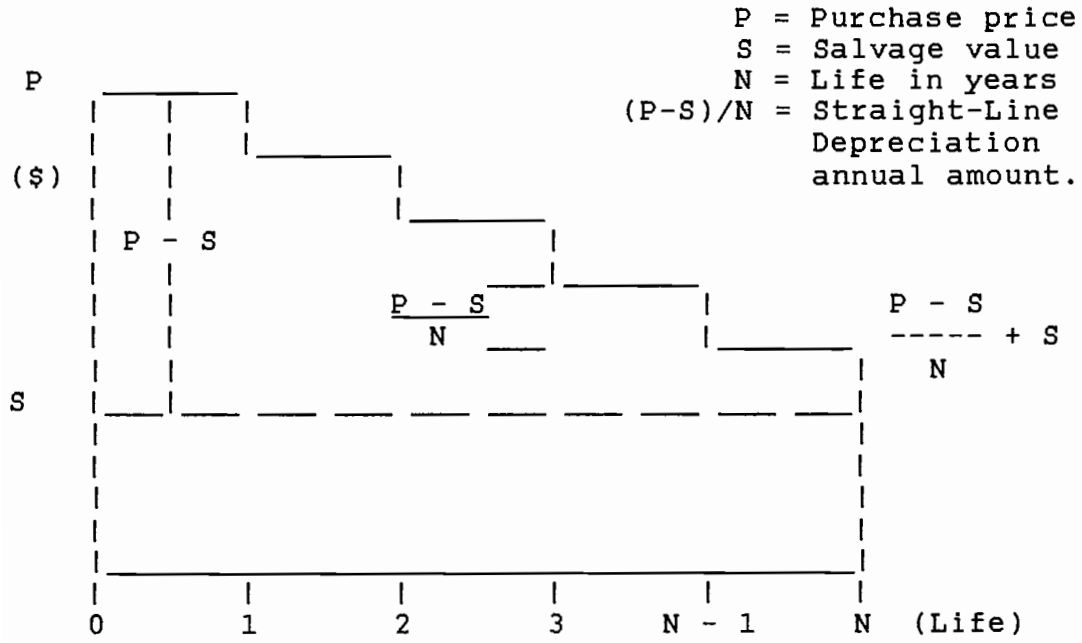

FIGURE 1. CAPITAL RECOVERY WITH THE STRAIGHT-LINE METHOD.

The average annual investment (this is where the name AAI method comes from) is derived in the following manner.

The amount of capital invested the first year is:

$S + (P - S)$

The amount of capital invested the last year is:

$S + (P - S)/N$

The average of this is equal to:

$1/2\ [S + (P - S) + S + (P - S)/N] \Rightarrow$

$1/2\ [2S + (P - S) + (P - S)/N] \Rightarrow$

$2S/2 + [(P - S)/2 + (P - S)/2N] \Rightarrow$

$S + [N(P - S)/2N + (P - S)/2N] \Rightarrow$

$S + [N(P - S) + (P - S)]/2N \Rightarrow$

$S + [(P - S)(N + 1)/2N] = AAI$

Since the AAI is the Average Annual Investment in a piece of equipment, an annual cost for interest, property tax, insurance, storage, and license fees can be determined by expressing these costs as a ratio of AAI. The total ownership cost per year is the depreciation cost per year plus these other annual costs:

$$AC = (P - S)/N + (AAI) \times I$$

I = costs expressed as a ratio of AAI

The AAI method works as well for a used piece of equipment as long as the remaining life and salvage value can be estimated. However, if a piece of equipment is used beyond its estimated useful life the AAI method no longer holds. Actual ownership costs of a piece of equipment used beyond its estimated useful life would be much lower than those calculated using the AAI method. Another method, such as the marginal cost (actual cost) method should be used for a piece of equipment being used beyond its estimated useful life. The next part of this appendix shows the calculation of equipment cost using the AAI method. Following this is a sample calculation of equipment cost for the same piece of equipment being used beyond its useful life. The marginal cost method is illustrated for this case.

