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UNIVERSITY OF MISSOURI

A REPORT
ON
A FIVE HUNDRED AND FIFTY KILOWATT PLANT

THESIS
FOR
THE DEGREE OF
BACHELOR OF SCIENCE
IN
ELECTRICAL ENGINEERING

UNIVERSITY OF MISSOURI

Elmer C. Robinson

1912.

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INTRODUCTION

The object of this thesis is to present a report on an electric generating station of the size most commonly encountered in electric lighting work. This size station , and others varying in size from a little smaller to a little larger capacity , are the type found all over the country with the exception of the cities and in most cases they are in the same condition. Very few of them keep complete reports and some do not keep any records at all except of the customers that have not paid their bills .

The writer has been associated with this plant and only in a few instances have figures been used which were not approximately correct.

The gathering of material for this report was started early in the school year and it was the object to get the full data for it but the Company changed hands , and at the same time policies , and as a result the gathering of material was somewhat checked and information was gathered from various and sundry sources which accounts for the brevity of some parts.

A few suggestions are to be made as to a better arrangement of machinery and to the handling of coal. A few changes in the present condition of steam lines will probably cut down the amount of coal

used and this will result in a lower cost per kilowatt hour .

Proposed changes of the station building will be taken up and while they may not be considered by the owners , they will however, be feasible.

The writer wishes to thank Mr. T.F.Fulkerson of the Moberly Light and Power Co. for the History of the plant and other information given : Mr. James T. Menefee , formerly manager of the Trenton Gas and Electric Co. Mr. B.T.Bowne , of the Trenton Gas and Electric Co. Mr __ Young and Mr. Wilbur Steele , engineers at the plant , for data and reports furnished .

E.C.Robinson .

Columbia Mo.
May, 24, I9I2.

The city of Trenton is the County Seat of Grundy County ,located in the north-western part of the State of Missouri.

By the census the population is given ,

I890	5039
I900	5396
I9I0	5656

which shows very little growth. These figures are a little low due to the fact that Trenton is partly a railroad town and these people might be called nomadic.

Trenton owes it's present prosperous condition to being in the center of the richest agricultural section in the state and to being a division point on the Chicago, Rock Island and Pacific Railway.

Trenton is connected to the outside world by two railroads , the Rock Island and the Quincy, Omaha, and Kansas City Ry. , The later being controlled by the Burlington Lines.

Trenton is located IOI miles north east of Kansas City and 84 miles east of St. Joseph.

Among the manafacturies , there is an ice plant, a branch of the National Pickle Company, (canning), Brick manafacturies, and Roller Mills.

The city water works is a Municipal Corporation and pumping is by electric power. The shops of the Rock Island are also driven by electricity.

The assessed valuation of Trenton in I9I0 was $ I,462,374.00

THE TRIBULATIONS OF AN ELECTRIC LIGHTING PLANT

OR

THE HISTORY OF THE TRENTON LIGHT AND POWER CO.

Twenty five years ago before the electric meter was a commercial success and when electric lighting was in it's infancy , the Thomson-Houston Company secured a franchise for installing an electric light plant in Trenton. They were not interested in the operation of the plant , but succeeded in inducing a Mr. Anderson ,who had formerly been a successful flouring mill owner and had made a saving of some twenty thousand dollars , to install the plant . Their main object was to sell the necessary dynamos and machinery at a large profit and in turn, they took a small amount of stock in the property. The electric plant developed slowly and owing to the fierce competition of the Gas Company which was then in operation, Mr. Anderson, after loosingthe greater part of his fortune , traded the plant to Mr. Corrington Layson, a professional trader who had no conception whatever of the electric business .

The property then became a trading stock and for several months was transferred almost monthly, until finally Messrs J.S.Parker and Geo. Gardnersucceeded in buying both the electric and gas plants which they combined . This property they operated for one year under the management of Penn Love, now manager of the Gallatin (Mo) municipal plant.

When they were foreclosed under a mortgage and the two plants brought only a total of about $I2000.00and were sold to twelve representative business men of Trenton, who after holding the property thirty days sold the same to W.B.McKinley of Champaign, Ills.,who is now head of the Illinois Traction Company and Chairman of the Republican Taft Campaign. McKinley later sold the property to T.F.Fulkerson and J.B.Carnes who operated it for five years , selling it to William Maul Measey of Philadelphia and his associates. Mr. Measey after operating it four or five years and after re-incorporating it , sold it in January I9I2to Mr. Burdett L. Bowne who is now the owner.

During all this time , the property was re-incorporated and the name changed four or five times . It has been known as the Trenton Gas and Electric Co., The Trenton Thomson-Houston Company, Trenton Gas Light and Power Co. , The Citizens Gas and Electric Company of Trenton , and The Trenton Light and Power Co.

A DESCRIPTION OF THE PROPERTY

BUILDING

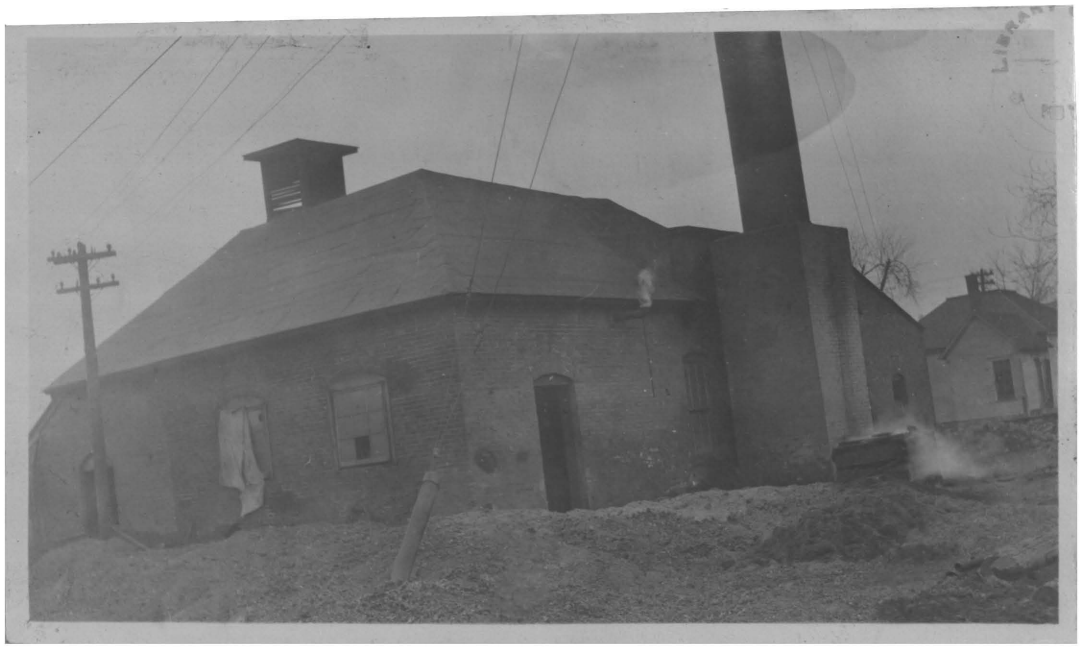
The building is located near the tracks of the Rock Island Lines , thus making coal handling comparatively easy.The building is of a very odd shape , as will been seen by the plan shown on the following pages and is entirely too small . The walls are of brick and the roof and roof trusses are of wood making it very susceptible to fire. The roof covering is rubberoid. The bottom of the trusses clear the floor I8 feet . The roof has burned from the building several times but each time has been replaced in the old form .The roof of the engine room and the boiler room are not joined except at the eaves.

The floors are of concrete and are in very good condition .

BOILER PLANT

The boiler plant consists of three (3) Murray fire tube boilers of one hundred and fifty (I50) horse power each and are set in one battery . They have been in operation about five (5) years .

All boilers are hand fired and have shaker grates



STATION BUILDING ; FROM THE NORTH WEST CORNER.

The boilers are in fairly good condition and seem adequate for the present load . Two boilers are used at one time.

These boilers are connected to a four (4) foot steel smoke stack eighty five (85) feet in height located at the southwest corner of the boiler room and on the outside . The stack has an approximate rating of three hundred and twenty five (325) horsepower. The stack is of heavy sheet steel and rests on a brick foundation six(6) feet square and eighteen (I8) feet high . The stack has been well painted and appears to be in very good condition . The stack is a guyed stack and has been in use for about five(5) years.

FEED WATER HEATER.

The feed water heater is a Murray with a rating of five hundred(500) horse power . It is located at the south east corner of the boiler battery. It is an open heater.

