THESIS

BOILER TEST

AT THE

POWER HOUSE

OF THE

KNOXVILLE RAILWAY & LIGHT COMPANY

FOR THE DEGREE OF

BACHELOR OF SCIENCE

IN

MECHANICAL ENGINEERING.

BY

W. R. SANDERS

UNDER

PROF. J. A. SWITZER.

1912

T H E S I S

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

C O N T E N T S

(1) Descriptive matter.

(2) Report of boiler test.

(3) Sketch of boiler room.

(4) Graphical Log.

(5) Smoke chart.

(6) Heat value of coal.

(7) Determination of moisture in coal.

(8) Original Data.

The object of this Thesis was to make a complete test of the boilers found in the plant of the Knoxville Railway & Light Co.

This plant consists of a battery of eight boilers the general arrangement of which is shown on page ( ) of the accompanying sketch.

The boilers numbered 1, 2, 3, 8, are of the Babcock & Wilcox design, each being rated at six hundred (600) H. P. while those numbered 4, 5, 6, 7, are made by the Sterling Boiler Works and are rated at three hundred (300) H. P.

The boilers are all hand fired and each is equipped with the sharf smoke preventor, which aids quite materially in keeping the tube free from soot.

The Babcock & Wilcox boilers are also equipped with super heaters. A closed feed water heater, taking exhaust steam from the boiler feed pump and certain of the auxilaries in the engine room, is used to heat the feed water. Two of these heaters are used being installed in duplicate each of which is shown at (A) in sketch.

The feed water is taken from a small creek which flows near the plant and enters the boiler practically clear and free from hardness. The temperature being near 180 degrees

The water flows by gravity to a feed pump shown at (B). These pumps are also installed in duplicate.

The water is fed into the boilers by either of two pipe lines. One is shown above the ground at (C), while

ths other is placed in conduits under the boiler room floor and is also shown at (D). Both of these two lines are topped into the main delivery line leading from the pump and by closing the globe valve (F) and opening (E), or vice versa, water is fed through either of the two lines.

The plant is equipped with a sturtevant system of forced draft which is needed only on special occasions, such as holidays when the plant is taxed to its fullest capacity.

Ordinarily the natural draft furnished by the two chimneys is sufficient to meet the demand.

These chimneys are cross connected, the breeching running from one to the other. The one shown at (H) in sketch is 135 ft. high while the one at (I) is 133ft.

The entire piping system of the plant is corvered with asbestos covering while the boiler shells are covered with a layer of brick and cement.

The coal is brought to the boiler room by means of a bucket conveyor shown at (K) in sketch.

The duration of this test was twenty four (24) hours. Starting at 12:00 P. M. Jan. 16, 1912 and ending at 12:00 P. M. Jan. 17, 1912.

It was conducted according to the rules of the A.S.M.E. the alternativmethod being used to start and stop.

Only the Babcock & Wilcox Boilers were used during the test. Boilers NO. 3 & 8 being fired during the entire

test while boilers No.1 was fired nineteen hours, No. 2 fired four hours.

The main blow-off pipe into which the blow-off from each boiler leads, was examined and it was found that the boilers were leaking at the rate of 204 lbs. per hour.

The instrument used in this test were all carefully calibrated before they were taken from the labraratory of the University of Tennessee.

The coal was weighed by lowering the bucket conveyor on the platform scales. These scales are specially designed and are accurate to within less than one-tenth of 1%.

Feed water was measured by means of a 3inch Venturimeter, which was inserted in the feed water line at (L). Readings were taken at one minute intervals, throughout the test and from these readings the total discharge was calculated. The meter was calibrated in the University of Tennessee labraratory, curves being drawn between deflection in feet of mercury as ordinates and discharges in pounds of water per minute as abscissas.

A thermometer well was inserted in the feed water line near the venturimeter and the temperature of the feed water obtained in this way.

The level of the water in each glass was noted at the beginning of the test and great care was exercised to have it at the same level at the end.

Steam pressure, boiler room, and internal air temperatures were each read at intervals of 15 minutes each.

The temperature of the escaping gases was taken in the breeching just before it entered the chimney by means of a Bristol pyrometer.

The quality of the steam was found by taking the temperature of the steam just after it left the boilers.

The coal was sampled at the time of weighing a sample taken from each bucket full weighed. From this a fair sample was selected, the moisture and heat value of which was determined in the labraratory of the University of Tennessee.

The heat value was determined by use of the Parr Calorimeter, the result of which is shown on page ( ).

Frequently flue gas analysises was made from samples taken from the breeching and from settings of each boiler.

These analysises showed a very low percent of CO2. This low percent of CO2 is due to either of two causes, leakage of air through boiler settings, or excess air through the grate bars.

While it is true comparatively thin fires were carried during the test which would make it possible for this excess air to get in in this way. Yet it cannot be said definately that this is the sole cause. However, it can be said that a munber of leaks were known to exist in the settings of the different boilers.