2. CALCULATION OF CABLE LOADER COST USING THE AAI METHOD

LET:

P = $190,000 (purchase price plus sales tax and freight minus tire replacement cost)

S = $38,000 (salvage value, 20% of P)

N = 8 (estimated years of life)

SMH=1600/yr.(estimate of scheduled machine hours per year) (200 scheduled shifts per year X 8 hours per shift)

I = 12% (.12) (inflation free company interest rate)

Property tax rate = $14.50 / $1000 of market value or $0.01450 / $1 of average annual investment

Insurance rate = $8.75 / $1000 of market value or $0.00875 / $1 of average annual investment

$$AAI = \frac{(P - S)(N + 1)}{2 \times N} + S$$

$$AAI = \frac{(190000 - 38000)(8 + 1)}{2 \times 8} + 38000 \Longrightarrow AAI = \$123,500$$

<u>OWNERSHIP PORTION OF COSTS</u>

$$\text{Depreciation (Straight-line method)} = \frac{(P - S)}{N} = \frac{190000 - 38000}{8 \text{ yrs.}} = \$19,000/\text{yr.}$$

Interest / year = AAI X I = $123,500 X .12 =$14,820/yr.

Property tax/year=AAI X .01450=$123,500 X 0.0145=$1,791/yr.

Insurance / year =AAI X .00875=$123,500 X 0.00875=$1081/yr.

Total Ownership Cost per Year=$36,692
Total Ownership Cost per Hour=$36,692/1600 SMH =$22.93/SMH
==========

OPERATING PORTION OF COSTS

Repair and Maintenance (50% of depreciation)
Repair and Maintenance = $19,000 X .50 = $9,500 / yr.

$9,500 / 1600 SMH = $5.94 / SMH

Fuel Consumption=2 gallons per machine hour. Assume loader works 7.5 hours per scheduled 8 hour day.

$$\frac{2 \text{ gallons}}{\text{machine hour}} \times \frac{7.5 \text{ machine hours of work}}{8 \text{ scheduled machine hours}} = 1.9 \text{ gallons / SMH}$$

1.9 gallons / SMH X 1600 SMH /year = 3040 gallons / year
3040 gallons / year X $0.80 / gallon = $2,432 / year
1.9 gallons / SMH X $0.80 / gallon = $1.52 / SMH

Lube and Oil=$0.20/$1 of fuel=.20 X $2,432/yr.=$486 / year
$0.20 / $1 of fuel = .20 X $1.52 = $.30 / SMH

Subtotal Operating Costs per Year = $12,418 /yr.

$$\text{Subtotal Operating Costs per Hour} = \frac{\$12,418}{1600 \text{ SMH}} = \$7.76 / \text{SMH}$$

$$\text{Tire Replacement Cost} = \frac{\text{Replacement cost } \$10,000}{\text{Estimated life (SMH) } 3000} = \$3.00/\text{SMH}$$

Total Operating Cost = $10.76/SMH

Total Equipment Cost (Ownership + Operating) = $33.69/SMH

For each hour the loader is scheduled to work, it must recover $33.69 to break even. This is also the hourly amount a crew on incentives would be charged to use this loader. A daily rate could also be determined using this cost.

3. EXAMPLE CALCULATION USING THE MARGINAL COST METHOD (NEXT YEAR'S ACTUAL COST)

Assume the loader in the previous example is being used in year nine. Since the loader was previously costed using an estimated life of eight years, it is incorrect to continue to use the AAI method of cost calculation. The average annual investment now becomes the current market value of the piece of equipment. For simplicity of calculation, the market value should be the fair market value at the start of the year and may include any value for tire, tracks, and wire rope. Also, since the piece of equipment has been depreciated over eight years, there would be no depreciation charges when a marginal cost method is used.

Example:

Let the current market value (MV) = $40,000 (includes tires and wire rope)

SMH = 1600/yr. (estimate of scheduled machine hours per year; 200 scheduled shifts per year X 8 hours per shift)

I = 12% (.12) (company interest rate, or MARR)

Property tax rate = $14.50 / $1000 of market value or $.01450 / $1 of average annual investment

Insurance rate = $8.75 / $1000 of market value or $.00875 / $1 of average annual investment

OWNERSHIP PORTION OF COSTS

Depreciation (equipment has been depreciated) = $0 / yr.

Interest / year = MV X I = $40,000 X .12 =$4,800/ yr.

Property tax/year=MV X .01450 =$40,000 X 0.0145= $580 / yr.

Insurance / year =MV X .00875=$40,000 X 0.00875= $350 / yr.

Total Ownership Cost per Year = $5,730
Total Ownership Cost per Hour = $5,730/1600 SMH=$3.59 / SMH
==========

Note that when switching from the AAI method to the marginal cost method, the ownership cost decreases from $22.93 / SMH to $3.59 / SMH. This difference becomes significant when planning bids on timber sales or when charging a crew for a piece of equipment.

