TIMBER TRANSPORTATION COSTS IN THE CALIFORNIA PINE REGION

by

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TIMBER TRANSPORTATION COSTS IN THE CALIFORNIA PINE REGION

INTRODUCTION

This paper is presented in the interests of the logging operators in the California Pine region with the sole purpose of bringing to light some of the costs of logging in this region. It is not meant in any way to criticize the methods some of the operators use, because it is realized that no set of laws or methods can be set down for a logging operation. Each operation deviates from another in various and sundry ways, and experience is the only form of insurance for a successful operation.

It is a known fact that few of the smaller operators keep any data on equipment operation costs. This paper will try to bring to the small operator, by cost analysis of the larger companies and individual pieces of equipment, a few of the fundamentals in how to determine machine rates. The formulae used in this paper for the most part are relatively simple and it is believed most small operators can substitute values that pertain to their own operation and obtain accurate results.

It must be remembered, however, that in the calculation of machine rates used in this treatise, certain definite conditions had to be assumed. The conditions prevailing on the 1942 to 1946 Clover Valley Lumber Company's operation, were used to calculate all machine

rates. Operators having local conditions similar to these will have costs paralleling those worked out in this paper. Operations, where some of the conditions differ, will have costs somewhat different. They will have to substitute in the formulae values paralleling their operation.

It must also be remembered that the initial costs of all equipment described in this paper, are current as of April, 1947. If prices change, and we know they will, this will affect the machine rates already established.

The material used in the writing of this paper was obtained from various sources. A part came from personal experience gained from employment as assista nt logging engineer for the Clover Valley Lumber Company, during the summer of 1946. Valuable experience was gained through this job in the operation, repair, and maintenance of logging tractors, arches, winches, trucks, bulldozers, graders, and scrapers. The greatest part of the material however, was obtained through letters and personal interviews with various logging engineers, woods superintendents, equipment dealers, and through various technical publications.

CLOVER VALLEY LUMBER COMPANY (30)

Lumber production in the California Pine region for all extensive purposes is dependent on the large scale operation. Most of these have been operating for a considerable number of years and are well established in their respective communities. A typical example is the Grayeagle operation near Quincy, California. The mill and headquarters of operation are located in a town known as Grayeagle. This town is owned and managed by the company, and the same stores and homes are in use today as when the town was built many years ago. These large operations, as a rule, own a part of the surrounding stumpage and purchase the rest from the government. It is customary in this region to have an agreement between the Forest Service and the operator, whereby the operator agrees to cut his land according to Forest Service standards, providing he gets accessible government stumpage in return. Both public and private lands are unified in this manner, which allows the large operator to cut on a sustained yield basis. Unification between

the rangers and the operators has advanced to a point where a private operator can be assured of a certain amount of stumpage per year, providing he keeps his agreements.

Most of the larger operations operate camps. They are, as a rule, of the same type as were in use fifty or more years ago. The majority of camps are on a lower level than the logging camps of the Douglas Fir region in regards to personal comfort of the individual logger. They are mobile, and the entire camp is moved approximately every five to eight years. The larger operations furnish transportation to and from camp as well as the necessary transportation to and from work. This is accomplished by a covered truck known as a "candy wagon." Most operators pay the logger one way travel time. This is necessary because of the long trips necessary to arrive on the job. On the Clover Valley operation on their summer show, it takes the "candy wagon" approximately one hour to get on the job.

In years past it was common practice to use the railroad speeder or a gasoline truck with railroad wheels. This method is gradually being replaced by the "candy wagon" due to its flexibility and speed. Where a company is operating in early spring or late fall, the weather and condition of the roads still necessitates the use of

the railroad for transporting the men to and from their work.

The larger companies cut from 200 M to 400 M per day, and many deck a certain percentage of their logs in order to keep the mill running and their men employed the entire year. This is practically impossible in the zones where pure Yellow Pine stands exist, because the logs will stain if decked for any length of time. Most of the companies are logging Douglas Fir and White Fir along with Yellow Pine, and they are the species decked. Practically all large scale operations are forced to close down during the winter months. The Clover Valley, Grayeagle, Diamond Match, Delliker, and Feather River operations close near the 15th of December and reopen the 15th of April. This is entirely dependent on the weather and road conditions. Cutting and bucking is usually started a month before the skidding operation, to enable the fallers and buckers to get out ahead of the noise and dust of the "cats."

A typical example of a large scale logging company is the Clover Valley Lumber Company of Loyalton, California. This Company started logging operations many years ago with their mill in the town of Loyalton in the Sierra Valley and their woods operations centered at Camp No. 1 in Clover Valley some twenty-five miles away. The logs

were skidded directly to the jammer and then loaded on logging cars. This meant building many miles of spur lines, because the timber was rather scattered. Later, a 3½ per cent adverse grade was put in to get the operations over a ridge and into the next valley. This was Squaw Valley, and again the same skidding and loading procedure was followed. As time went on, the railroad was pushed deeper and deeper, until now they have over fifty miles of mainline and are operating out of Camp No. 14. Their method of logging has changed radically since the early days of logging. Now most concern is shown over their logging trucks and not their railroad. On the average they build two miles of railroad every two years and forty to fifty miles of truck road every year. Truck roads are built according to the dictates of the topography, but the engineer strives to construct his roads no further than a quarter of a mile apart. Since all skidding is accomplished by tractors and arches, the unit must travel downhill with its load. This makes the maximum haul a little less than a quarter of a mile and the average haul a little less than an eighth. An arch can skid uphill to a certain extent, but not when laden with a load. The common practice in this region is for the tractor and arch to remain on the road, with the mainline played out through the arch and down the hill. This is

pulled in by means of the winch. When the logs are finally up to the level of the road, they are lifted up on the arch, pulled off the road but placed parallel to it, and the chockers released. In this manner an arch can skid on the lower side of the road a distance of approximately a hundred and fifty feet. This company operates four D8 tractor and arch units. The tractor is made by the Caterpillar Company, the D8 Winch by the Hyster Company, and the arch by the Carco Company. These units represent an initial outlay of approximately $16,691.13. This unit can be itemized as follows:

Cost of D8 tractor. $9747.50 (15)

Cost of D8 winch. $2689.88 (33)

Cost of logging arch. $4253.75 (40)

Total Cost of skidding unit. $16691.13

The capacity of this unit depends on how many chokers the rigging men are willing to handle, but they average 3000 board feet per load. In some cases the load is limited by the size of the timber. The Swayne Lumber Company of Oroville, California, had Sugar Pine so heavy that this condition existed. It is possible to skid up hill, but excessive winching is needed and the operation proves none to successful. Clover Valley allows their tractors and arches to go up a 35 per cent

grade empty; but when the grade exceeds this, they construct special go-back roads of lighter grades. The capacity per day of these arches depends on many factors. Speed of the tractor, topography, ground conditions, density of stand, size of timber, length of haul, capacity per load, and the ability of the cat-skinner and choker-setters are the most important. In the year of 1945, the Clover Valley arches averaged 50,000 board feet apiece per day. In 1946, they averaged 60,000. The increase was due chiefly to the higher caliber of men used in 1946. These men had just returned from the service, and the competition was greater than in 1945. All tractors are greased once a day. This is accomplished by a mechanic known as a "grease monkey" who goes to work at four p.m. and works until eight p.m., or until all equipment is refuelled and greased. He returns in the morning to start the engines prior to the arrival of the crew. This enables the tractor to warm up slowly and be in the peak of condition at starting time. All skidding tractors of any one side are parked as near together as possible at night. They are usually parked in a turnout with their front ends away from the road and parallel with each other. This allows the "grease monkey" to fuel the units with the least amount of wasted time. It is necessary every six or seven days to clean out the radiator

combs in this region. This is necessary because the tassels of the Mountain Mohogany lodge between the radiator combs and block the free passage of air. This is accomplished by a compressed air unit, approximately fifty feet of hose, and a nozzle. The radiator guard has to be removed for this operation, and it speeds up the procedure if all tractors are close together. The Clover Valley tractors are completely overhauled during the winter months. The last train out in December brings all equipment. This gives several mechanics all year employment, which makes it much easier to hold good men. This overhauling is accomplished in the main company shops at Loyalton.

The Company has two loaders of the converted shovel type. They are both diesel powered and completely mobile. One is a "P. and H." and the other is a "Bucyrus Erie." The "Bucyrus Erie" was purchased in 1939 at a cost of $6000, and because of its condition, is used only on the smaller side when two sides are in operation. The "P. and H." was purchased somewhat later for $20,000.00 and is the mainstay of the operation. The two loaders are dismantled, brought back to the shops, and completely overhauled each year. They are also greased and refuelled each night. Their capacity is limited only by

the number of trucks available and the amount of logs decked along the road. One loader can easily handle 300,000 board feet per day.

The crew consists of four men; the shovel operator, two hookers, and a man to clean up the logs prior to loading. The hourly wages of these men are as follows (30):

Loader Operator	$1.70
First Hooker	1.40
Second Hooker.	1.40
Knob Knocker	1.40
Wages per hour of loader crew	$5.90

This company operates a railroad jammer at the truck landing. It is an old "McGiffert" skidder and was purchased by the company in 1924 for $20,000.00. It is steam driven and fired by oil of the same type used by the locomotives. It has an eighth swing and will travel on the railroad under its own power. The maximum size log that it can lift is 4000 board feet. Anything larger than this would have to be lifted one end at a time. With a good crew of hookers and a good top loader this unit has loaded up to forty cars in eight hours. This would be approximately 350,000 board feet. The crew consists of a top loader, jammer operator, unloader operator, and three hookers. The hourly wage costs for the jammer is as follows (30):

Jammer Operator.....	$1.70
Top Loader.....	1.70
Unloader Operator.....	1.70
First Hooker.....	1.40
Second Hooker.....	1.40
Third Hooker.....	1.40
Total hourly wage costs for Jammer.....	$9.30

The trucks are unloaded at the landing by parbuckling. The trucks come to rest at a slight angle toward the brow log, so gravity will aid in the unloading process. The winch used is a single drum type powered by an old "White" truck engine. Both jammer and unloader are maintained by a mechanic who comes to work after the regular working hours. He also has the jammer fired and ready for operating before the regular crew reports for work. The jammer is fuelled from a tank car located on a siding alongside. This car is changed every two days by the locomotive.

This Company operates two locomotives. The one used for the bulk of the hauling is an articulated compound Mallet Baldwin rod engine. It is equipped with a side tank, therefore, requires no tender. It is has 6 pairs of coupled wheels with two wheeled truck at front, and rear. It has 44 inch drivers and an eight foot rigid wheel base. The water capacity is 2500 gallons and the fuel 1200

gallons. The total weight of this engine is 219,000 pounds. The engine with a fourteen car load is limited to a 3½ per cent grade and an 18 degree curve. The company uses a 45 pound rail with 17 ties per 30 feet. This engine is used to bring the empty cars out to the jammer from Loyalton, the average load of empties is 20 cars and the trip is approximately 50 miles. It is then used to haul the loaded cars back to Loyalton on the return trip. The maximum load over the 3½ per cent grade is fourteen cars. If the train is larger than this, the engine is compelled to make two or more trips over the summit carrying its fourteen cars each trip. The train when arriving in Loyalton, as a rule, has either fourteen or twenty-eight cars. If, for instance, they loaded sixteen cars in any one day, fourteen would be hauled to the mill, and the extra two would remain until the following day. This would continue until they had two full loads of fourteen and then the locomotive would make two trips over the summit. The other locomotive, a Baldwin "Eight", is also a rod engine but uses a tender. It weighs approximately the same as the "Mallet", but is older. It was purchased in 1938 from a defunct lumber company for $3500. It is used for switching purposes around the jammer, to help the "Mallet" over the summit, and to haul supplies into camp.

The logging cars used by this company are the skele-

ton type with four bunks. They are 40 feet long and cost approximately $500 in 1938. The company purchased a number of box cars from the Western Pacific Railroad Company, removed the superstructure, and converted them to logging cars. The box cars before any conversion work, cost $400 apiece. The average load for the logging cars is 8,500 board feet.

The trucks used by the Clover Valley Company are a fleet of twelve KR11 Internationals. They have a 197" wheelbase, and use 11.00 x 20 - 12 ply tires. The chassis and cab cost the company $6500 in 1945. The trailers are "Fabco," have eight wheels, and are equipped with air brakes that can be cooled by water on steep grades. These trailers are loaded on top of the chassis when returning empty. A "Braden" winch, located just to the rear of the cab, is used for this. This type trailer cost $5000 in 1945. The capacity of these units vary considerable with road conditions, length of haul, grades, and size of logs. The maximum load is 8,000 board feet with the average 7,000. Speed is another varying factor. They go as fast as they can with due regard to visibility, grade, and road conditions. The average would be approximately 10 miles an hour and the return trip, 15. A typical example of haul the company had in the summer of 1946, is as follows: The length of haul was 10 miles. The first

mile was a 2 per cent favorable grade, but a very poor dirt road. The next three miles were over a 2 per cent adverse, cutting the trucks down to five miles an hour. This section was graded once every two days and watered every night. The remaining six miles were all favorable, varying from 1 per cent to 8 per cent. This section was also graded and sprinkled in the same manner as the previous section. The trucks would make the downhill trip loaded in an average of one hour. The go-back trip took 40 minutes. In addition to the logging fleet, the company also operates a sprinkler, wrecker, diesel tank truck, and gasoline tank truck. They are all converted from retired "White loggers."

Three bulldozers, a motor grader, and scraper are also owned and operated by the company. The initial costs of these units are as follows (15):

Caterpillar D8 Tractor.	$9747.50
Caterpillar 8S Straight Blade	1483.12
Caterpillar Front End Cable Control Unit.	488.21
Total Unit Price	$11718.83

Caterpillar D8 Tractor.	$9747.50
Caterpillar 8A Angle Blade.	1834.52
Caterpillar Rear End Cable Control Unit .	984.58
Total Unit Price	$12530.60

Caterpillar D7 Tractor.	$7465.21
Caterpillar 7S Straight Blade	1286.85
Caterpillar Front End Cable Control Unit.	488.21
Total Unit Price	$9240.27

Caterpillar No. 212 Motor Grader.	$5172.00
Caterpillar No. 80 Scraper.	8892.50

Road building in this region presents a problem of major proportions. The Clover Valley Company builds relatively cheap roads. The cost per thousand for truck road construction and maintenance for the year 1946 was $0.55 or $392.47 per mile. Construction costs represent approximately two thirds of the above figures, while maintenance represents the remaining one third. In this area the timber is scattered, and only a percentage of the total stand is taken. This increases the truck mileage to a point where a cheap road is the only practical solution. When logging on government land, a certain standard is set and must be followed. In this operation, it stipulates a maximum of an 8 per cent grade on main roads, and 12 per cent on spurs. The curves must have a minimum radius of 50' on spurs and 100' on the main roads. Culverts must be large enough to carry the peak spring run-off, and on main roads high enough above the bottoms to prevent washing. Where the cost is not

excessive, the engineer constructs the road wide enough for two trucks to pass; where construction is heavy, they are constructed to have turnouts at least every 500 feet and intervisible. Clover Valley builds very few truck road bridges. This is due chiefly to the dry climate in the summer months. The bridges when they are built, are of the frame trestle type with 12" x 12" posts, caps, and sills. The stringers are 8" x 16" in two chords and spans of 16 feet. The decks are of 3" x 12" planking with run planks and guard rails.

Culverts are of the temporary type only. They are made of Pine or White Fir, because there is not enough Cedar or Douglas Fir to rely on. They are made of 2" x 12" planking nailed together to form a square pipe. Two or more are laid end to end to form the whole culvert.

McCLOUD RIVER LUMBER COMPANY (28)

Another typical example of a large operation of this region is the McCloud River Lumber Company. It is located at McCloud, California, a town of approximately 2400, (32 p. 133-136). This Company operates two logging camps. One is Pondosa, a little over 25 miles east of McCloud, and the other is White Horse, a few miles farther east. They are able to log the year around despite the bad weather encountered from January to April. The mill operates two eight-hour shifts per day and handles 350,000 board feet per shift. They operate their own railroad and use "Caterpillar D8's" to skid directly to the McGiffert Jammer in some cases. Their own railroad averages 15 miles, and they use the Southern Pacific's tracks for an additional 45 miles. On other sides they employ the use of trucks to haul the logs to the jammer. Their average truck haul is 7 miles.

A few of the most important operation costs are as follows:

Railroad Operation (28)

	Cost per M
Engineering and grading	$0.88
Track laying, track lifting and ties. .	1.05

Maintenance, operating, locomotive and car rental..... $2.84

Log Freight (Common carrier - 45 miles).. 1.53

Ave. construction cost per mile..... 3500.00

Ave. track laying cost per mile..... 3100.00

Log loading costs at the jammer amounts to $0.70 per M.

Skidding with "Caterpillar" D8 tractors with a maximum distance of 3500 feet amounts to $2.36 per M. for the railroad operation. In this operation, the tractors skid directly to the jammer.

In the truck operation, the skidding and loading operation amounts to $4.26 per M. Road buildings and maintenance for truck roads costs $1.50 per thousand. The truck hauling costs amount to $2.29 per thousand for a seven mile haul.

FRUIT GROWERS SUPPLY COMPANY (2)

Another example of a large scale operation in this region is the Fruit Growers Supply Company. Their holdings comprise three mills which are located at Hilt, Westwood, and Susanville, California. The total output of the three mills totals an approximate quarter of a billion feet per year. On their smallest operation, the Hilt operation, they employ "Sterling" chain drive trucks and haul a distance of 25 miles to Yreka. There, they are loaded on railroad cars with a "McGiffert" loader and shipped to Hilt. These trucks haul part of the way on the highway, so it is necessary to keep the loads down to 6500 board feet. Even with this load, it is possible to haul over a 6 per cent adverse and make fairly high speeds. The "first out" trucks make three daily trips putting in 13 hours per day.

The Westwood Operation produced 170 million board feet in 1946. During the winter and spring months, they skid directly to the railroad, because truck logging is not practical. The railroad haul is approximately 25 miles on their own line and an additional 45 miles over the Western Pacific Railroad. On this operation they use a 90 ton "Mikado" locomotive developing 30,000

pounds of traction force at the drawbar. This locomotive has to operate over a 1.5 per cent adverse grade, not compensated, and there are a number of 14 degree curves. The actual grade resistance is equivalent to a 2 per cent. This results in a rather costly operation, because the locomotive can only handle 12 cars at a time on the grade. This involves the use of three locomotives and train crews to handle the daily production and spot empties under the jammer.

On the Susanville operation, they employ the same system as the Westwood operation. They truck to the railroad when the weather conditions permit and skid directly to the jammer when it is impossible to use trucks. On this railroad they use a 90 ton geared "Lima" locomotive developing 42,000 pounds of traction force. The cars average 10,400 board feet per car. The mainline roadbed is ballasted and has 60 pound rails. It has a maximum 0.9 per cent adverse and 1.7 per cent favorable grade. Both of these grades are compensated and exist between their logging camp and the Souther Pacific Company's mainline, a distance of 20 miles. Between camp and the jammer they have a 1.2 per cent compensated adverse and a maximum curvature of 13 degrees. Their locomotive is capable of handling 32 cars up the 0.9 per cent adverse and 24 up the 1.2 per cent. On the return trip with

empties they can handle 50 cars. The above figures are dependent upon weather conditions since excessive cold weather affects the journal connections, and tonnage has to be reduced accordingly.

This company uses a "Shay" locomotive on their spurs. A favorable grade of 5 per cent and a 30 degree curve is sometimes used. When this sharp a curve is used, it is usually on the back end, so that a portion of the spur will only be in use for a week or more.

Railroad Construction Costs for 1946 (2)

Grading per mile ready for track.	$800.00
Tracklaying per mile.	900.00
Side surfacing per mile	600.00
Total grading, tracklaying, and surfacing exclusive of material.	$2300.00 per mile
Cost of Removing track per mile	700.00
Total Cost	$3000.00

Ties on spurs in this area will last approximately 8 years. If picked up and relayed within this period, four layings are the maximum because they become weakened at the ends from spike holes. The company used an average of 8641 ties per year for the past seventeen years. The mainline ties which are left undisturbed, will last about ten years.

The railroad operation cost approximately $0.08 per thousand board feet per mile. This cost is divided about as follows (2):

Maintenance	Labor	.023
	Material.	.007
Train Service . . .	Labor	.016
	Material.	.011
Local Repairs . . .	Labor plus maintenance.	.023
Miscellaneous		.002
Cost of hauling a thousand feet of logs a distance of one mile		$.082

The above figures are taken immediately preceding the 1946 season.

This company handles the spur depreciation in the following manner. The footage adjacent to a certain spur is estimated, and the spur investment written off on that basis. As a general rule they get from four to five million feet per mile, and the cost per thousand varies from $0.30 to $1.50 per thousand. This will depend on the stand per acre and the difficulties of construction. The main line is written off on a cost per thousand basis. The total footage in the area is estimated, and the total cost of the mainline as far as construction plus the estimated costs of extension is figured. This result gives a write-off applicable to the whole area.

