OVERALL EFFICIENCY AND OPERATION TEST OF POWER PLANT AT HARRIMAN, TENN.

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THE POWER PLANT.

This plant is located on the Emory River near Harriman, Tennessee. It is financed by the East Tenn. Power Co., and used to produce power, water and lights for the city of Harriman, which has a population of 7,500 (seven thousand five hundred).

The plant consists of two 200 (two hundred) B. H.P. Scotch Marine fire tube boilers. These boilers are installed on a concrete base and are hand fired (using lituminus slack coal). The steam that is produced by them is conveyed to the engine room (see sketch) by means of insultated pipes, where it is converted into electrical energy by operating three engines. These engines drive alternators by means of leather belts. The types and capacities of each engine and alternator are as follows:

I Atlas Engine, 10"x12", Drives a A. G. E. Alternator, Rating-2300 Volts, 25 Amps at 900 R. P. M. (Separate Woods D.C. Exciter; Rated at 120 Volts, 62 Amps at 1120 R. P. M)

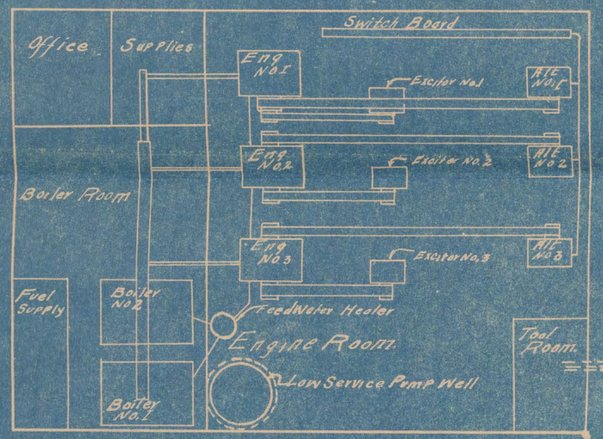
II Ames Iron Works Engine; 16"x16", Drives A.Wood alternator; Rating - 2300 Volts, 75.5 Amps at 450 R.P.M. (Separate G.E.D.C. Exciter, Rated at 75 Amps, 125 Volts at 1700 R. P. M.)

III Emperial Engine; 16"x16"; Drives A.G.E. Alternator; Rating-4000 Volts, 22 Amps, at 600 R.P.M. (Separate Woods D.C. Exciter; Rating 120 Volts, 62 Amps at 1120

R.P.M.)

The electricity that is generated by each of these alternators is phased in on one common switch board in such a manner that the output for each individual alternator may be read directly or the sum of the three may be read.

All of this machinery in the engine room is lubricated by gravity system, flowing from a reservoir located in the second story. After the oil passes thru the machinery it flows to the "Deep well" (see sketch) where it is sand filtered and returned to storage tank by means of a small pump. This oil is driven thru this cycle with a loss amounting to 7 (seven) gals. per 24 hours.



Diagramatic Sketch Showing Lay out Of Plant

Scale 1" = 10'-0"

THE TEST AND CONDITIONS.

The test on this plant was made December 27, 1926. It begun at 10,45 A.M. and lasted twenty four hours. All readings during this period were taken periodically (that are tabulated) every fifteen minutes. Due to the fact that the filter plant was not in continuous operation, the test on it was taken only eight hours and based on twenty four hours. All calculations for the test are carried out according to A.S.M.E. Code as far as possible in logical order.

This plant seems to be in good condition considering its age. At present it is operating at a load larger than designed for, although its value is overwhelming with obsolesence.

ROOM TEMPERATURES (DEGREE FAHRENHEIT)