The total load which the plant carried during the test was found by taking instantaneous readings of the K. W. meter throughout the test. From these readings the coal consumption per K. W. hour was calculated.

Smoke observations were carried on by comparison with the Ringelmann chart during the test from 2:00 P. M. to 5:00 P. M. Jan. 16th. From 8:00 A. M. to 12:00 A. M. Jan. 17th.

Observations were taken at one minute intervals and from points found in this way the chart shown on page ( ) was platted.

On the whole it can be said that the operation of this plant was as good as the average, of the plants of its size.

Mechanical Laboratory—UNIVERSITY OF TENNESSEE

REPORT OF BOILER TEST

Made by W. R. Sanders.

Date Jan. 12, 1912.

Kind of Boiler Babcock & Wilcox. *Manufactured by*

Duration of trial ..... Hours.		24
DIMENSIONS.		
Grate surface: length ... ft., width ... ft.	Sq. ft.	260.7
Water heating surface	"	11228.8
Superheating surface	"	
Height, chimney	Ft.	(1) 135 (2) 133
Ratio of draught area to grate		
Area, chimney	Sq. ft.	
Tubes: Diameter ..... No.		
Ratio heating to grate surface		4307:1
PRESSURE.		
Barometer	Inches mercury	29.026
Steam gauge	Pounds	162.6
Absolute steam pressure	Pounds	176.8
Draught gauge, near damper	Inches water	.252
" " in ash pit	" "	
TEMPERATURE.		
External air	Degrees F.	32.2
Boiler room	"	49.6
Escaping gases	"	354.8
Furnace	"	
Feed water	"	152.4
Steam	"	414
FUEL.		
Kind of coal		Jellico Bituminious
Locality		Jellico
Size of coal		Run of mines
Fixed carbon	Per cent.	
Volatile matter	"	
Moisture	"	3.7
Ash	"	867
B. T. U. per pound coal		12686
" " combustible		14476
Carbon in ash	Per cent.	
Total coal consumed	Pounds.	131419
Total wood	"	
Moisture in coal	Per cent.	3.7
Dry coal consumed	Pounds.	126556
Total refuse, dry	"	11395
Total refuse, dry	Per cent.	8.67
(c) Total combustible	Pounds.	115161
COMBUSTION—PER HOUR.		
Dry coal		5273
(c) Combustible		4798
Dry coal per square foot of grate		20.2
Combustible per " " "		18.3
Dry coal per " " heating surface.		.46
Combustible per " " "		.42

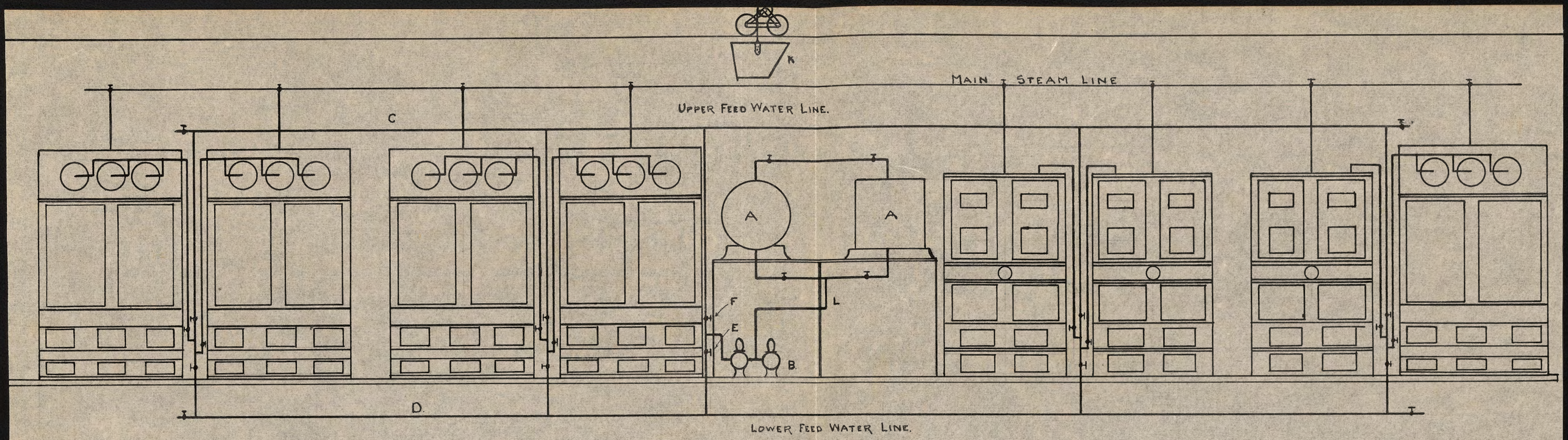
FLUE GAS.		
CO_2	Per cent. of volume	4.34
CO	" " "	.22
H	" " "	
Free oxygen	" " "	15.08
Air	Excess co-efficient.	
Quality of steam	Per cent.	
Superheat	Degrees.	42.6
TOTAL WATER.		
Total weight water used	Pounds.	1088990
Total evaporated, dry steam	"	1088990
Factor of evaporation		1.113
Equivalent evaporated from and at 212°	"	1212046
WATER—PER HOUR.		
Amount used	Pounds	45374.5
Evaporated dry steam	"	45374.5
Equivalent evaporated from and at 212°	"	50501
ECONOMIC EVAPORATION.		
Per Pound of Fuel.		
Actual, per lb. dry coal	Pounds.	8.28
Equivalent from and at 212° [dry coal]	"	9.67
Per Pound of Combustible		
Actual	Pounds	9.45
Equivalent evaporated from and at 212°	"	10.6
RATE OF EVAPORATION.		
Per Sq. Foot of Grate per Hour		
Actual from feed-water temperature	Pounds	174.05
Equivalent from and at 212°	"	193.5
Per sq. Foot of Water-heating Surface per Hour.		
Actual	Pounds	4.04
Equivalent from and at 212°	"	4.49
Per sq. Foot of Least Draught Area per Hour.		
Actual	Pounds.	
Equivalent from and at 212°	"	
HORSE POWER.		
*On basis 34½ pounds equiv. evap. per hour	H. P.	1463
Builders' rating	"	1794
Ratio of commercial to builders' rating	%	81
Heat generated per pound dry coal	B. T. U.	12686
Heat absorbed per pound dry coal	"	9338
Heat lost in flue per pound dry coal	"	
" " incomplete combustion lb. of coal	"	
" " in refuse, lb. of coal	"	3348
" " by radiation, etc., lb. coal	"	
(a) Efficiency of boiler	%	70.7
(b) Efficiency of boiler and grate	%	71.5