PIPE WORK

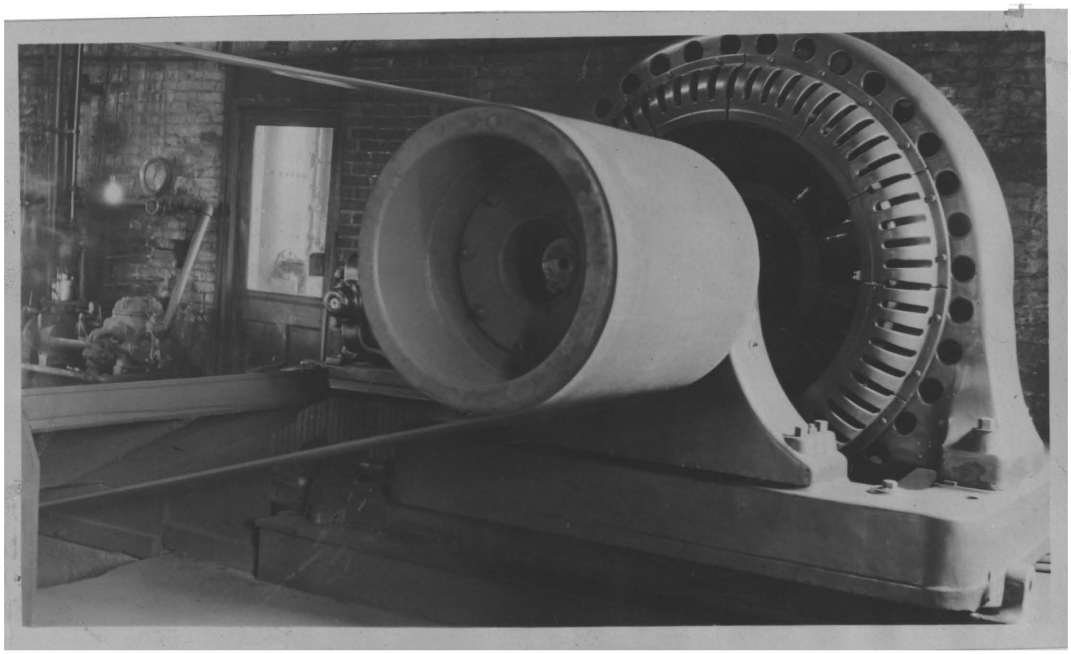
The pipe work in the plant is in very bad condition. There is little or no lagging on the header or steam lines and the leakage is very high. The design of

the pipe work is very bad and gives rise to enormous heat losses. The header is ten(I0) inches indiameter and the steam line is six (6) inches in diameter . The length of the steam line is about fifty feet . Two lines of steam piping being run from the boilers. The piping is of sufficient size for the present conditions but has too many right angled bends for economical operation. A design of a new piping system will be given on a later page.

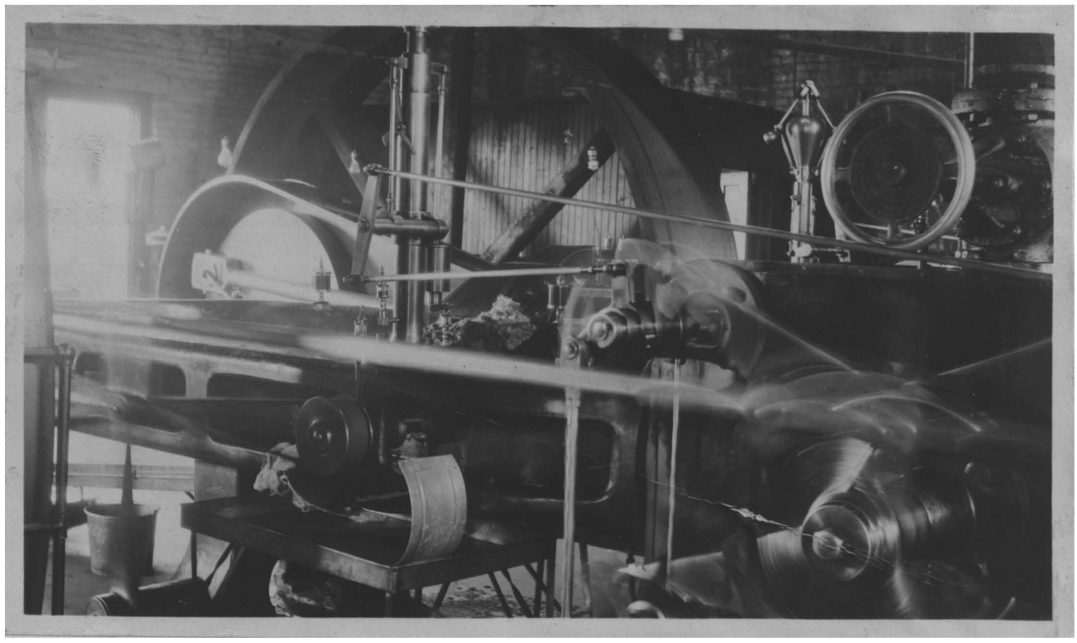
ENGINE ROOM EQUIPMENT

The engine room occupies the south half of the building and is separated from the boiler room by a brick wall. The electric generating plant consists of two(2) Corliss- Allis-Chalmers units.

The south unit consists of one(I) 2o"x42" Murray Corliss engine running at a speed of 80 r.p.m. and having a flywheel of I8' in diameter. This engine drives a 250kilowatt- 2200 volt - 3 phase - 60 cycle Allis-Chalmers revolving field generator at a speed of 600 r.p.m. by means of a belt drive. From a pulley on the shaft of this alternator, by means of a belt, is driven a Westinghouse exciter rated at I25 volts and running at a speed of I200 R.P.M.



NORTH GENERATOR, SOUTH GENERATOR IS OF THE SAME TYPE.



VIEW ACROSS THE TWO ENGINES. NEAREST ENGINE RUNNING WHEN PICTURE WAS TAKEN.

The entire unit is in fairly good condition.

The north unit consists of a 20" x 42" Murray Corliss engine running at a speed of I04 r.p.m. operating , by means of a belt over a I4' fly wheel, an Allis-Chalmers 300kilowatt-2200volt 3 phase - 60 cycle revolving field generator at a speed of 600 r.p.m. To this generator is belted an Allis-Chalmers exciter rated I20 volts- I25 amperes- and running at a speed of IIOOr.p.m. The cylinders of the ~~south~~ North engine are in a bad condition and should be rebored. The generator on this set is in very good condition . The engines are belted inverted and on the north set the distance between centers is only 27' This is due to the crowded conditions in the engine room . The throttle valve of the north engine is so located that the engineer to manipulate it, must stand directly under the belt and should the belt break the the valve stem would more than likely be broken off. To reach the engine room from the boiler room it is necessary to walk under the belt of the north unit and it is to be considered dangerous as there is not enough clearance above the floor.

FEED PUMPS

In the engine room are located two 6"x4"x 6" boiler

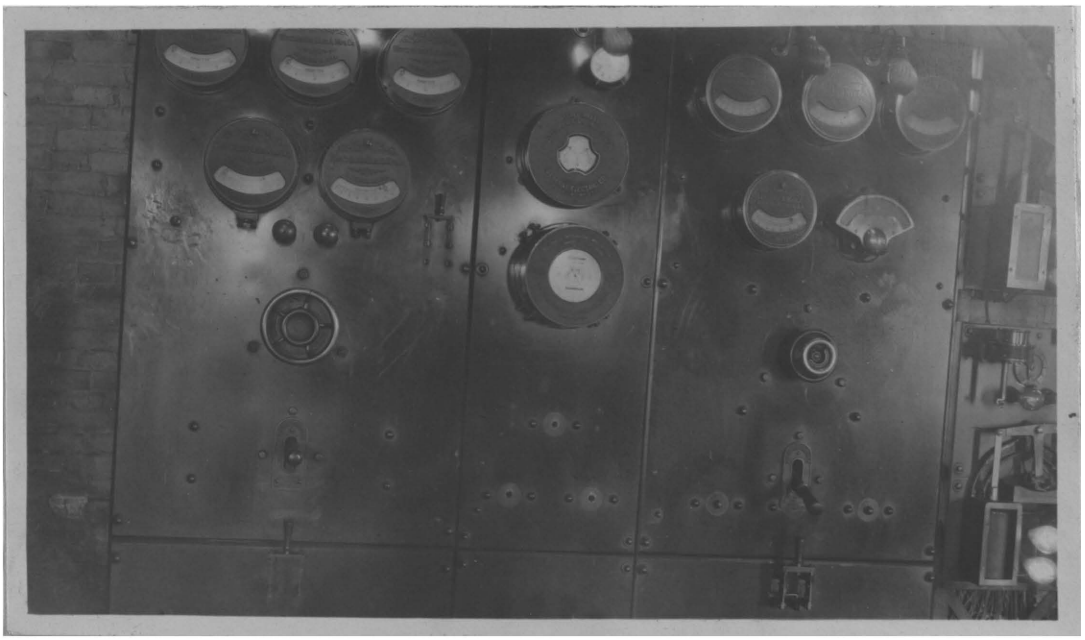
feed pumps .

SWITCH BOARD

The switchboard, located on the east side of the engine room , provides for the control of the two generators, two exciters, arc and incandescent lighting circuits, lighting and power feeders. The generators are connected to the switchboard through conduits under the floor.

The switchboard consists of three General Electric Co pannels and two Chapman regulator panels. In the main switchboard the two outside panels are duplicates each having 3 ammeters, 2 voltmeters , a D.C. and an A?C. voltmeter , and the lower part of the panels having the power and feeder switches. The center panel carries a three phase ground detector and a totalizing wattmeter. There are also switches and lamps to be used in synchronizing . The Chapman Regulator panels hold one 85 amp-250 kilowatt and one 20 amp - 5 ohm I80 kilowatt alternating current voltage regulators.

The switches are all of the plug type. The rheostats are located above the switchboard and are governed from the switchboard by means of sprockets. The voltage through the ammeters is 2200 volts and



THE SWITCH BOARD.

should be considered dangerous. There is a space of two feet between the wall and the switchboard and this puts every thing in rather close quarters.

ELECTRIC SERVICE FURNISHED

The electric service furnished consists of street lighting, commercial incandescent lighting ,and electric power.

