POWER CONSUMPTION FOR SMALL SAWMILL HEADRIGS

by

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CHAPTER I

THE PROBLEM

Statement of the problem. The problem involves the determination of head saw power input requirements for sawing logs of different diameter classes in small mills with circular head-rig; and the application of these findings in the determination of cost per thousand data for head saw power.

Justification of the problem. With some six hundred sawmills in Oregon alone, and with many of these of the small variety that has little or no engineering service, the matter of scientific power information assumes great signifigance. Coupled with the lack of engineering is the lack of printed material. It is the most forgotten phase in the field of lumber manufacture and perhaps the most important from the standpoint of production.

Each size and type of motor has different power characteristics of its own. The importance of selecting the proper size motor may be made more apparent when one considers that too big an electric motor may be only with thirty per cent effecient on a given load while one with an overload of say ten per cent may reach as high as ninety per cent effeciency. A change of only ten per cent in the effeciency of a motor may reasonably be expected to effect a savings of five hundred dollars a year in head saw power cost alone for a forty thousand capacity mill. Add to this the possibility of increased production and it is more yet.

Scope of the study. The study by its very nature is somewhat limited in its scope. There were neither testing material nor time to test different types of mills cutting different types of logs, but this study is at least indicative of what one may expect in similar mills, of which there are many. The test requires the use of at least three men and involves the use of testing equipment worth about three hundred dollars. Both of these are obstacles in the way of extensive testing. Another item is the fact that most of the mills around Corvallis are of the type tested.

In further qualification, it must be said that the power input mentioned herein is that involved in "breaking down" the log at the headsaw and does not include any refinement in manufacture.

CHAPTER II

REVIEW OF RELATED INVESTIGATIONS

Investigations of general aspects. If there is any one common characteristic of this problem it is the wide discrepancy found in what literature there is written on the problem. The very scarcity of printed material is striking in itself. Volumes have been written on head saws and their maintenance, but probably the most important aspect of head saws, namely the power required to run them, has been completely overlooked.

Text books dealing with lumber manufacture make only very general statements, for example, one author states that it takes from four and a half to eight horsepower for each one thousand board feet manufactured.[1] He does not state how far the manufacturing goes in the way of refinement, or the species cut, or the size of the lumber being cut. Another author dealing with Douglas-fir lumber manufacture gives the power requirements as being between four and six horse power per thousand board feet. He qualifies this by stating that this is electrical horse power.[2]

Saw manufacturers make only general recommendations in regard to the power requirements of a given saw, for example, they may say it takes from twenty five to forty horse-

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1 Ralph Clement Bryant, Lumber (New York: John Wiley & Sons, Inc., 1938). p. 146.

2 H. B. Oakleaf, Lumber Manufacture in the Douglas Fir Region (Chicago; Commercial Journal Co., Inc., 1920). p. 134.

power to run a given saw, this is for portable mills, but it is a typical illustration of the wide range of power given for a particular saw. They also say it is better to run a saw below speed and have this speed constant than to run it to proper speed and have this a variable speed. These are fine general statements, but they are of little vale to an operator choosing the right size motor.

Investigations of specific aspects. The only definite statement on the relationships of power to width of cut were from articles written in Russia and in Germany. These were of an experimental nature and were not on a commercial operation. The studies were from two different investigators and were in almost exact agreement.[3] These were the only two studies that the author found that attacked the problem from the scientific standpoint. The trade journals were supprisingly void of material.

Shortcomings of previous studies. The foregoing description of the previous studies brings to light glaring shortcomings both in the way of generalities and applicability of the findings. The most useful information must be taken from standard conditions that are similar to those found in the Douglas-fir region and applicable to small mills. For example, the work done by the Russian and German investigators while of scientific interest, has little application. The fact that most text book authors are from the east and in the

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[3] C. J. Telford, Operating Small Sawmills, Methods, Bibliography, And Sources Of Equipment (Forest Products Labratory, 1936), p. 19.

main write on Eastern species and Eastern conditions makes their contributions inapplicable to conditions as they exist here.