NOTE.—Actual evaporation signifies the evaporation from feed-water temperature to dry steam at gauge pressure. It is apparent evaporation corrected for calorimeter determination.

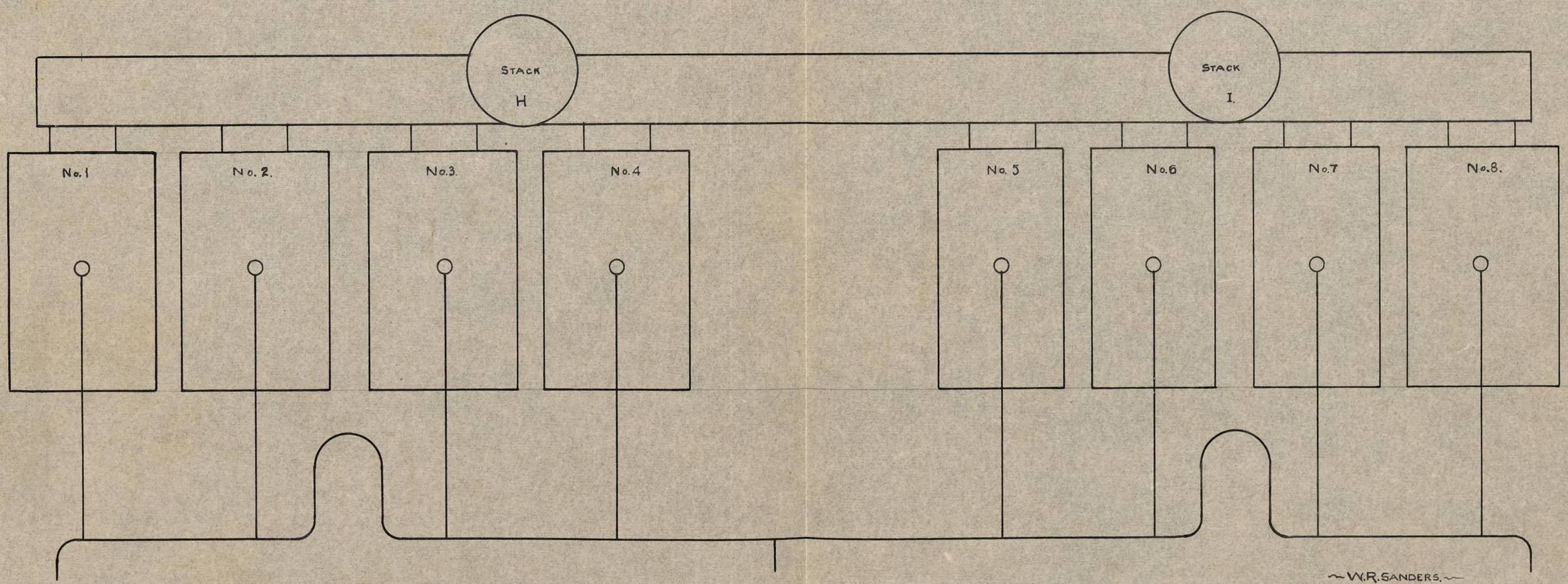
*Standard commercial H. P. (a) Computed from combustible. (b) Computed from coal.

(c) This is dry coal less refuse.

Total lbs. coal consumed per K. W. = 3.2 lbs.