The mainline write-off is $0.60 per thousand.

At the Westwood operation the company employs a fleet of "G.M.C." diesel 2 cycle trucks. On the Susanville operation they use "Peterbuilts" with "Cummins" 150 horsepower diesel engines. On the Hilt operation, they use "Sterling" chain drives. Most of their trucks have nine foot bunks, or one foot wider than is permissible on a highway haul. They build their own logging roads and try not to exceed a 6 per cent adverse. Frequent turnouts are employed on all roads. On spurs they sometimes use as high as 20 per cent favorable grades. All roads are watered during the day and maintained with a motor patrol.

The trucking costs are as follows (2):

Road construction.....	.35 per M per mile
Watering and maintenance.....	.20 per M per mile
Trucks (including write - off repairs, etc.....	.35 per M per mile

The large diesel trucks with the nine foot bunks can haul up to 10 thousand board feet per trip. Curves can have a mimimum radius of 50 feet.

LOGGING COSTS FOR COMPANY A
YEAR TO DATE

TRUCK LOADING	BOARD FEET	AMOUNT IN DOLLARS	DOLLARS PER M
Stumpage			
Company Timber	9,441,100	9,425.63	1.00
Government Timber	25,627,970	108,237.52	4.22
Other Timber	2,453,110	4,841.74	1.97
Total Stumpage	37,522,180	122,504.89	3.26
Falling and Bucking	35,418,500	104,404.43	2.95
Add 1945 Logs Left in Woods	2,000,000	7,267.89	3.63
	37,418,500	111,672.32	2.98
Less 1946 Logs Left in Woods	1,455,000	5,720.53	3.93
	35,963,500	105,951.79	2.95
Skidding with "Caterpillars"	35,963,500	94,902.91	2.64
Truck Loading	"	26,190.94	.73
Truck Road Construction and Maintenance	"	19,623.53	.55
Co. Trucking to Landing	32,505,000	96,582.90	2.97
Contract Trucking to Landing	3,458,500	11,311.83	3.27
Cost of Logs at Landing	35,963,500	477,058.84	13.27
Loading on Cars	"	20,780.85	.58
Railroad Operation	"	58,280.00	1.62
Railroad Maintenance	"	60,322.06	1.68
Trackage WPR.R.Co.	"	3,837.82	.11
Spur Amortization	"	2,690.17	.07
Mainline R.R. Depreciation	"	27,795.20	.77
Brush Disposal	"	33,681.75	.94
Foremen, Clerks & Scalers	"	15,999.52	.44
Logging Boarding & Cookhouse Expense	"	23,508.13	.65
Logging Industrial Ins.	"	19,723.56	.55
Misc. Logging Expense	"	11,870.59	.33
Logging Depreciation	"	17,576.30	.49
Unload & Deck Logs at Pond	"	6,937.69	.19
Log Cost to Mill Pond	35,963,500	780,062.48	21.69
Contract Logs, Stump to Pond	1,695,460	26,142.90	15.42
TOTAL LOG COST TO MILL POND	37,658,960	806,205.38	21.41

Logging Costs for Company A
Month of December

TRUCK LOGGING	BOARD FEET	AMOUNT IN DOLLARS	DOLLARS PER M
Stumpage			
Company Timber	781,700	1,001.89	1.28
Government Timber	1,816,400	7,706.69	4.24
Other Timber			
Total Stumpage	1,034,700	6,704.80	6.48
Falling and Bucking	303,000	1,715.40	5.66
Add 1945 Logs Left in Woods	-	-	-
	303,000	1,715.40	5.66
Less 1946 Logs Left in Woods	1,455,000	5,720.53	3.93
	1,152,000	4,005.13	3.48
Skidding with "Caterpillars"	848,000	2,974.52	3.51
Truck Loading	"	289.70	.35
Truck Road Construction and Maintenance	"	551.06	.65
Co, Trucking to Landing	-	-	-
Cost of Logs at Landing	848,000	4,080.37	4.81
Loading on Cars	"	388.51	.46
Railroad Operation	"	3,697.01	4.36
Railroad Maintenance	"	2,058.86	2.43
Trackage WP. R.R. Co.	"	103.13	.12
Spur Amortization	"	-	-
Mainline R.R. Depreciation	"	2,316.34	2.73
Brush Disposal	"	8.56	.01
Foremen, Clerks, & Scalers	"	1,709.33	2.02
Logging Boarding & Cookhouse Expense	"	1,637.73	2.12
Logging Industrial Ins.	"	673.85	.79
Misc. Logging Expense	"	5,144.59	6.07
Logging Depreciation	"	1,566.97	1.85
Unload & Deck Logs at Pond	"	133.87	.16
Log Cost to Mill Pond	848,000	15,358.38	18.11
Contract Logs, Stump to Pond	-	46.44	-
TOTAL LOG COST TO MILL POND	848,000	15,311.94	18.06

The logging costs listed on page 24 are typical of a large operation in this region. The company wishes its name to be withheld in presenting these cost figures because of competitive reasons; so it will simply be referred to as Company A. This company operates eight to nine months out of the year and cut 32,505,000 board feet (Pond scale) in the year 1946. In addition to this, they contracted 3,458,500 board feet for an average of $3.27 per thousand. From the chart it can be seen that they cut 9,441,110 board feet of company owned timber, 25,627,970 board feet of other privately owned timber. When buying from the government, they pay $5.00 per thousand for Yellow Pine and $2.50 per thousand for White Fir, Douglas Fir, and Cedar. Yellow Pine and White Fir comprise approximately ninety-five per cent of the cut.

Falling was accomplished by power saws in terrain where they could operate to good advantage. Trees on ridge tops and in steep canyons were felled by hand. The company ceases operations when snow conditions make continued logging impracticable. As a result, all phases of operation cease on the same day, and some logs are left behind for the following year. It is for this reason that part of the December 1946 cut is subtracted from the total, and that part of the December 1945 cut is added to the total.

This company operated a railroad and used trucks to haul to the jammer. The jammer is moved four or five times a year, depending on the size of the area of the individual sides. Two sides are kept operating most of the year. The average truck haul is approximately four miles, and the average railroad haul fifty miles.

Railroad maintenance was exceptionally high in 1946, because a large percentage of the ties were replaced. This was neglected during the war because of lack of labor and ties. No new railroad was built in this year.

This company operates over eleven miles of track owned by the Western Pacific Railroad Company, and pay 0.11 per thousand trackage fee for this privilege.

The government has certain regulations in regard to logging on public lands in this area. The timber is marked by the timber sales officer to cut about 50 per cent of the gross stand. Logging must be conducted in a manner to prevent excessive damage to the remaining stand and reproduction, and brush must be piled along the main wheel trails and truck roads. In addition to this all snags must be felled. Brush disposal, which includes falling snags as well as piling brush, amounts to quite an expensive item. In the year 1946, it is seen that this alone amounted to 0.94 per thousand. A "Caterpillar" D8 tractor with special superstructure for pushing snags has

been developed by this company and has been used for many years to good advantage.

In order to keep good men, this company finds they must operate an above average camp. Since a hundred per cent of the woods crew lives at camp, this runs into quite an expense. Although meals are charged at $1.50 per day per man, the company still plans on losing approximately $25,000 per year on their camp. It will be found that they lost $23,508.13 in the year 1946.

Logging depreciation is the actual depreciation on the woods equipment. On page 25 will be found the cost sheet for this same company for the month of December. It is interesting to note that the price of government timber is higher in December, indicating a larger percentage of Pine was cut in this month.

Falling, bucking, and skidding costs are also higher in December. This is brought about by the poor operating conditions during this month. Usually the last two weeks of the operation are carried on in light snow. This makes it exceptionally hard for the tractor operation. During the first and last month of the operating season, the company operated close to camp. Due to the poor condition of the logging roads at this time, short hauls are made, and the cutting is usually carried on in company timber. When the trucks are working on short hauls, they can naturally

haul more per day and thus reduce the cost per thousand; therefore, it will be found that although falling, bucking, and skidding costs are higher in December, they are over-balanced by the hauling costs, and it results in cheaper logs.

CONTRACT HAULERS

In addition to their own logging fleet, the Clover Valley Company hires a contract operator for part of the season. This particular operator has two units, both "GMC's". He received $100 per day per truck for the work on a three mile haul. The average load was 5000 board feet, and each truck averaged nine trips per day. The majority of operators in the region worked on a strictly per thousand basis or by the use of a formula. One company contracted logs delivered to the pond for $15.42 per thousand. This contract included falling, skidding, loading, and hauling. The haul was 17 miles on the highway, flat grades, and 4 miles of dirt roads at the loader end of the operation. The trucks were "GMC's" and averaged 5,000 board feet per trip.

A typical formula used by the contract haulers in this region is as follows: One dollar for the first mile per thousand and 10 cents per thousand for each additional mile. This will of course be altered to meet special conditions. The crew of the contract trucks usually provide their own room and board. An exception to this is the case at Clover Valley. Here, due to the distance to the nearest town, the crew live and eat with the company men at camp. Transportation to and from camp is provided by the company.

LOGGING TRUCKS

Chevrolet Logging Trucks

Light weight trucks and trailers are found in ever increasing numbers in this region. This was brought about by the large number of contract haulers who had little capital with which to start their business. These light trucks do have the advantage of low initial investment and an abundance of spare parts. Since these trucks are built up from a standard chassis in many different ways, no two are alike. The majority of the light units are either Chevrolet, Ford, G.M.C., or Dodge. The hourly cost figures will be given for the Chevrolet only, since the rest are similar as far as initial price and maintenance are concerned.

Approximate General Specifications (1)

(Built Up)

Engine	Chevrolet Load Master
Horsepower	90
Frame	Reinforced channel
Tires	8.25 - 20 - 12 ply loggers
Gross Vehicle Weight	16,000

Hourly Costs for Chevrolet Logging Trucks

Initial price, delivered, (Chassis plus built up frame, heavier transmission and logger tires)	$3,913.00 (1)
Less tires	517.02
Less tubes	56.34
Net initial investment	3,339.64
Fixed Charges	
Interest	.050
Depreciation	.334
License fees	.090
Insurance	.300
Overhead and risk	.155
Variable Charges	
Repairs	.240
Driver's Wages	1.600
Gasoline	.225
Grease	.015
Tires and tubes	.459
Total cost per hour	$3.488

Hourly costs for the Chevrolet logging truck were computed in the same manner as those for the Reo trucks. This unit uses 8.25 - 20 - 12 ply logger tires, and Their price was obtained from the Firestone Tire Company. Interest was taken as 3 per cent. Depreciation period

was taken as 5 years or 10,000 hours. License fees and insurance were obtained from the Reo Company in Portland for all sizes of trucks. Overhead and risk were taken as 20 per cent of the total fixed charges. It was assumed that $0.02 per mile is saved for future repairs. This truck will use approximately one gallon of gasoline for every 8 miles, one quart of oil, and one pound of grease per day. Tires will last approximately 15,000 miles on this truck in these conditions.

Reo Logging Trucks

Reo logging trucks are manufactured at Lansing, Michigan. Their popularity is rather limited, but their numbers are increasing. The main reason for their scarcity is the lack of repair facilities in the towns near the operation. During the war and the time since, operators have found it difficult to purchase the logging truck of their choice due to the reduced production and increased demand. As a result a few have purchased "Reos" from the Sacramento and San Francisco branch offices of the Reo Company. These operators are satisfied, however, and their popularity has increased.

The two sizes used mostly in this region and their general specifications are as follows:

General Specifications (10)

	Model 25 BL	Model 25 TL
Weight including cab	8,555 lbs.	9,000 lbs.
Engine	Continental B6 - 427	
Wheelbase	145"	145"
Maximum Brake Horsepower	127	127
Tire size	10.00 x 20 - 12 ply	
Rear Axle	Double Reduction	Double Reduction Tandem
Net log load in pounds	41,000	48,000
Price (delivered)	$6896.27	$9177.27

Hourly Costs of Reo Logging Trucks

	Model 25 BL	Model 25 TL
Initial investment (Delivered in California)	$6,896.27 (10)	$9,177.27 (1)
Less tires (charged off on mileage)	679.38	1,132.30
Less tubes (charged off on mileage)	70.32	117.20
Net investment	6,146.57	7,927.77
Fixed Charges		
Interest	.092	.119
Depreciation	.615	.793
License fees	.090	.090
Insurance	.300	.300

Hourly Costs of Reo Logging Trucks
(Continued)

	Model 25 BL	Model 25 TL
Fixed Charges, (Cont'd.)		
Overhead and risk . . .	.220	.260
Variable Charges		
Repairs	.240	.240
Driver's wages.	1.600	1.600
Gasoline.	.450	.450
Oil	.020	.020
Grease.	.015	.015
Tires and tubes	.599	.999
Total cost per hour.	$4.241	$4.886

In order to compute cost figures for logging trucks, definite conditions must exist and be applied to the data sheet. When the final cost per hour figure is obtained, it must be remembered that it applies to this one size truck, with its same equipment on this same logging show, and traveling the same number of miles per day as those stated in the problem. Any deviation from the above conditions would tend to alter the final result. These results would be next to worthless in other regions where conditions differ radically, but in the California Pine region, they tend to produce a true

approximation of logging truck costs. The operation chosen to figure all truck costs is an example of a typical truck haul in the California region. It is a ten mile haul in the Clover Valley operation. Medium sized trucks can make the downhill run loaded in approximately 60 minutes, and the return trip usually requires 45 minutes. The road is dirt, the steepest adverst is 2 per cent and the steepest favorable, 8 per cent.

Several costs pertaining to truck operations have been excluded purposely. Stowage costs as a rule are charged off at the mill end of the operation and not in the woods. At Clover Valley for an example, all trucks are stowed in the main shops for the winter, and the stowage costs are charged off to the shops.

The initial cost of these two models were obtained from the Reo Truck Company (10). They are the two most popular logging trucks in the Reo line, and the price is the delivered price in California.

Logging trucks in this region are depreciated either over a 4 or 5 year period. Since most operators prefer the 5 year period, it will be used in these calculations. A year of 2,000 hours was used, since this seems to be the number used by most operators. The following are the calculations for the Reo 25 BL: Depreciation =

$\frac{\text{Initial Investment}}{\text{Life in hours}}$ = Depreciation = $\frac{6,146.57}{10,000}$ = ,615.

Yearly license fees in this region amount to $180 per truck. This is the fee for both truck and trailer and is prorated over the annual 2,000 hours.

A 3 per cent interest figure was used in the calculation because that is the maximum safe investment obtainable and is the figure used by the majority of the larger companies.

License fee hourly cost = $\frac{\text{Annual license cost}}{\text{Hours per year}}$

" " " " = $\frac{180}{2,000}$

" " " " = $0.090

Insurance for one truck for one year on a fleet basis will cost approximately $600 per year as quoted by the Reo Company.

Insurance hourly cost = $\frac{\text{Yearly insurance cost}}{\text{Hours per year}}$

" " " = $\frac{600}{2,000}$

" " " = $0.300

Repairs, according to various Reo operators, cost approximately $0.02 per running mile (10). This, as a rule, is set aside in a sinking fund for future repair work. This varies with the operation to a great degree.

Hourly repair cost = (Cost per mile) (Average miles per hour)

" " " = (.02) (12)

" " " = $0.24

Drivers wages are taken from the "Union Wage Sheet" for this region.

The Reo units average 4 miles to the gallon on this type of an operation. This information was obtained from the Reo Company through various operators in this region (10).

$$\text{Gasoline hourly cost} = \frac{(\text{Average miles per hour})(\text{Price of gasoline per gallon})}{\text{Miles per gallon}}$$

$$\text{" " "} = \frac{(12)(1.15)}{4}$$

" " " = $0.45

These units according to the Reo Company, use one quart of oil per day (10). This, of course, would not be true of new units, but is the average counting the regular oil changes.

$$\text{Oil hourly cost} = \frac{(\text{Quarts of oil used per day})(\text{Price of oil per quart})}{(\text{Length of day in hours})}$$

$$\text{" " "} = \frac{(1)(0.16)}{8}$$

" " " = $0.020

According to the Reo Company, these units use on the average of one pound of grease per day (10).

$$\text{Grease hourly costs} = \frac{\text{(Pounds of Grease used per day) (Price of grease per pound)}}{\text{(Length of day in hours)}}$$

$$\text{" " "} = \frac{(1)\ (.12)}{8}$$

$$\text{" " "} = \$0.015$$

Tire costs present a complicated and important problem. Outside of wages they constitute the most expensive cost to the operator. Tires in this region operating over dirt roads will average only 15,000 miles to the tire. The average life of the same tire on graveled roads would be double this figure in most cases. The price of 10.00 x 20 - 12 ply tires is $113.23 apiece as quoted by the Firestone Company (11). The price of tubes for these tires is $11.72 per tube. Total price of tires plus tubes is:

6 tires @ 113.23 = $679.38

6 tubes @ 11.72 = 70.32

Total tire and tube cost. . . = $749.70

$$\text{Hourly tire and tube cost} = \frac{\text{Truck tire and tube cost}}{\dfrac{\text{(Tire life in miles) (Hours per day)}}{\text{(Av. miles per hour) (Hours per day)}}}$$

$$\text{" " " " "} = \frac{749.70}{\dfrac{(15{,}000)\ (8)}{(12)\ (8)}}$$

$$\text{" " " " "} = \$0.599$$

The aboce costs are current as of April 1947.

White Logging Trucks (26)

White trucks are manufactured by the White Motor Company in Cleveland, Ohio. This company makes five models for use in the logging industry; the WB 14, WB 20, WB 22, WB 26, and WB 2264. Engines are built by the White Company and are gasoline powered. They are all six cylinder "L" head type engines starting at 90 horsepower and going to 135 horsepower. These units are quite popular in this region having established themselves firmly in the early days of logging. Since this region tends toward medium sized trucks and trailers, the "White" line fits in perfectly. Four of the "White" models are single rear axle while the largest, the WB 2264, is tandem drive.

General Specifications (26)

	WB 14	WB 20	WB 22	WB 26	WB 2264
Engine	White 100 A Super Power	White 120 A Super Power	White 140 A Super Power	White 150 A Super Power	White 150 A Super Power
Maximum Brake Horse-Power	90	110	125	135	135
Rear axle	Single reduction	Single reduction	Single reduction	Single reduction	Single reduction
Tires	6.50x20	7.00x20	7.50x20	9.00x20	9.00x20
Gross Rating in lbs.	14,000	19,000	22,000	24,000	36,000
Price Delivered	$3,090.00	$4,950.00	$6,278.00	$7,050.00	$9,360.00

Hourly Costs of White Logging Trucks (26)

	Model WB 14	Model WB 20	Model WB 22
Initial price	$3,090.00	$4,950.00	$6,278.00
Less tire cost	216.48	275.88	317.88
Less tube cost	28.20	34.92	48.72
Net initial investment	2,845.32	4,639.20	5,911.40
Fixed Charges			
Interest	.043	.070	.066
Depreciation	.285	.464	.591
License fee	.090	.090	.090
Insurance	.300	.300	.300
Overhead and risk	.144	.185	.213
Variable Charges			
Repairs	.240	.240	.240
Drivers' Wages	1.600	1.600	1.600
Gasoline	.300	.300	.510
Oil (lubricating)	.015	.015	.020
Grease	.196	.248	.293
Tires and tubes	.196	.248	.293
Total cost per hour	$3.228	$3.527	$4.018

Hourly Costs of White Logging Trucks (26)

	Model 26	Model 2264
Initial price	$7,050.00	$ 9,360.00
Less tire cost.	631.72	1,036.20
Less tube cost.	67.30	113.00
Net initial investment. . .	6,360.48	8,210.80
Fixed charges		
Interest.	.095	.123
Depreciation.	.636	.821
License fee	.090	.090
Insurance	.300	.300
Overhead and risk . .	.164	.267
Variable charges		
Repairs	.360	.480
Drivers' wages. . . .	1.600	1.600
Gasoline.	.510	.600
Oil (lubricating) . .	.020	.030
Grease	.015	.020
Tires and tubes . . .	.552	.919
Total cost per hour. . . .	$4.342	$5.250

The hourly cost figures for the White trucks were computed in the following manner; tire and tube costs were obtained from the Firestone Company. Depreciation was figured in the same manner as for the Reo trucks. They were depreciated over five years or 10,000 hours.

A 3 per cent interest figure was used in the calculation, because this is the maximum safe investment obtainable, and is the figure used by the majority of the larger companies. Overhead and risk were taken as 20 per cent of the total fixed charges.

License fees and insurance were obtained through various operators and computed in the same manner as those for the Reo trucks. Repairs for these trucks were figured as .02 per mile for the smaller sized trucks, .03 for the WB 26, and .04 per mile for the WB 2264.

Drivers' wages were taken from the "Union Sheet" for this region. According to operators in this region, the WB 14 and WB 20, hauling a load over the route described in the Reo calculations, will use approximately one gallon of gas for every six miles. The models WB 22 and WB 26 will use one gallon for every 3.5 miles. Model WB 2264 will use one gallon for every 3 miles. The price of gasoline is $0.15 per gallon in this region.