Time	Tempt	Time	Tempt	Time	Tempt	Time	Tempt
10:45	81.0	6:15	80.0	1:45	82.0	9:15	92.0
11:00	80.5	6:30	81.0	2:00	82.0	9:30	92.0
11:15	81.0	6:45	82.0	2:15	82.0	9:45	92.0
11:30	81.0	7:00	82.0	2:30	84.0	10:00	90.0
11:45	82.0	7:15	88.0	2:45	84.0	10:15	89.0
12:00	83.0	7:30	88.0	3:00	83.0	10:30	88.0
12:15	83.0	7:45	85.0	3:15	84.0	10:45	85.0
12:30	82.0	8:00	85.0	3:30	83.0	Mean	= 84.6
12:45	81.5	8:15	85.0	3:45	83.0		
1:00	82.0	8:30	89.0	4:00	83.0		
1:15	82.0	8:45	86.0	4:15	82.0		
1:30	82.0	9:00	86.0	4:30	82.0		
1:45	84.0	9:15	86.0	4:45	82.0		
2:00	84.0	9:30	87.0	5:00	82.0		
2:15	81.0	9:45	87.0	5:15	81.0		
2:30	82.0	10:00	89.0	5:30	81.0		
2:45	80.5	10:15	88.0	5:45	82.0		
3:00	80.0	10:30	88.0	6:00	83.0		
3:15	79.5	10:45	88.0	6:15	83.0		
3:30	79.5	11:00	87.0	6:30	83.0		
3:45	83.0	11:15	86.0	6:45	84.0		
4:00	83.0	11:30	86.0	7:00	84.0		
4:15	82.0	11:45	85.0	7:15	83.5		
4:30	81.5	12:00	84.0	7:30	83.5		
4:45	82.0	12:15	84.0	7:45	85.0		
5:00	80.0	12:30	84.0	8:00	85.5		
5:15	80.0	12:45	81.0	8:15	86.0		
5:30	80.0	1:00	81.0	8:30	88.0		
5:45	80.5	1:15	81.0	8:45	90.0		
6:00	80.0	1:30	81.0	9:00	92.0		

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KILOWATTS READ FROM SWITCHBOARD.

	Time	K.W.	Time	K.W.	Time	K.W.	Time	K.W.
			P.M.					
(A.M)	10;45	185	6:15	275	1:45	195	9:15	180
	11:00	182	6:30	265	2:00	190	9:30	180
	11:15	160	6:45	265	2:15	185	9:45	175
	11:30	140	7:00	260	2:30	190	10:00	155
	11:45	120	7:15	260	2:45	185	10:15	150
(P.M)	12:00	100	7:30	225	3:00	190	10:30	175
	12:15	150	7:45	240	3:15	195	10:45	180
	12:30	155	8:00	220	3:30	185		
	12:45	165	8:15	200	3:45	190	Mean =	186.83
	1:00	290	8:30	195	4:00	90		
	1:15	285	8:45	185	4:15	90		
	1:30	290	9:00	175	4:30	85		
	1:45	285	9:15	165	4:45	85		
	2:00	280	9:30	162	5:00	80		
	2:15	275	9:45	150	5:15	90		
	2;30	180	10:00	145	5:30	85		
	2:45	200	10:15	220	5:45	80		
	3:00	170	10:30	220	6:00	140		
	3:15	170	10:45	200	6:15	140		
	3:30	180	11:00	190	6:30	140		
	3:45	180	11:15	190	6:45	170		
	4:00	180	11:30	190	7:00	175		
	4:15	200	11:45	185	7:15	185		
	4:30	240	AM 12:00	185	7:30	175		
	4:45	260	12:15	185	7:45	175		
	5:00	330	12:30	180	8:00	190		
	5:15	325	12:45	190	8:15	190		
	5:30	280	1:00	190	8:30	200		
	5:45	280	1:15	190	8:45	220		
	6:00	270	1:30	190	9:00	210		

FEED WATER TEMPERATURES (DEGREES FAHRENHEIT).

TIME	TEMPT	TIME	TEMPT	TIME	TEMPT	TIME	TEMPT
A.M.		P.M.		A.M.		A.M.	
10:45	183.5	6:15	179.5	1:45	179.5	9:15	186.0
11:00	182.2	6:30	181.3	2:00	179.5	9:30	185.0
11:15	185.0	6:45	184.0	2;15	179.5	9:45	185.0
11:30	184.0	7:00	185.0	2:30	180.5	10:00	185.0
11:45	180.0	7:15	187.0	2:45	180.5	10:15	183.0
(PM) 12:00	180.0	7:30	188.6	3:00	180.5	10:30	181.3
12;15	180.0	7:45	191.2	3:15	178.0	10:45	181.3
12:30	180.5	8:00	189.5	3:30	178.0		
12:45	196.0	8:15	189.5	3:45	178.0	Mean = 181.9	
1:00	191.3	8:30	188.6	4:00	177.0		
1:15	178.0	8:45	185.0	4:15	177.0		
1:30	178.0	9:00	182.0	4:30	179.5		
1:45	177.0	9:15	182.0	4:45	179.5		
2:00	178.6	9:30	181.3	5:00	179.5		
2:15	176.0	9:45	181.3	5:15	178.7		
2:30	178.0	10:00	182.0	5:30	179.5		
2:45	178.7	10:15	182.0	5:45	181.3		
3:00	176.0	10:30	182.0	6:00	182.0		
3:15	177.0	10:45	181.3	6:15	182.0		
3:30	180.0	11:00	181.3	6:30	182.0		
3:45	179.5	11:15	181.3	6:45	181.3		
4:00	179.5	11:30	180.5	7:00	181.3		
4:15	180.5	11:45	179.5	7:15	181.3		
4:30	181.3	12:00(AM)	179.5	7:30	182.0		
4:45	182.0	12:15	179.5	7:45	182.0		
5:00	181.3	12:30	178.0	8:00	183.0		
5:15	180.5	12:45	177.0	8:15	184.0		
5:30	181.3	1:00	177.0	8:30	183.0		
5:45	179.5	1:15	178.7	8:45	185.0		
6:00	180.5	1:30	178.7	9:00	185.0		
		1:45					
		2:00					
		2:15					
		2:30					
		2:45					