The street lighting consists of 34 arc lights, and 9I -32 candle power -II0 volt incandescent lamps. The arc lamps are 605 watts and 5.5 amperes .

Commercial service is furnished to 840 meter customers and about I7 flat rate customers. The total number of connected lights is approximately 8620 .

Electric Power Service is furnished to 25 customers having a total connected load of 450 horse power.

TOTAL CONNECTED LOAD

The total connected load in kilowatts is as follows,(approximately)

Commercial incandescent lighting	5I2
Street lighting	2I
Electric power service	340
Total connected load	873 kilowatts.

DISTRIBUTING SYSTEM

Electrical distribution is entirely by overhead system which includes approximately 37 miles of pole line in the city.

The secondary wiring from the transformer to the customer is paid for by the customer.

The line wire is mostly of No.6 B&S for the primary and house connections are of No.I2 B&S with a few exceptions . The number of poles is I775. No record is kept of the sizes and lengths of each size of wire.

METERS

The meters are owned by the company and no deposit is required.

TRANSFORMERS

No record is kept of the transformers .

ELECTRIC LIGHTING RATES

Electrical energy is furnished to the citizens of Trenton , by the Trenton Gas and Electric Co. at the rate of ten(IO) cents per kilowatt hour , unless by special contract. A 5% discount is allowed for ten days.

VALUATION

Land, building and fixtures,	6500
Boiler plant	8580
Electric generating plant	I7020
Distributing system	30000
Miscellaneous	I2900
Total	$75000

To put this in a more nearly itemized form ,

Generator 300 kw frtand setting	3420
Generator 250 kw " " "	2950
So. engine 350 hp " " "	4000
No. engine 350 hp " " "	4650
Switchboard	2000
Boilers settings	6000
Feed water heater	355
Pumps piping	225
Cost of building	3000
Value of real estate	3500
Stack	500
Pipe work and extra labor	I500
Value of pole line , transformers etc	30000
Belting ,piping & extras not inc above	I2900
Total	75000

The following Central Station facts and factors compare the electrical department of the Trenton Gas and Electric Co. with three cities in Iowa with an average population of 5670. The population of Trenton being 5656.

	Other cities	Trenton
Total Population	5670	5656
Station Capacity	268	550
Investment per KW Capacity	203	I36
Gross Annual income per kw	85	69.8
" "per $I00 INV		5I.2
Annual Income per Consumer	42	44.5
Total Con. Load per KW CAP	2	I.6
Lamp Load " " "	I.4	.93
Motor Load " " "	.5	.6I
Income per Capita	4.43	6.78
Investment per Capita	I0.00	II.66
Station Cap . per Capita	5I	9I
No. Consumers per I00 Pop.	I0	I4.5

CURVES

It will be noticed that the load curves are not as we would expect them i.e. with the peaks between 5 p m and IO p m , but with the peaks occuring in two or three places and some of them in the early hours of the morning . This is due to the fact that the city pumping plant does most of it's pumping in the night .

It is also seen that the point where we would expect the highest peak i.e. about dusk, we have a little less load than at three in the afternoon. This is due to a large installation of motors in the railroad shops.

This pump load would be a very good thing at the hour at which it runs if the price for power was higher but at the rate now charged it is a loosing proposition and is a detriment to the plant.

Street lights burn all night and several motors exclusive of the pump load run until midnight.

The average daily peak load is I70 K W Hrs. The average daily load is 2236 K W Hrs and from this, by the A.I.E.E. definition of load factor we get 54.8%

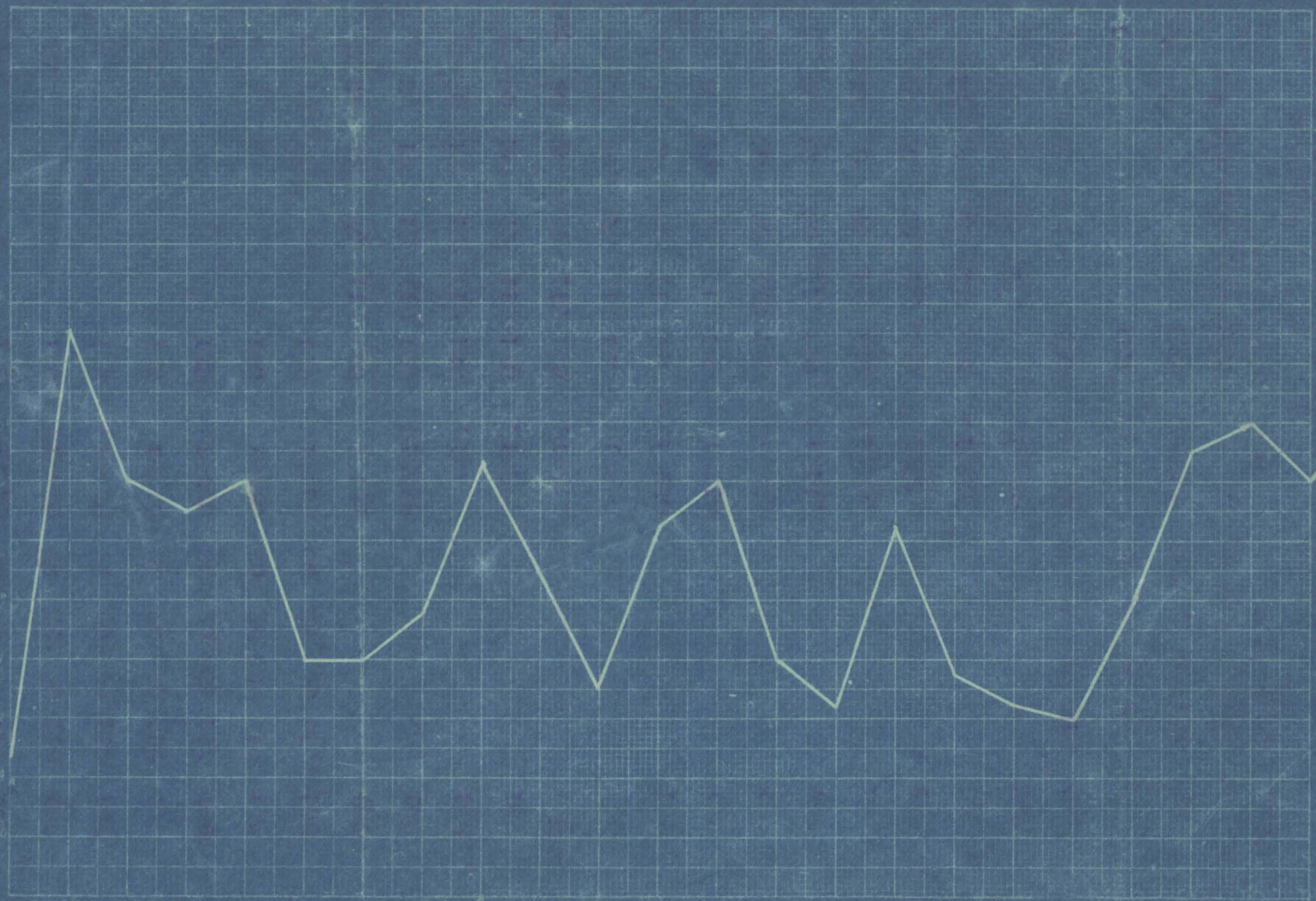
The curves shown are from actual runs and are typical of this plant.

TRENTON GAS AND ELECTRIC COMPANY.

DAILY LOG SHEET

Dec. 28-29 I9II.