The price of oil in this region is 0.65 per gallon. The WB 14 and WB 20 use approximately 3/4 of a quart of

oil per day counting regular oil changes. The WB 22 and WB 26 use approximately 1 quart, while the WB 2264 uses 1½ quarts.

The price of grease is $0.12 per pound. All White trucks except the tandem drive WB 2264 will use approximately one pound of grease per day. The WB 2264 will use approximately 1 1/3 pounds per day.

Tire Costs (11)

	WB 14	WB 20	WB 22	WB 26	WB 2264
Size of tires	6.50x20	7.00x20	7.50x20	9.00x20	9.00x20
No. of tires & tubes	6	6	6	6	10
Price per tire	$36.08	$45.98	$52.98	$103.62	$103.62
Price per tube	4.70	5.82	6.12	11.30	11.30
Total Price of tires & tubes	$244.68	$310.80	$366.60	$689.52	$1,149.20

International Trucks (40)

The most popular truck in this region is the International. Their popularity is due chiefly to their past record and to the regional repair facilities. They are manufactured in Chicago, Illinois, by the International Harvester Company. The logging industry in this region uses three sizes of these trucks, and they are the: K7, K8, and KR11.

General Specifications (40)

	K7	K8	KR11
Gross Vehicle weight rating	16,000 lbs.	20,000 lbs.	27,000 lbs.
Carrying capacity (cab, body, equipment & payload)	11,000 lbs.	13,000 lbs.	18,000 lbs.
Wheelbase	134" to 212"	137"to 197"	149"to 197"
Chassis weight	5,620 lbs.	6,550 lbs.	8,360 lbs.
Tires	7.00 - 20	7.50 - 20	9.00 - 20
Engine	International "Red Diamond"		
Maximum brake horsepower	100	126	148
Price	$3,209.16	$4,044.33	$7,572.72

International Logging Truck Model K7 - 134" Wheelbase (7)

Chassis.	$1,900.00
Tires.	303.00
Dual Rear Budd Wheels (Tax included) . .	112.50
Cab.	206.00
Windshield swipes.	7.50
Deluxe oil filter.	3.00
Increased cooling capacity	6.25
Increased capacity brakes.	18.50
Gasoline filter.	8.25
Dual 31 gallon fuel tank	67.50
Timken rear axle	234.00
Generator.	56.00
Total.	$2,822.50
Freight.	228.00
Handling charge.	45.00
Tire tax	34.56
Chassis tax.	64.57
Attachment tax	24.28
Total price delivered.	$3,209.16

The International K7 series also includes the 146", 158" and 176" wheelbase sizes. Their prices delivered in California are as follows:

K7 . . . . .146" wheelbase	$3,235.10
K7 . . . . .158" "	3,261.03
K7 . . . . .176" "	3,286.97

Cost per Hour for International Logging Trucks

K7
134" W.B.

Initial investment (delivered in Sacramento)	$3,209.16
Less tires	379.80
Less tubes	34 .92
Net investment	2,794.44
Fixed Charges	
Interest	.042
Depreciation	.279
License fee	.090
Insurance	.300
Overhead and risk	.142
Variable Charges	
Repairs	.240
Driver's wages	1.600
Gasoline	.321
Oil	.150
Grease	.015
Tires and tubes	.332
Total cost per hour	$3.511

International Logging Truck Model K8 - 137" Wheelbase (7)

Chassis	$2,500.00
Tires	381.00
Dual rear Budd wheels (tax included)	136.00
Windshield swipes	7.50
Increased cooling capacity	6.25
Cab	206.00
Red 361 Engine	150.00
Dual 31 gallon fuel tank	67.50
Generator	56.00
Deluxe oil filter	3.00
Total	$3,534.75
Freight	292.00
Handling charge	70.00
Tire tax	41.34
Chassis tax	85.53
Attachment tax	20.71
Total price delivered	$4,044.33

The International K8 series also includes the 149", 161", 179", and 197" wheelbase sizes. Their prices delivered in California are as follows:

K8	149" Wheelbase	$4,070.26
K8	161" "	4,096.20
K8	179" "	4,122.14

Cost per Hour for International Logging Trucks

K8
137" W.B.

Initial investment (delivered in Sacramento)	$4,044.33
Less tires	317.88
Less tubes	48.72
Net investment	3,677.73
Fixed Charges	
Interest	.055
Depreciation	.368
License fee	.090
Insurance	.300
Overhead and risk	.163
Variable Charges	
Repairs	.240
Driver's wages	1.600
Gasoline	.321
Oil	.150
Grease	.015
Tires and tubes	/239
Total cost per hour	$3.595

International Logging Truck Model KR-11-149" Wheelbase (7)

Chassis with flat - back cowl	$4,970.00
11.00 x 20 - 12 plu tires	171.00
Dual rear Budd wheels (tax included)	122.00
Cab	206.00
Windshield swipes	7.50
Rear view mirror	3.00
Red - 450 Engine with F 54 transmission	185.00
Timken U - 200 rear axle	420.00
300 Watt 6 Volts Generator	56.00
703 A B/L Auxiliary transmission	656.00
Dual 31 gallon fuel tank	67.50
Deluxe oil filter	3.00
Total	$6,867.50
Freight	400.00
Handling charge	90.00
Tire tax	46.68
Chassis tax	163.88
Attachment tax	64.16
Total price delivered	$7,572.72

The International K11 series also includes the 161", and 197" wheelbase sizes. Their prices delivered in California are as follows:

KR 11	161" wheelbase	$7,606.94
KR 11	197" wheelbase	7,658.74

Cost per Hour for International Logging Trucks

KR 11
149" W.B.

Initial investment (delivered in Sacramento)	$7,572.72
Less tires	621.72
Less tubes	67.80
Net investment	6,883.20
Fixed Charges	
Interest	.103
Depreciation	.688
License fee	.090
Insurance	.300
Overhead and risk	.236
Variable Charges	
Repairs	.360
Drivers' wages	1.600
Gasoline	.450
Oil	.020
Grease	.015
Tires and tubes	.551
Total cost per hour	$ 4.413

International West Coast Models (7)

This line of heavy duty logging trucks are manufactured by the International Harvester Company at Emeryville, California. They,like the "Kenworths" and "Sterlings," are custom engineered and custom built for extra heavy operation. Each individual unit is designed for one particular job, and the operator has a choice of 3 diesel and 2 gasoline engines, 6 transmission, and 4 auxiliary transmissions. Engines used in these models are either of the Cummins diesel type, Hall - Scott gasoline type, or the International - Continental gasoline type. Their prices cannot accurately be determined until an operator definitely stipulates what engine and accessories he needs for his job.

International makes six types of the West Coast models, and they are: W-3042-H, W-2064-H, W-4042-H, W-4564-OH, W-6564-OH, and W-9064-OH.

General Specifications of W - 9064 - OH (7)

Gross Vehicle Weight Rating . . . .90,000 lbs.

Wheelbase . . . . . 206" - 260"

General Specifications of W - 9064 - OH (7)

(Continued)

Engine.	Cummins diesel NHB - 600 or Cummins diesel NHB - 600 supercharged or Hall - Scott HS - 400
Rear Axle	Tandem - drive
Tires	14.00 - 24
Cost (Approximately).	$18,000.00

The hourly costs of the International trucks were computed in the same manner as those for the Reo trucks. Tire costs were obtained thru the Firestone Tire Company (11). Interest was figured at 3 per cent of the initial investment. The units were depreciated over 5 years or 10,000 hours. Overhead and risk were taken as 20 per cent of the total fixed charge. Repairs were computed as 2 cents per mile for models K7 and K8; 3 cents per mile for Model KR 11, and 4 cents per mile for Model W - 9064 - OH.

According to the International Harvester Company, their trucks get the following gas mileage (40):

Models	K 7	K 8	KR 11	W-9064-OH
Miles per gallon of gasoline	5.5	5.5	4	3

Oil and grease data was obtained from the International trucks in use at the Clover Valley Lumber Company, and various other operations (40).

Models	K 7	K 8	KR 11	W-9064-OH
Quarts of oil used per day	3/4	3/4	1	1¼
Pounds of grease used per day	1	1	1	1

Tires on these trucks in this region last approximately 15,000 miles.

Sterling Logging Trucks

The Sterling logging truck is used exclusively by a number of large operators in the California region. The Fruit Growers Supply Company at Hilt, California, uses the chain drive "Sterling" and has a fleet of twelve. The Grayeagle Lumber Company at Grayeagle, California, operate six of these units. They are used on adverse grades up to 10 per cent on this operation and haul up to 10,000 board feet per load. The California Door Company at Diamond Springs, California, uses six chain drive "Sterlings" (43). These trucks are engineered specifically for one particular hauling job, and the company believes that maximum economy and efficiency can only be obtained by this procedure (44). The Sterling trucks, like the "Kenworths", can be driven either by diesel or gasoline engines. The dual

drive, gasoline powered Sterling trucks, for hauling on-the-highway, sell for approximately $10,400.00 (8). This model will haul a load of 5000 board feet and will have a gross weight of approximately 72,000 pounds. On longer hauls diesel power would be substituted, and this will increase the price about $1100.00. This also increases the weight an additional 400 pounds.

Diesel engines are usually used for off-the-highway heavy duty models. They will either be a chain drive or dual enclosed drive. Trucks of this type range in price from $13,000.00 to $16,000.00 and will handle up to 20,000 board feet of logs (8).

Due to their similiarity to the Kenworth trucks the hourly cost figures will not be given.

Kenworth Logging Trucks (20)

Kenworth trucks are manufactured by the Kenworth Motor Truck Corporation in Seattle, Washington. These trucks are custom built to the needs of the operator and have been quite successful in heavy hauling operations. The trend in this region is toward the medium sized trucks, but some operators use Kenworth trucks entirely. These trucks can operate either with Cummins diesel, (24), Hall Scott gasoline (14), or Buda gasoline engines (12). When purchasing a Kenworth truck, the company upon examining the conditions of the operations, will

recommend a certain engine. The final choice, however, will naturally be left up to the operator.

These units are usually used for off-highway operations due to their size and weight. Bunks exceeding the allowable eight feet is the rule rather than the exception. The advantage in these large trucks are the large loads that they are capable of handling. The Model 548 with two trailers has a log capacity of 30,000 board feet.

The three most common unts of the Kenworth line are the Models 521, 524, and 548.

Kenworth General Specifications (20)

	Model 521	Model 524	Model 548
Engine (48)	Cummins HB - 600 or Hall-Scott 400 or Buda 6DC844	Cummins HB - 600 or Hall-Scott 400	Cummins HB - 600 or Hall-Scott 400
Horsepower	150	150	150
Gross vehicle weight	35,000 lbs.	54,000 lbs.	
Rear axle	Single	Tandem	Tandem
Tires	10.00x20 14 ply	11.00x22 14 ply	12.00x24 16 ply
Price delivered . .	$15,743.00	$20,768.00	$23,558.00

Initial Cost of Kenworth Logging Trucks Delivered in California (12)

	Kenworth Model 521 (Cummins Diesel Engine)	Kenworth Model 524 (Cummins Diesel Engine)	Kenworth Model 548 (Cummins Diesel Engine)
Initial Investment of chassis and cab. . . .	$11,640.00	$15,515.00	$18,105.00
Initial Investment of trailer	3,500.00	4,200.00	4,200.00
Tax and freight	500.00	700.00	900.00
Brake connections & valves	79.00	79.00	79.00
Fuel filter	24.00	24.00	24.00
Reinforced frame		100.00	100.00
Aux. transmission		150.00	150.00
Total initial investment	$15,743.00	$20,768.00	$23,558.00

Cost per Hour for Kenworth Logging Trucks

	Model 521	Model 524	Model 548
Initial investment	$11,640.00	$15,515.00	$18,105.00
Less tires. . . .	679.00	1,370.80	2,080.60
Less tubes. . . .	70.32	149.10	206.00
Net investment. .	10,890.30	13,995.10	15,818.40
Fixed Charges			
Interest . .	.163	.210	.237
Depreciation	1.089	1.400	1.582
License fee	.180	.180	.180

Cost per Hour for Kenworth Logging Trucks
(Continued)

	Model 521	Model 524	Model 548
Insurance	.180	.180	.180
Overhead & Risk	.361	.433	.475
Variable Charges			
Repairs. . .	.840	.840	.960
Drivers' wages	1.600	1.600	1.600
Diesel oil	.258	.258	.280
Oil	.030	.030	.030
Grease	.015	.015	.015
Tires & Tubes	.600	1.216	1.828
Total cost per hour	5.511	6.557	7.562

The above figures were computed in the same manner as those for the Reo trucks. Tire costs were obtained through the Firestone Company. Interest was figured at 3 per cent of the initial investment. The units were depreciated over 5 years or 10,000 hours. Overhead and risk were taken as 20 per cent of the total fixed charges. Repairs were computed as $0.07 per mile as recommended by the Kenworth Company. The Models 521 and 524 use approximately one gallon of diesel oil for every 4½ miles. The Model 548 uses one gallon for every 3 miles. These figures were obtained from the Kenworth Company (12).

These units will use approximately 1½ quarts of oil and one pound of grease per day. Tires on these trucks will last approximately 15,000 miles (12).

TRAILERS

In the early days of truck logging in California, the equipment was of the make shift variety. There were no trucks designed for the job, so almost any truck was put to use. For a time stake trucks were used solely. This meant small loads, short loads, inadequate springs, and many other difficulties. Later the trailer came into use, and they were generally a "homemade" affair, built up on discarded truck axles. As time went on, the business of making better trailers for logging settled into an industry. Many of the early day trailer manufacturers have now passed away entirely, but many of the pioneers such as Walker, Page, Beal, and Pierce are still in the business.

Wentworth and Irwin Trailers (47)

These trailers are made in Portland, Oregon, by "Wentworth and Irwin Inc." This firm has been making and selling logging trailers for many years and has earned a good name in the logging industry. They manufacture logging trailers in three sizes. The largest model is known as "Model U - 25,000 - Special." The specifications are as follows:

Gross vehicle weight rating. . . . 50,000

Timken tubular axle series 25,000

Silico manganese springs . . . . . 18 leaves 5x60x5/8

Brakes-"Timken Heavy Duty" 17½x5½

Reach pole . . . . . 10x10 - 24 -32

Basic tires. 12.00/24

Bunk length. . . . . 10 ft.

The price of the U - 25,000 Special as of April 1, 1947 is $4,600 delivered on the West Coast (27). The water tank capacity will vary with the individual operator. The normal tank holds 53 gallons, but larger tanks may be obtained. A water control is located in the cab, so it is unnecessary for the driver to leave the cab to release the water. All legal lights are installed when the trailer is delivered. They are built to operate with General Motor trucks, but will operate with any type. All General Motor Agencies in either the East or West Slope are authorized to sell these trailers.

The second largest trailer manufactured by this firm is known as "Model U - 1700" and sells for $3,640 on the West Coast (27). It is built similar to the larger trailer on a smaller scale. Specifications of the trailer Model U - 17000 are as follows:

Gross vehicle weight rating. 34,000

Timken tubular axle series. 17,000

Silico manganese springs. . . . . 16 leaves 4x54x5/8

Brakes - "Timken Heavy Duty". . . . 16½x7

Reach pole. . . . . 6½x9½ - 24 - 32

Basic tires 10.00/20

Bunk length . . . . . 8 ft.

Water tank capacity . . . . . 53 gallons

The smallest trailer is the Model U - 13000, and sells for $3,000 on the West Coast (27). This is the most popular trailer manufactured by the Wentworth and Irwin Company. Specifications for trailer Model U - 1300 are as follows:

Gross vehicle weight rating. 26,000

Timken tubular axle series 13,000

Silico manganese springs. . . . . 13 leaves 4x54x5/8

Brakes - "Timken Heavy Duty" 16½x6

Reach pole. . . . . 6½x9½ -,24 -32

Basic tires. 9.00/20

Bunk length. . . . . 8 ft.

Water tank capacity . . . . . 53 gallons

The Gunderson Trailer (13)

This trailer, although manufactured in Portland, Oregon, has found its way into many of the California operations. It is built to operate with White trucks, but can, with a few alterations, combine with any truck. This trailer includes a 43 gallon water tank in the frame and uses eight 10.00 x 20 - 12 ply tires. The reach is a Northwest Standard 7" x 9" and includes non-binding reach rollers. The price of the trailer complete delivered is $3,770.00 (13).

Cost per Hour of the Gunderson Heavy Duty Logging Trailer

Initial cost delivered in California . .	$3,770.00
Less tires	905.84
Less tubes	93.76
Net investment	2,770.40
Fixed Charges	
Interest @ 3 per cent	.042
Depreciation.	.277
Overhead and risk	.064
Variable Charges	
Repairs	.120
Grease.	.008

Cost per Hour of Gunderson Trailer (Cont'd.)

Variable Charges (Cont'd.)

Tires and tubes. 599

Total cost per hour 1.110

The costs listed above were calculated in the following manner. The current prices of tires and tubes were obtained from the Firestone Tire Company, (11, p. 114). Interest of 3 per cent on net investment was used because 3 per cent is the highest safe investment that can be obtained today and is the figure used by most large operators. The trailer was depreciated over a 5 year or 10,000 hour period. Overhead and risk were taken as 20 per cent of the total fixed charges.

Most operators, according to the Reo Company (10), set aside one cent per mile for future repair work for trailers. This is the figure used in these calculations. A trailer this size, based on trailers used on the Clover Valley Operation, will use approximately one half a pound of grease per day. The price of grease is $0.12 per pound. The average life of trailer tires is approximately 20,000 miles in this region. In these calculations it is assumed that the trailer returns to the woods riding the truck. In this way the tires are used on the one way haul only.

Reliance Trailers (37) (38)

A large percentage of the logging trailers in the California woods today are made by the Reliance Trailer and Truck Company. This is due to two reasons. First, the Reliance Company is an old established firm, having a good reputation of manufacturing good logging equipment for many years. Second, all of the engineering and manufacturing of these trailers is accomplished in San Francisco. They have been building logging trailers for over twenty-five years, starting with the early type solid-tired units. The company makes both the single axle and the four and six wheel trailers. While the single axle trailers are used in some operations, by far the greater majority are of the larger type. The larger trailers are of the articulated axle mounted type. This eliminates all torsional strains from being transmitted to the springs or frame. The most popular logging trailers put out by this firm are the Models 424L, 430L (now known as model 428L), 434L and the 450L.

The Model 424 - L is one of the most popular trailers manufactured by this company. It is light enough to be used on highway hauls, yet heavy enough to stand the punishment given a logging trailer on private dirt roads. The retail price of this trailer in San Francisco is $2900.00

(45). This price is current as of March 7, 1947. The rated capacity of the trailer is 6,000 board feet and weighs 5,160 pounds. The standard size tires to be used with this trailer are 9.00x20 duals, but 10.00x20 dual tires may be substituted. Equipment included in the sale is the swinging bolster on trailer with cross chains and chocks, also bolster with chains and chocks for truck, reverse vacuum tank, and break-away valve. If any extra equipment is desired, it will come as an additional cost. Some of the extra equipment available for this trailer are brake control valves for mounting in cab, air or vacuum, different types of air brakes, special wheel equipment, water tanks, loaders, special type reaches, a frame and trailer carrying equipment for trucks.

The next size trailer is the Model 430L or 428L. It has a capacity of 10,000 board feet and weighs approximately 5,800 pounds. The standard size tires to be used are 9.75x20 duals, but 10.00x22 dual tires may be substituted. The retail price is $3,200.00 in San Francisco as of March 7, 1947 (45). This trailer is small enough to be used on the highways of California if the load is limited, and sturdy enough to operate efficiently on the roughest roads. Equipment included in the sale of the 430L model is the same as the 424L.

The Reliance Company builds two types of trailers, which they class as springless type and are used for off-

highway operations. The smallest of this type is the Model 434L. It has a capacity of 10,000 board feet and costs $3,958.00 in San Francisco (45). The specifications are as follows:

Axles..... 18,000 pounds capacity each
Brakes..... 8" with 2/3" Brake lining
Brake control..... Westinghouse Air
Wheels..... Budd
Tires..... 11.00x22 - 12 ply dual
Log bunk width..... 8 to 10 feet
Reach..... 8" x 10" Steel

Equipment included with the sale of the 434L includes bunk with cross chains for truck, tank and lines for water on brakes, coupling, stinger, and bunk locks.

The largest model manufactured by the company is Model 450L, and it is of the off-highway type. It has a capacity of 14,000 board feet and costs $4,812.00 in San Francisco (45). The specifications are as follows:

Axles..... 25,000 pound capacity each
Brakes..... 20x8 with 2/4" brake lining
Brake control..... Westinghouse Air
Wheels..... Budd
Tires..... 12.00x24 - 14 ply Dual

Log bunk width . . . . . 10 feet

Reach . . . . . 8"x10" Steel

Equipment included with the sale of the 450L is the same as that of the 434L.