BAROMETRIC PRESSURE (15 Minute Intervals)

TIME		PRESSURE	TIME		PRESSURE	TIME		PRESSURE	TIME		PRESSURE
10:45	A.M.	29.68	6:15		29.65	1:45		29.65	9:15		29.76
11:00		29.68	6:30		29.65	2:00		29.65	9:30		29.77
11:15		29.70	6:45		29.64	2:15		29.64	9:45		29.78
11:30		29.69	7:00		29.64	2:30		29.64	10:00		29.78
11:45		29.69	7:15		29.64	2:45		29.64	10:15		29.76
12:00	P.M.	29.69	7:30		29.63	3:00		29.64	10:30		29.76
12:15		29.70	7:45		29.64	3:15		29.65	10:45		29.76
12:30		29.70	8:00		29.65	3:30		29.65	MEAN =		29.70
12:45		29.70	8:15		29.65	3:45		29.68			
1:00		29.70	8:30		29.65	4:00		29.68			
1:15		29.69	8:45		29.67	4:15		29.67			
1:30		29.69	9:00		29.65	4:30		29.70			
1:45		29.69	9:15		29.68	4:45		29.70			
2:00		29.69	9:30		29.69	5:00		29.70			
2:15		29.69	9:45		29.68	5:15		29.69			
2:30		29.69	10:00		29.69	5:30		29.69			
2:45		29.69	10:15		29.69	5:45		29.69			
3:00		29.69	10:30		29.69	6:00		29.70			
3:15		29.69	10:45		29.69	6:15		29.70			
3:30		29.70	11:00		29.70	6:30		29.70			
3:45		29.70	11:15		29.70	6:45		29.71			
4:00		29.70	11:30		29.70	7:00		29.72			
4:15		29.70	11:45		29.70	7:15		29.72			
4:30		29.70	12:00	A.M	29.68	7:30		29.75			
4:45		29.70	12:15		29.68	7:45		29.76			
5:00		29.68	12:30		29.68	8:00		29.76			
5:15		29.68	12:45		29.68	8:15		29.76			
5:30		29.66	1:00		29.67	8:30		29.74			
5:45		29.66	1:15		29.70	8:45		29.74			
6:00		29.66	1:30		29.65	9:00		29.76			

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COLORIMETER TEMPERATURES (Deg. Fahrenheit).

TIME	TEMPT F°	TIME	TEMPT F°	TIME	TEMPT F°	TIME	TEMPT F°
10:45	A.M. 222.8	6:15	224.7	1:45	227.0	9:15	231.0
11:00	221.0	6:30	224.7	2:00	227.0	9:30	228.3
11:15	219.0	6:45	223.5	2:15	227.0	9:45	229.0
11:30	222.8	7:00	223.8	2:30	228.0	10:00	229.0
11:45	223.5	7:15	222.8	2:45	228.0	10:15	230.0
12:00	P.M. 227.0	7:30	221.0	3:00	229.0	10:30	231.0
12:15	226.5	7:45	221.0	3:15	229.0	10:45	232.0
12:30	227.0	8:00	222.8	3:30	224.7	11:00	
12:45	227.0	8:15	217.5	3:45	225.5		
1:00	229.0	8:30	217.5	4:00	224.7		
1:15	228.0	8:45	217.5	4:15	225.5		
1:30	227.3	9:00	230.0	4:30	226.5		
1:45	227.5	9:15	230.0	4:45	226.5		
2:00	229.0	9:30	230.0	5:00	227.0		
2:15	230.0	9:45	228.0	5:15	227.0		
2:30	229.0	10:00	228.0	5:30	229.0		
2:45	229.0	10:15	229.0	5:45	228.0		
3:00	229.0	10:30	230.0	6:00	229.0		
3:15	228.3	10:45	231.0	6:15	230.0		
3:30	227.0	11:00	231.0	6:30	232.5		
3:45	228.3	11:15	230.0	6:45	232.0		
4:00	228.3	111:30	228.0	7:00	232.0		
4:15	228.3	11:45	228.3	7:15	230.0		
4:30	228.3	12:00	A.M. 228.3	7:30	231.0		
4:45	229.0	12:15	226.5	7:45	229.0		
5:00	226.5	12:30	226.5	8:00	229.0		
5:15	225.5	12:45	226.5	8:15	228.3		
5:30	222.8	1:00	226.5	8:30	230.0		
5:45	225.5	1:15	226.5	8:45	230.0		
6:00	224.7	1:30	226.5	9:00	231.0		