	Amp	Amp	Amp	Volt	Volt	K W Hrs	Amp	Amp	Amp	Volt	Volt
Noon					I20	8I2352	36	4I	36	I2I	II0
I					I20	8I2400	47	50	45	II0	I05
2					I20	8I2590	52	60	55	I06	I06
3	25	25	24	III	I20	8I2730					I06
4	55	57	55	III	I20	8I2860					I06
5	50	50	50	III	I20	8I30I0					I06
6	45	50	40	II2	I20	8I3090					I06
7	50	55	50	II2	I20	8I3I70					I06
8	65	70	60	II2	I20	8I3265					I06
9	60	65	60	II2	I20	8I34I0					I06
IO	55	60	55	II2	I20	8I3520					I06
II	25	25	20	II2	I20	8I3590					I06
Mdt	50	50	45	II2	I20	8I37I5					I06
I	50	50	45	II2	I20	8I3855					I06
2	20	I5	I5	II0	I20	8I3930					I06
3	20	I5	I5	II0	I20	8I3995					I06
4	45	45	40	II0	I20	8I4I20					I06
5					I20	8I4I95	20	24	20	II5	I06
6					I20	8I4260	20	28	20	II6	I06
7					I20	8I4320	26	30	22	II5	I06
8					I20	8I4420	50	52	50	II6	I06
9					I20	8I4570	54	60	55	II6	I06
IO					I20	8I4730	60	64	62	II7	I06
II					I20	8I4870	60	62	62	II6	I06
Noon					I20	8I5040	50	56	56	II6	I06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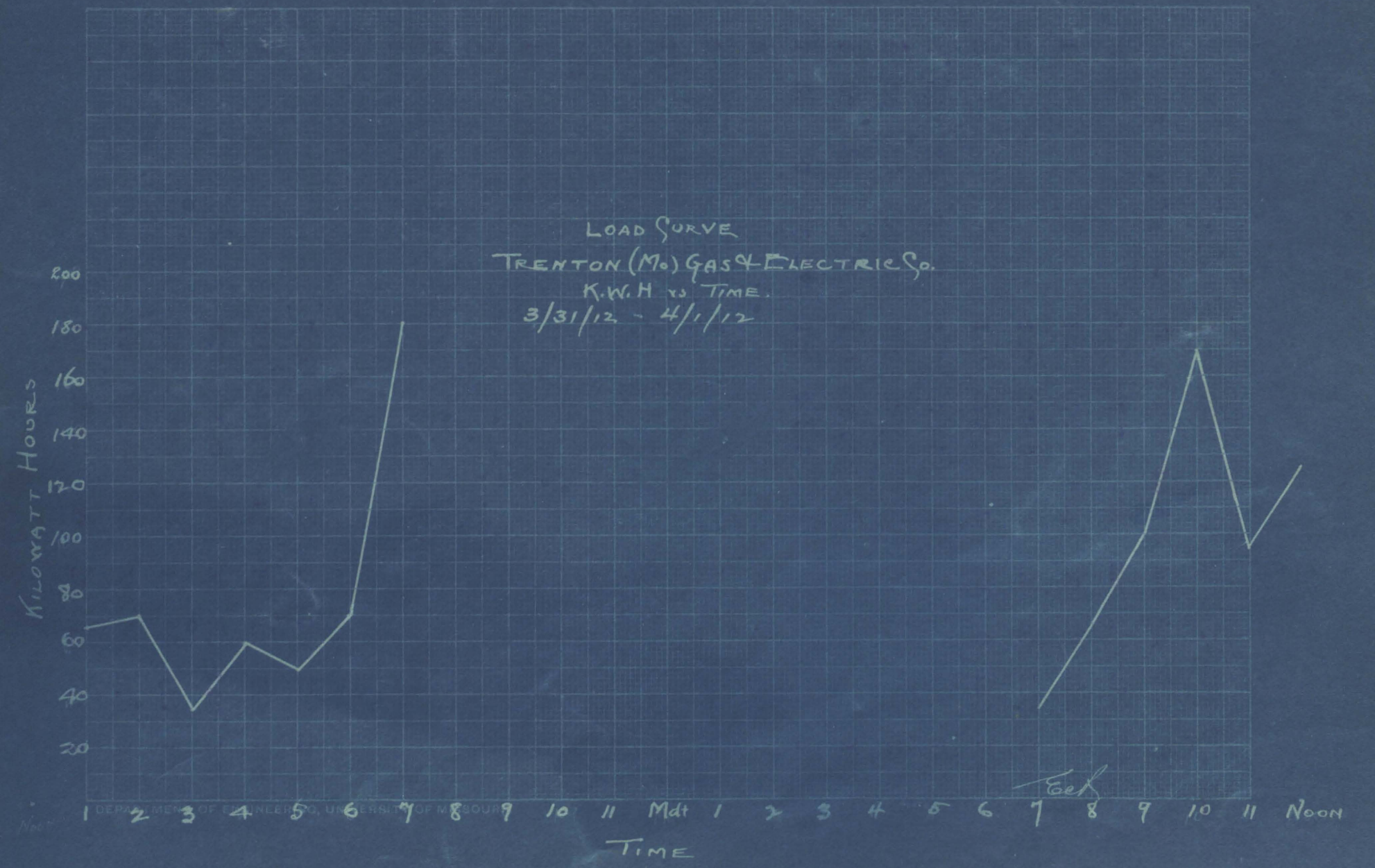
TRENTON GAS AND ELECTRIC COMPANY
DAILY LOG SHEET MAR.3I- APR I I9I2.

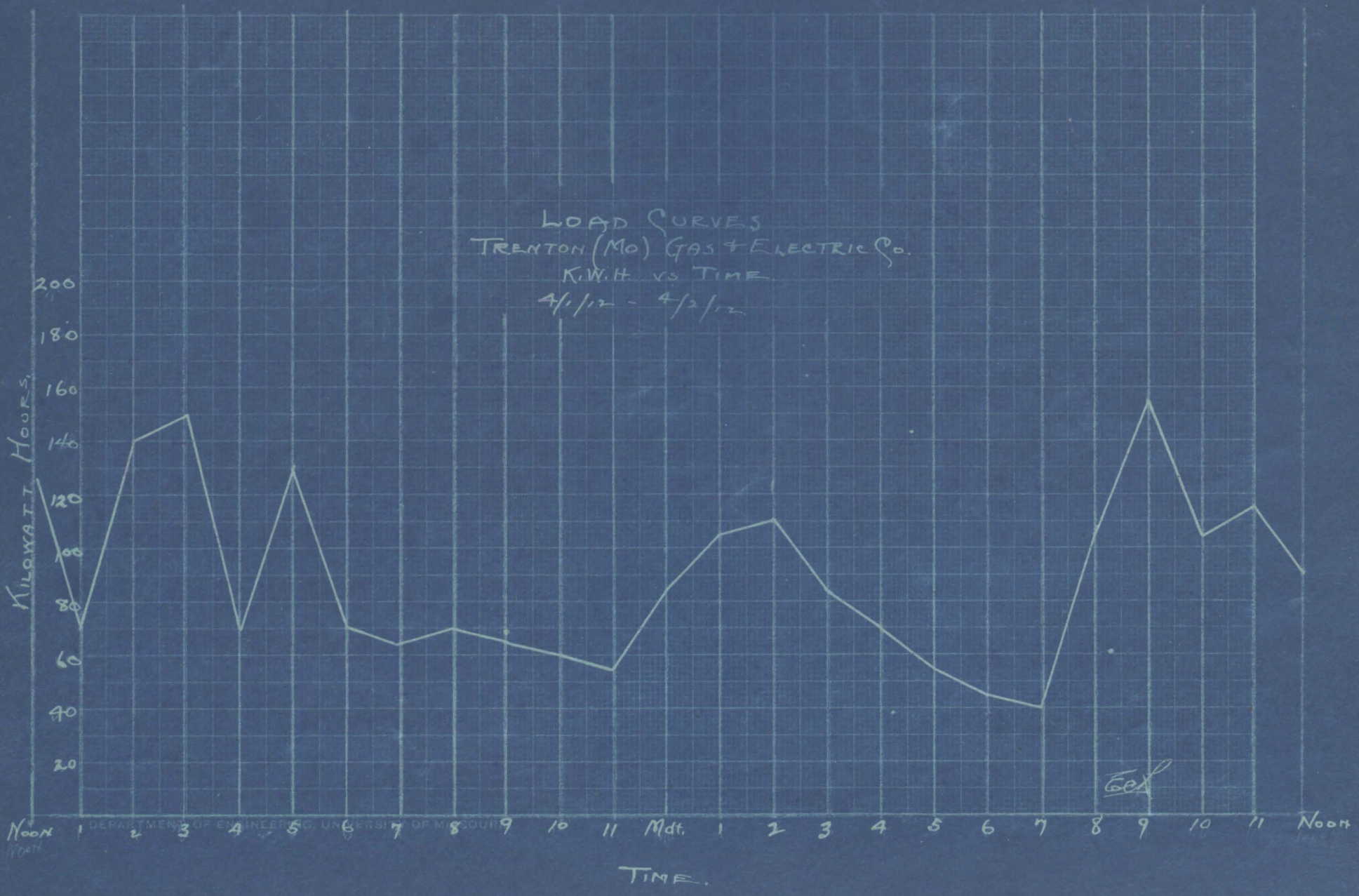
	Amp	Amp	Amp	Volt	Volt	K W Hrs	Amp	Amp	Amp	Volt	Volt
Noon					I20	476I5	22	25	20	II2	I05
I					I20	47680	24	26	20	II2	I05
2					I20	47750	24	26	20	II2	I05
3					I20	47785	8	I0	8	II6	I05
4	24	24	24	II5	I20	47845					I05
5	24	25	24	II5	I20	47895					I05
6	30	30	25	II5	I20	47965					I05
7	35	40	30	II5	I20	48I45					I05
8											
9											
I0											
II											
Mdt											
I											
2											
3											
4											
5											
6					I20	48830	I8	I8	I0	II2	I05
7					I20	48865	I6	I6	I2	II5	I05
8					I20	48930	22	30	26	II5	I05
9					I20	49030	40	45	45	II7	I05
I0					I20	49200	25	35	30	II5	I05
II					I20	49295	30	38	32	II5	I05



TRENTON GAS AND ELECTRIC COMPANY.