CATERPILLAR EQUIPMENT

The greatest majority of the logging units in the California woods today are manufactured by the Caterpillar Tractor Company of Peoria, Illinois. They are the producers of such items as tractors, bulldozers, scrapers, rippers, cable-controls, motor graders, diesel electric sets, and many more pieces of logging equipment. This firm is the result of two pioneer tractor manufacturers uniting. In 1925 Charles Holt and Daniel Best were joined to form the present Caterpillar Company. In the years up to the last world war "Caterpillar" built two lines of equipment, the gasoline type and the diesel. The diesel, due chiefly to low fuel consumption, has gradually replaced the old familiar "Sixties" and "Seventy-Fives." Due to extremely small demand for gasoline tractors, production of this type was discontinued prior to the beginning of the war and indications are that they will never again produce machines of that type.

This company works in conjunction with several other companies in the manufacture of what is known as "Logging Units." The Caterpillar tractor and Hyster winch and arch is a typical example of one of these units. Before this last war the Caterpillar Company and the La Plant Choate Company used to produce a bulldozer unit. The tractor

was made by the Caterpillar Company and the blade assembly by the La Plant Choate Company. Since the war, however, La Plant Choate has ceased to manufacture bulldozers and have concentrated on other dirt moving assemblies. This leaves the bulldozer manufacture entirely up to the Caterpillar Company.

The most familiar "Caterpillar" unit in the woods today is the D8 tractor. It is used as the power plant for arches, scrapers, rippers, bulldozers, winches, donkies and yarders. The approximate price of the D8 is $9,747.50, delivered in California (42). It will develop 113 drawbar horsepower and 131 belt horsepower. It has six speeds forward and two reverse, moving as fast as 4.9 miles an hour in sixth gear or as slow as 1.6 miles per hour in first. It has a gauge of 78 inches and weighs, ready for shipping, 34,160 pounds (4,p.4-5). The D8 can be used with the Hyster logging arch or the Carco Medium Yarder with little or no alterations. The Clover Valley Lumber Company has four Caterpillar D8 tractors pulling the Carco Yarder (arch) and have had excellent results.

The Caterpillar D7 tractor is the second largest size in this line. It can develop 80 drawbar horsepower and 92 belt horsepower. It has a gauge of 74 inches and weighs ready for shipping, 24,330 pounds. It has five forward speeds and four reverse, moving as fast as 6

miles per hour in fifth gear and 1.4 miles per hour in first (4,p.6). Many operators prefer the D7 because of its lower initial cost and speed. The Clover Valley Company has a D7 bulldozer that they consider ideal, because it is used in shallow cuts and in clearing small poles. Its increased speed and maneuverability make it more desirable than the larger D8. Its price, delivered in California, is approximately $7,465.21 (42). All of the Caterpillar tractors have an independent gasoline starting engine. This is located on the left side of the main engine. It is usually started by means of a crank with the D8, D7, and D6 and by a rope with the D4 and D2. The usual practice is to start the starting engine, let it warm up, cut it in on the main engine, and let it run until enough pressure is built up to run independently. The starting engine is then secured. When it is necessary to stop the tractor for any reason, the main engine is either kept running, or the tractor is parked on a slight incline to facilitate starting. The D7 is used mainly in the capacity of a bulldozer, for ground and arch skidding, to haul scrapers and rippers, and as the power plant for a donkey or yarder.

The Caterpillar D6 is used to a limited extent in the California woods. It is too small for most of the yarding operations. It is used as a bulldozer in light

cuts or as the power plant for a donkey. It can develop 55 drawbar horsepower and 65 belt horsepower. It has five forward speeds and four reverse, moving as high as 5.8 miles an hour in fifth gear and as slow as 1.4 miles per hour in first. It is available in two sizes, the 74 inch gauge weighing 17,330 pounds and the 60 inch gauge weighing 16,695 pounds (4.p.7). The approximate price of this tractor delivered in California, is $5,827.00 (42).

The Caterpillar Company also makes two smaller tractors, the D4 and the D2. They are very rarely seen on any logging operation in this region. In the last few years a special use has been developed for these two types, and that is supplying power for the power chain saw. If the D4 and D2 does appear in the woods, it is usually in this capacity. The Clover Valley Company has two of this type. One D4 with generator furnishing power for two Atkins Electric Power Saws, and one D2 furnishing power for one Atkins Electric Power Saw.

The Caterpillar bulldozer series are put to good use in almost every operation of any size in this region. The most practical use comes in the role of clearing right of way and the actual construction of logging roads. The Clover Valley Company keeps three bulldozers in constant use. They operate one 8S straight blade to clear landings, to keep the roads close to the skidding operation open, and to make the last minute alterations on the road

and especially to the turnouts. They also employ a 7S straight blade to clear right of way and a 8A to construct the logging roads. The main units in the woods today are the 8A, 8S, 7A, and 6S. The letters "S" and "A" indicate straight or angle blade. The numbers "8", "7", and "6" indicate the size tractors that handle these blades. The unit is operated either by a front or rear cable control. Up to the period before the war, the rear cable controls relied on an overhead structure to carry the cable to the blade. During the war they have improved the unit and now it has reached a point where the cable passes through a pipe just above the tracks. This improves the vision of the operator and places the cable control in the rear of the unit where it is relatively safe. The chief disadvantage of the front cable control is its location. It is situated rather low under the radiator and suffers damage when rocks, dirt, snow, and even saplings are forced up between the radiator shield and the rear of the blade. It also has the disadvantage of being exceptionally hard to work on when damaged due to the location of the blade. The advantages of the front cable control are initial price, and less cable to contend with.

The 8S bulldozer has a blade 135½ inches in length and 45½ inches high. It can be lifted to a height of 48

inches above the ground, and the unit weighs approximately 5200 pounds (4,p.11). The price of the unit delivered in California, is $1483.12 (42).

The 8A bulldozer has a blade 160 inches long and 38 3/4 inches high. It can be lifted to a height of 50 inches above the ground, and the unit weighs approximately 6070 pounds (4,p.13). The price of the unit delivered in California is $1,834.52 (42).

The 7S bulldozer has a blade 123½ inches long and 45½ inches high. It can be lifted to a height of 42 inches above the ground, and the unit weighs approximately 4340 pounds (4,p.12). The price of the unit delivered in California, is $1,286.85 (42).

The 7A bulldozer has a blade 152 inches long and 38 3/4 inches high. It can be lifted to a height of 40 inches above the ground, and the unit weighs approximately 5,245 pounds (4,p.13). The price of the unit delivered in California, is $1,638.71 (42).

The 6S bulldozer has a blade 98½ inches long and 37½ inches high. It can be lifted to a height of 36 inches above the ground, and the unit weighs approximately 2,725 pounds (4,p.12). The price of the unit is delivered in California is $1,020.70 (42).

The Caterpillar Company builds three sizes of scrapers or what is commonly called "carry-alls." They are the "80",

"70" and "60", and they carry 17½ yards, 11 yards and 7½ yards, respectively. They are built to operate with the Caterpillar D8, D7, and D6 tractors and Caterpillar rear cable control. Although built to carry dirt for fills in the construction of roads, the "carry-all" finds another use in the California woods in the carrying and distributing ballast. In many regions in California, especially near Mount Lassen, there exist pockets of partially decomposed lava rock. This is really a mixture of dirt and small pieces of lava about a half inch in diameter. This mixture makes an ideal summer ballast when spread by a carry-all" to a depth of six inches, watered during the night, and worked by a grader the following day. In most instances this ballast must be transported a considerable distance and the "carry-all" is the ideal piece of equipment. The Clover Valley Company operates one No. 80 scraper. This piece of equipment is new, so few operating costs were obtained.

To Determine Hourly Cost of Caterpillar
D8 Tractor - 78" Gauge

Cost of D8, F.O.B. Peoria, Illinois . . .	$9,300.00	(42)
Freight cost.	447.50	(42)
Initial Investment.	9,747.50	
Fixed Charges		
Depreciation.	.975	
Interest, taxes, insurance.	.292	
Overhead and risk (20 % of the above)	.253	
Total fixed charges	$1.520	
Variable Charges		
Repairs	.975	
Operator.	1.600	
Diesel fuel	.280	
Gasoline.	.020	
Lubrication oil	.160	
Grease	.090	
Total variable charges	$3.125	
Total cost per hour	$4.645	

The costs for the Caterpillar D8 tractor were computed as follows: The initial price f.o.b. was quoted by the Caterpillar Agency in San Leandro, California (42). Freight rates were obtained from the Southern Pacific Company and figured from Peoria, Illinois to San Leandro. Depreciation period was taken as 5 years

or 10,000 hours. This is the period advised by the Caterpillar Company, and the period used by the majority of logging companies.

$$\frac{\text{Initial investment}}{\text{Life in hours}} = \frac{9747.50}{10,000} = \$0.975$$

Interest, taxes, and insurance were taken as 10 per cent of the average annual investment.

$$\text{A.A.I.} = \frac{\text{Initial Investment} + \text{Annual investment}}{2} =$$

$$\frac{9747.50 + 1949}{2} = \$5848.50 \quad \frac{(\text{Average annual investment})(10\%)}{\text{Hours per year}} =$$

$$\frac{(5848.50)\ (.10)}{2,000} = .2924$$

Repairs were figured as 100 per cent of the annual depreciation.

$$\frac{(\text{Annual depreciation})(100\%)}{\text{Hours per year}} = \frac{(1949.50)\ (1.00)}{2,000} = \$0.975$$

The operators' wages for the D8, D7, and D6 type tractors are the same. This wage of $1.60 per hour is current as of March, 1947. This wage represents an increase of 15 cents over the wage of a year ago, as no new increase is expected for the first half of this year at least.

The fuel, gasoline, lubrication oil, and grease costs were obtained from actual experience with a Caterpillar D8 and D7 tractor on the Clover Valley operation during the season of 1946. It was found that the D8 will

use 16 drums of diesel oil per month. The month used for this determination had twenty-five working days, and the tractor worked eight hours per day. Each drum had a capacity of 55 gallons, but 50 gallons was the maximum that could be recovered. This was due to the drum not being full, leakage, spilling, and the inability to drain the last few gallons due to the shape of the drum.

$$\frac{(\text{Gallons per drum})(\text{Drums per month})}{(\text{Number of days})(\text{Hours per day})} = \frac{(50)(16)}{(25)(8)} = 4$$ Average gallons used per hour.

The price of diesel fuel in this region is 7 cents per gallon when purchased in large quantities.

Gasoline is used in the starting motors of the diesel tractors. They are started by hand, allowed to warm up, and then used to turn the main engine over until enough compression is built up to run independently. On new tractors this time is approximately four minutes, while on the older types it may take as long as 10 minutes on cold mornings. They use on the average 1.2 gallons per day or .15 gallons per hour. The price of gasoline delivered to the woods is 15 cents when purchased in quantities of a drum or more.

The D8 tractor used approximately 11.5 gallons of lubricating oil per six day week. The price is 65 cents per gallon delivered.

$$\frac{(\text{Gallons per week})(\text{price per gallon})}{(\text{days per week})(\text{hours per day})} = \frac{(11.5)(.65)}{(6)(8)} = \$0.16$$

The tractors in this region, because of the large amount of dust, are greased at least once a day, and those units engaged in exceptionally dusty jobs, like drawing scrapers, are greased twice a day. The average D8 unit working on the average job, will use six pounds of grease per day. The greatest part of this grease goes into the sealed bearings of the tracks. It has been my experience to find the average life of a sealed bearing to be approximately six months for the first year of operation and four months for the remaining years. The sealed bearings in the Clover Valley tractors are replaced but once a year. This is accomplished in the winter when the tractor is completely down for repairs. The location and nature of these bearings make it almost impossible to replace in the field. The current price of grease is .12 per pound.

$$\frac{(\text{Grease per day})(\text{Price of grease})}{\text{Working hours per day}} = \frac{(6)(.12)}{8} = .09$$

To Determine Hourly Cost of Caterpillar D7 Tractor - 74" Gauge

Cost of D7, f.o.b. Peoria, Illinois.....	$7,150.00 (42)
Freight cost.....	315.21 (42)
Initial investment.....	7,465.21
Fixed Charges	
Depreciation.....	.747
Interest, taxes, insurance.....	.224
Overhead and risk (20% of the above)	.194
Total fixed charges.....	1.165
Variable Charges	
Repairs.....	.747
Operator.....	1.600
Diesel fuel.....	.245
Gasoline.....	.019
Lubricating oil.....	.091
Grease.....	.076
Total variable charges.....	2.778
Total cost per hour.....	3.943

The fixed charges for the D7 tractor were figured in the same manner as those for the D8. The initial price is $7,150.00 f.o.b. Peoria, Illinois, as quoted by the Caterpillar Company at San Leandro, California, (42). A freight charge of $1.31 per hundred was quoted by the Southern Pacific Company from Peoria to San Leandro.

This unit ready for shipping will weigh approximately 24,330 pounds (4,p.7). All prices are current as of March 1947. The operator's wages are the same as that of the D8, namely $1.60 per hour.

The D7 tractor, from which studies have been made at the Clover Valley operation used 14 drums of diesel oil per month. The month used had 25 working days.

$$\frac{\text{(Cost per gallon) (Drums per month) (Gallons per drum)}}{\text{(Working days per month) (Working hours per day)}} =$$

$$\frac{(.07)\ (14)\ (50)}{(25)\ (8)} = \$0.245$$

This tractor uses approximately one gallon of gasoline per day for its starting engine.

$$\frac{\text{(Gallons per day) (Cost per gallon)}}{\text{Working hours per day}} = \frac{(1)(.15)}{8} = \$0.019$$

This tractor uses approximately 1.12 gallons of lubricating oil per day.

$$\frac{\text{(Gallons per day)(Price per gallon)}}{\text{Working hours per day}} = \frac{(1.12)(.65)}{8} = \$.091$$

This tractor uses approximately 5 pounds of grease per day.

$$\frac{\text{(Pounds per day)(Price per pound)}}{\text{(Working hours per day)}} = \frac{(5)(.12)}{8} = \$0.076$$

To Determine Hourly Cost of Caterpillar
D6 Tractor - 74" Gauge

Cost of D6, f.o.b. Peoria, Illinois. .	$5,600.00 (42)	
Freight Cost	227.02 (42)	
Initial investment	5,827.02	
Fixed charges		
Depreciation.		.583
Interest, taxes, insurance. . . .		.175
Overhead and risk (20% of the above)		.152
Total fixed charges		$ .910
Variable Charges		
Repairs		.583
Operator.		1.600
Diesel fuel		.193
Gasoline.		.014
Lubricating oil		.084
Grease.		.060
Total variable charges.		$2.534
Total cost per hour.		$3.444

The fixed charges for the D6 tractor were figured in the same manner as those for the D8 and D7. The initial price is $5,600.00 f.o.b. Peoria, Illinois, as quoted by the Caterpillar Company at San Leandro, California (42). A freight charge of $1.31 per hundred was quoted by the Southern Pacific Company from Peoria to San Leandro. This unit ready for shipping will weigh

approximately 17,330 pounds (4,p.7). All prices are current as of March 1947. The operator's wages are the same as that of the D8 and D7, namely $1.60 per hour. The D6 tractor uses approximatley eleven drums of diesel oil per month (6,p.203). The month taken had twenty-five working days.

$$\frac{(\text{Cost per gallon})(\text{Drums per month})(\text{Gallons per drum})}{(\text{Working days per month})(\text{Working hours per day})} =$$

$$\frac{(.07)(11)(50)}{(25)(8)} = \$0.193.$$

This tractor uses approximately $\frac{3}{4}$ of a gallon of gasoline per day for its starting engine (6,p.2-3).

$$\frac{(\text{Gallons per day})(\text{Cost per gallon})}{(\text{Working hours per day})} = \frac{(\frac{3}{4})(.15)}{8} = \$0.014$$

This tractor uses approximately 1,04 gallons of lubricating oil per day (6,p.2-3).

(Gallons per day)(Price per gallon) = $0.084

This tractor uses approximately 4 pounds of grease per day (6,p.2-3).

$$\frac{(\text{Pounds per day})(\text{Price per pound})}{\text{Working hours per day}} = \frac{(4)(.12)}{8} = \$0.06$$

Hourly Cost of the Caterpillar No. 80 Scraper
Under Average Logging Conditions

Cost of No. 80 Scraper, f.o.b. Peoria, Illinois	$8,565.00 (42)	
Freight Cost	327.50 (42)	
Initial Investment	8,892.50	
Fixed Charges		
Depreciation		1.111
Interest, taxes, insurance		.278
Overhead and risk (20% of the above)		.278
Total fixed charges		$ 1.667
Variable Charges		
Repairs		.555
Cutting Edges		.100
Tires		.520
Cables and Sheaves		.310
Grease		.090
Total variable charges		1.575
Total cost per hour		$3.242

The hourly costs for the Caterpillar No. 80 scraper were computed in the following manner: The initial price of $8,565.00 f.o.b. Peoria, Illinois, was quoted by the Caterpillar Company (42). Freight charges of $131 per hundred from Peoria to San Leandro were quoted by the Southern Pacific Company. This unit

weighs 25,000 pounds ready for shipping (4,p.14-15). The Caterpillar scrapers are depreciated over 4 years or 8,000 hours. This is the recommended time stated by the Caterpillar Company (6,p.3). The Clover Valley Lumber Company has only one scraper, a No. 80, but being only two years old, they do not have enough information to determine a reasonable depreciation period. Depreciation = $\frac{\text{Initial cost}}{\text{Life in hours}} = \frac{8892.50}{8000} = \$1.111$

Interest, taxes, and insurance are taken as 10 per cent of the average annual investment. A.A.I. = $\frac{\text{Initial investment} + \text{Yearly depreciation}}{2} =$

$\frac{8892.50 + 2223.12}{2} = \$5557.81$ ($\frac{\text{Average annual Investment}}{\text{Yearly working hours}}$)($10\%$) $= \frac{(5557.81)(.10)}{2000} = .278$

Repairs are taken as 50 per cent of the yearly depreciation charge. Repair hourly cost $= \frac{(\text{Depreciation})(50\%)}{(\text{Yearly working hours})}$

$\frac{(2223.12)(.50)}{2000} = \$0.555$

The operator's wages are charged off to the tractor, so it does not enter into these calculations.

This unit will use one cutting edge for the apron every 200 hours. (Actually, the cutting edge on the Clover Valley "carry-all" or scraper lasted well over 200 hours but it was working in exceptionally fine material and had

long haul. On the average haul in average material, the life span would be close to 200. The price of the cutting edge for the No. 80 is approximately $20.00.

Cutting edge hourly cost = $\frac{\text{Cutting edge cost}}{\text{Life in hours}} = \frac{20.00}{200} =$ $0.10

The tires on this unit will last about 5000 hours, and the approximate price is $2600 for the set (11, p.114). These figures are taken from the "Caterpillar Handbook" (5,p.29), since the Clover Valley scraper is too new to obtain any tire costs. Tire costs per hour =

$$\frac{\text{Tire cost}}{\text{Life in Hours}} = \frac{2600}{5000} = \$0.52$$

The cable and sheave costs were taken from the Caterpillar Handbook" (5,p.29). It is figured at ½ cents per yard for the average production of 63 yards per hour. The average capacity is 14 yards, and the unit makes 4.5 trips per hour.

This unit will use 6 pounds of grease per day. This is the average figure obtained from the Clover Valley scraper. A large percentage of this grease goes in the bearings of the apron. These bearings, especially on extremely dusty operations, have to be greased three times a day. Grease hourly costs = (Grease used per hour) (Grease price) = (.75)(.12) = .09

Hourly Cost of the Caterpillar No. 70 Scraper
Under Average Logging Conditions

Cost of No. 70 Scraper, f.o.b. Peoria, Illinois. . . .	$6,050.00 (42)	
Freight cost.	229.25 (42)	
Initial investment.	6,279.25	
Fixed Charges		
Depreciation		.785
Interest, taxes, insurance		.196
Overhead and risk.		.196
Total fixed charges.		1.177
Variable Charges		
Repairs.		.393
Cutting edges.		.075
Tires.		.480
Cable and Sheaves.		.225
Grease		.075
Total variable charges		1.248
Total cost per hour		$2.425

The hourly costs of the Caterpillar No. 70 scraper were computed in the same manner as the No. 80. Initial cost of $6,050.00 f.o.b. Peoria, was quoted by the Caterpillar Company (42). The freight charge is $1.31 per hundred from Peoria to San Leandro. The unit weighs 17,500 pounds ready for shipment (4,p.14-14).

The average life of the cutting edge is 200 hours,

and the price for this unit is $15.00 (42). Cutting edge hourly costs = $\frac{\text{Cutting edge cost}}{\text{Life in hours}} = \frac{15}{200} = \$0.075$

The average life of a set of tires is 5000 hours, with a set costing approximately $2,400.00 (11,p.14).