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PRESSURE IN LBS. PER SQ. IN. (ABSOLUTE)

OBS	TIME	PRESSURE	TIME	PRESSURE	TIME	PRESSURE	TIME	PRESSURE.
	10:45	124.7	6:15	134.7	1:45	133.7	9:15	153.7
	11:00	130.7	6:30	122.7	2:00	136.7	9:30	153.7
	11;15	134.7	6:45	133.7	2:15	130.7	9:45	152.7
	11:30	128.7	7:00	132.7	2:30	128.7	10:00	150.7
	11:45	120.7	7:15	129.7	2:45	134.7	10:15	152.7
	12:00PM	124.7	7:30	129.7	3:00	131.7	10:30	152.7
	12:15	131.7	7:45	125.7	3:15	132.7	10:45	152.7
	12:30	129.7	8:00	130.7	3:30	129.7		
	12:45	131.7	8:15	128.7	3:45	132.7	MEAN =	138.38
	1:00	132.7	8:30	129.7	4:00	127.7		
	1:15	130.7	8:45	130.7	4:15	133.7		
	1:30	128.7	9:00	134.7	4:30	134.7		
	1:45	131.7	9:15	134.7	4:45	129.7		
	2:00	129.7	9:30	134.7	5:00	135.7		
	2:15	132.7	9:45	134.7	5:15	131.7		
	2:30	130.7	10:00	130.7	5:30	137.7		
	2:45	129.7	10:15	134.7	5:45	134.4		
	3:00	134.7	10:30	132.7	6:00	154.7		
	3:15	134.7	10:45	128.7	6:15	154.7		
	3:30	134.7	11;00	126.7	6:30	152.7		
	3:45	136.7	11:15	121.7	6:45	149.7		
	4:00	137.7	11:30	125.7	7:00	153.7		
	4:15	142.7	11:45	128.7	7:15	152.7		
	4:30	136.7	12:00AM	124.7	7:30	153.7		
	4:45	132.7	12:15	129.7	7:45	153.7		
	5:00	129.7	12:30	123.7	8:00	153.7		
	5:15	142.7	12:45	127.7	8:15	152.7		
	5:30	133.7	1:00	124.7	8:30	152.7		
	5:45	129.7	1:15	126.7	8:45	153.7		
	6:00	129.7	1:30	132.7	9:00	152.7		

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POWER PLANT TEST AND CALCULATIONS.

1. Total Grate Surface for Both Boilers = 99.58 sq. ft.

2. " Combustible Space " " = 108 Cu. Ft.

3. " Heating Surface " " = 2442.3 sq ft.

4. Total Amount of Coal Used in 24 hrs. = 37148 Lbs.

5. " " " " " per hour = 1548 Lbs.

6. " " of Ashes Removed from ash pits during 24 hours = 2100 Lbs.

7. Total amount of ashes removed per hr. = 87.5 Lbs.

8. Total amt of water fed to boilers in 24 hrs. = 48000 gals. (352800) ∠65

9. Total Amt of water fed to boilers per hr = 2000 gals.

10. Coal analysis (As fired):

(a) Percent moisture in coal = 1.5%

(b) " Ash " " = 11.5%

(c) " Volatile Matter = 34%

(d) " Fixed carbon " = 55%

(e) " Percent Co_2 in Flue Gases = 14.6%

(f) " B.T.U. Per lb. of coal as fired (tested by "Pairs" Standard Colorimeter) = 12630 Per. lb.