OPERATING PORTION OF COSTS

Repair and Maintenance (estimate of actual cost)=$15,000/yr.
$15,000 / 1600 SMH = $9.38/SMH

Fuel Consumption=2 gallons per machine hour. Assume loader works 7.5 hours per scheduled 8 hour day.

$$\frac{\text{2 gallons}}{\text{machine hour}} \times \frac{\text{7.5 machine hours of work}}{\text{8 scheduled machine hours}} = 1.9 \text{ gallons/SMH}$$

1.9 gallons / SMH X 1600 SMH /year = 3040 gallons/year
3040 gallons / year X $0.80 / gallon = $2,432/year
1.9 gallons / SMH X $0.80 / gallon = $1.52/SMH

Lube and Oil=$0.20 / $1 of fuel=.20 X $2,432 /yr.=$486/year
$0.20 / $1 of fuel = .20 X $1.52 =$.30/SMH

Operating Costs per Year = $17,918/yr
Operating Costs per Hour = $17,918 / 1600 SMH = $11.20/SMH

Tire and wire rope replacement costs have been included in the current market value using this method. As an option, these items can be costed out separately. Appendix E shows an example of estimating wire rope cost based on production.

Total equipment cost (Ownership + Operating)= $23,648/year
$23,648 / 1600 SMH = $14.78/SMH

Note that the total equipment cost using the AAI method is $33.69/SMH while the marginal cost method is $14.78/SMH.

4. EXAMPLE OF INFLATING EQUIPMENT COSTS

Assume that the cable loader costed in part 2 was for base year 1987. The loader will be used in 1988. To account for inflation, the 1987 base year cost should be inflated.

INFLATING OWNERSHIP COSTS

Assume:
General inflation rate = 6% (0.06) (estimate for 1988)

Inflate the ownership cost as follows:

ownership cost (current year) X (1 + general inflation rate) = ownership cost (next year)

22.93 / hr. X (1 + 0.06) = $24.31 / hr.

INFLATING OPERATING COSTS

Repair and Maintenance (inflate 6% (0.06))

$9,500 (1987) / year X (1 + 0.06) = $10,070 / year (1988)
$5.94 (1987)/ SMH X (1 + 0.06) = $6.30 / SMH (1988)

Fuel Consumption = 2 gallons per machine hour. Assume loader works 7.5 hours per scheduled 8 hour day. Estimated fuel cost (1988) = $0.85 / gallon.

$$\frac{\text{2 gallons}}{\text{machine hour}} \times \frac{\text{7.5 machine hours of work}}{\text{8 scheduled machine hours}} = 1.9 \text{ gallons/SMH}$$

1.9 gallons / SMH X 1600 SMH /year = 3040 gallons/year
3040 gallons / year X $0.85 / gallon = $2,584/year
1.9 gallons / SMH X $0.85 / gallon = $1.62/SMH

Lube and Oil=$0.20/$1 of fuel=.20 X $2,584 /yr.=$517/year
$0.20 / $1 of fuel= .20 X $1.62 = $.32 / SMH

Subtotal Operating Costs per Year = $13,171 / yr
Subtotal Operating Costs per Hour=$13,171/1600 SMH=$8.23/SMH

$$\text{Tire Replacement Cost} = \frac{\text{Replacement cost}}{\text{Estimated life (SMH)}} = \frac{\$10{,}500}{3000} = \$3.50/\text{SMH}$$
(1988 estimated cost)

Total Operating Cost = $11.73/SMH

Total cost (ownership plus operating) = $36.04/SMH

Note that inflation causes an increase of $2.35/SMH ($33.69/SMH (1987) versus $36.04/SMH (1988).

APPENDIX D

1. OWNERSHIP PERIOD GUIDE

TABLE D1. GUIDE FOR SELECTING OWNERSHIP PERIOD BASED ON APPLICATION AND OPERATING CONDITIONS.