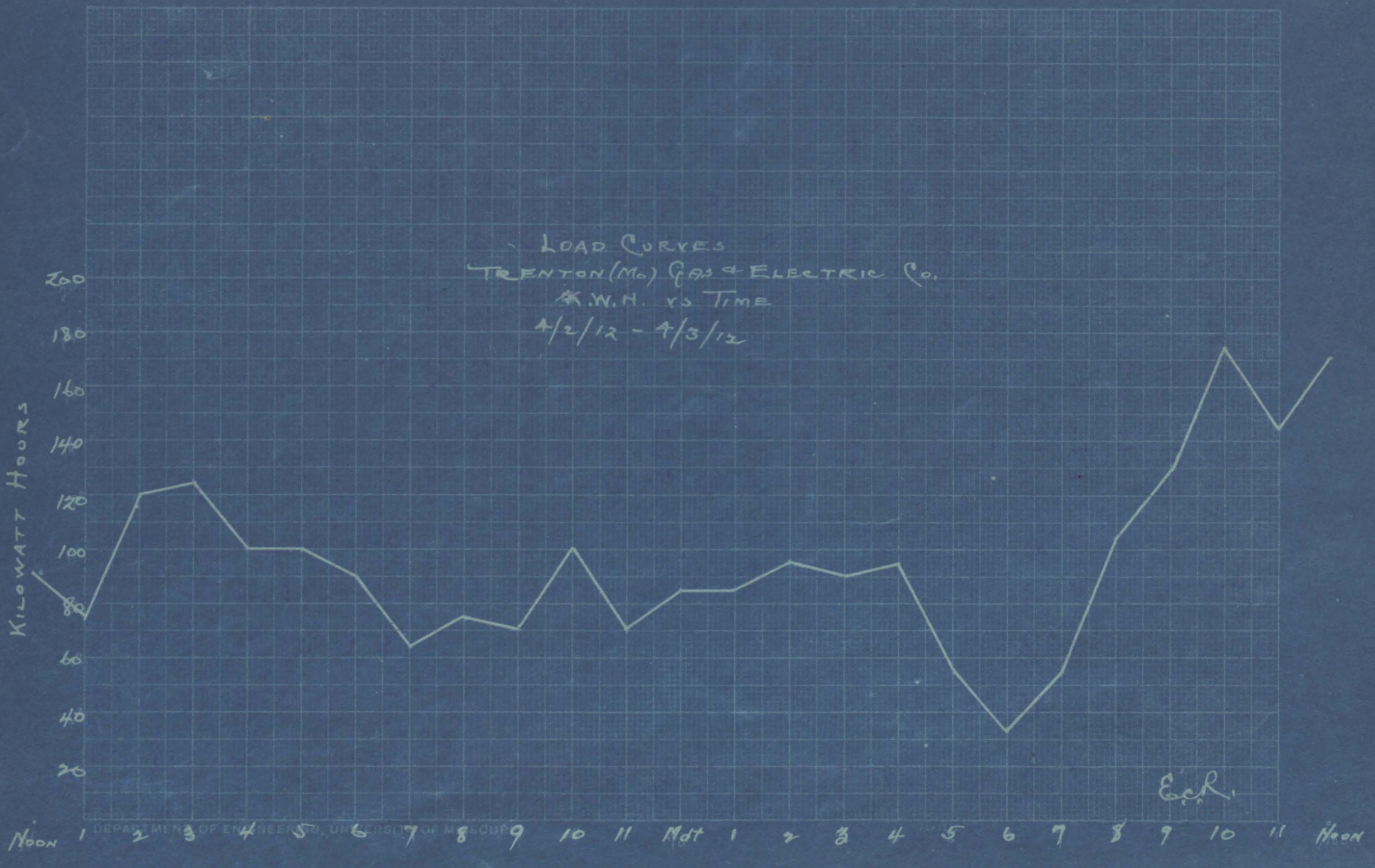
DAILY LOG SHEET Apr. I - Apr/2, I9I2.

	Amp	Amp	Amp	Volt	Volt	K W Hrs	Amp	Amp	Amp	Volt	Volt
Noon					I20	49420	24	22	26	II5	I05
I					I20	49490	32	40	32	II5	I05
22					I20	49630	40	47	44	II5	I05
33					I20	49780	30	37	32	II5	I05
4	40	40	30	II5	I20	49850					I05
5	40	40	35	II5	I20	49980					I05
6	30	25	25	II5	I20	50050					I05
7	40	45	40	II2	I20	50II5					I05
8	40	45	30	II2	I20	50I85					I05
9	40	40	30	II2	I20	50250					I05
I0	30	35	30	II2	I20	503I0					I05
II	30	25	25	II2	I20	50365					I05
Mdt	35	40	35	II2	I05	50450					I05
I	35	35	30	II2	I20	50555					I05
2	35	35	30	II2	I20	50665					I05
3	20	I5	I5	II2	I20	50750					I05
4					I2o	50820	20	22	20	II5	I05
5					I20	50875	20	24	20	II5	I05
6					I20	50920	I5	I0	I0	II2	I05
7					I20	50960	24	26	22	II3	I05
8					I20	5I065	36	42	40	II2	I05
9					I20	5I220	38	46	42	II2	I05
I0					I20	5I325	38	46	44	II5	I05
II					I20	5I440	22	34	24	II5	I05



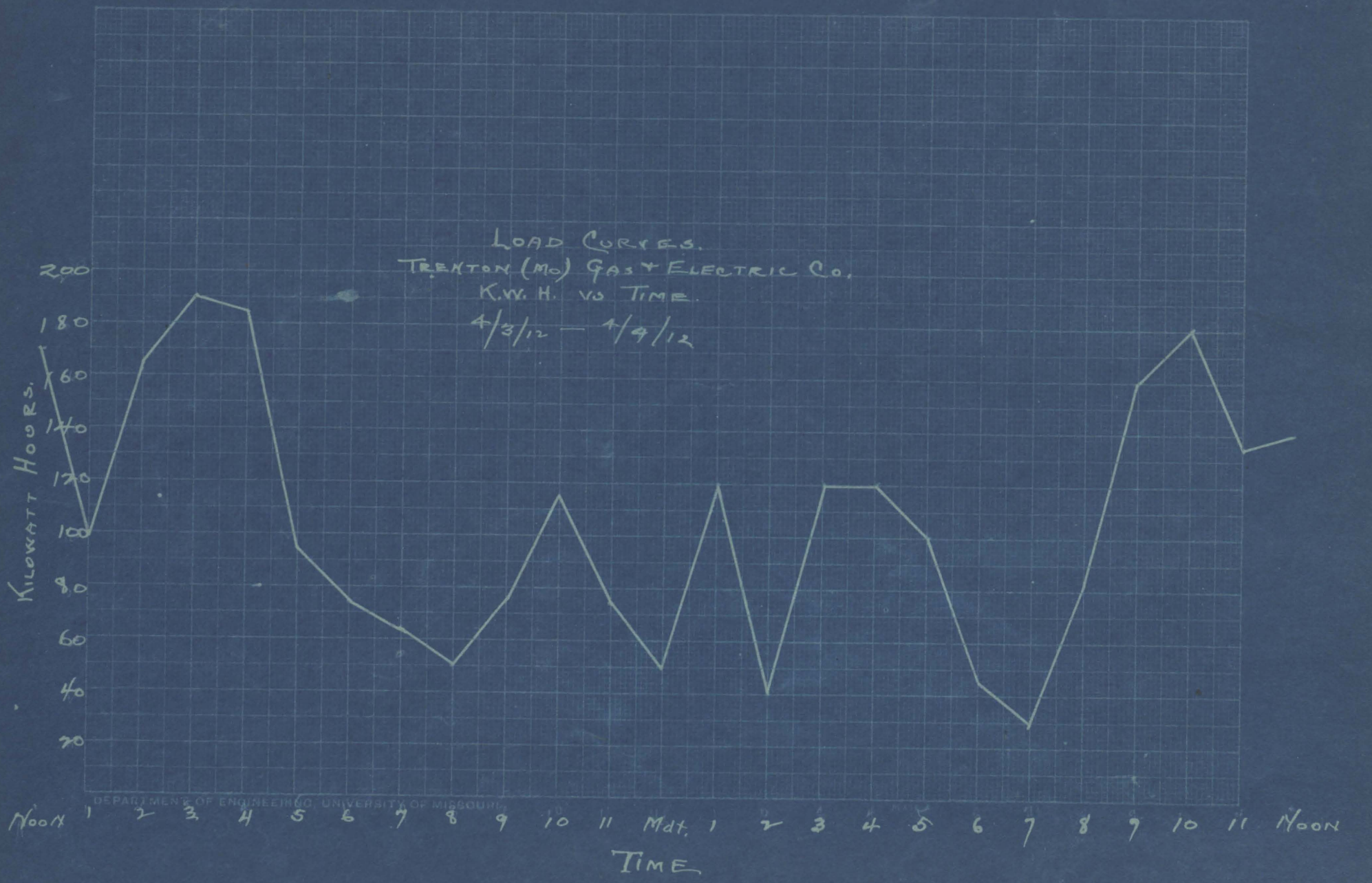
TRENTON GAS AND ELECTRIC COMPANY.
DAILY LOG SHEET April 2-3, I9I2.

	Amp	Amp	Amp	Volt	Volt	K W Hrs	Amp	Amp	Amp	Volt	Volt
Noon					I20	5I520	22	28	22	II5	I05
I					I20	5I595	34	42	34	II2	I05
2					I20	5I7I5	24	30	24	II4	I05
3					I20	5I840	35	35	30	II5	I05
4	40	40	35	II5	I20	5I940					I05
5	30	30	30	II5	I20	52040					I05
6	25	25	25	II5	I20	52I30					I05
7	40	40	40	II5	I20	52I95					I05
8	40	45	40	II5	I20	52270					I05
9	35	35	35	II5	I20	52340					I05
I0	45	50	45	II5	I20	52440					I05
II	20	25	20	II5	I20	525I0					I05
Mdt	35	35	30	II5	I20	52595					I05
I	35	35	30	II5	I20	52680					I05
2	35	35	30	II5	I20	52775					I05
3	35	35	30	II5	I20	52865					I05
4	20	25	20	II5	I2o	52960					I05
5					I20	530I5	20	24	2o	II5	I05
6					I20	53050	I5	I0	5	II3	I05
7					I20	53I05	24	2&	22	II2	I05
8					I20	532I0	38	44	42	II5	I05
9					I20	53340	47	54	53	II5	I05
I0					I20	535I5	48	56	52	II5	I05
II					I20	53660	48	54	52	II5	I05



TRENTON GAS AND ELECTRIC COMPANY
DAILY LOG SHEET April 3-4, I9I2.