11. Mean Tempt of Flue Gases = 420°F.

12. " " " Feed Water = 181.9°F

13. " " " colorimeter = 227.72°F

14. " " " Steam Pressure (Absolute) = 138.381bs. per sq. in.

15. Barometric Pressure = 29.7 in Hg.

16. Mean Room Temperatures = 84.6°F.

17. Average K.W. on switch board during 24 hrs. = 186.83

18. Quality of Steam = X = H - h - $\frac{.047\ (t_2 - t_1)}{L}$

Where H = Total Heat of 1 lb. of Stm. at boiler Pr.

" L = Latent " " " " " " " "

" H = Total of Stm at reduced Pr. after passing ovifice

" h = Total Heat of Stm. At Reduced Pr (throttling Col.)

" t_1 = Tempt of Sat. Stm at reduced Pr.

" t_2 = " " Stm at Almos Pheric Conditions.

" 0.47 = Specific Heat of Sat. Stm at Atmos Pr.

$\therefore X = \frac{1191.8 - 1150.4 - 0.47\ (227.7 - 212)}{870.5}$

$\therefore X = 96.1\%$

19. Water Actually Evaporated = Total Quantity of Water used X Quality of Stm. = 48000x0.961 = 46128 Gallons.

20. Factor of Evaporation = F = $\frac{H - q_2}{970.4}$

Where H = Heat content of one lb. of Stm. at observed pr. & Tempt. or Quality above 32°F:

Where q_2 = Heat content of 1 lb. of Feed Water At^2 Observed Tempt, B.t.u. per lb.

Where 920.4 = latent heat of 1# of stm at atmospheric conditions.

$\therefore F = \frac{.961x869.6 - 181.9 - 32}{970.4} = 1.08$

21. Equiv Water Evaporated into dry steam from and at 212° = Quality of Stm. x Factor of evaporation X lbs. of water fed to Boiler.

$\therefore$ = .961x1.08x48000x8.35 = 58070.4 lbs.

22. Boiler H.P. Developed.

= Equiv. Evaporation from and At. 212° Per hr.

÷ 34.5

Where 34.5 = A.S.M.E. one B.H.P. Under above conditions.

$$\therefore \text{ B.H.P.} = \frac{16700 \times 1.08}{34.5} = 520$$

23. Rated H.P. = 400

24. Evaporation lb per lb.of Coal as fired.

(a) Actual = $\frac{\text{Total water red to boiler.}}{\text{Wt of coal consumed}}$

$$= \frac{420800}{37148} = 11.32 \text{ Lbs Per Lb.}$$

bequivalent = $\frac{1.08 \times 420800}{37148} = 12.23$ Lb Per Lb.

25. Evaporation Lb Per Lb of Dry Coal:

(a) Actual = $\frac{\text{Total Wt of Water Fed to boiler}}{\text{Wt of Dry Coal consumed.}}$

$$= \frac{420800}{37148 - (37148 \times .015)} = 11.50 \text{ Lb Per Lb}$$

(b) Equivalent = $\frac{1.08 \times 420800}{37148 - (37148 \times .015)} = 12.42$ Lb Per Lb

26. Evaporation Lb. Per Lb. of combustible:

(a) Actual = $\frac{\text{Total No of Lbs of Water Fed to Boiler}}{\text{Wt of Coal used - Ash - Moisture}}$

$$= \frac{420800}{37148 - (37148 \times 0.13)} = 13.02 \text{ Lb Per Lb.}$$

27. Equivalent Evaporation Lb, Per Lb, of combustible as burned: = $\frac{\text{Total water fed to boiler}}{\text{Wt of coal used - Refuge removed.}}$

$$= \frac{420800 \times 1.08}{37148 - 2100} = 12.93 \text{ Lb Per Lb.}$$

28. Dry Coal Fired Per Sq Ft of Grate Surface Per Hr.

$$= \frac{\text{Total No. of Lbs of Coal used.- Percent Moisture.}}{\text{Sq Ft of Grate Surface.}}$$

$$= \frac{37148 - (.015 \times 37148)}{99.58} = 15.31 \text{ Lbs Per Hr.}$$

29. Combustible Burned on Grates Per Hr. = Wt of Coal used per hr - Wt of Ash Per Hr. - 1.5% of coal used per hr. = 1548 - 87.5 - .015x1548 = 1437.28 Lbs Per Hr.