Proposed Contributions of The Present Study. The present study aims at attacking the problem from the most practical aspect possible, to go out and measure the input in a regular typical operation and from that find what it cost for headsaw power. Perhaps the "typical" mill seems a bit misleading, but as it is used here, it is a mill with a double circular saw headrig, with a edger and cut off saws. The mill has a daily capacity of about thirty thousand feet per day. Since this type of mill is so common, it is thought that the findings from this mill would be especially useful. In this connection it must be pointed out that, while with the handicaps that the author encountered make extensive testing impossible, there is a sufficiency of samples to cover a rather limited range of log diameters.

CHAPTER III

FIELD EQUIPMENT USED IN EXPERIMENT

Use of Wattmeters. Since this test was primarily one of power input, the wattmeters were of utmost importance in the determination of the objective. The wattmeters were in the circuit behind the current transformers that reduced the potential. The wattmeters were graduated in scales so that they could be read directly for any voltage hook up. The use of recording drum type of wattmeter would have been desirable because the load at any one point could be recorded. The wide fluctuations in load and the short load period makes the use of them impossible, however.

Use of Current Transformers. As has been breifly stated the current transformers were used to bring the potential down to that suitable for the wattmeters. On their successful operation depended the accurate operation of the wattmeters. This is especially true in preventing overheating. There were two transformers, one for each of the wattmeters.

Use of the Stop Watch. Since electrical energy is measured in units of killowatt hours, to measure the energy expended the wattmeter readings must be multiplied by the time the load is applied. This time element is all important as it makes the determination of energy possible.

The Use of the Scale Stick. In addition to the measurement of the power input, it was necessary, for the purpose of this study, to measure the width face for each.

Much of this had to be estimated as there wasn't time to measure all the cuts, but to aid the estimator in checking on his judgement, the scale proved invaluable. The scale stick was also helpful in checking on lengths when this was necessary.

CHAPTER IV

EXPERIMENTAL PROCEDURE

<u>Wattmeter Reading Technique</u>. Considerable skill and judgement were required in reading the wattmeters to compensate for the fluctuations of the wattmeters. An average of the hands readings were needed. Since the load period often did not exceed five seconds, the time for reading was very short. Ascertaining the correct average figures was indeed one of the major field problems.

<u>Stop Watch Reading Technique</u>. As has been stated before, the accuracy of the data was wholly dependent on the accuracy of the timing. The timing period being short, about five second, made the accurate reading even more important. The timing covered the time the saw entered the cut until the saw was free at the other end of the log. In logs where the sawyer had to stop to wait for power in the middle of the log, the timing just covered the actual traveling time of the carriage.

<u>Estimating Technique</u>. The estimator both timed the carriage and estimated the face widths of the saw cut. The timing of the carriage had to necessarily coincide with the carriage travel, and the measurement of the face widths. All the measuring was figured on the average width, and to do this it was necessary to measure both ends of the pieces that were wedge shaped. Because of the time element, there was more estimating than measuring. One of the biggest aids to the estimator was that many of the cants were of standard

size. For example, many of the pieces has a twelve inch face.

Data Recording Technique. Each of the members of the three man crew had his own particular data to record. Each of the men reading wattmeters recorded the readings opposite the appropriate log number and cut number. Recording for the estimator was somewhat more involved because he had to record the time it took to cut, the width of cut, and the diameter and length of the log.

CHAPTER V

COORDINATING FIELD DATA

Control Methods. To insure that the proper wattmeter reading applied to the proper log or cut in the log required a system of control. In this study it was very simple but adequate. Each log was given a number, and the cuts within the log were assigned consecutive numbers. Thus, log ten cut five could be easily traced on all of the data sheets.

Arrangement of data. As the material was transferred from the separate data sheets to the master sheets, it was arranged in columns in such a way that the necessary computations could all be made on the one sheet. This arrangement minimizes the chance of confusing the basic data. Another advantage of using columns is that it facillitates computation and aids in making totals easier to obtain.

CHAPTER VI

COMPUTATION OF POWER DATA

Use of a Constant in Power Computation. Since there seemed no way to divorce the power consumed to run the machinery light and the load induced by sawing; a constant was derived so that the power measured represented the load only. This constant was found by measuring the power to run the carriage and auxiliary equipment independent of sawing. In this particular case it was found to be about thirty two killowatts or stated in other terms about forty three horse power. This represented frictional losses also.