PLAN SHOWING ARRANGEMEN OF BOILERS IN THE PLANT OF THE K.R.R & L.CO.



~W.R. SANDERS.~

Pounds Per Sq In.

170
160
150

Boiler Pressure.

Degrees F.

500
400
300

Steam Temp.

Degrees F.

500
400
300

Escaping Gases.

Pounds Water Per Min.

1400
1200
1000
800
600
400

Feed Water Supply.

Degrees F.

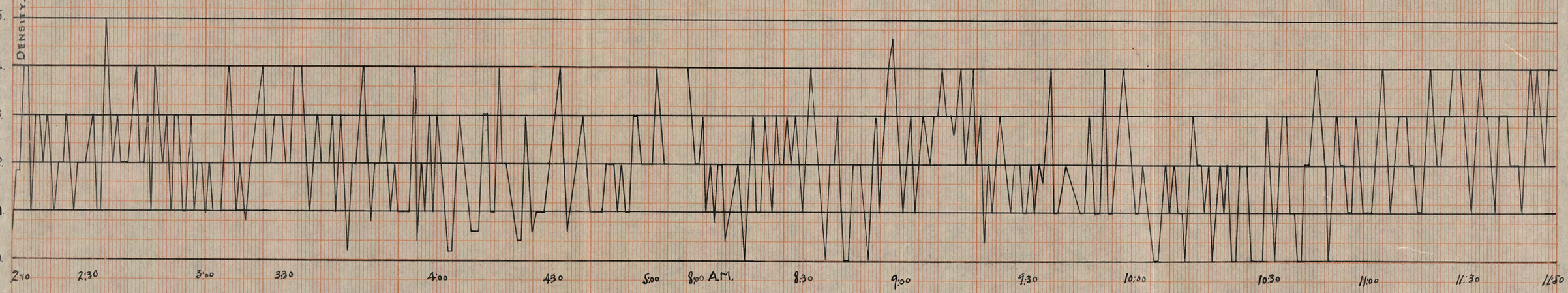
200
100
0

Feed Water Temp.

12:00 1:00 2:00 4:00 6:00 8:00 10:00 12:00 1:00 2:00 4:00 6:00 8:00 10:00 12:00

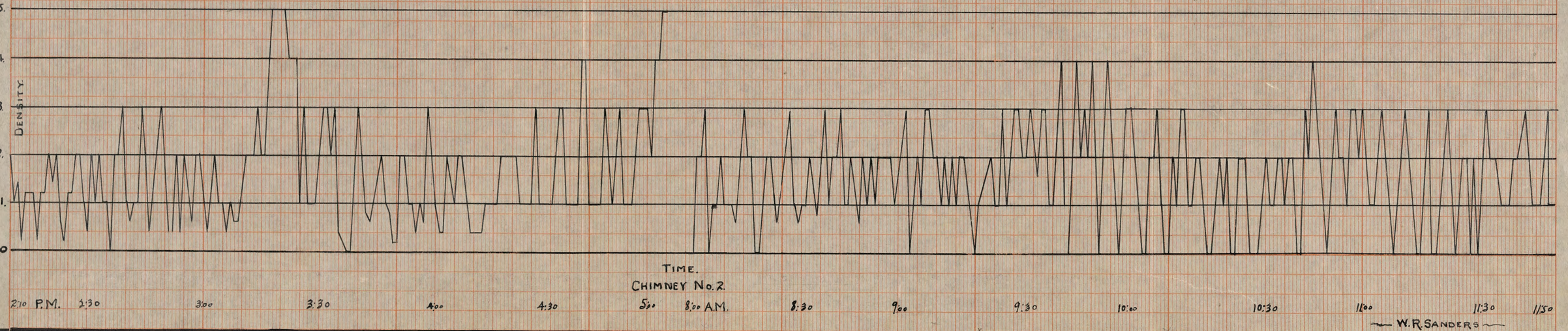
A.M. P.M.

W.R. Sanders.



CHIMNEY No. 1.

RINGELMANN SMOKE CHART. MADE DURING TEST.



CHIMNEY No. 2.

W. R. SANDERS

"Perfect" PROFILE PAPER. PLATE. A. EUGENE DIETZGEN Co.

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Determination of heat value of coal.

Laboratory of University of Tennessee.

Room temperature.	74.4	
Readings.		
Minute. 1	71.75	
" 2	71.77	
" 3	71.77	Ignition.
" 4	75.50	
" 5	75.83	
" 6	75.95	
" 7	75.97	
" 8	76.00	
" 9	76.00	
" 10	75.98	
" 11	75.97	
" 12	75.97	
" 13	75.97	
" 14	75.96	
" 15	75.95	
" 16	75.94	
" 17	75.93	
" 18	75.92	

Determination of Moisture in Coal from Test of Boilers of

KNOXVILLE RAILWAY & LIGHT COMPANY.

Coal from 12:00 A. M. to 12:00 P. M. First Sample.