30. Combustible Burned on Grate Per Sq Ft. of Grate Surface per hr. = $\frac{\text{Combustible Burned on Grates Per Hr.}}{\text{Area of Grate Surface}}$

= $\frac{1437.28}{99.58}$ = 14.43 Lb Per Sq. Ft Per Hr.

31. Evaporation Lbs Per Sq Ft of Heating Surface.

(a) Actual = $\frac{\text{Total Water Fed to Boiler}}{\text{Sq Ft of Heating Surface}}$

= $\frac{420800}{2442.3}$ = 172.3 Lbs Per Sq Ft.

(b) Equivalent = $\frac{420800 \times 1.08}{2442.3}$ = 186.07

32. Number of 1000 B.T.V. Absorbed Per Sq. Ft. of Heating Surface. = $\frac{\text{Heat Value of Coal as Fired x No. of Lbs. of Coal used.}}{\text{Sq. Ft of Heating Surface.}}$

= $\frac{12630 \times 37148}{2442.3}$ = 192105. 4 BTU. Per Sq. Ft.

33. Combustible Space Per Lb of Coal as Fired Per Hr. Per Cu. Ft.

= $\frac{\text{Coal Used Per Hr.}}{\text{Cu. Ft of Combustible Space.}}$

= $\frac{1548}{108}$ = 14.33 Cu. Ft. Per Lb. Per Hr.

34. Efficiency of Boiler, Furnace and Grate = Heat Absorbed by Boiler Per Lb. of Coal as Fired ÷ Heat content of one Lb of coal = $\frac{100 \times 12.23 \times 970.4}{12630}$ = 93.96%

35. Combustible As Fired

= 100% - Percent Moisture and Ash

= 100 - 1.5 - 11.5 = 87. Percent.

36. Colorific Value of the Combustible as Fired

= $\frac{\text{Heat Value of one lb of Coal.}}{\text{\% Combustible as Fired.}}$

= $\frac{12630}{87}$ = 14563 B.T.V.

37. Efficiency Based on Combustible;

= $\frac{\text{Heat Value of one Lb of Coal.}}{\text{Colorific Value of Combustible as Fired.}}$

$= \frac{12630}{14563} = 86.04$ Percent.

38. Overall Thermal Efficiency.

= Heat value corresponding to K. W. on switch board

÷ Heat value of coal

* $= \textcircled{C} = \frac{24 \times 186.83 \times 3415}{37148 \times 12630} = 3.33$ Percent.

* (Due to high water, steam pumps were run constantly during test to keep water out of deep well, thereby decreasing K.W. at switch board.)

EFFICIENCIES OF ENGINES.

The indicator cords taken on these engines were taken at irregular interval, due to the fact that the plant was so heavily loaded and it was impossible to get them otherwise. The cords on the following page show the conditions of engines no's 1&2 but was impossible to indicate the small engine (No. 1Atlas) The tabulated efficiencies on following pages show how the efficieneies vary with the load.

Formalues for Computing Efficiencies:

I. H.P. (Indicated Horse Power) = $\frac{P\ L\ A\ N}{33000}$

Where P = Mean Affective Pressure (lbs. per sq. in.)

" L = Length of stroke in Ft

" A = Area of Cylinder (in. sq. ft)- Area of Piston Rod ÷ 2

" N = No of Working Strokes (2xRPM.)

" 33000 = Ft. Lbs. Per Minute

S.B.H.P. (Horse Power Developed on Switch Board) = 1.3 x K.W. = H.P.

EFFICIENCY OF IMPERIAL ENGINE (NO III)

CORD No.	M.E.P.	I.H.P.	K.W.H.P on S.B.	Eff. of Eng & generator.
1.	9.69#°	28.94	0.00	0.00% @ 225RPM.
2.	32#	96.25	73.70	76.48 @ 226 "
3.	32.2	96.75	80.40	82.11 @ 227 "
4.	30.8	92.50	87.10	94.18 @ 226 "
5.	32.0	97.00	87.10	89.75 @ 227 "
6.	32.0	95.48	87.10	91.25 @ 225 "
7.	34.0	101.48	93 80	92.40 @ 225 "
8.	42.60	127.98	113.9	88.85 @ 227 "
9.	42.30	126.78	113.9	89.80 @ 225 "
10.	42.30	126.0	113.9	90.30 @ 225 "

EFFICIENCY OF AMES ENGINE (NO.2)

