On Nov. 22, 1904 at 3 P.M. nine time a combined test of the boiler, engine & electric plant in use at "B" compr. plant was started and continued until 9 P.M.

Feed water, coal, & ashes were weighed draft gage was read & a calorimeter was used at the boiler house.

at the engine house indicator cards were taken of the Ideal Tandem compound non-cond. engine every 15 min. The watt meter ~~was~~, three ammeters, voltmeter & ground detectors and steam gage were read at the same time the cards were taken.

No calorimeter was used on the steam as it was evidently too wet. The watt meter readings were also taken at intervals during the night & till 9 P.M. the next day. They are always taken at 6 P.M. & 7 A.M. The official reading was taken at 12 M. Nov. 26 at which time the blank flange separating No 1 boiler from the others to supply this engine alone was removed. The coal was weighed up to this period as well.

all these records are in the original books among the mechanical test books.

Following is a compilation of the K.W. hrs. output on the switch board against the coal used. For the period covered by the test and for the total period these may be fairly set against each other but at other periods the coal is large as enough is wheeled before the boiler to last the night.

Coal cost on the coal platform is given as #3.47 per ton of 2000# by the clerks books for 1904.

		K.W.	Coal	
Nov 22. —	3-9. 6 hrs.	216	2250	
Nov 22 —	9-7- 10 hrs.	221	2235	
Nov 23 —	7-7 — 24 hrs	960	10545	Mach. Shop ran part of night.
Nov 24 —	7-7 — 24 hrs	610	12830	
Nov 25 —	7-7 — 24 hrs	980	9050	M.S. part of night.
Nov 26 —	7-12 — 5 hrs.	80		
	93	3073	#36910	

The Engine & Dyn. were idle 3 hrs of this time. at noon Nov-23, 24, 25.

Coal per K.W. during test — #10.41
total time #12.01

cost of coal per K.W. total time 2.084 ¢
during test 1.806 ¢

Average output of dynamo during 90 working hrs. as above 34.14 K.W.

See also page 11

An Electric Pump Installation

proposed for Pumphouse below "E" shaft on the creek.

The total amount of water to be pumped for the days supply is about 250000 gals. (see report to Gen. Mgr. of July 19, 1904) which is about all I think the creek could be depended upon to supply during the dry season.

From a graphical log of the load on the electric plant it appears that an additional load of from 40-50 K.W. could be placed on the dynamo from 6 P.M. – 6 A.M. without serious overloading.

250000 ÷ 12 = 20833 gals per hr. = 347.2 gals per min.

350 gals per min × 8.33 = 2915.5 # per min.

$\frac{2915\text{\#} \times 520' \text{ head}}{33000} = 46$ H.P. 520' = pressure of 225# per sq. in.

Highest observed at pump including friction is 200# & then water was in the body of the tank. total

225# is I think safely above the maximum.

46 H.P. Theoretical load ÷ 80% = 57.5 H.P. highest actual load. 57.5 × .746 = 42.89 Max load in K.W.

This could be safely carried during the 12 hrs. from 6 P.M. – 6 A.M.

At the pumphouse we are now using coal alone and find (Mr. Campbells statement) that it requires 300# per hr. with boiler in good condition and running 24 hrs.

During November we ran 24 hrs per day up to the 15th & there after shut down at 9:30 P.M. & started again at 5 A.M. or 16.5 hrs. per day.

During this 608 hrs an average of 10000 gals per hr. was probably pumped or a total of 6,080,000 gals. The coal cost as the rate of 300# per hr would be 91.2 Tons. The book cost is $3.47 ~~to return~~ & it will cost the remainder of $4 to team the coal.

Cost of 6,080,000 gals.

Steam Pump.