Tire hourly cost = $\frac{\text{Tire cost}}{\text{Life in hours}} = \frac{2400}{5000} = \$0.480$

Cable and sheave costs are calculated as ½ cents per yard (39) (5,p.29). The average load for this size is 10 yards and 4.5 loads per hour was taken as average. Cable and sheave hourly costs = (Loads per hour)(Average load) (.005) = (4.5)(10)(.005) = .225

This unit will use 5 pounds of grease per day (6,p.3). Grease hourly cost = (Grease per hour)(Grease cost) = (.625)(.12)=$.075

Hourly Cost of the Caterpillar No. 60 Scraper
Under Average Logging Conditions

Cost of No. 60 Scraper f.o.b. Peoria, Illinois.	$4,275.00	(42)
Freight cost	161.13	(42)
Initial investment	4,436.13	
Fixed Charges		
Depreciation.	.555	
Interest, taxes, insurance.	.139	
Overhead and risk	.139	
Total fixed charges	.833	
Variable Charges		
Repairs	.278	
Cutting edges	.045	
Tires	.400	
Cables and sheaves.	.160	
Grease.	.060	
Total variable charges.	.943	
Total cost per hour.	$1.776	

The hourly costs of the Caterpillar No. 60 scraper were computed in the same manner as the No. 80. Initial cost of $4275.00 f.o.b. Peoria, Illinois, was quoted by the Caterpillar Company (42). The freight charge is $1.31 per hundred from Peoria to San Leandro. This unit weighs approximately 12,300 pounds ready for shipping (4,p.14-15).

The average life of the cutting edge is 200 hours, and price for this unit is $9.00 (42). Cutting edge

hourly cost = $\frac{\text{Cutting edge cost}}{\text{Life in hours}} = \frac{9}{200} = \$0.045$

The average life of a set of tires is 5,000 miles with the price as $2,000.00 for the set (11,p.114). Tire

hourly cost - $\frac{\text{Tire cost}}{\text{Life in hours}} - \frac{2000}{5000} - \$0.40$

Cable and sheave costs are calculated as ½ cents per yard (5,p.29). The average load for this size scraper is 7 yards, and 4.5 trips per hour was taken as average. Cable and sheave hourly costs = (Loads per hour) (Average load) (.005)= (4.5)(7)(.005) = .16

This unit will use 4 pounds of grease per day (6,p.3). Grease hourly cost = (Grease per hour)(Grease cost) = (.5)(.12) = $0.075

Hourly Cost of the Caterpillar 8 A Bulldozer
Under Average Logging Conditions

Cost of 8A bulldozer f.o.b. Peoria, Illinois	$1,755.00(42)
Freight Cost	79.52(42)
Initial investment	1,834.52
Fixed Charges	
Depreciation	.183
Interest, taxes, insurance	.055
Repairs	.092
Total fixed charges	.330
Variable Charges	
Cutting edge	.160
Grease	.002
Total variable charges	.162
Total cost per hour	.492

The hourly costs of the Caterpillar 8A bulldozer were computed as follows: The initial price of $1,755.00 f.o.b. was quoted by the Caterpillar Agency in San Leandro, California (42). Freight rates were obtained from the Southern Pacific Company and were quoted as $1.31 per hundred pounds from Peoria, Illinois to San Leandro, California. The approximate weight of this unit ready for shipment is 6070 pounds (4,p.10-11). The depreciation period was taken as five years or 10,000 hours. This is the period used by most of the operators in this re-

gion. Depreciation = $\frac{\text{Initial investment}}{\text{Life in hours}} = \frac{1834.52}{10,000} = \$0.183$

Interest, taxes, and insurance were taken as 10 per cent of the average annual investment.

A.A.I. = $\frac{\text{Initial investment} + \text{Annual investment}}{2} =$

$\frac{1834.52 + 366.90}{2} = \$1100.71$/

$\frac{(\text{Average annual investment})(10\%)}{\text{Hours per year}} = \frac{(1100.71)(.10)}{2,000} = \$0.055$

Repairs were figured as 50 per cent of the annual depreciation. Repair cost = $\frac{(\text{Annual depreciation})(50\%)}{\text{Hours per year}} =$

$\frac{(366.90)(.50)}{2,000} = \$0.0917$ or 0.092/

There are no operator's wages charged off to the bulldozers.

The 8A bulldozer will use one cutting edge every 300 hours. This is taken from the "Caterpillar Handbook" (5,p.29) and has been approximated by a Clover Valley bulldozer. The cutting edge for the 8A costs $50.00 (42). Cutting edge hourly cost = $\frac{\text{Costs of blade}}{\text{Hours in use}} =$

$\frac{50.00}{300} = \$0.160$

This blade will use approximately .013 pounds of grease per hour according to the "Caterpillar Handbook" (5,p.29). Grease cost per hour = (Pounds per hour) (Cost per pound) = (.013)(.12) = /002

Hourly Cost of the Caterpillar 8S Bulldozer
Under Average Logging Conditions

Cost of 8S bulldozer, f.o.b. Peoria, Illinois	$1,415.00 (42)
Freight cost	68.12 (42)
Initial investment	1,483.12
Fixed Charges	
Depreciation	.148
Interest, taxes, insurance	.044
Repairs	.074
Total fixed charges	.266
Variable Charges.	
Cutting edge	.160
Grease	.002
Total variable charges	.162
Total cost per hour	.428

The costs for the 8S Caterpillar bulldozer were computed in the same manner as those for the 8A. The initial cost f.o.b., Peoria, Illinois, is $1,415.00 (42). The freight rate as quoted by the Southern Pacific Company was $1.31 per hundred pounds from Peoria to San Leandro. The unit weight 5,200 pounds ready for shipment (4,p.10-11)

Hourly Cost of the Caterpillar 7S Bulldozer
Under Average Logging Conditions

Cost of 7S bulldozer, f.o.b. Peoria, Illinois.....	$1,230.00 (42)
Freight cost.....	56.85 (42)
Initial investment.....	1,286.85
Fixed Charges	
Depreciation.....	.129
Interest, taxes, insurance.....	.039
Repairs.....	.065
Total fixed charges.....	.233
Variable Charges	
Cutting edge.....	.15
Grease.....	.002
Total variable charges.....	.152
Total cost per hour.....	.385

The hourly costs of the Caterpillar 7S bulldozer were computed in the same manner as those for the 8A and 8S. The initial price was $1,230 f.o.b., Peoria, Illinois (42). The freight rate was quoted as $131 per hundred pounds by the Southern Pacific Company from Peoria to San Leandro. This unit weight 4340 pounds ready for shipping (4,p.12). The cutting edge and grease cost for this unit and the 7A are identical.

Hourly Cost of the Caterpillar 7A Bulldozer
Under Average Logging Conditions

Cost of 7A bulldozer, f.o.b. Peoria, Illinois. . . .	$1,570.00 (42)	
Freight cost	68.71 (42)	
Initial investment	1,638.71	
Fixed Charges		
Depreciation.		.164
Interest, taxes, insurance. . . .		.049
Repairs		.082
Total fixed charges		.295
Variable Charges		
Cutting edge.		.150
Grease.		.002
Total variable charges.		.152
Total cost per hour.		.447

The hourly costs of the Caterpillar 7A bulldozer were computed in the same manner as those for the 8A and 8S. The initial price was $1,570.00 f.o.b. Peoria (42). The freight rate was quoted as 1.31 by the Southern Pacific Company from Peoria, Illinois to San Leandro, California. This unit weighs 5,245 pounds ready for shipment (4,p.13). The cutting edge of the 7A costs approximately $45.00 and lasts about 300 hours according to the "Caterpillar Hand Book" (5,p.29).

Cutting edge hourly cost = $\frac{\text{Cost of blade}}{\text{Hours in use}} = \frac{45}{300} = .15$

This blade will use approximately .013 pounds of grease per hour according to the "Caterpillar Handbook" (5,p.29). Grease hourly cost = (Amount used per hour) (price per pound) = (.013)(.12) = .002.

Hourly Cost of the Caterpillar 6S Bulldozer Under Average Logging Conditions

Cost of 6S bulldozer, f.o.b. Peoria, Illinois	$985.00 (42)
Freight cost	35.70 (42)
Initial investment	1,020.70
Fixed Charges	
Depreciation	.102
Interest, taxes, insurance	.031
Repairs	.051
Total fixed charges	.184
Variable Charges	
Cutting edge	.133
Grease	.002
TotalTCost per hour	.319

The hourly costs of the Caterpillar 6S bulldozer were computed in the same manner as those for the 8A and 8S. The initial price was $985.00 f.o.b. Peoria, Illinois (42). The freight rate was quoted as $131 per hundred pounds by the Southern Pacific Company from Peoria to San Leandro. This unit weighs 2,725 pounds ready for shipment (4,p.12). The cutting edge of the 6S costs approximately $40.00 and lasts about 300 hours (42). Cutting edge hourly cost $= \frac{\text{Cost of blade}}{\text{Hours in use}} = \frac{40}{300} = \$0.133$

To Determine Hourly Cost of Caterpillar #12 Motor Grader and Caterpillar #212 Motor Grader

	#12	#212
Cost f.o.b. Peoria, Ill...	$8,100.00 (42)	$5,000.00 (42)
Freight charges.....	281.65	172.00
Initial investment.....	8,381.65	5,172.00
Fixed Charges		
Depreciation.....	.542	.323
Interest, taxes, insurance.	.236	.145
Overhead and risk (20% of the above)..	.152	.094
Total fixed charges...	.912	.562
Variable Charges		
Repairs.....	.524	.323
Operator.....	1.575	1.575
Diesel fuel.....	.193	.140
Gasoline.....	.014	.014
Lubricating oil.....	.084	.078
Grease.....	.060	.050
Total variable charges	2.450	2.180
Total cost per hour.....	$3.362	$2.770

The fixed charges for the Caterpillar motor grader were figured in the same manner as those for the Caterpillar D8. The initial price delivered in California was quoted by the Caterpillar Company. This price is current as of April, 1947.

	#12(5,p.29)	#212(5,p.29)
Diesel fuel per day in gallons.....	22.5	16
Gasoline per day in gallons	¢	¢
Lubricating oil per day in gallons.....	1.04	.96
Grease per day in pounds..	4	3.3

Prices for the above items are the same as those used for the Caterpillar D8.

Hourly Cost of the Caterpillar No. 24 Cable Control Under Average Logging Conditions

Cost, f.o.b. Peoria, Illinois.....	$470.00 (42)
Freight cost.....	18.21 (42)
Initial investment.....	488.21
Fixed Charges	
Depreciation.....	.049
Interest, taxes, insurance.....	.015
Repairs.....	.024
Total fixed charges.....	.088
Variable Charges	
Cable costs.....	.013
Grease.....	.002
Total variable charges.....	.015
Total cost per hour.....	$0.10

The hourly costs of the Caterpillar No. 24 cable control were computed as follows: Initial cost of $470.00

was quoted by the Caterpillar Company at San Leandro (42). This price is f.o.b. Peoria, Illinois. The freight charge as quoted by the Southern Pacific Company was $3.31 per hundred pounds. This unit weighs 550 pounds ready for shipment (4, p.17). Depreciation, interest, taxes, insurance, and repairs were computed in the same manner as the 8A bulldozer. This unit is used on one of the Clover Valley D7 tractors and was found to use .10 pounds of grease per day on the average.

Grease hourly cost = (Pounds used per hour)(Cost per pound)

= (.013)(.12)

= .002

Cable costs were figured as follows: The unit holds 75 feet of half inch cable. It uses two lines per year, and half inch cable costs $0.17 per foot (39). Cable hourly costs = $\frac{(\text{Line used in feet})(\text{Price per foot})}{\text{Yearly working hours}}$ =

$\frac{(150)(.17)}{2,000}$ = $0.013

LOGGING TRACTORS

International Tractors

International tractors commonly known as "trac tractors," are manufactured by the International Harvester Company of Chicago, Illinois. They are powered by International diesel engines and are of the four-cycle valve-in-head type. These units have a distinctive gasoline conversion system for starting their engines. This system simply converts the diesel into a gasoline engine for starting. Sizes TD 6, TD 9, and TD 14 are all cranked by hand, and the larger two sizes TD 18 and TD 9, employ electric starting equipment. The engines are fairly easy to start, because compression is reduced from a ratio of 14 to 1 for diesel operation to 6½ to 1 for gasoline operation. The unit uses spark plugs and carbureted gasoline for starting only. The electric starting equipment is composed of a heavy-duty automatic type unit generator, electric starting motor and two heavy-duty 6 volt batteries. These units are controlled by the conventional type steering clutches (18,p.9). When buying this type of tractor, the buyer has a choice of six different types of track shoes. They are as follows: (18,p.42-43).

1. Tee type inclined ice grousers.
2. Wide overlapping shoes.
3. Non-overlapping grouser shoes.
4. "V" type ice grousers.
5. Street plates.
6. Universal flat shoes.

The TD 24 is a new product for the International Harvester Company, and little definite information is accessible. The estimated belt horse-power is 150 and the price is undetermined. The general information for the TD 18, TD14, TD9, and TD 6 is as follows:

	TD 18 (18, p. 4)	TD 14 (18, p.7)	TD 9, (18, p.27)	TD 6 (18,p.29)
Belt horsepower	84.66	64.02	45.91	36.23
Drawbar horsepower	70.59	54.04	38.88	29.49
Number of cylinders	6	4	4	4
Shipping weights in lbs.	22,250	15,550	9,525	7,010
Price (delivered in Sacramento, California)(40)	$8,200.00	$6,500.00	$4,400.00	$3,400.00

International tractors are the power plants for various types of equipment. Companies working with "International" to produce logging equipment units are (19):

Company Name	Equipment
Adams	Road Machinery
Bucyrus - Erie	Bulldozers and Scrapers
Hough	Loaders and Brooms
Be - Ge	Scrapers and Levelers
Carco	Winches, Loaders and Arches
Isaacson	Bulldozers, Rooters and Winches
Murray	Scrapers

One of the most common "International" combination units seen in the California woods is the International TD 18 tractor, Carco Model G winch, and Carco medium yarder. The cost of the above combination is as follows:

International TD 18 tractor..... $8,200.00 (35)
Carco Model G winch..... 2,000.00 (31,p.8)
Carco medium yarder..... 3,900.00 (31,p.14)
Total price..... 14,000.00

The cost of the International TD 18 bulldozer unit is as follows:

International TD 18 tractor..... 8,200.00 (35)
Bucyrus Erie bulldozer..... 2,300.00 (3,p.23)
Total price..... $10,500.00

Hourly Costs of International Tractors

	TD 18	TD 14
Initial investment (Delivered, Sacramento, Calif.)...	$8,200.00 (40)	$6,500.00 (40)
Fixed Charges		
Depreciation.....	.820	.650
Interest, taxes, insurance	.246	.195
Overhead and risk.....	.231	.169
Total fixed charges....	1.279	1.014
Variable Charges		
Repairs.....	.820	.650
Operator.....	1.600	1.600
Diesel fuel.....	.227	.193
Gasoline.....	.019	.014
Lubrication oil.....	.089	.084
Grease.....	.076	.060
Total variable costs...	2.831	2.601
Total cost per hour.....	4.110	3.615

Hourly Costs of International Tractors

	TD 9	TD 6
Initial investment (Delivered in Sacramento, Calif.)	$4,400.00 (40)	$3,300.00 (40)
Fixed Charges		
Depreciation.....	.440	.330
Interest, taxes, insurance	.132	.099
Overhead and risk.....	.114	.086
Total fixed charges....	.686	.515

Variable Charges

Repairs.....	.440	.330
Operator.....	1.600	1.600
Diesel fuel.....	.140	.88
Gasoline.....	.014	.012
Lubrication oil.....	.081	.052
Grease.....	.045	.045
Total variable costs....	2.320	2.127
Total cost per hour.....	3.006	2.642

The fixed charges for the International tractors were figured in the same manner as those for the Caterpillar D8.

International Tractors

Size	TD 18	TD 14	TD 9	TD 8
Diesel fuel used per day, ingallons	26	22.5	16	10
Gasoline used per day in gallons	1	½	½	½
Lubricating oil used per day in gallons	1.1	1.04	1.03	.8
Grease used per day in pounds	5	4	3	3

The prices used for the above are the same as those used for the Caterpillar D8.

Cletrac Tractors

Cletrac tractors are manufactured by the Cleveland Tractor Company of Cleveland, Ohio. These tractors are either gasoline or diesel powered. "Cummins" and "Cletrac" made the diesel engines, while "Hercules" makes the gasoline units.

The Cletrac tractors have electric starting and therefore, use no starting engine. This operates on the same principle as an automobile and saves considerable time. Instead of the conventional clutch type steering, these tractors use a "controlled differential steering". This method was developed, and patented by this company. In this method power is engaged to both tracks at all times. This eliminated shock to the power train and torsional strain to the frame, gears, and shafts of the tractor. The operator can vary the speed of each track at will and has full control at all times (29,P.7).

Three most common units of this line found in the woods today, are the FDL, FD, and DDH.

The FDL is the largest of the line developing 136 draw bar horsepower (29). It can be powered either by a Cummins diesel or Hercules gasoline engine.

The FD develops 96.9 drawbar horsepower and can be powered either by a Cummins siesel or a Hercules gasoline engine (29).

The FD develops 96.9 drawbar horsepower and can be powered either by a Cummins diesel or a Hercules gasoline engine (2().

The smallest size used in the woods is the DDH. It develops 61.18 horsepower when using a diesel engine. It also can be powered either by a Cletrac diesel or a Hercules gasoline engine (29).

To Determine Hourly Cost of Cletrac FDL Tractor

Initial investment (Delivered in Calif. Cummins diesel engine)	$10,080.00
Fixed Charges	
Depreciation	1.008
Interest, taxes and insurance	.302
Overhead and risk (20% of the above)	.262
Total fixed charges	1.572
Variable Charges	
Repairs	1.008
Operator	1.600
Diesel fuel	.298
Lubrication oil	.160
Grease	.090
Total variable charges	3.156
Total cost per hour	4.728

The fixed charges for the Cletrac FDL tractor were

figured in the same manner as those for the Caterpillar D8 tractor.

This tractor, when working on dkidding operations, will use approximately seventeen drums of diesel oil per month. Costs were figured for the diesel engines only, because gasoline engines in tractors this size are considered impracticable by most operators. These units use no starting engine and hence use no gasoline. Lubricating oil and grease costs were figured in the same manner as those for the Caterpillar D8.

To Determine Hourly Cost of Cletrac FD and DDH Tractors

	FD	DDH
Initial investment.....	$9,090.00 (49)	$5,470.00 (49)
(Delivered in California Cletrac diesel engines)		
Fixed charges		
Depreciation.....	.909	.537
Interest, taxes, insurance	.273	.161
Overhead and risk (20% of the above).	.236	.140
Total fixed charges.....	1.418	.838
Variable Charges		
Repairs.....	.909	.537
Operator.....	1.600	1.600
Diesel fuel.....	.262	.175
Lubrication oil.....	.091	.084

	FD	DDH
Grease.	.076	.060
Total variable charges. . .	2.938	2.456
Total cost per hour.	4.356	3.294

The fixed charges for the Cletrac FD and DDH tractors were figured in the same manner as those for the Caterpillar D8 tractor. The initial price delivered in California was quoted by the Cletrac Company (49). This price is current as of April 1947.

The FD and DDH, when working on skidding operations, will use approximately 13 and 10 drums of diesel oil per month, respectively. Costs were figured for the diesel engines only, because gasoline engines in tractors of this size are considered impracticable by most operators. These units have no starting engine and hence use no gasoline. Lubricating oil, and grease costs were figured in the same manner as those for the Caterpillar D7 and D6 tractors.

Allis Chalmers Tractors

Allis-Chalmers tractors are made by the Allis Chalmers Manufacturing Company of Milwaukie, Wisconsin. These units are diesel powered by General Motors Diesel engines. They have the advantage of electric starting, therefore, requiring no gasoline starting engine. Their method of steering is the conventional clutch method, and the unit employees a muffler (50).