TRACK-TYPE TRACTORS	Intermittent full throttle operation. No impact. Pulling scrapers, most agricultural drawbar, stockpile, and landfill work.	Medium impact conditons. Production dozing in clays, sands, gravels. Most land clearing and skidding applications.	Continuous high impact conditions. Heavy rock ripping. Pushloading and dozing in hard rock. Tandem ripping.
Small	12,000 Hours	10,000 Hours	8,000 Hours
Large	22,000 Hours	18,000 Hours	15,000 Hours
WHEEL SKIDDERS	Intermittent skidding for short distances, no decking. Good underfoot conditions: level terrain, dry floor, few if any stumps.	Continuous turning, steady skidding for medium distances with moderate decking. Good underfooting: dry floor with few stumps and gradual rolling terrain	Continuous turning, steady skidding for long distances with frequent decking. Poor underfoot conditions: wet floor, steep slopes, numerous stumps.
	12,000 Hours	10,000 Hours	8,000 Hours
Off Highway Trucks and Tractors	Well maintained haul roads. Construction use mostly on well maintained roads.	Varying loading and haul road conditions. Typical road-building use on a variety of jobs.	Consistently poor haul road conditions. Extreme overloading. Oversized loading equipment.
	25,000 Hours	20,000 Hours	15,000 Hours

Adapted from the Caterpillar Performance Handbook

See note on ownership guide, page 91.

TABLE D2. GUIDE FOR SELECTING OWNERSHIP PERIOD BASED ON APPLICATION AND OPERATING CONDITIONS.

WHEEL LOADERS	Intermittent truck loading from stockpile. Free flowing, low density materials. Light snowplowing. Load and carry on good surface for short distances with no grades.	Continuous truck loading from stockpile. Low to medium density materials in properly sized bucket. Loading from bank in good digging. Load and carry on poor surfaces and slight adverse grades.	Loading shot rock (large loaders). Handling high density materials with counterweighted machine. Steay loading from very tight bank. Continuous work on rough or very soft surfaces.
Small	12,000 Hours	10,000 Hours	8,000 Hours
Large	15,000 Hours	12,000 Hours	10,000 Hours
TRACK-TYPE LOADERS	Intermittent truck loading from stockpile. Minimum traveling, turning. Free flowing, low density materials with standard bucket. No impact.	Bank excavation, intermittent ripping, basement digging of natural clays, sands, silts, gravels. Some traveling. Steady full throttle operation.	Continuous work on rock surfaces. Large amount of ripping of tight, rocky materials. High impact conditions.
	12,000 Hours	10,000 Hours	8,000 Hours
MOTORGRADERS	Light road maintenance. Light snow plowing. Large amounts of traveling.	Haul road maintenance. Road construction, ditching. Medium to heavy snow removal.	Maintenance of hard pack roads with embedded rock. Continuous high load factor. High impact.
	20,000 Hours	15,000 Hours	12,000 Hours

Adapted from the Caterpillar Performance Handbook

See note on ownership guide, page 91

Note on ownership guides:

The ownership hours found in these guides are based on actual machine hours. Since there are more scheduled machine hours in a year than there are machine hours, the ownership period must be adjusted to reflect this. An example follow.

A small track-type tractor is operating in Zone B. The estimated total machine hours from the table is 10,000. The machine is scheduled to work 200 shifts with an average shift length of 8 hours. It is estimated that this machine will actually operate 6 hours of the 8 hour shift.

Scheduled machine hours/year=
200 shifts X 8 hours/shift=1600 smh/yr.

$$\text{Machine hours/year} = 1600 \text{ smh/yr} \times \frac{6 \text{ machine hours / shift}}{8 \text{ smh / shift}} =$$

1200 machine hours / year

The total life in years then becomes:
10,000 machine hours/(1200 machine hours /year)=

8.33 years (round to 8.5 years)

The 8.5 years is used to determine yearly depreciation charges. The hourly charge to recover is still based on scheduled machine hours. Example:

$$\text{Depreciation} = \frac{P - S}{N} = \frac{140{,}000 - 28{,}000}{8.5} = \$13{,}176/\text{year}$$

Hourly charge to recover per SMH=$13,176/1600 smh=$8.24/smh

APPENDIX E

1. CONVERTING WIRE ROPE LIFE BASED ON PRODUCTION TO LIFE IN HOURS.

CONVERTING WIRE ROPE LIFE BASED ON PRODUCTION TO LIFE IN HOURS

To convert an estimate of wire rope life from total production to scheduled machine hours, the following parameters must be known:

Gross MBF (or other measure) produced between wire rope replacement.

An estimate of average production (gross MBF) per day.

The average scheduled hours per shift.