Computation of Power Input. To find the number of killowatts required to make a particular cut, all that is necessary is to add the two wattmeter readings together and from this subtract the constant. This gives the net power required to do that particular piece of work. To convert this from killowatts to terms of energy or killowatt hours, the killowatts used were multiplied by the time in seconds divided by thirty-six hundred, the number of seconds in an hour, to put it on an hourly basis. This figure of killowatt hours was probably the most significant since it put the data in a form to apply a cost factor. In order to put the power in a form that is generally more commonly recognized, that of horse power, the net killowatts is divided by .746 or the number of horsepower in a killowatt. Applying this factor of killowatt hours to the log scale in the log, gave the cost of headsaw power on a per thousand basis.

Computation of Power Cost Per Thousand. One of the major problems in computing the cost per thousand is that of finding the average cost of a killowatt hour. This was done by finding the cost of the different quantities of electricity at the different rates for each. This was pro rated on the basis of the amount used and divided on the quantity to find the average cost, which was found to be $.0211 per killowatt hour. Applying this figure to the log scale and the power consumed gave the power cost per thousand.

CHAPTER VII

SUMMARY AND RECOMMENDATIONS

Summary. To summarize the study is somewhat difficult in that there are so many aspects. Some generalities are, however, quite obvious. The cost per thousand of sawing was seen to be directly influenced by the size of the log. There was enough difference that when operating on a very close margin the difference could make a small log submarginal. Another deduction is that while many of the items are measurable, there are influences that may be just as important that can't readily be measured. These are in fact of such importance that they make application of this material to other operations somewhat questionable.

Recommendations. The author would like to see this study used as the basis for further investigation. Some of the shortcomings of this paper could be overcome by using it as a precedent. The field data needs to be more complete by the measurement of a larger number of samples covering a wider diameter range. It is also important to get enough samples for each diameter so that factors such as a hard log would not have undue effect on the average.

In line with the findings of this report, it is to be recommended that before installations are made that a careful survey be made of the power requirements. In the mill tested, it was found that in some peak loads the moter was loaded to four times its rated capacity. To aid the sawyer in determining when the motor is fully loaded a wattmeter placed in the view of the sawyer might well act as a guide. This would help keep the sawyer from overloading to the point of endangering the motor or even blowing fuses. This would lessen expensive shutdown costs and lower the cost of mill maintenance.

TABLE I

SUMMARY TABLE OF KILLOWATT HOURS CONSUMED

PER FACE WIDTH FOR TWENTY-EIGHT FOOT LOGS

Face Width In Inches	Av. K.W. Hrs. Consumed	Av. Cost Per K.W. Hr.	Cost Per Face Width
6	.084	.0211	.0018
7	.107	.0211	.0022
8	.128	.0211	.0027
9	.176	.0211	.0037
10	.189	.0211	.0039
11	.272	.0211	.0057
12	.271	.0211	.0057
13	.259	.0211	.0055
14	.295	.0211	.0062
15	.388	.0211	.0082
16	.437	.0211	.0092
17			
18	.471	.0211	.0099
19	.432	.0211	.0091
20	.482	.0211	.0102

TABLE II

SUMMARY TABLE OF SAWING COST PER THOUSAND
BY LOG DIAMETERS FOR TWENTY-EIGHT FOOT LOGS

Diameter Classes	Ave. K.W. Hours	Sawing Cost	Log Scale	Sawing Cost Per M
8	.312	.0066	56	$.118
9	.853	.01799	70	.257
10	.865	.01825	90	.2028
11	1.181	.025	112	.223
12	1.628	.034	138	.246
13	2.317	.049	170	.288
14				
15				
16				
17	2.298	.0495	324	.153
18	3.287	.069	374	.184
19	4.824	.102	420	.243
20				
21	5.296	.112	532	.210
Average Cost Per M				$.1909