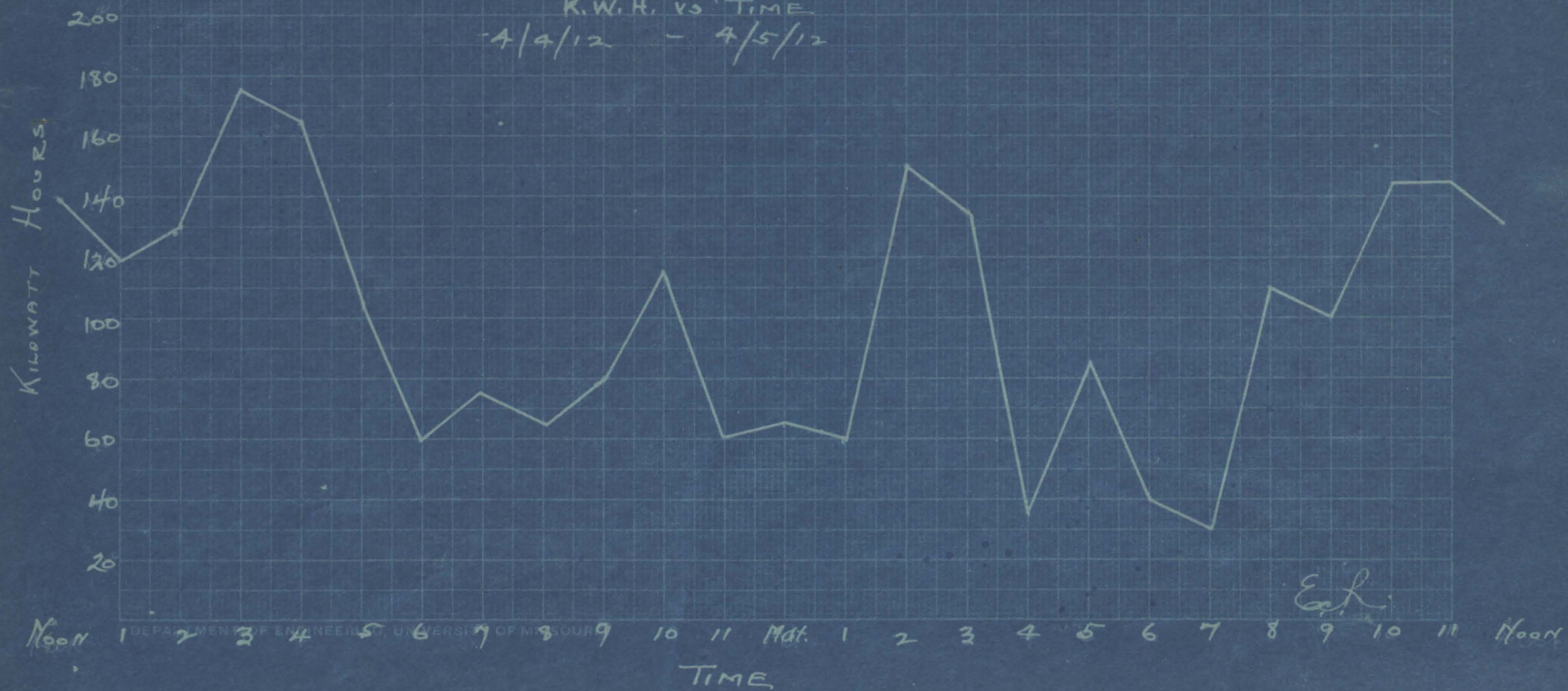
	Amp	Amp	Amp	Volt	VoltK	W Hrs	Amp	Amp	Amp	Volt	Volt
Noon					I20	53830	48	54	52	II5	I05
I					I20	53930	48	44	46	II5	I05
2					I20	54095	46	54	52	II5	I05
3					I20	54285	28	34	30	II5	I05
4	30	#o	25	II5	I20	54400					I05
5	30	35	27	II5	I20	54495					I05
6	25b	25	25	II5	I20	54570					I05
7	25	25	25	II5	I20	54635					I05
8	40	45	40	II5	I20	54685					I05
9	55	55	55	II6	I20	54760					I06
I0	50	50	45	II6	I20	54875					I05
II	25	25	20	II6	I20	54940					I05
Mdt	25	20	20	II6	I20	54990					I05
I	35	35	30	II6	I20	55II0					I05
2	20	20	I5	II5	I20	55I50					I05
3	20	I5	I5	II5	I20	55270					I05
4					I20	55330	34	38	34	II5	I05
5					I20	55430	34	38	36	II5	I05
6					I20	55475	I5	I5	5	II5	I05
7					I20	55505	I0	I0	5	II5	I05
8					I20	55590	44	50	46	II5	I05
9					I20	55750	42	50	47	II5	I06
I0					I20	55935	32	40	32	II5	I05
II					I20	56070	44	52	46	II5	I05


LOAD CURVES.
TRENTON (Mo) GAS & ELECTRIC CO.
K.W.H. VS TIME.
4/3/12 — 4/4/12
KILOWATT HOURS.
200
180
160
140
120
100
80
60
40
20
DEPARTMENT OF ENGINEERING, UNIVERSITY OF MISSOURI
Noon 1 2 3 4 5 6 7 8 9 10 11 Mdt. 1 2 3 4 5 6 7 8 9 10 11 Noon
TIME

TRENTON GAS AND ELECTRIC COMPANY
DAILY LOG SHEET April 4-5, 1912.

	Amp	Amp	Amp	Volt	Volt	KW Hrs	Amp	Amp	Amp	Volt	Volt
Noon					120	56210	48	52	50	115	105
1					120	56330	24	32	36	115	105
2					120	56460	44	50	46	115	105
3					120	56635	30	38	34	115	105
4	45	45	40	115	120	56800					105
5	30	30	25	115	120	56905					105
6	25	25	25	115	120	56970					105
7	35	40	40	115	120	57045					105
8	45	55	45	115	120	57110					105
9	50	55	50	115	120	57190					105
10	30	30	25	115	120	57305					105
11	25	25	20	115	120	57365					105
Mdt	20	25	20	115	120	57430					105
1	20	25	20	115	120	57490					105
2	35	35	30	115	120	57640					105
3	20	15	20	115	120	57775					105
4	35	35	30	115	120	57805					105
5	35	35	30	115	120	57890					105
6	5	5	10	115	120	57930					105
7	5	5	7	115	120	57960					105
8	40	40	35	116	120	58070					105
9	25	25	20	115	120	58170					105
10	35	35	30	115	120	58315					105
11	45	45	40	115	120	58460					105

Load Curves.
Trenton (Mo) Gas & Electric Co.
K.W.H. vs Time
4/4/12 - 4/5/12



TRENTON GAS AND ELECTRIC COMPANY
DAILY LOG SHEET April 4-5, 1912.

	Amp	Amp	Amp	Volt	Volt	KW Hrs	Amp	Amp	Amp	Volt	Volt
Noon	45	45	40	115	120	58590					105
1	40	40	35	115	120	58650					105
2	30	30	25	115	120	58795					105
3	40	40	38	115	120	58945					105
4	40	40	35	115	120	59080					105
5	30	30	25	115	120	59160					105
6	30	30	25	115	120	59250					105
7	10	10	15	115	120	59295					105
8	40	40	40	115	120	59355					105
9	40	35	35	115	120	59440					105
10	30	30	30	115	120	59530					105
11	25	25	20	115	120	59585					105
Mdt	35	35	35	115	120	59670					105
1	35	35	30	115	120	59755					105
2	35	35	30	115	120	59850					105
3	20	20	15	115	120	59910					105
4	20	20	15	115	120	59970					105
5					120	60095	36	40	36	115	105
6					120	60150	1	2	3	115	105
7					120	60180	18	18	10	115	105
8					120	60240	24	30	24	115	105
9					120	60400	35	42	40	116	105
10					120	60540	42	48	44	115	105
11					120	60690	30	36	30	115	105