91.2 Tons @ $4 = $364.80
2 Men @ $60 = $120.00
Total $484.80
Electric Total = 301.10
Apparent saving per mo. $183.70

Electric

Coal. 12# per K.W. hr.
350 gals per min =
289.5 Hrs.
40 K.W.
11580.0 K.W. hrs.
12
2)138.960 # Coal
69.48 Tons
3.47
48636
27792
20844
$241.0956
60.
1 Year $301.10

This apparent saving is based on the coal cost figured from the test of Nov. 22 which is on a very light load. It is only reasonable to expect that with the plant working under a larger load this can be reduced materially. Indeed I expect that the actual amount of coal which we would burn at "B" above that now used, if this pumping were added to the electric load would not exceed 15 Tons per month.

5/

Arranging for a fixed charge to be made against the various buildings taking heat from the system at "E".

Dec 8, 1904.

"E" dry (room between ceiling & floor) about 30000 cu ft.
about 90° F all the time
about 720 sq. ft radiation.

Capt. shop. about 45000 cu ft.
about 50° F all the time. 100 sq ft radiation.

Fire Hall about 14000 cu ft
about 50° F about 240 sq. ft radiation

Surface office about 20000 cu ft
about 70 sq. ft Rad.

Supply Warehouse about 45000 cu ft
about 140 sq. ft Rad.

Office about 40000 cu. ft.
642 sq. ft. Rad.
650 watts in Rad.

Capt Brown House about 14000 cu ft
about (Rad 302) 310 Rad

Mrs. Clubb about 15000 cu ft
about (Rad 344) 350 Rad.

Machine Shop about 260000 cu ft
about 3500 Rad

(6)

Keaseby & Mattison's table for heat lost from pipes give a loss of 20000 B.T.U. per hr from a bare pipe with a pressure of about 5#.

assuming an efficiency of our covering method to be about 50% it would seem about fair to assume a loss for every 100' distance of about 10000 B.T.U. per hr.

Now the B.T.U. radiated by a bare pipe (having 1 sq. ft. ext. area) with pressure of 5# & surrounding temp of 68° is 425 about. or about 25000 B.T.U. lost per hr.

Then it seems to me considering all our conditions that it would be fair to charge each building in addition to its own radiation with 3 sq. ft of radiation for every 100' distance from the source of supply! This would make the radiation chargeable against each building as follows.

	Rad
"E" dry	727 ✓
Carpt. Shop	110 ✓
Fire Hall	249 ✓
Surface	95 ✓
Warehouse	157 ✓
Office	680 ✓
Carp Brooms Rig	331 ✓
Clubbs	371 ✓
Mach Shop	3518 ✓
	6238 sq. ft.

Oil House 130 sq. ft

6368

"C" Fuel Consumed Dec 1/03 — Nov 30/04 "E"

	Coal	Wood	Rock Hoisted.	Coal	Wood	Rock.
Dec	178 150		10892.0	329325	67	10554.0
Jan	102 565	60	11476.5	483343		9781.8
Feb	58755	25	4901.4	291219		4334.4
Mar	8550	85¼	6736.8	257578	106½	6176.1
Apr	71867	88¾	11883.9	383706	58	9126.6
May	176896		12721.8	350233		5363.4
June	166015		12827.1	379710		11555.2
July	142093		10736.0	339466		10513.8
Aug	175306		10993.4	381710		11781.0
Sept.	90345	73½	11925.9	330478		11543.7
Oct.	39175	122¾	12555.4	241975		12632.4
Nov.	128650	36	12432.2	203502	52	11937.2
	1, 334, 367	491¼	130082.4	3,772245	283½	115299.6

Ratios used

58 % R.H.
42 % Hoist.

Summer months
Apr, May, June, July, Aug, Sept.

Ratio Used

Summer		Winter
R. H	18	12
Hoist	22	22
Compr	50	28
Heat & Lgts	10	38

"E" Compr Ran night shift & when "7" was shut down during Sept. Shut down entirely in Oct.