As an example, assume the following:

Gross MBF produced between replacement = 6000 MBF
Gross MBF produced per day (estimated) = 40 MBF / day
Average scheduled hours per shift = 8.5 hrs

The number of days between replacement =

6000 MBF / (40 MBF/day) = 150 days

The number of scheduled hours between replacement =

150 days X 8.5 hours/day = 1275 scheduled machine hours

To determine the cost of line replacement, the following must be known:

Total wire rope length to be replaced.

Price per unit length of wire rope.

As an example, assume the following:

Total wire rope length = 2500 feet
Price per foot of wire rope = $1.34 / foot

The total cost of wire rope replacement is:

2500 feet X $1.34 / foot = $3350

The cost per scheduled machine hour for wire rope replacement becomes:

$3350 / 1275 SMH = $2.63 / SMH

APPENDIX F

1.BRIEF DESCRIPTION OF MONETARY INCENTIVE PROGRAMS

1. BRIEF DESCRIPTION OF MONETARY INCENTIVE PROGRAMS

Monetary incentive programs can be summarized in two general forms. One form negotiates a price, or "cost goal", to do a job. The job can be anything from road construction to yarding and loading a logging setting or unit. The price negotiated is usually stated in a price per unit of production, such as $/MBF or $/station. A pool of money is then generated by the crew by multiplying the contract rate per unit of production by the units produced. From this crew "revenue" pool expenses such as labor costs, equipment costs, penalties for safety or quality infractions, and administration costs are subtracted. The money remaining after subtracting all crew costs from the crew revenue is the bonus pool. This bonus pool is distributed among the crew in a variety of combinations. The crew may receive 100% of the bonus or they may get as low as a 50%-50% split with the company.

Another form of monetary incentives gives an increase in wages for an increase in a target production level. For example, if a target level of 1 MBF/man-hour was set and actual production of 1.1 MBF/man-hour was reached, actual production would be 10% higher than the target production. Wages would be increased by 10% as a result.

Additional information on these incentive programs and the subsequent distribution of the bonus pool is available in the paper "Logging Incentive Systems" (Olsen, 1987).

APPENDIX G

1. AN OVERVIEW OF OREGON'S WORKERS' COMPENSATION SYSTEM

AN OVERVIEW OF OREGON'S WORKERS' COMPENSATION SYSTEM

An overview of Oregon's Workers' Compensation system requires a description of the different agencies involved and the roles they play.

State Legislature:
1) Makes and ammends the laws governing the system.
2) Establishes the benefit levels for injured workers.

Governor:
Signs legislative measures into law.

Workers' Compensation Department (WCD):
Responsible for the enforcement and regulation of Oregon's Workers' Compensation Law.

Workers' Compensation Board (WCB):
Provides for the settlement and disposition of contested claims.

National Council on Compensation Insurance (NCCI):
A national rate-making organization, provides statistics to help insurance carriers set rates for job classifications. The Oregon Council on Compensation Insurance (OCCI) is an affiliate of NCII.

Oregon Insurance Commissioner:
Regulates activities of Oregon's insurance carriers.

Insurance carriers:
Ultimately set rates for job classifications based on the information provided by NCCI and OCCI. Provides coverage to employers and benefits to workers.

The calculation of insurance rates for Workers' Compensation is complicated at best. However, understanding the basics of rate setting is vital to good cost records. The National Council on Compensation Insurance is a national rating organization. They collect detailed payroll and claims statistics annually

from insurance carriers and use this information to develop annual "pure" premium rates. Pure premium rates are limited to what is required to pay claims and exclude consideration of administration expenses by individual insurance carriers. Rates differ by industry classification, according to the relative hazards of each.

Individual insurance companies modify the rates given by NCCI to cover administrative and business expenses. The rates for Oregon carriers can be twenty-five percent greater than those established by NCCI. Rates are based on a dollar per 100 dollars of payroll. For example, the rate for logging in Oregon is approximately $27 per $100 of payroll (1986 figure). This means that claims in the logging classification will average a total of $27 for each $100 of payroll. The cost of claims is transferred directly to the insured in the form of premiums. For each $100 of payroll in the logging classification, $27 of premium will be paid by the logging company.

Classification rates vary for each insurance carrier, but this variation will be slight since pure rates are set by NCCI and individual carriers wish to remain competitive. Some insurance carriers have a preferred rate which can further reduce the classification rates up to 10%. These preferred rates are given to companies that consistently have good

safety records and pay over a certain amount in premiums each year. Classification rates are updated annually by NCCI and take effect on January 1. The insured company may have a premium period which is different than January 1 to December 31. In this case, the rates in effect at the time of the premium renewal last for the entire premium period. A revised rate is assigned at the start of the next premium period.