Cord No.	Mep	I.H.P.	K.W.HP ONS.B.	Eff.of Eng & Generator.
1.	8.76	27.53	0..0	0 % @ 235RPM.
2.	70.9	222.50	174.2	78.30 @ 237 "
3.	70.70	222.22	174.2	78.38 @ 237 "
4.	71.12	222. 20	174.2	78.38 @ 236 "
5.	70.75	222. 05	174.2	78.44 @ 236 "
6.	71.40	224.05	187.6	89.75 @ 237 "
7.	71.80	225.20	201.0	89.31 @ 236 "
8.	71.40	223.45	201.0	90.20 @ 236 "


No Load
225 R.P.M.
M.E.P = 9.4
65 KW
226 R.P.M.
M.E.P = 30.8
70 KW
226 RPM
M.E.P = 34
Imperial Engine (No 3)
(2)
65 K.W.
226 R.P.M.
M.E.P = 32.
(5)
65 K.W.
227 R.P.M.
M.E.P = 32.
(8)
85 K.W.
227 R.P.M.
M.E.P = 42.6
(3)
60 KW
227 R.P.M.
M.E.P = 32.2
(6)
65 K.W.
225 R.P.M.
M.E.P = 32.
(9)
85 KW
225 R.P.M.
M.E.P = 42.6

(1) Ames Engine (No 2)

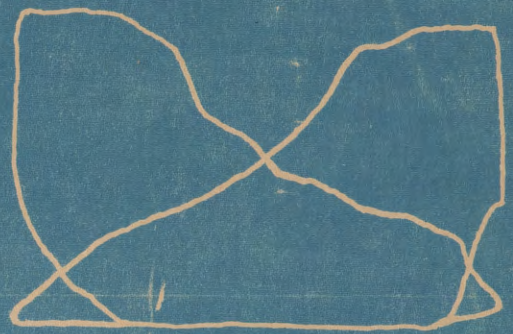
No Load 235 RPM: MEP=8.76

(2)

130 K.W. 236 R.P.M. MEP=71.12

(5)

(7)



150 K.W. 236 R.P.M. MEP=71.8

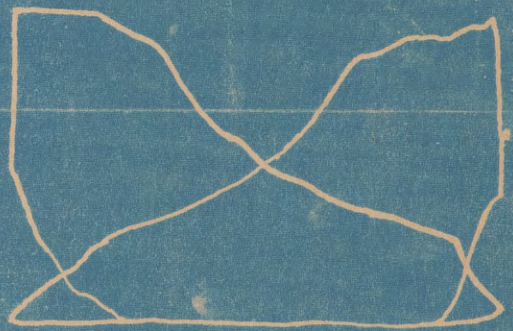
130 K.W. -237 RPM - MEP=70.9

(3)

130 K.W. 236 R.P.M. - MEP=70.76

(6)

(8)



150 K.W. 236 R.P.M. - MEP=71.4

130 K.W. 237 R.P.M. MEP=70.7

140 K.W. 237 R.P.M. MEP=71.4

20

THE FILTER PLANT.

The water for the filter plant is first pumped from the "Deep well" (see Lay out sheet) by means of the low service pump. The elevation of the bottom of this well is only about (sixteen feet) 16' above the normal level of the river. The pump that is used here is a "Cameron" single stoge antrifugal one, and lifts water sixty feet, up to the mixing chamber. Here lime and alumin are introduced in corrected proportions and the water flows out into the coagulating basin. From here it gravitates thru mechanical sand filters and then chlorine is added just before it gravitates into the clear well. From the clear well it is pumped to the city reservoir by means of the "high service pump". This pump is a "Cameron" three stoge antrifugal one and lifts water 300' (three hundred feet)

FILTER PLANT.

CHEMICALS USED.

Ala Floc (instead of lime)

Rate - 1.25 oz. per.min.

First shift - 9.1 Lbs.

Second " - 29.2

Total per 24 hrs = 38.3 Lbs.

CHLORINE

I'st shift	140 - 10 140 - 44 602	Second shift	140 - 4 139 - 8

Total used for 48 hrs = 2.24 Lbs.

" " " 24 " = 1.12 "

CHEMICAL TEST OF WATER.