"C"

1 cord wood = 1000 # coal

Months	# Coal Equiv. to coal + wood used	Whole Tons Rock Hoist	Ratio # Coal : Tons Rock	Remarks.
Dec	174150	10892	15.99	
Jan	162565	11477	14.16	60 cd wood
Feb	83755	4901	17.09	Strike Feb. 14th
Mar	93800	6737	13.91	85 cd. wood Strike ended about Mar 10.
Apr	160617	11884	13.52	89 cords " .
May	176896	12722	13.90	
June	166015	12827	12.94	
July	142093	10736	13.24	
Aug	175306	10993	15.94	
Sept	163845	11926	13.74	73 cords wood
Oct	161925	11555	12.10	122 cords wood
Nov	164650	12432	13.24	36 cords wood.
Total	1825617	130082	Average 14.03	

"C" has a feedwater heater, runs rockhouse including steamhammer all the year. Has a Nordberg hoist which is likely a little better on steam than the Fraser & Chalmers at "E".

9/

"E"

At "E" are a 7 x C Hoist, a 10 drill comp, a feedwater heater, three Rock-type x steam hammer, and the heating system of about 6200 □ft rad. Steam hammer was changed to air about the middle of October. Comp. ran in October not at all since there after. 7 in Sept. night shift x when "7" was shut down. all other months.

Month	# coal equiv to coal + wood burned	Whole Tons Rock Hoisted.	Ratio # Coal / Tons Rock.	Remarks.
1903 Dec	396 325	10544	37.55	67 wood
1904 Jan	483 343	9782	49.41	
Feb	291 219	4334	67.19	Strike 12th on
Mar	364 078	6176	58.95	106½ wood Strike to 10th about
Apr	441 706	9127	48.39	58 wood Shaft idle 6 days Gates crusher. Timber + men
May	350 233	5363	65.31	Shaft idle 16 days. Gates Crusher. Timber + men hoisted.
June	379 710	11555	32.08	
July	339 466	10514	32.30	
Aug	381 710	11781	32.40	
Sept	330 478	11544	28.63	Comp. Ran only nights x when "7" was shut down
Oct	241 975	12632	19.16	Comp. Shut down.
Nov	255 502	11937	21.40	52 wood. No hammer.
Total	4255745	115299	Av. 36.91	

Month	100 H.P. 20 hrs per day - 26 days. # Coal Used for Compr.	Coal left for Hoist, R.H. + Heating	Ratio Last col. # coal / Tons Rock	Hoisting + R.H. Ratio allowed.	Diff. or Ratio Heating	Appr. Coal for heating	Remarks.
1903 Dec	180 000	216325	20.50	16 +	4	4 [illegible]000	Judge Fair for future.
1904 Jan	200 000	283343	28.96	17 −	12	117000	40 Tons
Feb	150 000	141219	32.58	16 +	16	65000	50 "
Mar	150 000	204078	33.04	18 +	15	86000	50 "
Apr.	180 000	261706	28.67	17 +	11	109000	50 "
May	180 000	170233	31.74	18 +	13	75000	30 "
June	180 000	199710	17.28	14 +	3	34000	20 "
July	180 000	159466	15.17	15 +	—	—	10 "
Aug	180 000	201975	17.15	16 +	1	11000	—
Sept	120 000	210478	18.22	16 +	2	23000	5 "
Oct	00	241975	19.16	16 +	3	37000	15 "
Nov	00	255502	21.40	16 +	5	59000	20 "
						658000	30 "
							320 Tons.

10)

It seems ~~that~~ a fair fixed charge for 6238 sq. ft of heating surface for a year is about 320 Tons coal at a cost of #3.50

$$\frac{320 \times 3.50}{6238} = \#.1795 \text{ per sq. ft. per year.}$$

To make a total yearly charge, I think that the sq. ft of radiation multiplied by say 18¢ would be about right. This could be spread over the year as seemed fit.