The four most common units of the "Allis Chalmers" line, found in the California woods today, are the HD 14, HD10, HD 7, and the HD 5. The general specifications of the four types are as follows:

	HD 14	HD 10	HD 7	HD 5
Drawbar horsepower	132.14	86.63	57.3	37.4
Belt horsepower	150.48	101.62	68.86	45.1
Shipping weight	29,400	22,000	13,600	11,250
Engine make	--------General Motors Diesel---------			
Cost f.o.b., Milwaukie (50)	$10,650.00	$7,450.00	$5,380.00	$3,670.00
Cost, delivered in California (50)	11,252.00	7,901.00	5,658.00	3,890.00

Hourly Costs of Allis Chalmers Tractors

	HD 7	HD 5
Initial cost f.o.b. Milwaukie, Wisconsin. . .	$5,380.00 (50)	$3,670.00 (50)
Freight charges.	278.00	220.00
Initial investment	5,658.80	3,890.00
Fixed charges		
Depreciation	.556	.389
Interest, taxes, insurance . . .	.170	.117
Overhead and risk. . .	.147	.101
Total fixed charges. .	.883	.607
Variable Charges		
Repairs	.566	.389

	HD 7	HD 5
Operator	1.600	1.600
Diesel fuel	.193	.140
Lubrication oil	.084	.081
Grease	.060	.045
Total variable	2.503	2.255
Total cost per hour	3.386	3.862

Hourly Costs of Allis - Chalmers Tractors

	HD 14	HD 10
Initial cost f.o.b. Milwaukie, Wisconsin	$10,650.00 (50)	$7,450.00 (50)
Freight charges	620.00	451.00
Initial investment	11,252.00	7,901.00
Fixed Charges		
Depreciation	1.125	.790
Interest, taxes, insurance	.338	.237
Overhead and risk	.293	.205
Total fixed charges	1.756	1.232
Variable Charges		
Repairs	1.125	.790
Operator	1.600	1.600
Diesel fuel	.298	.262
Lubrication oil	.160	.091
Grease	.090	.076
Total variable cost	3.273	2.819
Total cost per hour	5.029	4.051

The fixed charges for the Allis-Chalmers tractors were figured in the same manner as those for the Caterpillar D8. The initial price delivered in California was quoted by the Allis-Chalmers Company. This price is current as of April, 1947.

Size	HD 14	HD 10	HD 7	HD 5
Diesel fuel per day in gallons	32	30	22.5	16
Lub. oil per day in gallons	1.96	1.2	1.04	1.03
Grease per day in pounds	6	5	4	3

The prices used for the above are the same as those used for the "Caterpillar" D8.

LOGGING LOCOMOTIVES

(Shay Engines)

These are in use today, a number of locomotives in the logging industry in California. For the past ten years or so their numbers have been on the decline, but the fact still remains that a large percentage of the logs hauled in this region are still hauled by railroad. This decrease was especially true during the war when locomotives were impossible to acquire. This paper will not attempt to present any advantages or disadvantages of railroad transportation, but simply to give some initial and maintenance costs on logging locomotives and cars. The Lima Locomotive Works Inc., is the largest manufacturers of logging locomotives. Their plant is located at Lima, Ohio, where all of their equipment is manufactured. When purchasing a locomotive, the freight charge is added to the initial cost and in this case amounts to 75¢ per hundred. All locomotives up to a certain size, Class 36-2, are shipped on flat cars. Locomotives larger than the 36-2 are shipped on their own wheels, providing they are built for a standard gauge track. If the locomotive is larger than the 36-2, but has narrow or unusual gauge,

it is shipped with standard gauge trucks, and the engine trucks are loaded on a flat car accompanying the locomotive. All small parts are removed and placed iside the cab which is carefully enclosed or in a separate box on the car (22,p. 25).

The Lima Locomotive Works Inc., has a service department located in San Francisco, California. This service is in existence to assist the customers in obtaining the utmost efficiency from their product. When the locomotive is delivered, a representative from this service department will be on hand to engineer the installation of the new unit and to instruct the crew. They also make calls on the operator to make inspections and offer any assistance necessary.

The logging industry is too diversified in its requirements to have any one locomotive to satisfy all conditions. As a result there are numerous types and models. Even though the different companies have established definite models, it is hard to find two locomotives alike in this region. This is easily understood when we realize that every operator has different requirements for his equipment. As a rule the operator plans his operation down to the last detail and then sends in a list of requirements that his locomotive must have to operate on his show. A typical list, known as "Memorandum of Conditions" is put out by the Lima Locomotive Works for the convenience

of the buyer. If they do not have a model to fit these conditions, they call on their engineering department to design a locomotive to do the job.

Of all the different type locomotives found in the California woods, the majority of them fall into one general classification. The majority are of the "Shay" geared type. They have three cylinders to give an even torque and uniform exhaust. The frames are either made of standard I beam sections or of the girder type. One of the greatest advantages of the geared locomotive is the absence of "hammerblow" on the rail. This is caused by the counterbalance in the driving wheels of direct drive locomotives. Due to this fact the geared locomotive is easier on the rails and as a result can operate on much lighter rails. The "Shay" is driven by gears mounted on the driving shaft. These driving shafts are provided with universal couplings and slip joints which enables the engine to run on sharp curves and uneven track. Another desirable feature of the geared locomotive is the ease in which it can be replaced on the rails. It is seldom necessary for another locomotive to halp a geared locomotive on to the track. This locomotive uses all of its wheels as driving wheels and is capable of producing a greater drawbar pull than the geared type of the same tractive power.

To determine the size of the locomotive required a number of factors must first be considered. Some of these are length of road, gauge, fuel used, weight of rail, steepest grade in per cent, radius of sharpest curve, kind of cars used, weight of cars empty and loaded, number of cars empty and loaded, number of cars to be handled per trip, whether loaded or empty cars are to be handled per trip, whether loaded or empty cars are to be handled over grade, and whether curve occurs on grade. A typical example of determining the size locomotive to buy is as follows:

The Clover Valley Lumber Company of Loyalton, California, wishes to purchase a locomotive for their operation. After making a survey of the proposed location, they come to the conclusion that the following conditions prevail: The maximum curve to be encountered will be 18 degrees and the maximum grade 3½ per cent. The company expects to haul 14 cars at a time, and the average load per car is 5,000 board feet. The cars are all of the 8-wheel logging type weighing approximately 10,000 pounds (22,p.22). The type of timber to be hauled will be Yellow Pine, and its weight is approximately 4,000 pounds per 1,000 feet.

It will be necessary to compute the total train resistance exclusive of the locomotive first. Next, it is necessary to compute the locomotive resistance in order

to obtain the total resistance. Train resistance is composed mainly of three individual factors. First, is grade resistance. This is taken as 20 pounds per ton for each per cent of grade, using the steepest grade (22,p.7). Next, is curve resistance. This is taken as 0.8 pound per ton for each degree of curvature using the sharpest curve (22,p.7). Third, is rolling friction. This depends on the weight per axle, speed, method of lubrication, condition of the track, etc. The figure generally used for this is 10 pounds per ton (22,p.7).

Load

Fourteen cars weighing
10,000 pounds apiece..... = 140,000 pounds (22,p.22)

5,999 board feet per car weighing 8,000

pounds per 1,000 feet = 40,000 pounds

Fourteen cars with a load of 40,000
pounds each = 560,000 pounds

Total load in pounds = 700,000

Total load in tons = 350

Grade resistance

20 x 3.5 x 350..... 24,500

Curve resistance

18 x 0.8 x 350..... 5,040

Rolling friction

10 x 350..... 3,500

Total train resistance in pounds = 33,040

We will assume a certain class locomotive to determine the total resistance of the locomotive. The Shay "Class 125-3" weighs 131.5 tons and will be used as an example (22,p.9).

Grade Resistance

20 x 3.5 x 131.5 9,205

Curve Resistance

18 x 0.8 x 131.5 . . . . . 1,893.6

Rolling Friction

10 x 131.5 1,315

Total locomotive resistance in pounds = 12,414

The resistance of the train plus that of the engine will equal the tractive power required.

33,040 + 12,414 = 45,454 pounds

The tractive power of the Shay 125 - 3 is 53,000 (22,p.9), so the engine will be large enough to handle the fourteen car load over this road. Actually, the Clover Valley Company has approximately the same size locomotive, but handles twelve cars instead of the fourteen maximum. They do this because they wish to introduce a safety factor which is necessary when logging on extremely good shows because the cars may average up to 8,000 board feet.

In the California pine region, the most popular "Shay" models are the Classes 60 - 3, 70 - 3, 90 - 3, and "Pacific Coast" type.

Class 60-3 Specifications (22,p.9)

Weight	122,400 pounds
Cylinders: number	3
diameter	11"
stroke	12"
Wheel base: total	35'6"
Drivers: number	12
diameter	32"
Tractive power	25,830 pounds
Extreme height of locomotive	13' 7"
Extreme width of locomotive	9' 9"
Minimum gauge practicable	36"
Sharpest curve advised	100 radius
Lightest rail advised	45 pounds

The approximate price of the Shay 60 - 3 is $45,000 f.o.b. Lima, Ohio. Freight charges from this point to the West Coast will be $0.75 per hundred. (1,224.00)(.75) = $918.00 freight charges. Total price of "60 - 3" is approximately: $45,918.00 (41)

Class 70 - 3 Specifications (22,p.9)

Weight	15,200 lbs.
Cylinder: number	3
diameter	12"
stroke	15"
Wheel base: total	40' 2"
Drivers: number	12
diameter	36"
Tractive power	30,350 lbs.
Extreme height of locomotive	14' 9"
Extreme width of locomotive	10' 5"
Minimum gauge practicable	36"
Sharpest curve advised	100' radius
Lightest rail advised	45 lbs.

The approximate price of the Shay 70 - 3 is $50,000 f.o.b. Lima, Ohio. Freight charges from this point to the West Coast will be $0.75 per hundred. (1,582.00)(.75) = $1,176.50. Total price of the 70 - 3 will be approximately $51,176.50 (41).

Class 90 - 3 Specifications (22,p.9)

Weight	191,600 lbs.
Cylinders: number	3
diameter	14½"
stroke	15"
Wheel base: total	43' 3½"

Drivers: number. 12

diameter. . . . . 36"

Tractive power . . . . . .40,400 lbs.

Extreme height of locomotive . . . . . 13' 8"

Extreme width of locomotive. . . . . 10' 10"

Minimum gauge practicable. . . . . 4' 8½"

Sharpest curve advised . . . . . 100' Radius

Lightest rail advised. . . . . 60 lbs.

The approximate price of the Shay 90 - 3 is $60,000 f.o.b. Lima, Ohio. Freight charges from this point to the West Coast will be $0.75 per hundred. (1,916.00)(.75) = $1,437.00. Total price of the 90 - 3 will be approximately $61,437.00 (41).

The "Pacific Coast" Shay Specifications (21,p.1)

Weight . . . . . 181,000 lbs.

Cylinder: number 3

diameter. . . . . 13"

stroke. . . . . 15"

Wheel base: total. . . . . 42' 2"

Drivers: number. 12

diameter. . . . . 36"

Tractive power . . . . . 38,200 lbs.

The approximate price of the Pacific Coast Shay type is 55,000 f.o.b., Lima, Ohio. Freight charges

from this point to the West Coast will be $0.75 per hundred. (181,000)(.75) = 1,357.50. Total price of the "Pacific Coast" type is approximately $56,357.50 (41).

LIMA LOCOMOTIVE WORKS, INCORPORATED

LIMA, OHIO

Memorandum of Conditions (22,p.28)

From.....
Gauge of track (i.e., space between rails.....
Description of Fuel.....
Weight of Rail per yard....Tie spacing to center.....
Length of Haul.....Maximum speed.....
Steepest upgrade for empty cars....Length of same.....
Steepest upgrade for loaded cars...Length of same.....
Must train be started on grade, Empty?...Loaded?.....
Radius of sharpest curve.....
If curve occurs on grade, give curve and grade.....
Greatest number of cars to be handled per trip,
Loaded.....Empty.....
Weight of car, empty.....Weight of car loaded.....
Style of couplers.....Height of couplers from rail....
Kind of traffic.....
.....
Are there any limitations as to height or width?.....
(If there are any limitations as to height and width, indicate on diagram on the reverse side of this sheet.)
Remarks.....
.....
.....
.....
.....
Send sketch profile of road if possible, showing location of grades and curves, giving length, etc.

Signed.....

Date.....

HYSTER EQUIPMENT

Hyster equipment is widely used in the logging industry, and the California region is no exception. They are a pioneer manufacturer of tractor mounted equipment, having made the Hyster arches used with the first "Caterpillar" track type tractors. This Company works in conjunction with the Caterpillar Company in building different types of tractor mounted equipment. Hyster products used in the woods today are namely, towing winches, logging arches, tractor yarders and donkeys, and hystaways.

The towing winch is made especially for use on the Caterpillar D8, D7, D6, D4, and D2 tractors. Each winch is designed especially for the horsepower available and the job it has to do. The largest winch, known as the D8N is the most common in the woods today. It is used both for ground skidding and with the logging arch. Although the D8N winch can be used with different type arches, the D8 tractor, D8N winch and Hyster arches work in perfect combination. This combination is the most common in the California woods.

It is exceptionally rugged, weighing 3,675 pounds

without cable, is direct geared and reversible. All controls are located near the driver's seat usually on his left side (16,p.12-12).

Optional equipment for the D8N winch includes the automatic brake. The nature of logging operations today almost make this brake a necessity. This is a patented design and is rather simple in operation. It simplifies the "hauling in" operation for the driver to a great extent. If a constant pull is stopped suddenly for any reason by the driver, the brake automatically takes hold, thus eliminating the necessity of setting the brake by hand and releasing the clutch. This in turn keeps the line taught, thus reducing excessive shock on the main line and chokers, and thus increasing cable life.

D8N Specifications (16, p.12-13)

Available line pulls:	With standard drum
Low gear, bare drum	53,000 lbs.
full drum	34,000 lbs.
High gear, bare drum	35,000 lbs.
full drum	25,000 lbs.
Line speeds:	
Low gear, bare drum	82 f.p.m.
full drum	126 f.p.m.
High gear, bare drum	124 f.p.m.
full drum	175 f.p.m.
Drum size:	
Barrel diameter	15"
Cable capacity:	
Maximum line	260' 1"
Approximate weights (without cable):	
Standard winch, with 15" drum, net weight with lubricant	3,675 lbs.

Cost of Owning and Operating
Hyster D8N Towing Winches per Hour

Delivered Price	
(March 1947).....	$2689.88 (34)
Fixed Charges	
Depreciation.....	0.269
Interest, taxes, insurance.....	0.081
Total fixed charges.....	0.350
Variable Charges	
Repairs (including labor).....	0.135
Lubrication.....	0.023
Cable and rigging.....	0.481
Total cost per hour.....	$0.83

In computing the hourly cost of the Hyster D8N winch, the following procedure was followed. It has been found that the average life of a winch of this type is five years or 10,000 hours (23,p.60). This has been proven thru studies conducted by the Hyster Company (33). Therefore, Depreciation = $\frac{\text{Delivered price}}{\text{Total life in hours}} = \frac{2689.88}{10,000} =$ $0.269

Interest, taxes, and insurance has been taken to equal 10% of the average investment per year. The figure 10% was taken for two reasons. First, this is the figure used by the Hyster Company (33), and second, this

is the average figure used by the majority of logging companies in California. Therefore, Annual depreciation = $\frac{\text{Initial investment}}{\text{Life in years}} = \frac{2689.88}{5} = \$537.98$

Average annual investment = $\frac{\text{Initial investment + annual depreciation}}{2} = 1613.93$. Therefore, average annual investment = $1613.93

Interest, taxes, and insurance = $\frac{(\text{Average annual investment})(10\%)}{\frac{\text{Life in hours}}{\text{Life in years}}} = \frac{(1613.93)(.10)}{\frac{10,000}{5}} =$

$0.081.

The cost of repairs and labor was taken as 50% of the original investment divided by the total number of hours. $\frac{(2689.88)(.50)}{10,000} = \$0.135$

Lubrication costs were computed as follows: A D8N winch uses on the average of .036 gallons of oil per hour. Oil was figured at $0.65 per gallon. (.036)(.65) =.023.

Cable and rigging costs were computed from Rolser's Logging and Equipment Supplies, Corvallis, Oregon (39), and Hyster "Cost Tables". One inch cable is the recommended size for the D8N winch. The recommended type is 6 x 19 Seale 1 W.R.C. Improved Plow Steel Preformed Rope (33).

D7N Towing Winch

The D7N towing winch is a very popular winch in the California region. It is second only to the D8N in so far as the number in actual operation are concerned. It is built on exactly the same lines as the D8N only on a slightly smaller scale. It also has the advantage of the optional automatic brake. It is used on D7 tractors hauling Hyster arches and to a larger extent on construction jobs. The size of the D7 tractor makes it ideal for most bulldozing jobs, and the D7N winch fits in perfectly. It is used with a single speed producing 60% more than the tractor's maximum drawbar pull (16,p. 16-17).

All three winches, D8N, D7N, and D6N, have a special drawbar or coupler. It is built extremely strong in order to withstand the vertical stress produced by the arch in heavy logging. It is located 3½" higher than the regular drawbar, thus providing more clearance as well as more strength. The yoke may be locked in a fixed position or be allowed to swivel (16,p.17).

D7N Specifications (16,p.16-17)

Available line pulls:	
Bare drum	34,500 lbs.
Full drum	23,000 lbs.
Line speeds:	
Bare drum	89 f.p.m.
Full drum	133 f.p.m.
Drum size:	
Barrel diameter	15"
Cable capacity:	
Maximum line	365' 7/8" or 280' 1"
Net weight (without cable, built-in drawbar and automatic brake)	2,350 lbs.

Cost of Owning and Operating
D7N Hyster Towing Winches per Hour

Average Logging Conditions

Delivered price	$1,942.00 (34)
Fixed Charges	
Depreciation	0.194
Interest, taxes, insurance	0.058
Total fixed charges	0.252
Variable Charges	
Repairs, including labor	0.097
Lubrication	0.013
Cable and rigging	0.218
Total variable charges	0.328
Total cost per hour	$0.68

These costs are West Coast prices and are current as of March, 1947. They have been computed in the same manner as those for the D8N winch.

Hyster D6N Towing Winch

The D6N winch is used to a limited extent in the California region. It is used with a Caterpillar D6 tractor, but the combination is too small for use with arches in most operations. There are, however, a number in use as bulldozers. The flexibility and

price of the D6 tractor makes it ideal for light work. The D6N finds a place in the smaller operations where initial expense is a limiting factor and large trees seldom encountered. The D6 tractor, and D6N winch can handle most any job the smaller operator has to do, and as a rule, do it with less expense. Another field where this combination is ideal is in pole and post logging. The D6N winch is direct geared, single speed, and reversible. It can develop a pull 58% greater than the drawbar pull of the D6 tractor (16,p.21).

D6N Specifications (16,p.21)

Available line pulls:

Bare drum	25,000 lbs.
Full drum	14,000 lbs.

Line speeds:

Bare drum	92 f.p.m.
Full drum	161 f.p.m.

Drum size:

Barrel diameter	10"

Cable capacity:

Maximum line	400'$\frac{3}{4}$" or 300'7/8"

Net weight (without cable)..... 1,625 lbs.

Cost of Owning and Operating
D6N Hyster Towing Winches per Hour

Delivered price	$1,267.07 (33)
Fixed Charges	
Depreciation	0.127
Interest, taxes, insurance	0.038
Total fixed charges	0.165
Variable Charges	
Repairs, including labor	0.064
Lubrication	0.009
Cable and rigging	0.179
Total variable charges	0.252
Total cost per hour	$0.42

These costs are for the West Coast and are current as of March, 1947. They have been computed in the same manner as those for the D8N winch.

Hyster D4N and D2N Towing Winch

These two winches along with their respective power plants are not used in the California woods for hauling logs with sulkies. The combination is too small for the type of timber they have to handle and so far have failed to make their appearance in that capacity. The D4N winch is used, however, when logging poles and post materials. In this region it is used mainly in ground

skidding. The D2N is very rarely seen in the actual skidding of logs. They are both direct-geared, one speed, reversible winches. The D4N develops a pull 96% greater than the drawbar pull while the D2N develops 103% (17,p. 14)(17,p.18).

D4N Specifications (17,p.14)

Available line pulls:

Bare drum	15,400 lbs.
Full drum	8,580 lbs.

Line speeds:

Bare drum	91 f.p.m.
Full drum	164 f.p.m.

Drum size:

Barrel diameter	8"

Cable capacity:

Maximum line	484'5/8" or 333'$\frac{3}{4}$"

Net weight (without cable)..... 13,000 lbs.

D2N Specifications (17,p.18)

Available line pulls:

Bare drum	12,000 lbs.
Full drum	5,500 lbs.

Line speeds:

Bare drum	92 f.p.m.
Full drum	200 f.p.m.

Drum size:

Barrel diameter	6"

Cable capacity:

Maximum line	400'5/8" or 277'$\frac{3}{4}$"

Net weight (without cable)	850 lbs.

Cost of Owning and Operating Hyster
Towing Winches per Hour

Average Logging Conditions

Model.....	D4	D2
Delivered price.....	$945.63 (33)	$764.02 (33)
Fixed Charges		
Depreciation.....	0.095	0.076
Interest, taxes, insurance..	028	0.023
Total fixed charges....	0.123	0.099
Variable Charges		
Repairs, including labor..	0.048	0.038
Lubrication.....	0.010	0.111
Cable and rigging.....	0.134	0.008
Total variable charges.	0.201	0.157
Total cost per hour.....	$0.32	$0.26

These costs are for the West Coast and are current as of March, 1947. They have been computed in the same manner as those for the D8N winch.