The classification rates go through four adjustments before a final premium is reached. These four adjustments are: an adjustment for experience modification, a premium discount, a Workers' Compensation Department tax, and a workday tax. Each of these four adjustments will be discussed in detail.

Experience modification--The experience modification, also known as experience rating, is a means in which the manual rates for job classifications can be adjusted to reflect an individual company's loss expectations. The manual rate is a job classification average, most companies will not have claims that equal this average. To reflect this deviation from the average, the manual rates are modified based on the actual claims characteristics of the insured. If the insured has lower actual losses than expected, the manual rates are adjusted downward. If the insured has higher actual losses than expected, the manual rates are adjusted

upward. The actual and expected losses of an insured company is calculated by NCCI over a base period of time, usually three years.

Since the experience modification is being calculated during the current policy period the experience period is actually the first three of the last four years. For example, the experience rating for policy year 1987 would be calculated from company claims statistics for 1983, 1984, and 1985. For policy year 1988, the claims statistics for 1984, 1985, and 1986 would be used. Another important feature of the experience modification is that NCCI weights the frequency of accidents higher than the severity. This means that a company with fewer costly accidents may have a higher experience modification than a company with one or two severe accidents.

There are several ramifications of which to be aware when considering experience modification and monetary incentive programs. First, the experience modification is determined from a base period of the first three of the last four years as discussed above. This means that a company that had one or two bad safety years in the past four years could still have a high experience rating even though the current crew (who may be all new employees) has a very good safety record. Second, the experience rating is determined for the company as a whole. Individual crews are not

considered. A safe crew could be paying for the accidents or unsafe actions of another crew.

There is no easy solution to this problem with the way the current Workers' Compensation system is set up. A company with several crews may need to set up a system of deducting an amount of a crew's incentive pay based on the frequency of accidents. Also, a well administered monetary incentive program should not result in an increase in accidents. It's important that the members of the yarding and loading crew be aware of how this experience modification is set and how safe working practices can bring the cost of Workers' Compensation down while increasing the amount of incentive pay available.

Premium discount--A discount will be applied to the premium after it has been adjusted for experience modification. The discounts are based on the amount of expected annual adjusted premium paid during a policy year. No discount applies to the first $2,500 of annual premium. For 1986, the premium discounts are as follows:

AMOUNT OF ADJUSTED PREMIUM	PERCENT DISCOUNT
$2,501 to $10,000	6%
$10,001 to $30,000	10%
$30,001 to $50,000	12%
$50,001+	14%

Workers' Compensation Department tax--A tax is applied to the net premium (the experience modification premium minus the premium discount). This tax is used to cover the administrative costs of the Workers' Compensation Department and the Workers' Compensation Board. The tax rate is set by the state legislature and is the same for all companies. The rate remains in effect for the entire policy period. For 1986, the WCD tax rate was 12% of the net premium.

Workday tax--For each day or part day worked by each employee, a tax is assessed. Since January 1, 1984, a tax of $.26 per full day or part day worked per employee has been assessed. Fourteen cents is contributed by the worker while the remaining $.12 is contributed by the employer. This tax is used to support the Handicapped Workers' Reserve Fund, the Workers' Re-employment Reserve Fund, and the Retroactive Reserve Fund.

APPENDIX H

1. ASSESSING SAFETY AND QUALITY INFRACTIONS IN A MONETARY INCENTIVE PROGRAM

ASSESSING SAFETY AND QUALITY INFRACTIONS

A properly administered monetary incentive program must have the means to maintain safety and quality standards at a desired level. Without control over these items the cost of logging could increase as Workers' Compensation premiums rise due to an increased accident rate or as logging contracts become harder to obtain due to a reputation of a poor quality job. Quality involves both log quality (logs manufactured to purchasers' specifications) and contract compliance quality (proper utilization and environmental quality such as brush disposal and erosion control).

METHODS CURRENTLY BEING USED-- There are methods being used to insure safety and quality are maintained within the framework of a monetary incentive program.