I would suggest book keeping methods as follows:

Charge the heating ~~plant~~ account with coal @ 3.50 as given in the above table. Credit these amounts to the "E" boiler plant. The varying amts. in diff. month will keep heating account about even.

Charge the various buildings using heat at the rate of #18 per 100 sq. ft. heating surface per year as given in foregoing table. Credit these amounts to heating account.

For private parties obtaining heat I would suggest the following distribution of the total yearly charge.

Jan 1/6	May none	Sept 1/12
Feb 1/6	June none	Oct 1/12
Mar 1/6	July none	Nov 1/12
Apr 1/12	Aug none	Dec 1/6

While not strictly accurate I think this will prove satisfactory.

For Company accts. an even charge every month would probably keep the accounts in best shape.

(11)

Test of No 1 Boiler at "B"
Champion Mine. ~~Nov~~. 22, 1904.

Duration — ~~X~~ 6 hrs.
Method of starting — — alternate.
1 — Bursts — Fire box with crown & arch tubes.
Pittsburg lump fuel. analysis 13680 B.T.U.
1.2 % Moisture.
8.67 % Ash.

Grate Surface — — — —	32.07 □ ft.
Length of Boiler — — —	16.0 ft. (tubes.
Diam. " — — —	60".
Water heating surf. — — —	1142.9 #
Weight of Coal as fired — — —	2250 #
Percentage of moisture in Coal — —	1.2
Total weight of dry Coal Consumed	2223.0 #
Percentage of ash & refuse in Coal —	7.29 %.
Total ash & refuse —	164.0 #
Total combustible consumed —	2086.0 #
Total weight of water fed to boiler — —	17400. #
Factor of Evaporation — — —	1.1080
Moisture in steam — — —	1.37 %
Quality of steam — — — —	98.63 %.
Water Evap. Corrected for Quality of steam — —	17160.62 #
Equiv. water evap. into dry steam from and at 212° F — —	19013.97 #
Coal consumed per hr. actual conditions —	375.0
Dry coal consumed per hr — — —	370.5
Dry Combust " " " — — —	347.7

Dry Coal burned per sq. ft. Heating S. per hr	11.55
Water fed per hr	2900.0
" Evap per hr. correct. for steam qual.	2860.1
Equiv. Evap. per hr. from and at 212°	3169.0
" " " " " " " "	2.773
per sq. ft of water heating surf.	

Average Quantities.

Boiler pressure by gage	128.6
Atmos. "	14.0
Temp. of feed water	151.7° F.
Temp. of flue gases	524.7° F.
H.P. devel. by boiler	91.85
Rated H.P.	112 H.P.
Percent. of Rated H.P. Developed	82%

Economic Results.

Water apparently evap. (actual conditions) per pound of coal fired	7.733
Equiv. evap. from and at 212°F per pound of coal fired	8.451
Equiv. evap. from and at 212°F per pound of combustible	9.115

Efficiencies.

Calorific value of dry coal per #	13680
" " " combustible " #	14978
Efficiency of boiler including grate	59.658%

13

Nordberg 125 Drill Air Compr.

Champion Copper Co.

Computations for Cu. Ft. free air per rev.

Air Cyl (L.P.) on ~~H.P.~~ L.P. Steam Engine.

Diam. 36.740"

Rod – 3 5/8" diam on Crank Side piston.

Rod – 3 3/8" " " Head " " .

$2(36.74)^2 - 18.37^2 = 337.46$.

18.37 Rod. $337.46 \times 3.1416 = 1060.1643$.

1060.1643 # area Cyl.

9.6336 " Rod.

1050.5307 # Eff area of Air Cyl. on L.P. engine.

3 5/8" Rod area Kent. 10.3210

3 3/8" " " " 8.9462

$2(19.2672)$

Av. area Rods – 9.6336 #

Air Cyl on H.P. Steam Engine

Diam. 37.225.

Rod. 3 5/8" Crank end

Rod 3 3/8" Head end.