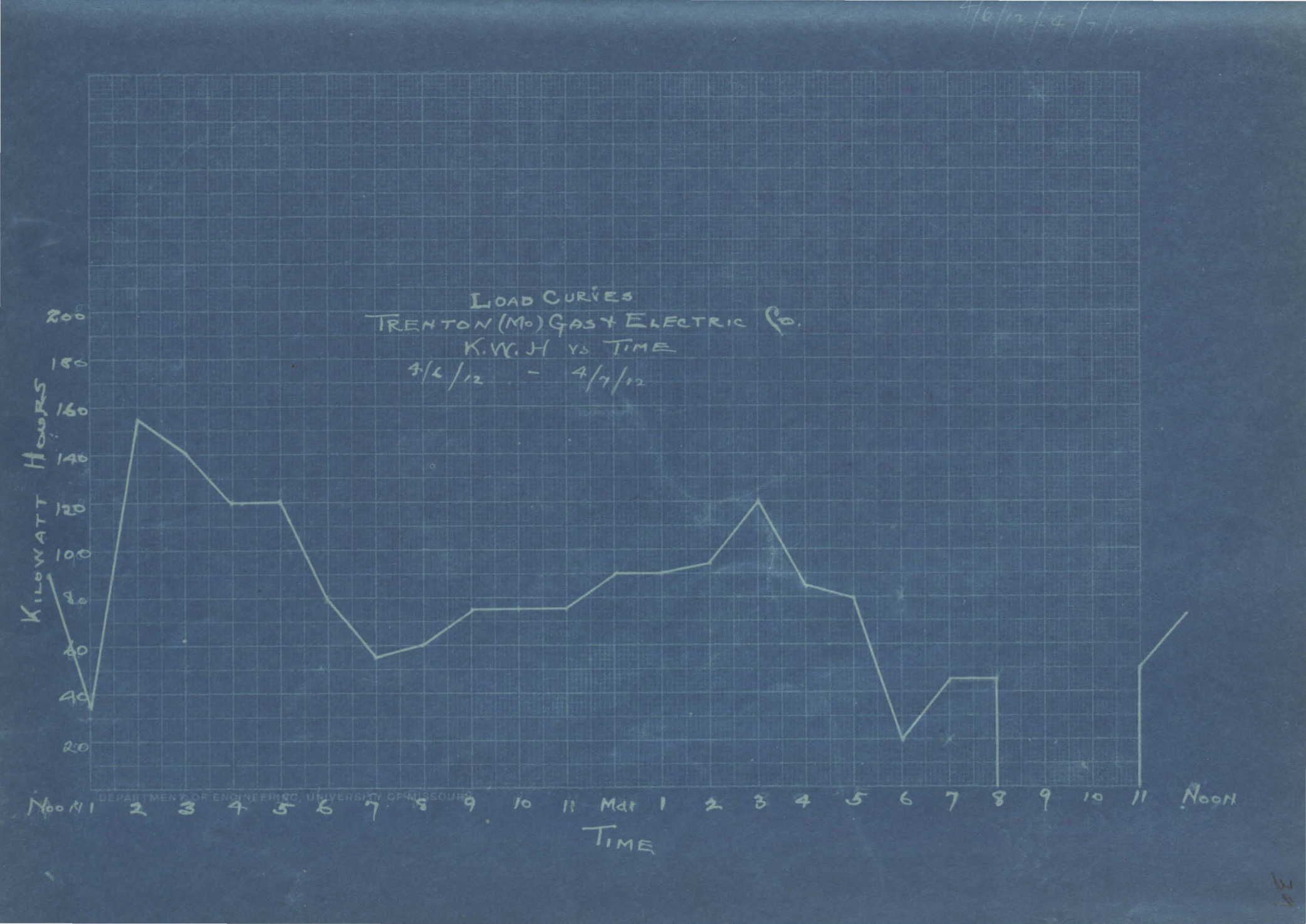
4/5/12 - 4/6/12

Load Curves
Trenton (Mo) Gas + Electric Co.
K.W.H. vs Time
4/5/12 - 4/6/12

TRENTON GAS AND ELECTRIC COMPANY

DAILY LOG SHEET April 6-7, I9I2.

	Amp	Amp	Amp	Volts	Volt	KW Hrs	Amp	Amp	Amp	Volt	Volt
Noon					I20	60780	42	46	48	II5	I05
I					I20	609I5	42	48	44	II5	I05
2					I20	6Io70	44	50	48	II5	I05
3					I20	6I2I0	28	30	28	II6	I05
4	30	30	25	II6	I20	6I330					I05
5	33	33	26	II5	I20	6I450					I05
6	30	30	30	II5	I20	6I530					I05
7	36	30	30	II5	I20	6I585					I05
8	50	50	45	II5	I20	6I645					I05
9	45	40	40	II5	I20	6I720					I05
I0	40	35	35	II5	I20	6I795					I05
II	30	30	25	II5	I20	6I870					I05
Mdt	35	35	35	II5	I20	6I960					I05
I	35	35	35	II5	I20	62050					I05
2	30	35	30	II5	I20	62I45					I05
3	25	25	20	II5	I20	62265					I05
4					I20	62350	20	24	22	II6	I05
5					I20	62430	2o	24	22	II5	I05
6					I20	62460	I	2	3	II5	I05
7					I20	625I5	22	24	20	II5	I05
8											
9	Off to make repairs and clean up										
I0					I20	62730	I0	20	I0	II7	I05
II					I20	62780	24	26	20	II5	I05
Noon						68870					


LOAD CURVES
TRENTON (MO) GAS & ELECTRIC CO.
K.W.H VS TIME
3/6/12 - 4/7/12
KILOWATT HOURS
200
180
160
140
120
100
80
60
40
20
Noon 1 2 3 4 5 6 7 8 9 10 11 Mar 1 2 3 4 5 6 7 8 9 10 11 Noon
TIME
DEPARTMENT OF ENGINEERING, UNIVERSITY OF MISSOURI

In arriving at the output to the busbars the writer was compelled to take a rather doubtful figure but never the less it is not very far off .

To get this readings were taken in the station for a period of seven days and at hourly intervals . Readings taken several months before compared very favorably with the ones given here so it was assumed that the load could be taken as an average of these .

From these readings it was found that the average output from the bus bars was 2208 Kilowatt hours. per day.

As the plant runs 365 days a year we have 805920 KW Hrs per year .

The amount of coal used could only be determined by amounts used in previous months and this equalled on an average I6.3 tons per day or 59495 tons per year ,or II899000 # per year.

We then have $\frac{\text{II899000}}{805920}$ = I4.76 pounds of coal per kilowatt hour.

Now if the total number of kilowatt hours per year is 805920 and the cost of generating and distributing is $ 28I77.75 we have a cost of $ .0349 per kilowatt hour which is a little too high . This cost per kilowatt hour could be reduced a small fraction of a cent as some of the expense figures cover the expense not only of the electric plant but the gas plant as well

In figuring the expenditures as well as the incomeonly approximate results could be obtained .

Superintendence	a $I00	mo		I200
Book keeper	a 48	"		576
3-Linemen 2-60	I-50	"		2040
2-Engineers	a 65			I560
3-Firemen	50			I800
			7I76	
Depreciation				500
Interest	a 5%			3750
Taxes				I50
Insurance				75
Office expense				500
			4975	
Coal				98I6.50
Oil				I50
Supplies				6000
			I5966.50	
Total			28II7.50	

[illegible].75 Total yearly exp.

This figure will possibly be a little high but is taken to be on the safe side.

CONCLUSION

Successful operation of an electric plant necessitates the furnishing of a reliable , continuous , and satisfactory supply of electricity and and it is now becoming customary to measure the excellence of service upon the basis of interruptions . Further the plant must operate economically and must earn enough profit to at least keep it properly maintained and pay a reasonable rate of interest on the investment.

As will be noticed by the previous pages the pounds of coal per kilowatt hour is high and this makes a higher variable charge upon the station and in this way raises the cost per kilowatt hour.

It has not been the intentions of the writer to criticize the plant with any other feeling than to suggest a few improvements which would help in the operation of the plant.

The changes in the building were for the purpose of relieving the crowded condition in the engine room and to give a longer wheel base for the North unit . This would cut down the fixed load on the engine . By increasing the size of the engine room it is also possible to move the switchboard from it's present position , which is too near in line with the belt of the North unit.

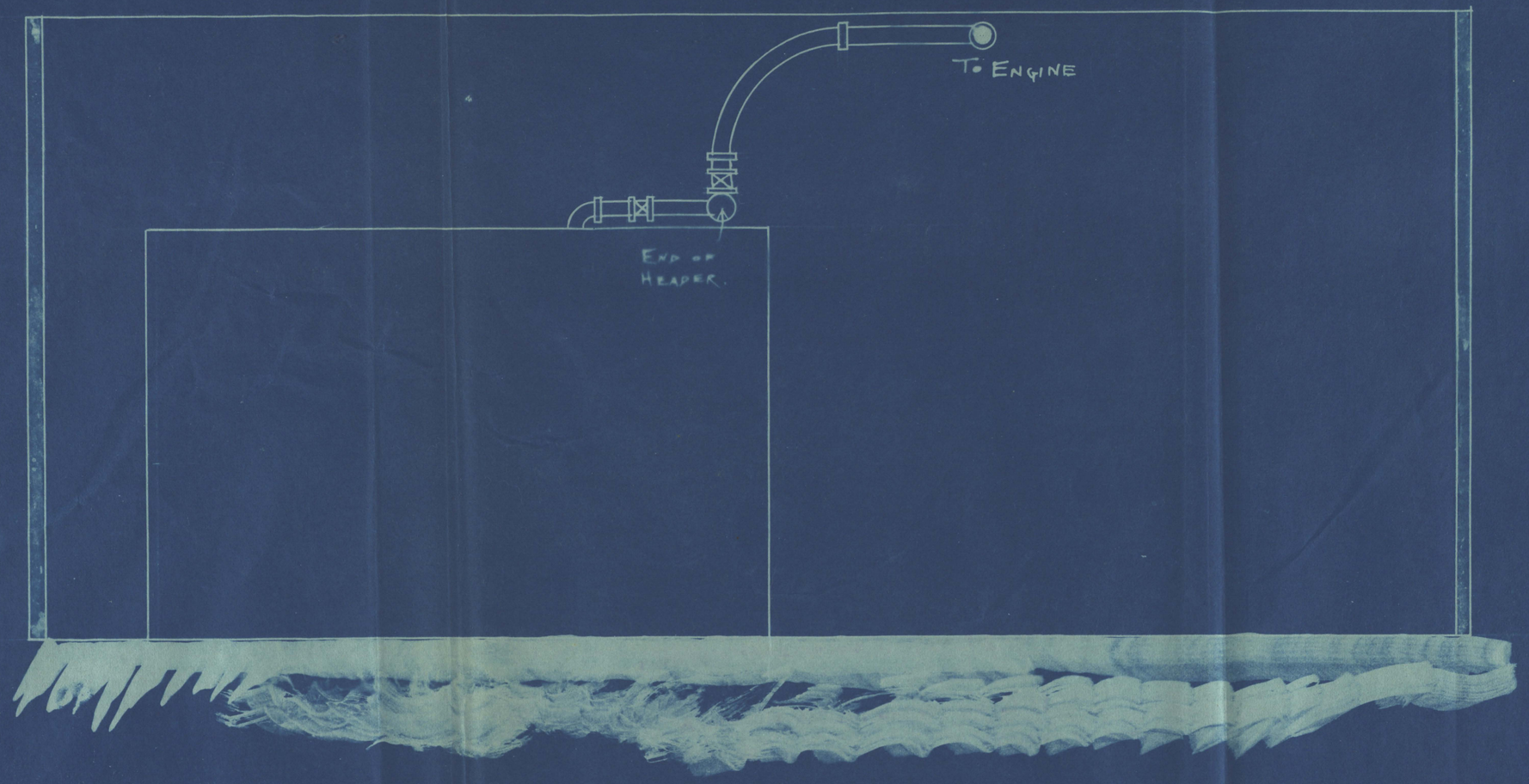
By changing the wall on the east side of the boiler room a great deal more coal storage space is available.