Safety--The contract rate negotiated to do a job is always calculated with safety in mind. The rate is based on a production amount that the crew can reach while working in a safe manner. Administrative controls are often used to maintain safety standards. This involves the logging foreman or supervisor talking to the crew, identifying the problem, and having both the crew and company, if necessary, take corrective action to eliminate the problem. If the problem persists,

other actions such as dismissal of employees may become necessary. In combination with administrative controls, there are several methods used that penalizes the crew monetarily for safety infractions. If the cost of Workers' Compensation increases this cost is passed on to the crew in the form of a higher labor burden. This can decrease the amount of bonus pool that is available to the crew.

Unfortunately, the Workers' Compensation experience rating is set yearly and is based on the first three of the last four years, as discussed in the section on Workers' Compensation. A more immediate penalty is often assessed in addition to this future increase in the labor cost. These penalties often take the form of a monetary decrease in the bonus pool. The decrease is often a percent decrease for each reportable accident. For example, a five percent decrease in the bonus pool may be assessed for each reportable accident.

There are other methods of controlling safety which are outside the scope of this report. These methods involve specific safety incentive programs which may or may not be used in conjunction with productivity incentive programs. However, the general consensus among industries presently using monetary incentive programs is that safety does not deteriorate when a crew is placed on a properly administered program.

Log quality--It is not difficult for a logging contractor to know the specifications that a mill or purchaser requires for delivered logs. These specifications can then be reflected in the contract rate negotiated for the incentive unit. If log quality is not met, there are several options that can be used to bring quality up to standards. The first option would be to use administrative controls much like those used for safety infractions. The administrator of the operation must be able to identify whether the log quality is not being met due to the falling and bucking crew or the yarding and loading crew. In most cases a few inspections in the field will reveal the source of the problem. If administrative controls are not adequate to bring log quality up to standard, then a penalty is usually assessed. This can take the form of a reduction in the bonus pool of anywhere from one percent to five percent.

Another option that may be viable in some logging contracts is to pass any monetary penalties assessed against a logging company back to the crew that caused the penalty. Many mills now have some sort of log quality program which assess a penalty or gives a bonus depending on the level of log quality met. The penalty/bonus is usually calculated on a $/MBF basis for the volume delivered in a one month period. It may not

be possible to track the monthly volume to a particular unit but the sale, and in most cases the crew, can be tracked. The penalty/bonus should be passed on as quickly as possible and this can be given to the crew as an increase or decrease in the amount of bonus pool made available.

Compliance work quality--In the case of monetary incentive programs, compliance work quality infractions must pertain only to that work required of the incentive crew.

Cable yarding crews--Typically, the only compliance work a cable-logging crew is responsible for is YUM yarding (yarding unutilizable material) and streamcourse cleanout (removing large woody material inadvertently placed in a stream during logging). These two work items need to done in conjunction with the yarding of merchantable material to avoid the cost of moving in and setting up a separate yarder. Fortunately, these two items are typically the only ones required of a cable logging crew so it is relatively easy to control the quality of these items. Since YUM yarding and streamcourse cleanout are known in advance, these items should be included in the price negotiated for the unit. Failure to complete these items to standard can then be handled administratively or with a monetary penalty as

discussed in the previous sections. Another control an administrator of the operation can have for these quality items is to require the work to be completed before the crew moves to a new unit. This essentially "forces" the crew to keep current with the compliance work required.

Ground-based yarding crews--The compliance work required of ground based crews is typically more involved than that required of cable crews. In addition to YUM yarding and streamcourse cleanout, items such as brush piling and erosion control work (water barring, erosion control grass seeding, scarification of roads and skid trails) is also required. Typically, a ground-based logging operation will have one crawler piling brush concurrent with the skidding operation. The brush piling may or may not be in the same unit as the skidding operation. YUMing may take place concurrent with the skidding although it is not uncommon for one or two skidding machines to YUM an area after the merchantable material has been removed.

These compliance work situations are more difficult to include in an incentive program than those required of cable yarding crews. If a contractor has good production records for compliance work, it would be possible to include the compliance work with the skidding of merchantable material. The cost goal would

include the cost of compliance work. The contract would have to include provisions for keeping the work current. An amount of money could be held out of the final settlement until the compliance work was completed. As an alternative to holding money out of the compliance settlement, a contractor may elect to declare a unit complete once all compliance items have been accepted.

If a contractor does not have good compliance production records, an option would be to treat some of the compliance work as a separate job. For example, the brush piling and any erosion control work such as scarification and water barring might be kept as a separate job. Yarding of unutilizable material could be included with the skidding of merchantable logs, the same as with cable crews. If the compliance crew spends any time skidding logs, those hours for labor and equipment would be charged against the operation.