Hyster D8 Logging Arch

The greatest number of arches in the California Pine area are of this type. The Caterpillar D8 tractor has proven the most satisfactory size, and the Hyster D8 arch is the common arch for this size tractor. The

entire product is made by the Hyster Company, except the wheels, which are made by the Athey Products Corporation. The arch has only one piece of optional equipment, and this is the hitch. It can either be of the non-swiveling type used on tractors with a movable drawbar or the swiveling hitch for tractors with a rigid drawbar (16,p.14).

D8 Specifications (16,p.14)

Overall width	11'5"
Wheel base, from axle to drawbar pin, adjustable from	10'7" to 11'8"
Roll height, to top of roll, adjustable from	11'1" to 12'0"
Wheels	Athey Model 7D8
Net weight, not including wheels	6,150 lbs.

Cost of Owning and Operating A Hyster D8 Logging Arch

Delivered price	$4,253.75	(33)
Fixed Charges		
Depreciation	0.425	
Interest, taxes, insurance	0.128	
Total fixed charges	0.553	
Variable Charges		
Repairs, including labor	0.537	
Lubrication	0.008	

Variable Charges Cont.,

Cable, hooks, and ferrules..... 0.456

Total variable charges..... 1.001

Total cost per hour.....$1.55

The method of computing the above costs are as follows: The average life of this type of arch as figured by most of the logging companies in California, as well as the Hyster Company, is five years or 10,000 hours (23,p.60). Therefore, Depreciation = $\frac{\text{Initial cost}}{\text{Life in hours}}$ = $\frac{4253.75}{10,000} = 0.425$

Interest, taxes, and insurance are taken as 10% of the average annual investment = $\frac{\text{Initial cost}}{\text{Life in years}} = \frac{4253.75}{5} =$ $850.75. Average annual investment = $\frac{\text{initial cost} + \text{annual investment}}{2} = \frac{4253.75 + 850.75}{2} = 2552.25$

$\frac{(\text{Average annual investment})(10\%)}{\frac{10,000}{5}} = \frac{(2552.25)(10\%)}{2,000} = .1276$

or $0.128

Repairs, including labor was computed the same as depreciation plus the cost of one set of track replacement assembly, less plates over the depreciation period.

Lubrication was computed as follows: The price of oil at .65 a gallon, and grease at .12 per pound. The D8N used .003 gallons of oil per hour and .052 pounds of

grease. These figures are results of tests carried on by the Hyster Company. (.003)(.65) = .00195
(.052)(.12) = .00624
.00819 or $0.008 per hour.

Chokers

Since the mainline is charged off on the winch, only the chokers remain to be charged off to the arch. The figure .456 was taken from data put out by the Hyster Company (33).

The second most popular arch in this region in the Hyster line is the Hyster D7N arch. This is made on the same manner as the D8N except on a slightly smaller scale. It is made especially for use with the Caterpillar D7 tractor and the Hyster D7N winch. It can be operated with almost any type tractor or winch, but for its peak performance the above mentioned combination must be used. On most shows the D7N arch is large enough. It is certainly large enough when used on relatively flat country and hauling medium sized logs. When there is a chance of steep country and large logs, most operators prefer the D8 arch. During the war and the period since, the supply of D8 arches and Caterpillar D8 tractors have not been large enough to meet the demand. As a result many operators have had to purchase the D7 combination, and there

are increasing numbers in the field today. Many small operators prefer the D7 combination, because of the initial cost, not only of the tractor but of the winch and arch.

D7N Specifications (16,p.18)

Overall width	10"
Wheelbase, from axle to drawbar pin, adjustable from	9'2" to 9'11"
Roll height, to top of roll, adjustable from	9'11" to 10'7"
Wheels	Athey Model 7D7
Net weight, not including wheels, approx.	4.640 lbs.

Cost of Owning and Operating A Hyster D7N Logging Arch

Delivered price	$3,565.50	(33)
Fixed Charges		
Depreciation	0.357	
Interest, taxes, insurance	0.107	
Total fixed charges	0.464	
Variable Charges		
Repairs, including labor	0.446	
Lubrication	0.007	
Cable hooks and ferrules	0.303	
Total variable charges	0.756	

Total cost per hour..... $1.22

The above costs were figured in the same manner as the costs for the D8 arch.

Hyster D6N Logging Arch

This arch finds limited service in the California woods. It is too small for the size logs the average logger has to contend with. It is built to operate in smaller timber, and on relatively flat ground. A few are found with the smaller operations because of their lower initial cost, and they find a place in an operation where the tractor can be used in a dual role. Some small operators use the Caterpillar D6 for a bulldozer to build roads and later as the power plant for the D6N arch. The arch is built on the same lines as the D8N and the D7N except on a smaller scale.

D6N Specifications (16,p.22)

Overall width..... 9'2"

Wheelbase, from axle to drawbar pin, adjustable from..... 8'9" to 9'6"

Roll height, to top of roll, adjustable from..... 8'11" to 9'7"

Wheels..... Model 7D6 Athey Wheels

Net weight, without wheels, approx..... 3.100 lbs.

Cost of Owning and Operating
the Hyster D6N Logging Arch

Delivered price	$3,003.50	(33)
Fixed Charges		
Depreciation	0.300	
Interest, taxes, insurance	0.090	
Total fixed charges	0.390	
Variable Charges		
Repairs, including labor	0.371	
Lubrication	0.007	
Cable, hooks, and ferrules	0.222	
Total variable charges	0.600	
Total cost per hour	$0.99	

The above costs were figured in the same manner as those for the D8 arch.

D4 and D2 Logging Sulkies

Unlike the larger arches which operate on tracks, the smaller arches, known as sulkies, operate on pneumatic tires. They are designed for use with Caterpillar D4 and D2 tractors, respectively. The pneumatic tires have the advantage of keeping the logging roads in fairly good condition. If the operator is assured of dry firm ground for his roading surface, he may order steel wheels as optional

equipment. For the majority of operations in this region the pneumatic tires are used. The sulky is an ideal piece of equipment for skidding poles and piling. Up to now very few have made an entrance in this region, but as the demand for poles becomes more acoute, their numbers are bound to increase. Their cost puts them well within the range of the small operator, and for the logger who is interested simply in small logs or poles they are ideal.

D4 Sulky Specifications (17,p.13)

Wheelbase, drawbar to axle..... 9'0"

Overall width..... 8'9"

Roll height, to top of roll..... 7'0"

Wheel-bearings..... Timken

With Pneumatic Tires (size 13.00x24 - 16 ply)

Net weight, approximately..... 2,600 lbs.

With Steel Wheels (tire width 12", diameter 4'4")

Net weight, approximately..... 2,675 lbs.

D2 Sulky Specifications (17,p.17)

Wheelbase, drawbar to axle	9'0"
Overall width	7'8"
Height to top of rear sheave	6'0"
Wheel-bearings	Timken
With Pneumatic Tires (size 11x24 - 14 ply)	
Net weight, approximately	1,700 lbs.
With Steel Wheels (tire width 10", diameter 4'4")	
Net weight, approximately	1,800 lbs.

Cost of Owning and Operating
Hyster D4, and D2 Sulkies

Model	D4	D2
Delivered price	$1,264.00 (33)	$975.50 (33)
Fixed Charges		
Depreciation	0.126	0.098
Interest, taxes, insurance	0.038	0.029
Total fixed charges	0.164	0.127
Variable Charges		
Repairs, including labor	0.152	0.116
Lubrication	0.003	0.003
Cable, hooks, and ferrules	0.149	0.124
Total variable charges,	0.304	0.243
Total cost per hour	$0.47	$0.37

The above costs were figured in the same manner as those for the D8 arch.

Hyster Tractor Yarders and Donkeys

In this region, as in most, old tractors unsuited for hauling arches or bulldoxing are put to use as the power plant for a yarder or donkey. Many of the old gasoline tractors, the "Caterpillar 75" for example, are found in this capacity. The Hyster Company builds multiple drum winches for this use, and they are found working in connection with cold decking, loading, high lead logging, and many other uses. They are made in five sizes and are known as D8 Tractor Yarder, D7 Tractor Donkey, D6 Tractor Donkey, D4 Tractor Donkey, and D2 Tractor Donkey.

Hyster D8 Tractor Yarder

This yarder is a three drum unit which can be used on the Caterpillar D8, RD8, or 75 tractors. It is mounted on the rear of the tractor, and the operator sits facing the drums and his work. While most of the logging in the East Slope is accomplished by the use of arches and shovel loaders, quite a number of high lead operations are found on the West Slope. When the high lead system is used, the D8 Tractor Yarder of this type is

often found. It can develop a mainline pull up to 56,000 pounds and has four speeds on all three drums (16,p.15).

D8 Specifications (16,p.15)

Drum sizes:	Main	Haulback	Strawdrum
Barrel diameter..	12"	12"	8½"
Barrel length....	36"	36"	10"
Cable capacity.....	1000'1 1/8" 1250'1"	2600'5/8" 3200'9/16"	3000'3/8" 4400'5/16"

Cost of Owning and Operating
the Hyster D8 Tractor Yarder

Delivered price.....	$6,576.00 (34)
Fixed Charges	
Depreciation.....	0.658
Interest, taxes, insurance.....	0.197
Total fixed charges.....	0.855
Variable Charges	
Repairs, including labor.....	0.329
Lubrication.....	0.023
Cable	
Main drum.....	0.540
Haulback drum.....	0.546
Straw drum.....	0.264
Total variable charges.....	1.702
Total cost per hour.....	$2.56

The method used to determine the hourly cost of the D8 tractor yarder is as follows: The delivered price is $6,576.00 and is current as of March, 1947 on the West Coast (33). Depreciation is based on five years or an average of 10,000 hours. These figures were obtained from the Hyster "Cost Sheet" (33). Therefore,

$$\frac{\text{Initial cost}}{\text{Life in hours}} = \frac{6576}{10{,}000} = .6576 \text{ or } .658$$

Interest, taxes, and insurance were taken as 10% of the average annual investment. Ten per cent is the average per cent figure used by the larger operators in California, and it is also used by the Hyster Company in their "Cost Sheets" (33). Average annual investment =

$$\frac{\text{Initial investment} - \text{annual depreciation}}{2} = \frac{6576 - \frac{6576}{5}}{2} =$$

$3,945.60.

$$\frac{(\text{Average annual investment})(10\%)}{\frac{\text{Life in hours}}{\text{Life in years}}} = \frac{(3945.6)(10\%)}{\frac{10{,}000}{5}} = .19728$$

or $0.197

Repairs, including labor charges was computed as 50% of the depreciation charge. (Depreciation)(50%) = (.658)(.50) = 0.329

Lubrication was computed on the following basis: oil at .65 per gallon and grease at .12 per pound. The D8

yarder according to the Hyster Company uses .034 gallons of oil and .013 pounds of grease per hour. Therefore,

$$(.034)(.65) = .0221$$
$$(.013)(.12) = .0016$$
$$.0237 = \text{Lubrication cost per hr.}$$

Cable costs were computed from figures obtainable from the Hyster "Cost Tables" (33) and Rolser's Logging and Equipment Supplies, Corvallis, Oregon (39). The main drum holds 1,000 feet of 1 1.8" line, and the price was quoted as $0.54 per foot. The yarder will use approximately two main lines per year. $\frac{(2000')(\$.54)}{2000 \text{ hours}} = \$0.540$

The haulback drum holds 2,600 feet of 5/8" line, and the price was quoted as $0.21 per foot. The yarder will use approximately two haulback lines per year.

$\frac{(5200')(\$0.21)}{2000 \text{ hours}} = \$0.546$

The strawline drum holds 4,400 feet of 5/16" line, and the price was quoted as $0.12 per foot. The yarder will use approximately one strawline per year.

$\frac{(8800)(\$0.12)}{2000 \text{ hours}} = \$0.263$

Hyster D7L Tractor Donkey

This type donkey is used to a certain extent on the West Slope in high lead logging and loading. It is similiar to the D8 yarder, but it is built on a smaller scale.

It has two speeds on all drums, and the unit comes in either two or three drums. The third drum is optional, and may either be a straw line drum or a gypsy spool. A line pull of 29,068 pounds on the bare main drum can be developed with this donkey (16,p.20).

D7L Specifications (16,p.20)

Drum size:	Main	Haulback	Strawdrum
Barrel diameter....	10"	8"	6½"
Barrel length.....	24 7/8"	24 7/8"	10"
Cable capacity	960 ft 1"	2360' 7/16"	2940'7/16"

	Double Drum	Three Drum
Net weight including transmission and controls, but without cable.....	4,300 lbs.	4,700 lbs.

Cost of Owning and Operating
the Hyster D7L Tractor Donkey
for One Hour

Delivered price.....	$4,075.00 (34)
Fixed Charges	
Depreciation.....	0.408
Interest, taxes, insurance.....	0.102
Total fixed charges.....	0.510
Variable Charges	
Repairs, including labor.....	0.204
Lubrication.....	0.007

Cable, Main drum	0.413
Haulback drum	0.331
Straw drum	0.176
Total variable charges	1.131
Total cost per hour	$1.64

The cost per hour computations for the D7L were figured in the same manner as the D8 yarder except for lubrication and cable costs. The hourly lubrication costs are as follows: the D7L donkey uses .009 gallons of oil and .013 pounds of grease per hour. The price of oil was taken as $0.65 per gallon while grease was $0.12 per pound. The amounts used per hour were taken from the Hyster "Cost Sheet", (33) while the prices of grease and oil are average for the West Coast.

$$\begin{array}{l} (.009 \text{ gallons})(.65) = .00585 \\ (.013 \text{ pounds})(.12) = .00156 \\ \hline .00741 = \end{array}$$

Lubrication cost per hour.

Cable costs per hour are as follows: the main drum holds 960 feet of 1" line; the haulback holds 2,360 feet of 7/16" line; and the strawdrum holds 1,470 feet of 5/16" line. The same West Coast cable prices were used.

Hyster D6N Tractor Donkey

This type donkey is used to a limited extent in this region. In most operations where it is used, it is in the capacity of a loader. It has two drums with the gypsy

spool optional. It is built to operate with a Caterpillar D6 tractor, and like the larger models, the operator sits facing the donkey and the work.

D6N Specifications (16,p.23)

Drum size:	Main Drum	Upper Drum
Barrel diameter.....	10"	10"
Barrel length.....	18"	18"
Cable capacity:		
Maximum line, evenly spooled or.....	700'7/8" or 860' ¾"	1240' ½" or 1600'7/16"

Net weight, approximately..... 3,365 lbs.

Cost of Owning and Operating the Hyster D6N Tractor Donkey

Delivered price.....	$2,442.58 (34)
Fixed Charges	
Depreciation.....	0.244
Interest, taxes, insurance.....	0.073
Total fixed charges.....	0.317
Variable Charges	
Repairs, including labor.....	0.122
Lubrication.....	0.006
Cable	
Main drum.....	0.241

Cable cont.,

Haulback drum	0.224
Total variable charges	0.593
Total cost per hour	$0.91

The cost per hour computations for the D6N were figured in the same manner as the D8 yarder, except for the lubrication and cable costs.

The hourly lubrication costs are as follows: the D6N donkey uses .007 gallons of oil and .013 pounds of grease per hour. The price of oil was taken as $0.65 per gallon, while grease was $0.12 per pound.

(.007 gallons)(.65) = 0.00455
(.013 pounds)(.12) = 0.00156
$0.00611 = Lubrication cost per hour.

Cable costs per hour are as follows: the main drum holds 860 feet of ¾" line, and the haulback 1,600 feet of 7/16" line. The same West Coast cable prices were used.

Hyster D4 and D2 Tractor Donkey

These two donkies are used to a very limited extent in this region. They are too small for the average operator and are seen only in the smaller shows where the initial investment is the controlling factor. They are both of the double drum type and weigh 1,730 and 1,150

net pounds, respectively (17,p.16)(17,p.19). The cost on the West Coast of the D4 is $1702.45, while the D2 is $868.00 (34).

TIRES

Tires and their repair are a major item in any logging region. This region is especially hard on tires, because of the low caliber logging roads the tires must operate on. Very few of the roads are ballasted due to the large amount of road to be maintained. The Clover Valley Company uses 11.00x20 0 12 ply tires on their fleet of twelve KR11 International trucks. Each tire costs approximately $129.47 and tube $13.89. This represents an initial outlay of $143.36 per wheel or $2007.04 per truck. (11,p.92). Theoretically, a tire of this size has a life span of approximately 50,000 miles on paved highway or from 10,000 to 20,000 on the average logging road. On the Clover Valley operation, however, the average span is near 15,000 miles. This company, as do all large companies, operates a tire repair shop. One man is on duty the entire working day either changing or repairing truck or trailer tires. This shop is located as a rule midway between the truck loader and the landing. Each truck is required to stop at the least once a day for tire pressure testing. Keeping the same pressure in both tires of a dual is of the utmost importance. This is necessary to insure each tire of supporting its share of

the load. Tires of the same size on any one truck is an absolute necessity.

Tire and tube costs of the most common sizes will be found on the next few pages. These prices are quoted to buyers who have two or more logging trucks.
Pneumatic tires of the type that logging trucks use today are relatively new, and few loggers know too much about them. Truck tires are of two major types, highway and off-highway. It is in the off-highway type that the California logger is most interested. The first prerequisite for good maintenance program is a definite routine in checking and caring for the tires. If this is correctly established, it will decrease work stoppages, increase working hours, make wheel equipment last longer, and reduce cost per hour. The four major factors that govern the number of hours of continous service a tire will deliver are: Load, inflation, vehicle speed, and haul road condition. Every tire has a maximum air pressure at which it can operate, and over loading cannot be compensated for by over inflation. Tires have a definite load which they can carry with a certain air pressure at a certain speed. Increasing the speed decreases the maximum load. As an example, a 10.00 - 20 tire is given a rating of 3,650 pounds maximum at 60 pounds air pressure at 25 miles an hour. The same tire with the same air pressure can

handle 4,780 pounds at speeds less than 25 miles an hour (11,p.41).

In calculating the maximum load a certain truck and trailer can carry, it must be remembered that when going up a grade, some of the load shifts from the front wheels to the rear. This results in the rear tires being temporarily overloaded. When the unit goes down grade, part of the load shifts to the front tires. This condition is more serious, because there are only two tires forward, while there are usually four in the rear.

For every load there is a definite inflation pressure. When the tire is underinflated or overinflated, less than normal service is obtained. This is one of the main reasons for the daily tire check. When a tire is overinflated, the load is carried in the middle of the tread surface, leaving the shoulders with little or no load. This will cause excess wear and may cause the tire to dig in thus stalling the truck. Underinflation causes excessive bulging, excessive internal heat, uneven wear, and eventually the breaking down of the tire. Tire pressure should be checked at least once a day and the tire gauge at definite intervals.

Logging trucks for the most part in this region operate on their own roads and use off-the-highway tires. These tires are engineered to run at the slower speeds.

Excessive speeds increase internal temperatures to a point where their life is greatly reduced. The storing of tires in this region is a major item. The following is taken from "Firestone - Off - the Highway Tires" (11,p.64):

1. Storage rooms should be dark, cool, dry, clean and free from drafts. Sunlight and heat causes rubber to age, lose strength, and elasticity. Moving air oxidizes faster than still air. Ozone produced by electrical discharges also increases oxidation.

Cover windows and skylights. Keep floorw clean, especially from oil, grease, gasoline, etc. If necessary, cover floors with clean wooden slats at least half an inch thick.

2. Keep tire - storage room as cool as possible. Low temperatures are desirable.

3. Very large and heavy tires can be placed vertically in stalls, with a V - shaped support under them to spread the load. Shift tire positions periodically to prevent flat spotting.

4. Tires not too large and heavy to be piled should be stacked horizontally and not laced or staggered. Limit the height of each pile so that the bottom tire is not distorted.

Do not put tires of different sizes in the same pile, unless storage space is limited. In that case, put the

larger tires at the bottom.

5. Before storing used tires, clean them thoroughly, inspect carefully for any damage, and repair if necessary.

6. If tires must be stored out of doors -- whether unmounted, or mounted on vehicles -- clean and dry them, and apply a preservative. Finally, wrap or cover them with waterproof material.

7. When a rubber-tired vehicle is placed in storage, block it up to take its weight off the tires, and deflate the tires. If the vehicle cannot be blocked up, check air pressure twice a month and keep tires properly inflated. A waterproof covering prolongs the life of both tires and vehicle.