The changing of the steam piping , from short right angled bends to long radial bends, will cut down the friction loss in the pipe and good laging will also cut down the radiation losses and each of these means a saving of coal and this in turn means more profit to the owner.

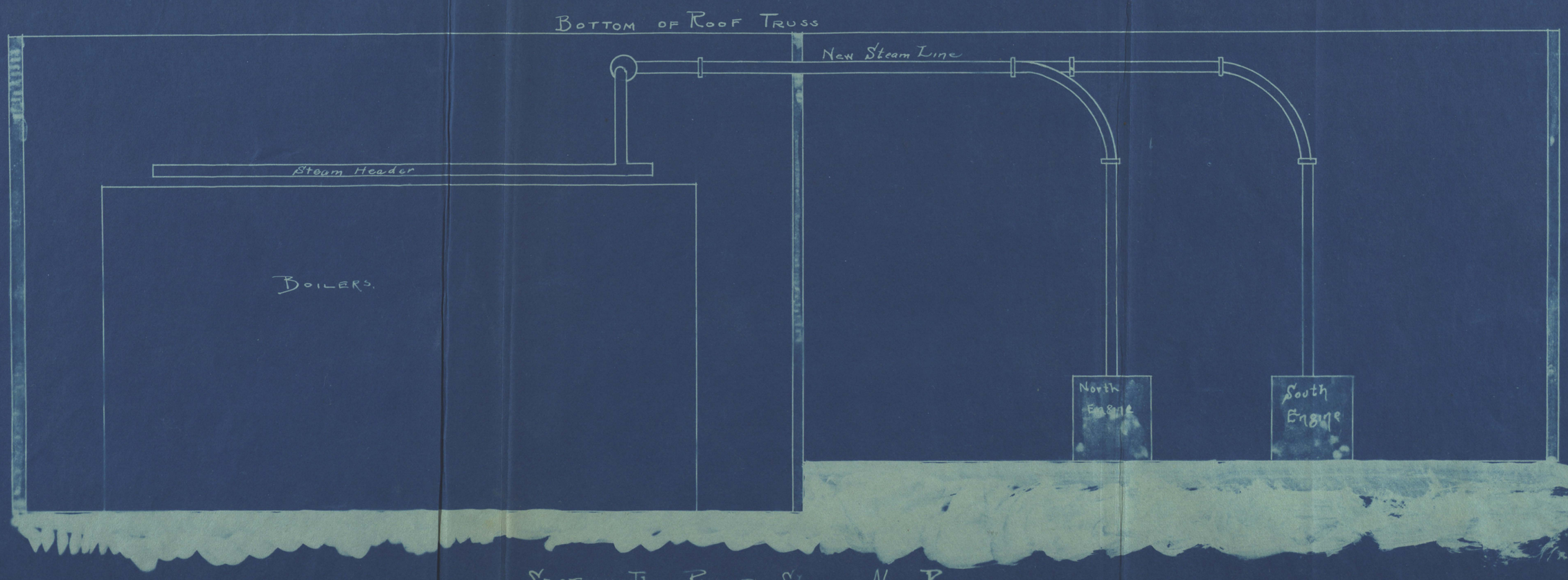
It was the writers intention to cover this more fully but circumstances altered the case and partly due to lack of time and of money , the plant being some 200 miles distant ,several things were not taken up which would fit in very well with the material herewith presented.

From the growth of Trenton in the past twenty years and from the present load the plant seems to be of adequate size for the present needs and, unless something out of the ordinary happens , for the future needs.

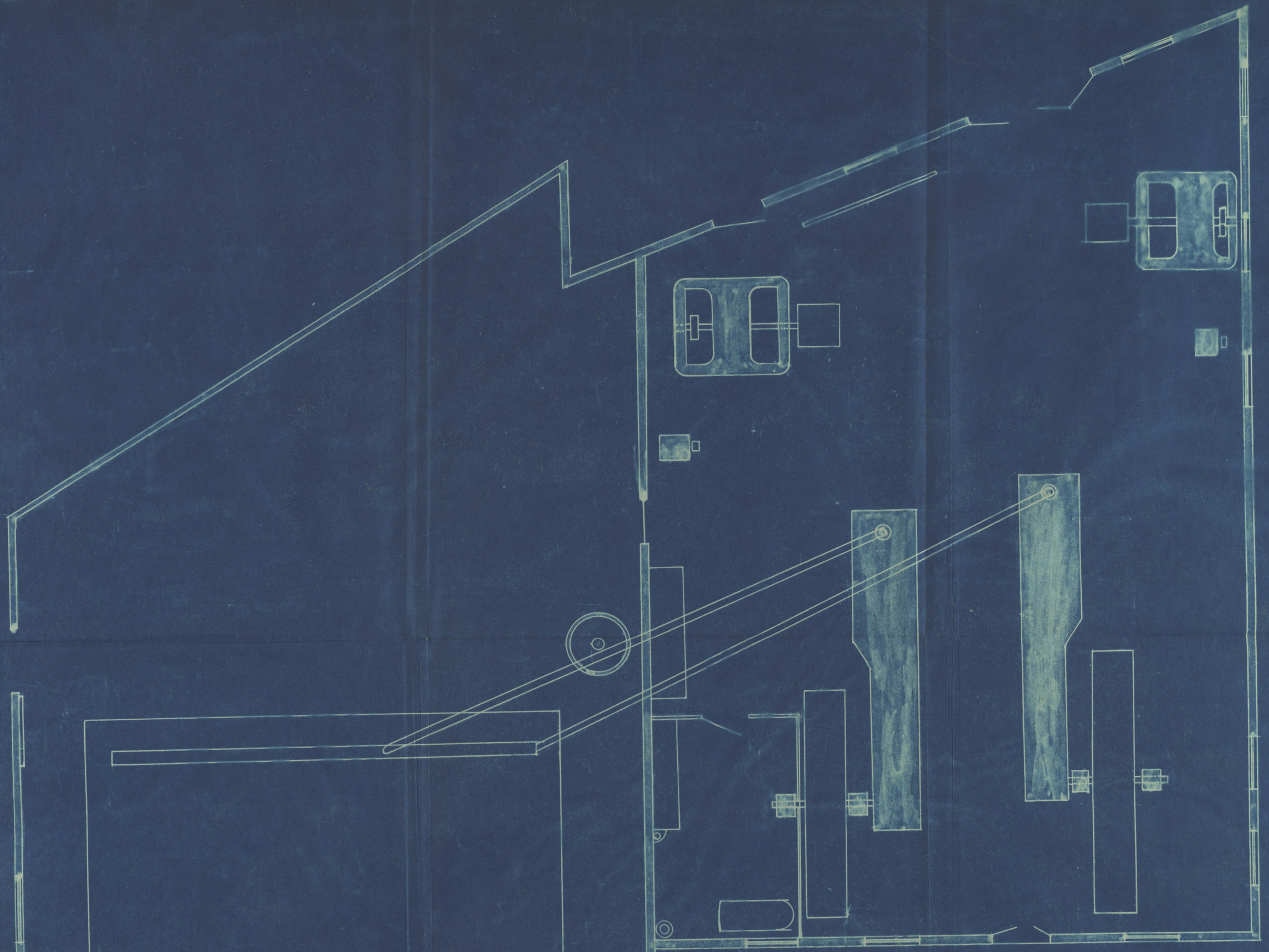
IT is the writers opinion that the changes proposed would be of great benefit to the plant.



Looking North



Section Thru Plant Showing New Piping.
Looking West.



PRESENT
CONDITION.

14'

15'

PRESENT WALL

COAL STORAGE

ENGINE ROOM

35'

34'

PROPOSED NEW STEAM LINE

BOILER ROOM

FEED WATER HEATER

FEED PUMPS

STEAM HEADER

TOILET AND LOCKER ROOM.

PLAN OF STATION SHOWING NEW WALLS AND NEW PIPEING.