$2(37.225 - 18.6125)^2 - 18.6125^2 = 346.425$

~~3.1416~~ $346.425 \times 3.1416 = 1088.3288$ □" area Cyl

9.6336 Rod

1078.6952 # Eff area of air cyl on H.P. eng.

1078.6952

1050.5307

$2(2129.2259)$

$144 \overline{)1064.61295} = 7.393$ □ft Av. area of two cylinders.

7.393 x 16 (ft. piston moves per rev) = 118.288. Cu. ft of free air made per Rev of engine

14

Mr. Corbetts figures on cu. ft. free air made at "7" her # of coal burned during the time the compressor was running.

Cu. ft. free air per lbs. used = 119.86.

Week ending	Oct. 7.	285
	" 15	290
	" 22	312.
	" 29	298
	Nov 5	275
	12	204
	19	281
	26	263
	Dec 3	275
	10	253
	17	257
	24	264
	Dec 31	252

1.5 Dimensions & clearances from figures on cylds.

	I	II	III	IV
Vol. Head End	7948.1376	18262.9968	54437.28	109930.56
" Crank End	7518.72	17833.5792	54007.86	109501.14
Clearance	476.8882	1040.9908	2395.24	3847.57
Vol Head + Clear	8425.0258	19303.9876	56832.52	113778.13
" Crank + Clear	7995.6082	18874.57	56403.10	113348.71

T/6

"D" Hoisting Plant. 3000' Engine.

The "D" hoist is of Nordberg Mfg. Co make, having ~~two~~ a corliss engine 24"x60" at either end of a double conical drum whose large diameter is 14'-1 5/8" & the small diameter 7'-0 3/4". The straight face part of the drum will hold 1986'-1 1/4" rope & either conical end 1048 ft. With 100# steam at throttle this hoist is capable of starting a load of 4 1/2 tons rock from a depth of 3000 ft. The max. hoisting speed to be 2500' per min. The inclination of the shaft is 69°-30' from the horizontal. The hoist is supplied with steam brake and reverse.

Steam is supplied by either of two 84"x16 ft Round top Locomotive boiler made by the Lake Superior Boiler Works Houghton, Mich.

The steam nozzles of these boilers are ~~at~~ below the throttle of the engine & the length of pipe to the nearest boiler is & to the farthest boiler is ft. The steam line is 8" and covered with Johns-Manville 1" Asbestos Sponge-felt.

The steam from the pipe line enters a receiver separator of times the volume of an engine cylinder.

17

"D" hoist.

The exhausts from the two engines are brought together & carried in a 12" pipe through a Webster oil separator to a Webster open feed water heater & into the mains of a Webster heating system which heats a dry nearby. A back pressure of 3# sometimes obtains on the exhaust line. The average boiler pressure carried is 95#.

~~but the boilers are~~

The hoist is directly back of the shaft on the footwall side and about 400 ft from the "collar".

The average load of rock hoisted during November was 2.06 short Tons. The skips weigh 2000# each.

This boiler plant also supplies steam for a 12 x 24 Nordberg corliss engine for driving the rockhouse crushers.

For the first four days of November 1905, the rockhouse engine & dry were supplied from the old plant leaving the new plant to supply steam only for the new hoist. For the remainder of the month the rockhouse & dry were supplied from the new plant. The number of skips of rock hoisted with the levels from which they were hoisted, the

3 total skips for rock, total skips men & timber, and account of coal burned were recorded each day.

The labor for each 24 hrs is as follows.

2 hoisting engrs. @ ---
2 oilers @ ---
2 firemen @ ---
coal passers @ ---

Following is a tabulation of the ~~appointment~~ skips of rock hoisted with the levels from which hoisted.