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APPENDIX

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	12	6	177	32	145	194.30	.242
2	13	7	185	32	153	205.02	.297
3	9	5	154	32	122	163.48	.169
4	10	6	182	32	150	201.00	.250
5	9	6	135	32	103	138.02	.272
6	10	6	136	32	104	139.36	.173
7	10	7	158	32	126	168.84	.245
8	10	6	166	32	134	179.56	.223
9	10	6	154	32	122	163.48	.203
10	10	7	157	32	125	167.50	.243
Total					1284	1743.73	2.317

Diameter 13" Length 28'

1	8	9	80	32	48	64.3	.12
2	11	10	178	32	146	195.7	.406
3	8	6	117	32	85	113.9	.142
4	9	6	127	32	95	127.3	.158
5	10	7	147	32	115	154.2	.224
6	6	4	82	32	50	67.0	.055
7	6	5	140	32	108	144.8	.15
8	6	5	92	32	60	80.4	.083
9	6	6	80	32	48	64.3	.08
10	6	5	86	32	54	72.4	.075
Total					809	1084.3	1.493

Diameter 11" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	9	5	92	32	60	80.42	.083
2	9	6	107	32	75	105.53	.125
3	8	5	102	32	70	93.83	.097
4	10	5	127	32	95	127.34	.132
5	6	5	73	32	41	54.96	.057
6	6	6	81	32	49	65.68	.082
7	6	5	71	32	39	52.27	.054
8	6	6	76	32	44	58.98	.073
Total						639.31	.703

Diameter 10" Length 28'

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	14	6	122	32	90	120.6	.150
2	16	8	163	32	130	174.3	.289
3	18	10	177	32	145	195.4	.403
4	14	8	117	32	85	113.9	.189
5	14	7	163	32	131	175.6	.255
6	18	8	165	32	133	178.3	.296
7	19	10	162	32	130	175.3	.361
8	20	11	166	32	134	179.6	.409
9	10	5	112	32	80	107.2	.111
10	10	6	123	32	91	121.9	.152
11	10	5	110	32	78	104.6	.108
12	10	6	125	32	93	124.7	.155
Total						1771.4	2.778

Diameter 21" Length 22'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	7	5	115	32	83	111.3	.115
2	8	6	142	32	110	148.5	.183
3	6	5	99	32	67	89.8	.093
4	9	6	118	32	86	115.3	.143
5	6	5	83	32	50	67.0	.069
6	6	6	87	32	55	73.8	.092
7	6	5	88	32	56	75.1	.078
8	6	6	80	32	48	64.3	.080
Total						745.1	.853

Diameter 9" Length 28'

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	14	5	168	32	136	182.3	.189
2	12	5	156	32	124	166.2	.172
3	18	7	159	32	127	170.2	.247
4	22	9	192	32	160	214.5	.400
5	12	5	152	32	120	160.8	.167
6	14	6	163	32	131	175.6	.218
7	21	7	156	32	124	166.2	.241
8	21	7	187	32	155	207.8	.301
9	21	10	185	32	153	205.1	.425
10	10	5	156	32	124	166.2	.172
11	10	6	151	32	119	159.5	.198
Total						1974.4	2.730

Diameter 22" Length 22'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	10	6	129	32	97	130.02	.162
2	11	7	192	32	160	214.46	.311
3	8	6	141	32	109	146.10	.182
4	10	6	142	32	110	147.44	.183
5	12	9	182	32	150	201.06	.375
6	12	8	164	32	132	176.94	.293
7	13	9	162	32	130	174.25	.325
Total						1190.27	1.831

Diameter 12" Length 28'

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	14	8	145	32	113	151.41	.251
2	18	12	179	32	147	197.00	.490
3	15	9	167	32	135	180.95	.337
4	16	12	192	32	160	214.46	.533
5	20	12	176	32	144	193.01	.480
6	21	18	187	32	155	207.76	.775
7	9	6	125	32	93	124.65	.155
8	13	8	156	32	124	166.20	.275
9	13	8	178	32	146	195.69	.324
10	13	8	160	32	128	171.57	.284
11	13	8	161	32	129	172.91	.287
12	13	7	156	32	124	166.20	.241
13	13	7	166	32	134	179.61	.261
14	13	7	191	32	159	213.12	.309
15	13	7	183	32	151	802.40	.294
						2736.99	5.296