Weight of watch glass	9.774
" " " " coal	12.453
Weight of coal	2.679
Weight after heating No. 1	12.352
" " " No. 2	12.354
Percent	.377

Coal from midnight to 5:00 A. M. Second Sample.

Weight of watch glass	9.633
" " " " coal	11.092
Weight of coal	1.457
Weight after heating No. 1	11.032
" " " No. 2	11.092
Percent	.411

Coal from 5:00 A. M. to 12:00 A. M. Last Sample.

Weight of watch glass	15.863
" " " " coal	17.503
Weight of coal	1.640
Weight after heating No. 1	12.406
" " " No. 2	
Percent	.256
Average Percent	.256

Determination of Moisture in Coal from Test of Boilers of

KNOXVILLE RAILWAY & LIGHT COMPANY.

Coal from 12:00 A. M. to 12:00 P. M. First Sample.

Sample No. 2

Weight of watch glass	8.244
" " " " coal	11.293
Weight of coal	3.049
Weight after heating No. 1	11.172
" " " No. 2	11.178
Percent	.391

Coal from midnight to 5:00 A. M. Second Sample.

Weight of watch glass	8.981
" " " " coal	11.005
Weight of coal	2.024
Weight after heating No. 1	10.910
" " " No. 2	10.920
Percent	.419

Coal from 5:00 A. M. to 12:00 A. M. Last Sample.

Weight of watch glass	14.810
" " " " coal	16.541
Weight of coal	1.731
Weight after heating No. 1	16.492
" " " No. 2	
Percent	.225
Average Percent	.379

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Steam Temperature & Pyrometer Readings.

Time.	Steam Temp.		Pyrometer readings
	Boiler No. 1	No. 3	
12:00	414	415	400
12:15	424	415	395
12:30	416	418	390
12:45	417	410	390
1:00	416	408	385
1:15	416	410	360
1:30	414	418	363
1:45	414	374	360
2:00	414	415	358
2:15	419	420	353
2:30	418	400	355
2:45	418	410	355
3:00	418	415	353
3:15	418	413	340
3:30	415	380	360
3:45	410	420	360
4:00	412	415	360

Steam Temperature & Pyrometer Readings (con.)

Time.	Steam Temp.			Pyrometer Readings
	Boiler No. 1	No. 2	No. 3	
4:15	409	403	416	350
4:45	410	400	412	325
4:30	412	409	415	330
5:00	413	406	418	360
5:15	418	418	419	360
5:30	418	415	375	380
5:45	422	414	375	380
6:00	420	414	476	375
6:15	417	415	425	375
6:30	414	409	485	375
6:45	416	410	415	370
7:00	418	410	420	370
7:15	416	408	424	360
7:30	414	406	413	340
7:45	415	406	411	320
8:00	414		395	320
8:15	416		405	350
8:30	418		417	370
8:45	418		424	380
9:00	422		417	470

Steam Temperature & Pyrometer Readings (con.)

Time.	Steam Temp.		Pyrometer Readings
	Boiler No. 1	No. 3	
9:15	422	000	350
9:30	420	000	350
9:45	419	000	340
10:00	424	000	340
10:15	420	000	350
10:30	420	000	340
10:45	420	417	315
11:00	420	410	305
11:15	420	403	320
11:30	416	395	300
11:45	418	398	320
12:00	408	380	280
12:15	408	372	300
12:30	402	392	340
12:45	398	380	360
1:00	000	415	340
1:15	000	412	310
1:30	000	403	310
1:45	000	406	310
2:00	000	410	330
2:15	000	408	320
2:30	000	415	310

Steam Temperature & Pyrometer Readings (con.)

Time.	Steam Temp.		Pyrometer Readings
	Boiler No. 1	No. 3	
2:45	000	409	305
3:00	000	398	270
3:15	000	400	290
3:30	000	407	300
3:45	000	398	295
4:00	000	395	305
4:15	000	410	340
4:30	000	375	335
4:45	000	406	320
5:00	420	385	320
5:15	422	398	300
5:30	423	390	340
5:45	424	405	370
6:00	426	411	385
6:15	425	423	400
6:30	425	433	390
6:45	427	420	395
7:00	428	427	385
7:15	432	422	395
7:30	425	427	395
7:45	424	420	385
8:00	424	425	390
8:15	425	420	390
8:30	423	423	380

Steam Temperature & Pyrometer Readings (con.)

Time.	Steam Temp.		Pyrometer Readings	
Boiler No.	1	No. 3		
8:45	420	424	380	
9:00	422	397	385	
9:15	424	425	395	
9:30	430	422	390	
9:45	427	421	380	
10:00	424	425	410	
10:15	434	433	405	
10:30	432	433	402	
10:45	428	440	400	
11:00	424	435	400	
11:15	420	425	390	
11:30	420	420	390	
11:45	428	415	390	
12:00	426	417	380	
				No. 2
Total	33960	37987	34424	614.3
Average	419.2	417.4	354.8	409.5

Average Temperature of Steam 414 Degrees F.