	2nd	3rd	4th	5th	6th	7th	8th	Poor Rock	Men & Timber	Av. Load Rock
First 4 days	195	86	129	240	102	149	101	7	24	2.06 Tons
Rem 22 days	950	325	696	1137	554	920	595	925	268	"
~~total~~	1145	411	825	1377	656	1069	696	932	292	
~~December~~ →	1104	431	1000	1075	971	478	771	~~4th~~ 45	Poor 1376	2.107
Distance from load to dump	250	380	505	630	755	880	1005			

Coal Burned in lbs.

	Old Plant	New Plant	% Hoist	% R.H. & Dry	
First 4 days	12645	27360	68.4	31.6	100.00
Last 26 days		209072	#@ above rate 143005 ~~66067~~ or 71.5 Tons	#@ above rate ~~#3~~ 66067 33.03 Tons	

Coal & Rock Ratios

Period	Tons Rock Hoisted	Average Depth of Hoist	Tons Coal burned for hoisting	Rock Coal Ratio at depth	Rock Coal Ratio @ 600ft
4 days 1st Nov	2079	606	13.68	152	154
Rem 26 days Nov	12570	629	71.50	176	185
Full Month	14649	625	85.18	172	179
December	15278	613	94.05	162	166

19
4

The hoisting of poor rock was assumed to be from the same average depth as the hoisting of copper rock. The skips of timber & men were not used in making up the ~~coal~~ Rock: coal ratios.

On Saturday nights hoisting stops at 11:00 P.M. and starts again at 7:00 A.M. Monday morning. Steam is kept up on the boiler and sometimes ~~hoisting~~ for men & timber ~~is done~~ are handled.

20

"7" Heater Pumps.

#1 Pump.

6" Diam $7\frac{5}{16}$" stroke.

M.E.P— 5.0 R.P.M. 57

6" = 28.27 □".

$7\frac{5}{16}$" = 7.3125" = .6094 ft.

$$\frac{5.0 \times .6094 \times 28.27 \times 57}{33000} = .149 \text{ H.P.}$$

#2 Pump

$$\frac{15.6 \times .6094 \times 28.27 \times 57}{33000} = .464 \text{ H.P.}$$

#3 Pump.

$$\frac{41.25 \times .6094 \times 28.27 \times 57}{33000} = 1.227 \text{ H.P.}$$

#4 Pump

$$\frac{112.9 \times .6094 \times 28.27 \times 57}{33000} = 3.359 \text{ H.P.}$$

"7" Vac. Pump.

" diam. M.E.P. 1.2 lbs

$12\frac{31}{32}$ " stroke. R.P.M = 57

20" diam =

$12\frac{31}{32}$" = 12.96875" = 1.0807 ft.

$$\frac{1.2 \times 1.0807 \times 615.75 \times 57}{33000} = 1.379 \text{ H.P.}$$

Air Pump Condenser

$10\frac{7}{8}$" diam R.P.M. 57

$19\frac{1}{8}$" stroke M.E.P. 3.2

$19\frac{1}{8} = 19.125" = 1.594$ ft.

$10\frac{7}{8}$" diam = 92.886 □"

~~3.2 x~~

$$\frac{3.2 \times 1.594 \times 92.886 \times 57}{33000} = .818 \text{ H.P.}$$

Tank Pump

5" diam. = 19.635 □". 13" stk = 1.0833

M.E.P = 9.2 lbs. R.P.M. = 57.

$$\frac{9.2 \times 1.0833 \times 19.635 \times 57}{33000} = .338 \text{ H.P.}$$

Circ Pumps Intercooler

2 pumps Horse Power of both together .66 H.P.

Seebers figure on
coal & rock ratios
at champion mine
etc page 1

Save these
figures.

also following ;-

Test at "B" Plant,	Page 1 & 11
Some Pumps Sta. figure	" 3
"E" Heating system	" 5
Coal & Rock figures, "C,"	" 7
" " " " E	" 9
"B" compresson data,	" 13
"D" Hoist "	" 16
" " "	" 18
"F" Pumps etc	" 20

F.F.