Diameter 21" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	12	7	193	32	161	215.75	.313
2	11	6	150	32	118	158.12	.197
3	13	8	161	32	129	172.86	.287
4	12	6	185	32	153	205.42	.255
5	12	6	165	32	133	178.22	.222
6	13	7	174	32	142	192.80	.276
7	13	8	191	32	159	213.06	.290
8	13	8	147	32	115	154.10	.210
9	13	8	151	32	119	159.46	.264
Total						1649.49	2.298

Diameter 17" Length 28'

1	8	5	142	32	110	147.44	.153
2	12	6	172	32	140	187.66	.233
3	8	5	130	32	98	131.36	.136
4	7	5	117	32	85	113.93	.118
5	9	6	143	32	111	148.78	.185
6	6	5	82	32	50	67.02	.069
7	6	5	90	32	58	77.74	.081
8	6	6	92	32	60	80.42	.100
9	6	5	85	32	53	71.04	.074
Total						1025.39	1.149

Diameter 10" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	8	5	109	32	75	100.50	.104
2	9	6	121	32	89	119.26	.148
3	8	6	117	32	85	113.90	.142
4	9	7	125	32	93	124.62	.181
5	6	9	69	32	37	49.58	.093
6	6	8	82	32	50	67.00	.111
7	6	6	86	32	54	72.36	.090
Total						647.22	.870

Diameter 11" Length 28'

1	9	6	170	32	138	184.97	.230
2	9	5	119	32	87	116.61	.121
3	10	5	133	32	101	135.38	.140
4	8	5	104	32	72	96.51	.100
5	8	5	110	32	78	104.55	.108
6	8	5	102	32	70	93.83	.097
7	8	5	105	32	73	91.85	.101
Total						829.70	.897

Diameter 11" Length 24'

1	10	6	113	32	81	108.54	.135
2	10	6	132	32	100	134.00	.167
3	12	8	181	32	149	199.66	.331
4	10	7	142	32	110	147.40	.214
5	13	6	165	32	133	178.22	.222
6	13	6	125	32	93	124.62	.155

Note: wattmeter heated

Diameter 13" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	16	15	136	32	104	139.4	.433
2	24	16	172	32	140	187.6	.622
3	28	17	149	32	117	156.7	.552
4	12	10	130	32	98	131.3	.272
5	18	12	150	32	118	158.2	.393
6	12	12	166	32	134	179.6	.477
7	22	12	170	32	138	185.0	.46
8	10	12	140	32	107	143.4	.357
9	18	13	172	32	140	187.7	.506
10	26	12	176	32	144	193.0	.48

Note: wattmeter heated.

Diameter 30" Length 18'

1	14	16	127	32	95	127.3	.442
2	13	12	173	32	141	189.0	.175
3	10	6	137	32	105	140.8	.175
4	9	6	160	32	128	171.6	.213
5	10	7	145	32	113	151.5	.220
6	11	7	165	32	133	178.3	.259
7	12	7	150	32	118	158.2	.229
8	12	7	150	32	118	158.2	.229
Total					951	1274.9	1.942

Diameter 12" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	14	9	146	32	114	152.8	.285
2	18	12	167	32	135	181.0	.450
3	12	8	152	32	120	160.8	.267
4	13	9	192	32	160	214.5	.400
5	12	8	173	32	141	189.0	.313
6	14	8	184	32	152	203.8	.338
7	18	11	183	32	151	202.4	.461
8	11	9	146	32	114	152.8	.285
9	13	8	154	32	122	163.5	.271
10	13	9	148	32	116	155.5	.290
11	13	8	159	32	127	170.2	.282
12	13	8	165	32	133	178.3	.296
13	13	9	150	32	118	158.2	.294
14	13	8	161	32	129	172.9	.287
15	13	9	154	32	122	163.5	.305
Total					1949	2519.2	4.824