Average Temperature of Escaping Gases 354.8

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Net Weight of Ash.

Time.	Net weight.
5:15	1582
6:35	680
1:10	1533
2:15	1183
2:30	1303
3:04	1833
10:19	1698
10:43	1593
Total	11395 Pounds.

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT COMPANY.

FLUE GAS ANALYSIS.

Time.	CO.	O.	CO.	Boiler No.	Remarks.
1:10	5.40	13.9	0	8	
1:40	4.20	15.8	0	3	
2:15	6.80	12.2	0	Breeching.	3 Boilers f
2:35	6.20	13.0	0	"	fired No.
2:45	5.60	13.8	2	"	1,318.
3:10	4.80	15.0	0	"	NO. 2 Boiler
3:25	3.60	16.4	2	"	fired making 4.
3:35	4.70	15.9	0	"	
3:45	4.80	15.0	1	"	
4:10	7.20	11.7	0	"	
4:35	7.00	13.4	0	8	
4:55	4.60	15.35	0	3	
5:15	7.20	12.6	0	2	Solution bad
5:45	7.00	12.0	0	2	pump out of
6:00	6.40	13.0	0	2	order.
6:45	0.40	18.0	4	"	Pump repaired
8:00	3.40	16.6	0	"	fresh K. O. H.
8:25	3.60	16.6	0	"	
8:40	4.00	16.1	2	"	
9:15	3.20	17.0	0	"	
9:45	3.80	17.2	0	"	
10:10	4.60	15.0	0	"	
10:40	3.00	16.9	0	"	
11:00	3.20	16.8	0	"	

FLUE GAS ANALYSIS (con.)

Time.	Co.	O.	Co,	Breeching	Remarks.
11:30	2.0	18.4	0	"	
12:00	2.5	18.0	0	"	
12:30	3.9	15.8	0	"	
1:00	2.2	18.2	2	"	
1:30	4.4	15.0	6	"	
2:00	4.2	15.4	2	"	
2:20	3.5	16.5	1	"	
2:45	2.7	17.9	2	"	
3:05	3.8	16.2	4	"	
3:25	1.6	18.6	0	"	
4:00	4.7	15.1	2	"	
4:20	4.0	16.2	1	"	
5:00	5.2	14.0	5	"	
5:30	3.1	16.9	2	"	
6:00	3.6	16.6	1	"	
7:15	6.8	12.4	2	"	
7:45	3.6	16.4	2	"	
8:30	6.8	13.8	1	"	
9:30	3.8	15.6	2	"	
Total	186.7	684.6	4.5		
Average	4.34	15.08	.22		

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Net Weight of Coal

Time.	Net weight.
11:52	2234
12:00	2282
12:08	2262
12:26	2274
12:33	2323
12:40	2294
1:36	2304
1:45	2602
1:50	2155
2:03	2172
2:10	2283
2:16	2266
2:23	2292
2:30	2275
2:45	2318
2:50	2288
2:57	2295
3:05	2327
3:13	2332
3:22	2344
3:30	2324
3:37	2335
3:48	2255
3:56	2275

Net Weight of Coal. (con.)

Time.	Net Weight.
4:05	2333
4:11	2353
4:20	2313
5:45	2342
6:50	2246
7:00	2308
7:03	2247
7:13	2273
7:25	2089
Total	75508

Coal from midnight to 5 A. M.

11:50	2243
12:10	2211
12:30	2255
12:50	2304
1:32	2311
1:55	2413
2:23	1003
4:00	2413
Total	17153

Coal from 5 A. M. to end.

5:00	2413
5:01	2449
5:03	2413
5:07	2413
5:19	2485

Net Weight of Coal (con.)

Time.	Net Weight.
5:35	2493
5:47	2479
6:00	2509
7:15	2311
7:25	2316
7:56	2279
8:06	2413
8:15	2289
8:27	2249
8:37	2313
10:27	2293
11:50	315
11:58	326
Total.	38758
Grand Total.	75503
	17153
	38758
Total.	131419

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Steam Guage Readings.

Time.	Boiler.		
	No. 1	No. 3	No. 8
12:00	159	159	159
12:15	165	162	160
12:30	161	162	165
12:45	162	161	160
1:00	160	160	159
1:15	154	155	156
1:30	160	159	158
1:45	162	163	163
2:00	160	159	158
2:15	161	162	160
2:30	160	158	160
2:45	159	159	158
3:00	163	164	161
3:15	160	156	156
3:30	158	158	159
3:45	158	158	159
4:00	159	160	160

Steam Guage Readings. (con.)

Time.	Boiler.			
	No. 1	No. 2	No. 3	No. 8
4:15	160	162	160	160
4:30	160	162	161	161
4:45	159	162	160	160
5:00	155	155	153	153
5:15	158	160	159	160
5:30	160	161	160	159
5:45	160	161	158	160
6:00	165	161	159	160
6:15	165	165	162	159
6:30	160	161	159	159
6:45	164	163	163	162
7:00	165	164	162	163
7:15	165	165	164	165
7:30	164	164	162	165
7:45	164	163	163	163
8:00	165		163	163
8:15	162		160	161
8:30	161		161	164
8:45	165		164	164

Steam Guage Readings. (con.)