Tire Costs for Firestone Special Purpose Logging Truck Tires, April, 1947 (11,p.92)

Example of trucks using tires	Size	Ply rating	Total tire cost including excise tax
Chevrolet Pickup.....	6.00 - 16	6	21.50
G.M.C. 2 ton.....	6.00 - 20	6	29.42
Chevrolet Model 4103 - 04.....	6.50 - 20	6	36.08
Chevrolet Model 3804.	7.00 - 17	8	36.60 (Highway traction type)
Chevrolet Model 3804.	7.00 - 18	8	36.93
International Model K7	7.00 - 20	8	45.98
	7.00 - 20	10	63.30
G.M.C. Model C.G.100.	7.50 - 15	10	55.92
Chevrolet Model 3807.	7.50 - 17	8	44.33
International Model K8	7.50 - 20	10	52.98
Chevrolet Model 4418.	8.25 - 20	10	86.17
G.M.C. Series 200....	9.00 - 20	10	103.62
Sterling Model HCS225H	9.75 - 20	12	110.03
Reo Model 25T.....	10.00 - 20	12	113.23
Mack Model LJSW.....	10.00 - 22	12	116.04
Sterling HCS 235 H...	10.00 - 24	12	113.52 (Highway traction type)
International Model W3042H.....	11.00 - 20	12	129.47
Kenworth Model 548...	11.00 - 22	12	137.08
Mack Model LMSWM.....	11.00 - 24	14	135.14
G.M.C. Model 750.....	12.00 - 20	14	184.94 (Highway traction type)
Mack Model LMSWM.....	12.00 - 24	16	208.72 (Highway traction type)
Mack Model LR.....	14.00 - 24	16	277.72 (Highway traction type)

Firestone Logging Truck Tube Costs
for Common Size Tires (11,p.92)

Size	Total tube cost including excise tax
6.00 - 16	3.36
6.00 - 20	3.82
6.50 - 20	4.70
7.00 - 17	4.41
7.00,- 18	4.64
7.00 - 20	5.82
7.50 - 15	6,12
7.50 - 17	4.41
7.50 - 20	8.12
8.25 - 20	9.39
9.00 - 20	11.30
10.00 - 20	11.72
10.00 - 24	12.55
10.00 - 22	12.09
11.00 - 20	13.89
11.00 - 22	14.91
11.00 - 24	16.47
12.00 - 20	18.44
12.00 - 24	20.60
14.00 - 24	32.07

WAGES

All employees of the larger companies in this region are required to belong to a union. The union in this region is a branch of the A.F. of L. and is exceptionally powerful. Meetings are held once a week in the larger camps, usually in the cook house. Officers are elected for each individual camp or chapter, and they meet with officers of other chapters regularly. Wage contracts are drawn between the union and the individual companies, and that wage prevails throughout the season. This is the minimumwage, however, and the companies may raise the wage if they wish. A definite seniority system exists in that a man cannot be transferred to a job of a lower pay grade, unless he is payed the hourly wage of his previous job. A typical example exists when a hooker on a jammer has an accident. If the head loader steps down to handle the hooker's job, he will be payed first loaders wages for the time he remains on that job. No one can be dismissed by the company unless sanctioned by the union.

The unions and companies have for the past six years been working together perfectly. This has been brought about by the scarcity of labor and the high price of lumber. Whether this condition will continue to exist is

an uncertainity that no one can hope to answer.

The wages existing today in this region will be found in the following tables:

Union Wages for the California Pine Region (30)

	1945	1946 - 7
Hooker.....	$1.25	$1.40
Faller.....	$1.27½	$1.42½
Buckers.....	$0.95 / M plus .15/ hour	$1.10 / M plus .15 / hour
Limbers.....	$0.95 / M plus .15 / hour	$1.10 / M plus .15 / hour
Knob knockers.....	$1.25	$1.40
Bull buck.....	$300 / Mo. plus room and board	$350 / Mo. plus room and board
Scaler.....	$1.31½	$1.46½
Filer.....	$1.39	$1.54
Cat skinner.....	$1.45	$1.60
Candy wagon driver..	$1.27	$1.42
Head cook.....	$1.06½	$1.21½
Baker.....	$0.97	$1.12
Dishy.....	$0.90	$1.05
Flunky.....	$0.90	$1.05
Bull cook.....	$1.02½	$1.17½
Choker setter.....	$1.25	$1.40
Jammer operator.....	$1.55	$1.70

	1945 Cont.	1946-7 Cont.,
Truck loader.....	$1.55	$1.70
Car loader.....	$1.55	$1.70
Bulldozer operator.	$1.45	$1.60
Motor grader.....	$1.42½	$1.57½
Right of way.....	$1.27½	$1.42½
Truck driver.....	$1.32	$1.60
Truck mechanic.....	$1.37½	$1.52½
Cat mechanic.....	$1.50	$1.65
Cat greaser.....	$1.45	$1.60
Section boss.....	$1.17½	$1.32½
Section labor.....	$1.02½	$1.17½
Brush pilers.....	$1.05	$1.20
Fire warden.....	$1.25	$1.40
Blacksmith.....	$1.30	$1.45
Truck greaser.....	$1.32	$1.47
Water wagon driver..	$1.27	$1.42
Cat boss.....	$300 / Mo. plus room and board	$350 / Mo. plus room and board
Power saw operator.	$0.25 / M plus .15 / hour	$0.30 / M plus .15 / hour

STATE REGULATIONS GOVERNING SIZE, WEIGHT, AND LOAD (9,p.236-247)

Width of Vehicles. (a) The total outside width of any vehicle or the load thereon shall not exceed 96 inches, except as otherwise provided in this section.
(b) When any vehicle is equipped with pneumatic tires the maximum width from the outside of the one wheel and tire to the outside of the opposite outer wheel and tire shall not exceed 100 inches, but in such event the outside width of the body of such vehicle or the load thereon shall not exceed 96 inches.

Height and Length of Vehicles. (a) No vehicle unladen or with load shall exceed a height of 13 feet 6 inches.
(b) No vehicle shall exceed a length of 35 feet.
(c) No combination of vehicles coupled together shall exceed a total length of 60 feet.

Length of Loads. (a) The load upon any vehicle operated alone, or the load upon the front vehicle of a combination of vehicles, shall not extend more than three feet beyond the front wheels of such vehicle or the front bumper of such vehicle if it is equipped with such a bumper.

(b) The load upon any motor vehicle alone or an independent load only upon a trailer or semi-trailer shall not extend to the rear beyond the last point of support for a greater distance than that equal to two-thirds of the length of the wheel base of the vehicle carrying such load, provided, the wheel base of a semi-trailer shall be considered as the distance between the rearmost axle of the towing vehicle and the rearmost axle of the semi-trailer.
(c) The load upon any combination of vehicles, except loads of poles or pipes shall not exceed 75 feet measured from the front extremity of the last vehicle or load.

Trailers and Towed Vehicles. (a) When one vehicle is towing another the drawbar or other connection shall not exceed 15 feet from one vehicle to the other.
(b) When one vehicle is towing another, there shall be an additional connection between said vehicles sufficient to hold the vehicle being towed in the event the drawbar or other regular connection should break or become disconnected.
(c) When one vehicle is towing another and the connection consists of a chain, rope or cable, there shall be displayed upon such connection a red flag or cloth not less than 12 inches square.
(d) No person shall operate a train of vehicles when any trailer, semi-trailer or other vehicle being towed whips

or swerves from side to side dangerously or unreasonably or fails to follow substantially in the path of the towing vehicle.

Axle Weight Limits. The gross weight imposed upon the highway by the wheels on any one axle of a vehicle shall not exceed 18,000 pounds and the gross weight upon any one wheel, or wheels, supporting one end of an axle and resting upon the road-way shall not exceed 9,500 pounds.

Ratio of Weight to Length. Every vehicle whether operated singly or in a combination of vehicles, and every combination of vehicles must comply with both subdivisions (a) and (b) of this section. The limitations imposed by this section are in addition and supplemental to all other provisions of this code imposing limitations upon the size and weight of vehicles.

(a) The total gross weight with load imposed on the highway by any of two or more consecutive axles of a vehicle, or of a combination of vehicles where the distance between the first and last axles of said two or more consecutive axles is 18 feet or less, shall not exceed that given for the respective distance in the following table:

Distance in feet between first and last axles of group	Allowed load in pounds on group of axles
3	30,100
4	30,800
5	31,500
6	32,200
7	32,900
8	33,600
9	34,300
10	35,000
11	35,700
12	36,400
13	37,100
14	43,200
15	44,000
16	44,800
17	45,600
18	46,400

(b) The total gross weight with load imposed on the highway by any vehicle or combination of vehicles where the distance between the first and last axles is more than 18 feet shall not exceed that given for the respective distances in the following table:

Distance in feet	Allowed load in pounds
18	46,400
19	47,200
20	48,000
21	48,800
22	49,600
23	50,400
24	51,200
25	55,250
26	56,100
27	56,950
28	57,800
29	58,650
30	59,500
31	60,350
32	61,200

Distance in feet (Cont.)	Allowed load in pounds (Cont.)
33	62,050
34	62,900
35	63,750
36	64,600
37	65,450
38	66,300
39	67,150
40	68,000
41	68,000
42	68,000
43	68,000
44	68,000
45	68,000
46	68,800
47	69,600
48	70,400
49	71,200
50	72,000
51	72,800
52	73,600
53	74,400
54	75,200
55	76,000
56 or over	76,800

(c) The distance between axles shall be measured to the nearest even foot. When a fraction is exactly one-half foot, the next larger whole number shall be used.

Officers May Weigh Vehicles and Require Removal of Excess Loads. (a) Any peace officer having reason to believe that the weight of a vehicle and load is unlawful is authorized to require the driver to stop and submit to a weighing of the same either by means of portable or stationary scales and may require that such vehicle be driven to the nearest public scales as is the event such scales are within five miles.

(b) Whenever an officer upon weighing a vehicle and load as above provided determines that the weight is unlawful, such officer may require the driver to stop in such a place as is suitable and remove such portions of the load as may be necessary to reduce the gross weight of such vehicle to those limits permitted under this code. All material so unloaded shall be cared for by the owner or operator of such vehicle at the risk of such owner or operator.

(c) Any driver of a vehicle who fails or refuses to stop and submit the vehicle and load to a weighing, or who fails or refuses when directed by an officer upon a weighing of the vehicle to stop and otherwise comply with the provisions of this section, is guilty of a misdemeanor.

Unlawful to Exceed Weight Capacity of Bridge or Other Structure. (a) No person shall drive a vehicle over any bridge, causeway, viaduct, trestle, or dam constituting a part of a highway when the weight of such vehicle and load thereon obtains a greater weight than the maximum weight which such bridge or other structure with safety to itself will sustain.

ESTIMATED HOURLY PRODUCTION

"CATERPILLAR" D 8 TRACTOR, D8N TOWING WINCH

AND D 8 LOGGING ARCH (33) (36)

(In Board Feet Per Hour - Scribner Decimal C Scale)
32' Logs

Av. Dia. of Logs	Av. Logs Per Load	Av. Bd. Ft. Per Load	Average Length Haul in in Feet - One Way		
			1000'	2000'	3000'
16"	12.0	3840	13,300	8,400	6,300
20	10.0	5600	19,400	12,200	8,900
24	7.5	6000	20,800	13,100	9,600
28	5.0	5800	20,200	12,700	9,300
32	4.0	5900	20,500	12,900	9,400
36	3.2	5900	20,500	12,900	9,400
40	2.5	6000	20,800	13,100	9,600
44	2.0	5900	20,500	12,900	9,400

Note: These estimated production figures are calculated and are based entirely upon ideal conditions of level ground, a balanced operation, 100% operating efficiency, and logs weighing approximately eleven pounds per board foot Scribner Decimal C Scale. Fifty minute hours are used, six minutes per load for hooking and unhooking and loads of more than four logs to be bunched for the arch tractor. Average travel speeds: Loaded - second gear - 194 f.p.m., unloaded - fourth gear - 317 f.p.m.

Factors to be considered when using these figures,

1. Difficulty in maintaining average board feet per load.
2. Variable conditions of terrain, ie. adverse grades, soil conditions, etc.
3. Undergrowth.
4. Weather conditions.
5. Altitude.
6. Mechanical condition of equipment.
7. Scattered timber stands.
8. Variable weight of logs in mixed stands of timber.
9. Efficiency of overall operation.

Seventy percent of the above figures should be used as an estimate for a fairly good logging operation with no adverse grades for the loaded haul to the landing. For difficult operations, 40 per cent of the above figures may be used.

LOCAL TRENDS AND RECOMMENDATIONS FOR REDUCING LOGGING COSTS

There have been developed in the logging industry two kinds of operators: first, the private operator, who owns his own logging equipment and hauls his own logs; second, the contract hauler who takes contracts to haul logs for other operators. These may be further subdivided by type of haul. It may either be a straight highway haul, straight off the highway haul, or a combination of both.

Every operator, no matter what type, has his individual problems. Some of these are strictly local, and no help can be expected from the experience of other operators. But for the most part the individual problems are more or less universal throughout this particualr region. Some may experience a certain difficulty early in the logging season while others may have the same difficulty later. The majority of these difficulties, although they may seem complicated at the time, are fairly simple as they are worked out. An example of this is the labor shortage existing in the woods during the 1942 logging season. All companies were affected, and some to the extent where log production was curtailed to

a marked degree. As a result the operators tried various and sundry methods of remedying the situation. Some of the ideas helped, while others failed, but it brought out the fact that some unification between operators was absolutely necessary. This was accomplished to a certain extent through local clubs and organizations in this region; but the fact still remains that no organization exists today specifically for that purpose. The operators in the Sierra Valley region, who number about ten, assembled in an impromtu meeting and agreed upon the following proceedure: to attract men to the woods by the offer of higher wages, to establish better living conditions, and to provide transportation to towns. Most companies accomplished this by operating the camps with the intention of losing money. This is shown by the fact that most of the larger companies plan on losing from $20,000 to $25,000 per season on their camps. Bunk houses were reconditioned, "candy" wagons were made more comfortable, and week-end transportation to town was provided. Wage increase was automatically requested by the union and provided by the companies. This is an example of what a small community can do and it brings to light the advantage of having a larger organization that is capable of covering the entire region.

Another problem which is in the process of being

solved and which is universal throughout this region is that of year around logging. Some companies have gone far in the settlement of this problem. Of course, one realizes that some shows are completely summer operations, but that others are questionable, and much can be gained by year around logging. The winter lay-off of men and the storing of equipment are the big disadvantages of a strict summer operation. The McCloud River Lumber Company has accomplished a great deal in this problem, having two year around sides (25). They accomplish this by truck hauling to the railroad in the summer and by direct skidding to the railroad during the winter months.

Woods-to-camp-to-mill communication is another large and unsettled factor. A few operations have excellent communication from the woods and camp to the mill, while others have practically nothing. This is an accomplished time saver in the handling of surprise breakdowns or injuries. Some companies have gone so far as to install a two way radio communication between the woods operation and camp. This is the exception rather than the rule, however, and most woods operations still remain without any sign of communication.

All operators, large and small, are finding it necessary to keep cost figures on their equipment. To the average small operator this is a ridiculous waste

of time and money. This was the attitude taken many years ago even by the larger operators, but most of them are now keeping some sort of books on machine rates and operation costs. This practice has proven itself to be practical in the larger companies and will do likewise in the smaller operations.

A simple procedure practiced by all large companies and some small companies is that of having "Driver's Daily Reports". The forms used in the different companies vary, but the main idea is the same, and much can be gained by their use. Every driver's report should include the following data:

Truck number

Driver

Date

Speedometer, finish

Speedometer, start

Mileage today

Time, start. Hrs....Min....

Time, finish. Hrs....Min....

Overtime. Hrs....Min....

Gasoline bought outside. Gals....Cost....

Gasoline from our garage. Gals....

Oil, quarts

Number trips

Amount hauled each trip (if scales are in use)

Road condition

Faulty equipment (explain)

Accidents (explain)

A few of the larger operations who maintain their own roads employ the use of mile posts. This is to enable the truck driver, when seeing a stretch of faulty road, to locate it accurately when reporting to the engineer or in filling out their time slips.

Some operators employ the services of a truck dispatcher. His sole purpose is to space the trucks in such a manner that no "bunching" at the loader exists. In some operations, especially if there is one slow driver or truck, the entire fleet will tend to pile up behind him. This results in a large amount of idle time at the loader. It is common practice for the dispatcher to stagger the starting times for the trucks thus eliminating initial bunching.

A useful service, coming into practice in the woods operation, is the practice by various equipment representatives of making field visits. This tends to promote more understanding by the manufactrer of the existing field conditions. It also helps the operator and his employees to fully understand the individual piece of equipment and to operate it to its best advantage.

A definite method should be established to enable the operator to calculate the exact size truck needed to fulfill his requirements. If this method of selecting the right truck for the right job was employed, it would save considerable expense and time. It would eliminate the use of over-sized trucks for a light haul, but more important, would exclude the prevalent use of light trucks for heavy hauls. Several truck manufacturers exist who will make an analysis of your particular conditions and recommend the correct size truck for the job. They employ certain formulae for determining the required horsepower when field conditions are known. A typical example is the method used by the Kenworth Company. The following problem is an example to determine the average miles per hour that a Kenworth Model 548 logging truck can travel up a 1% grade (12). A good macadam road and an elevation of 4000 feet were assumed for this problem. The Kenworth Model 548 develops 265 horsepower at 2000 revolutions per minute. The greatest torque developed, however, is 760 foot pounds at 1550 R.P.M. (20,p.3). Therefore, the greatest power is obtainable at that engine speed and calculations for hauling the load are computed at that speed.

Derate engine 8% for accessories (12)

Derate engine 12% for altitude (3% per 1000 foot of

elevation) (12).

Derate available power 15% for transmission gears (12).

Rear axle ratio 8.15 to 1 (12).

Tires 1200 x 24 - rolling radius = 22.4 inches (12).

Rolling resistance on road = 2.25% (12).

The formula to find the necessary torque to lift this load up a one per cent grade is as follows:

$$\text{Torque} = \frac{(\text{Grade plus rolling resistance})(\text{Rolling radius of tires})(\text{Total load})}{(\text{Factor of 1200})(\text{Efficiency of motor at 92\%})(\text{Engine loss for altitude \& gear loss})(\text{Differential rates})} = \frac{(1 + 2.25)(22.4)}{(1200)(.92)(.88)}$$

$$\frac{(14300)}{(.85)(8.15)} = 1550 \text{ foot pounds.}$$

Model 440 Hall Scott engine has 760 foot pounds torque, therefore, $\frac{1550}{760} = 2.04$ reduction. The nearest gear combination afforded in the transmission is 2.16 to 1 (overdrive 2nd gear) (20,p.3).

The formula to find miles per hour is as follows (12)

$$\text{M.P.H.} = \frac{(\text{RPM})(\text{Rolling radius})}{(\text{Factor of 168})(\text{Total gear ratio})}$$

$$\text{M.P.H.} = \frac{(1550)(22.4)}{(168)(2.16 \times 8.15)}$$

M.P.H. = 11.7 on 1% grade

Only through methods like the above can one obtain a true picture of what a specific truck will do under

certain conditions. Nothing is left up to guess work, but is calculated mathematically to give a correct answer. If the operator will use methods such as these to determine what type of equipment he needs and what it will do after he procures it, the efficiency of his operation is bound to be increased.

The pioneering of truck logging has been completed, and major companies have seen fit to invest in equipment. The trend during these past few months seems to be increasing toward this type of operation at the expense of the contract hauler. Due to the extreme shortage of equipment during the war, there has been an increase in contract haulers, but there has been a reversal of this trend recently due to the increasing availability of new trucks.

Another reason for the increase in private hauling is the gradual elimination of railroad hauling. This is due to the fact that most timber being cut in this region is on a sustained yield basis, and the cut per acre is not sufficient to merit the investment necessary to build railroads.

The trend in this region in regard to truck type is summed up by Leslie Vogel of the Mack Truck Company (46) who says: "If we were to set up an ideal logging truck, it would be somewhat as follows: A three axle truck

driven on both rear axles with a dead front axle; minimum 10.00 x 22 tires all around; approximately 175 horsepower engine; 50 gallon fuel capacity; a frame of high-tensile steel (approximately 150,000 pounds per square inch tensile strength test); at least ten speeds forward in the transmission to fully utilize the horsepower available from the engine, while at the same time giving maximum road performance".

The trend in tires in this region is toward the 22 inch tire. This is relatively a new thing in this industry, but with increased speeds, manufacturers were forced into devising greater brake efficiency. In order to obtain this, the brake drums had to be made larger. They could not be made any wider, because they would crowd against the truck springs, so they had to increase the diameter. This brought the brake drum too close to the tire rim, so the only alternative was to increase the tire size. This resulted in increasing the tire life as well as the brake efficiency.

CONCLUSIONS

It is difficult to analyze logging costs, primarily because no two companies have yet arrived at a standard means of establishing these costs. For instance, some firms set trucks up as capital investment, while the majority consider them as operating equipment.

It is my belief that the only true cost picture can be obtained through individual cost analysis. Each piece of equipment of a combination must be figured separately, and the individual results combined. In calculations of this nature certain items must be assumed especially when planning in the future. If the company has on record previous equipment costs, the assumptions will naturally carry more weight.

Logging as shown in this paper is an expensive proposition. During the past five years numerous logging companies have come into existence. It is apparent that in the years to come the demand for lumber will fall below the supply that these operations are capable of producing, and many will cease to function. Which will go and which will remain has yet to be determined. It is also apparent that the operation without future plans, without a thorough knowledge of existing conditions, and without the capabilities of hard work, will fall by the

wayside.

It is hoped that this paper might help in a small way to enlighten a few in the problems confronting the logging industry today.

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