Diameter 19" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	7	8	117	32	85	113.94	.118
2	10	9	139	32	107	143.43	.267
3	10	8	137	32	105	140.70	.233
4	13	9	142	32	110	147.40	.275
5	12	8	153	32	121	160.80	.269
6	16	9	169	32	137	183.58	.342
7	9	7	115	32	83	111.22	.161
8	12	7	154	32	122	163.48	.237
9	13	6	161	32	129	172.86	.215
10	13	6	166	32	134	179.56	.223
11	13	7	128	32	96	128.64	.187
12	13	7	133	32	101	135.34	.196
13	13	8	129	32	97	129.98	.216
Total						2764.00	2.939

Diameter 18" Length 28'

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	7	5	81	32	49	65.66	.068
2	8	6	103	32	71	95.14	.118
3	10	7	110	32	78	104.52	.152
4	6	5	81	32	44	65.66	.068
5	6	6	84	32	52	69.68	.087
6	6	5	85	32	53	71.02	.074
Total						471.68	.567

Diameter 10" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	6	7	87	32	55	73.70	.107
2	10	8	116	32	84	112.56	.187
3	6	5	101	32	69	924.6	.096
4	5	6	99	32	67	89.78	.112
5	10	7	135	32	103	138.02	.200
6	6	5	75	32	43	57.62	.060
7	6	6	88	32	56	75.04	.093
8	6	6	91	32	59	79.06	.098
9	6	5	86	32	54	72.36	.075
10	6	5	82	32	50	67.00	.083
Total						905.07	1.111

Diameter 12" Length 28'

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	6	6	82	32	50	67.0	.083
2	9	7	127	32	95	127.3	.185
3	8	5	94	32	62	83.0	.086
4	9	6	102	32	70	93.8	.117
5	10	6	127	32	95	127.3	.158
6	6	5	82	32	50	67.0	.069
7	6	6	91	32	59	79.1	.098
8	6	6	84	32	52	69.7	.175
9	6	6	77	32	45	60.3	.075
Total					578	774.5	1.046

Diameter 10" Length 28'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	12	7	138	32	106	142.09	.206
2	14	11	172	32	140	187.66	.428
3	11	7	148	32	116	155.49	.226
4	13	9	168	32	136	180.23	.340
5	11	8	170	32	138	184.99	.307
6	14	9	176	32	144	193.03	.360
7	15	11	176	32	144	193.03	.440
8	10	8	147	32	115	154.15	.256
9	10	6	161	32	129	172.92	.215
10	10	6	164	32	132	176.94	.220
11	10	6	160	32	128	171.58	.213
12	10	6	160	32	128	171.58	.213
13	10	6	159	32	127	170.24	.212
Total						2253.93	3.636

Diameter 18" Length 28'

1	6	5	55	32	23	30.8	.032
2	8	5	71	32	39	52.3	.054
3	9	5	70	32	38	50.9	.053
4	6	5	65	32	33	44.2	.046
5	6	5	70	32	38	50.9	.053
6	5	5	65	32	33	44.2	.046
Total					204	273.3	.284

Diameter 8" Length 26'

BASIC DATA SHEETS

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	8	6	87	32	55	72.7	.092
2	9	6	125	32	93	124.7	.115
3	8	5	170	32	138	184.9	.192
4	9	6	210	32	178	238.6	.229
5	11	7	150	32	118	158.2	.229
6	6	6	110	32	78	104.6	.130
7	6	5	187	32	155	207.8	.215
8	6	5	162	32	130	174.3	.181
9	6	6	150	32	118	158.2	.197
Total					1063	1424.0	1.648

Diameter 11" Length 28'

	Width	Time	Total K.W.	Con. K.W.	K.W.	H.P.	K.W. Hrs.
1	8	6	107	32	75	100.50	.125
2	9	6	147	32	115	154.10	.192
3	7	5	100	32	68	91.12	.094
4	5	5	105	32	73	97.82	.101
5	9	6	155	32	123	164.82	.205
6	6	5	86	32	54	72.36	.075
7	6	5	92	32	60	80.40	.083
8	6	5	81	32	49	65.66	.068
9	6	6	90	32	58	77.72	.097
Total						904.50	1.040

Diameter 10" Length 28'