Time.	Boiler No. 1	Boiler No. 3	Boiler No. 8
9:00	165	161	164
9:15	160	164	165
9:30	160	161	164
9:45	164	164	165
10:00	162	162	162
10:15	162	162	162
10:30	161	161	162
10:45	164	164	162
11:00	162	162	161
11:15	161	161	162
11:30	165	165	168
11:45	161	162	164
12:00	162	162	162
12:15	161	163	163
12:30	160	161	160
12:45	159	160	160
1:00		157	157
1:15		158	158
1:30		167	162
1:45		163	162
2:00		164	160
2:15		162	161

Steam Guage Readings. (con.)

Time.	No. 1	No. 3	No. 8
2:30		162	163
2:45		164	161
3:00		163	162
3:15		164	160
3:30		161	160
3:45		157	155
4:00		162	160
4:15		160	159
4:30		158	160
4:45		159	160
5:00	162	163	163
5:15	163	162	160
5:30	160	157	160
5:45	163	163	163
6:00	162	162	160
6:15	164	164	165
6:30	163	162	161

Steam Guage Readings. (con.)

Time.	Boiler.			
	No. 1	No. 3	No. 8	
6:45	163	164	163	
7:00	163	163	162	
7:15	162	161	161	
7:30	164	164	162	
7:45	162	162	160	
8:00	161	160	159	
8:15	161	162	163	
8:30	161	161	162	
8:45	162	162	164	
9:00	161	161	160	
9:15	156	156	157	
9:30	158	157	158	
9:45	162	161	162	
10:00	159	158	160	
10:15	160	158	159	
10:30	163	163	161	
10:45	165	160	160	
11:00	161	160	160	
11:15	165	163	162	
11:30	165	159	160	
11:45	162	162	161	
12:00	162	162	163	No.2
Total.	13248	15778	15772	2499
Average.	163.5	162.6	162.6	161.9

Average Steam Pressure 162.6

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Draft Guage Readings.

Time.	Readings.	Time.	Readings.
12:00	000	6:15	187
12:15	000	6:30	187
12:30	000	6:45	187
12:45	000	7:00	187
1:00	000	7:15	187
1:15	375	7:30	187
1:30	250	7:45	187
1:45	312	8:00	250
2:00	312	8:15	187
2:15	250	8:30	187
2:30	312	8:45	250
2:45	343	9:00	187
3:00	250	9:15	375
3:15	250	9:30	375
3:30	250	9:45	375
3:45	500	10:00	375
4:00	375	10:15	375
4:15	250	10:30	375
4:30	187	10:45	000
4:45	125	11:00	250
5:00	125	11:15	250
5:15	375	11:30	250
5:30	187	11:45	250
5:45	187	12:00	250
6:00	187	12:15	250

Draft Guage Readings. (con.)

Time.	Readings.	Time.	Readings.
12:30	250	7:00	250
1:00	125	7:15	250
1:15	250	7:30	125
1:30	250	7:45	250
1:45	500	8:00	250
2:00	250	8:15	125
2:15	250	8:30	125
2:30	250	8:45	250
2:45	250	9:00	250
3:00	250	9:15	250
3:15	250	9:30	250
3:30	250	9:45	250
3:45	250	10:00	250
4:00	250	10:15	250
4:15	250	10:30	187
4:30	250	10:45	250
4:45	000	11:00	250
5:00	250	11:15	250
5;15	250	11:30	250
5:30	250	11:45	250
5:45	250	12:00	250
6:00	250		
6:15	250	Total.	22459
6:30	250		
		Average.	.252
6:45	250		

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT COMPANY.

Temperature Readings.

Time.	Readings.	
	External Air.	Boiler Room.
12:30	38	51
1:00	39	51
1:30	45	52
2:00	41.5	54
2:30	41.5	56
3:00	42.5	55
3:30	42.5	56
4:00	41.	54
4:30	42	57
5:00	41.5	54
5:30	42	56
6:00	41	56
6:30	40	51
7:00	37	50
7:30	35	46
8:00	34	47
8:30	32	46
9:00	31	45
9:30	32	47
10:00	32.5	47
10:30	32	56
11:00	33	57
11:30	31	55
12:00	32	54
12:30	32	45

Report of the Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Temperature Readings.

Time.	Readings.	
	External Air.	Boiler Room.
1:00	32	47
1:30	32	44.5
2:00	30.5	41
2:30	30.25	40
3:00	29	50
3:30	29	53
4:00	28	39
4:30	28	42
5:00	29	39
5:30	29	38
6:00	28	40
6:30	27	51
7:00	28	52
7:30	29	41
8:00	31	43
8:30	32	43
9:00	35	45
9:30	37	46
10:00	39	42
10:45	44	51
11:15	44	53
11:45	45	52
12:00	45	53
Total.	1684.5	2450
Average.	32.2	49.