	Raw	Filtered
Alkalinity	10	12
Hardness	16.9	19.5
Free Co_2		0
Color		0
P. H. Value	6-8	7-3
B-Coli-24hrs	2/2	0/6
" " 48 "	2/2	0/6
Agar	52	
Chlorine		0.05
Turbidity	170	

FILTER PLANT CONDITIONS DURING ONE EIGHT HOUR SHIFT

		1PM	2	3	4	5	6	7	8	9	10	11	12	1 A.M.
Loss of Head	No.1									-	-	2'0"	2'0"	2'0"
	No.2									-	-	1'2"	1'2"	1'2"
Rate of Flow in Gal.24hr.	No.1									5-0	5-0	5-0	5-0	5-0
	No.2									-	-	5'0"	5'0"	5'0"
Reservoir Depth -- Ft. (750,000 Gal/ Size)										9	8	9	10	11
Clear Well Depth -- Ft. (220,000 Gal/ Size)										13	13	12	11	10
Coag.Basin Depth -- Ft. (400,000 Gal/ Size)										11'6"	11'6"	11'6"	11'6"	11'6"
Lbs. of Chlorine Per 24 Hrs.										--	--	3.5	3.5	3.5
Main Pressure # sq.in.										123	145	145	145	145
Low Serrive Pump 1155 RPM														
H.S. Pump-Speed 1745 RPM														

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FILTER PLANT CONDITIONS DURING ONE EIGHT HOUR SHIFT (Cont'd)

		2 A.M.	3	4	5	6	7 A.M.
Loss of Head	No. 1	2'2"	2'2"	2'4"	-	-	-
	No. 2	1'4"	1'4"	1'4"	-	-	-
Rate of Flow in Gal. 24Hr	No. 1	5-0	5-0	5-0	-	-	-
	No. 2	5'0"	5'0"	5'0"	-	-	-
Reservoir Depth -- Ft. (750,000 Gal Sz)		12	13	13	13	-	-
Clear Well Depth-- Ft. (220000 Gal. Size)		9	9	12	13	-	-
Coag. Basin Depth Ft. (400000 Gal. Size)		2A.M. 11'6"	3 11'6"	4 11'6"	5A.M. 11'6"	6 -	7 A.M. -
Main Pressure # Sq.in.		145	145	145	123	-	-
Lbs. of Chlorine Per 24hrs.		3.5	3.5	3.5	3.5	-	-
Low Serrive Pump 1155 R.P.M.							
H.S. Pump- Speed 1745 R.P.M.							

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FILTER PLANT OPERATION

	First Shift		Second Shift		Total
L. S. Pump	Stop	3.P.M.	Stop	4.30 A.M.	
" " "	Start	12.55P.M.	Start	10.15P.M.	
L.S.Hrs Pump		2hrs &5min.		6 hrs &15min.	8.35
H.S. Pump	Stop	2:30 P. M.	Stop	320 A.M.	
" " "	Start	12:45 P.M.	Start	10 P. M.	
H.S. Hrs Pump		1 - 45'		5 - 20	7.08

GALS. OF WATER PUMPED TO CITY RESEVOIR

Integrator reading 2'nd Shift = 20949

" " 1'st " = 20440

Total integrator reading = 509

Gals, pumped per 24 hrs. = 509x600= 305400

House water pumped.

House water meter reading 2'nd Shift = 218059

" " " " 1'st " = 215129

Total gallons per shift - - - - - - = 2930

Gals per 24 hrs. = 2930

Power station water pumped.

Power sta. water meter reading 2'nd shift = 1772100

" " " " " 1'st " = 1761700

Total gals per shift - - - - - - - - - - = 10400

Filter wash water used. - - - - - - - - = 13625

Low service pump delivery (gallons) = 300,000

Total pumpage in 24 hrs. = 319025 Gals.

K.W. HOURS USED IN PUMPING.

L.S.Pump Meter Reading 2'nd Shift = 56710

" " " " First " = 56610

Total K.W.H. per shift. - - - - - - - - 100

House Meter reading 2'nd shift = 8882

" " " First " = 8863

Total K.W.H. for shift - - - - - - - - 19

H.S.Pump meter reading for 2'nd shift = 401500

" " " " " First " = 400800

Total K.W.H. Per shift - - - - - - - - = 700

Total K.W.H. for operation = 819

Then Total Pumpage per K.W.H. = $\frac{319025}{819}$ = 389 Gals of water.

APPROVAL

The foregoing thesis is hereby approved as a creditable study of an Engineering subject carried out and presented in a manner sufficiently satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is to be understood that by this approval the undersigned does not neccessarily endorse or approve any statement made, but approves the thesis only for the purpose for which it is submitted.

Name _____

Title _____