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Feed Water Temperature.

Time.	Temperature.	Time.	Temperature.
12:05	165	2:25	171
12:10	182	2:30	174
12:15	189	2:35	174
12:20	195	2:40	174
12:25	164	2:45	176
12:30	146	2:50	176
12:35	136	2:55	180
12:40	138	3:00	188
12:45	169	3:05	190
12:50	162	3:10	190
12:55	138	3:15	174
1:00	153	3:20	169
1:05	157	3:25	165
1:10	153	3:30	163
1:20	148	3:35	162
1:25	146	3:40	161
1:30	128	3:45	161
1:35	179	3:50	161
1:40	186	3:55	160
1:45	190	4:00	162
1:50	190	4:05	192
1:55	184	4:10	200
2:00	175	4:15	202
2:05	178	4:20	204
2:10	194	4:25	204
2:15	180	4:30	204
2:20	169	4:35	204

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Feed Water Temperature.

Time.	Temperature.	Time.	Temperature.
4:40	198	6:55	195
4:45	193	7:00	160
4:50	192	7:05	160
4:55	195	7:10	161
5:00	188	7:15	161
5:05	166	7:20	163
5:10	158	7:25	161
5:15	161	7:30	162
5:20	157	7:35	162
5:25	149	7:40	169
5:30	150	7:45	167
5:35	144	7:50	167
5:40	148	7:55	168
5:45	150	8:00	169
5:50	153	8:05	176
5:55	165	8:10	180
6:00	173	8:15	182
6:05	171	8:20	183
6:10	170	8:25	184
6:15	168	8:30	157
6:20	169	8:35	151
6:25	168	8:40	149
6:30	174	8:45	149
6:35	176	8:50	147
6:40	146	8:55	146
6:45	152	9:00	146
6:50	152	9:05	146

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Feed Water Temperature

Time.	Temperature.	Time.	Temperature.
9:10	146	11:25	136
9:15	147	11:30	135
9:20	147	11:35	138
9:25	146	11:40	131
9:30	145	11:45	131
9:35	146	11:50	131
9:40	147	11:55	131
9:45	148	12:00	132
9:50	148	12:05	132
9:55	148	12:10	132
10:00	147	12:15	132
10:05	145	12:20	132
10:10	144	12:25	129
10:15	144	12:30	128
10:20	143	12:35	127
10:25	142	12:40	126
10:30	140	12:45	126
10:35	140	12:50	126
10:40	134	12:55	126
10:45	138	1:00	127
10:50	136	1:05	128
10:55	135	1:10	130
11:00	136	1:15	130
11:05	137	1:20	130
11:10	138	1:25	130
11:15	138	1:30	130
11:20	137	1:35	130

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Feed Water Temperature.

Time.	Temperature.	Time.	Temperature.
1:40	130	3:55	132
1:45	130	4:00	131
1:50	130	4:05	131
1:55	130	4:10	130
2:00	130	4:15	131
2:05	130	4:20	132
2:10	131	4:25	135
2:15	132	4:30	136
2:20	132	4:35	139
2:25	132	4:40	142
2:30	132	4:45	145
2:35	132	4:50	148
2:40	132	4:55	151
2:45	132	5:00	153
2:50	132	5:05	155
2:55	132	5:10	155
3:00	133	5:15	156
3:05	134	5:20	156
3:10	134	5:25	156
3:15	134	5:30	156
3:20	135	5:35	156
3:25	133	5:40	159
3:30	135	5:45	163
3:35	133	5:50	167
3:40	133	5:55	168
3:45	133	6:00	169
3:50	133	6:05	169

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Feed Water Temperature.

Time.	Temperature	Time.	Temperature.
6:10	163	8:25	129
6:15	142	8:30	128
6:20	140	8:35	127
6:25	138	8:40	129
6:30	136	8:45	124
6:35	136	8:50	126
6:40	136	8:55	134
6:45	136	9:00	132
6:50	136	9:05	132
6:55	136	9:10	150
7:00	123	9:15	160
7:05	133	9:20	163
7:10	138	9:25	160
7:15	138	9:30	157
7:20	156	9:35	155
7:25	155	9:40	154
7:30	165	9:45	149
7:35	156	9:50	148
7:40	154	9:55	152
7:45	152	10:00	152
7:50	148	10:05	152
7:55	144	10:10	149
8:00	143	10:15	146
8:05	142	10:20	142
8:10	138	10:25	142
8:15	131	10:30	142
8:20	130	10:35	144

Report of Boiler Test of KNOXVILLE RAILWAY & LIGHT CO.

Feed Water Temperature.

Time.	Temperature.	Time.	Temperature.
10:40	146		
10:45	149		
10:50	141		
10:55	151		
11:00	151		
11:05	151		
11:10	151		
11:15	154		
11:20	158		
11:25	161		
11:30	173		
11:35	179		
11:40	181		
11:45	181		
11:50	181		
11:55	180		
12:00	180		