REPORT OF A 24-HOUR TEST OF THE BOILER PLANT AT THE CHAMPION MILL.

Object of Tests:-

The purpose of this test was to determine the evaporative performance of the plant as a whole with the idea in mind of improving the plant and effecting a saving by new equipment, that is larger boilers with mechanical stokers.

The test was conducted under the supervision of the Mechanical Engineer, with the assistance of mill employees.

Description of Plant:-

The Champion Mill boiler house contains four 225 H.P. Stirling boilers with Andrews grates, two 200 H.P. Marine boilers equipped with the Hawley down draught furnace, and three 150 H.P. Marines with Herringbone grates.

The draft is induced by a large fan at the base of the stack. The fan is driven by the boiler house engine.

The coal comes in from the coal dock on a gravity tram. After passing through a crusher, it is discharged into a car which travels over the coal storage bins. There are five of these bins holding approximately twenty-nine tons each. From these bins the coal is carried in chutes to convenient places on the floor for the firemen. The ash and refuse is raked into a covered trench running in front of the boilers, and there washed to a bucket elevator where it is taken to such a height that it can be washed into the tailing launder from the mill.

There are two economizers, one taking the escaping gases from the Stirling boilers and the other from the Marines. Each has a by-pass direct to the stack so that either economizer may be cut out of service if desired.

There are three feed pumps, two triplex and one duplex plunger. The 8" by 7" stroke triplex is capable of handling the plant alone but the other two must operate together. The triplex pumps are belt driven by the boiler house engine. The feed piping is so arranged that all the water may be passed through either economizer or divided and each economizer take the watdr for the boilers whose gases pass through it.

A 10" by 24" single cylinder Corliss engine, spoken of heretofore as the boiler house engine, drives the coal tram, the triplex feed pumps, the economizers, the induced draft fan and the ash elevator.

Coal:-

The coal used during this test was from the mill dock and was taken just as it came in the daily operations. It is a Pittsburgh coal and was bought under the following proximate analysis; Volatile Matter %, Fixed Carbon %, Ash %, Sulphur %, and B.T.U. per pound of dry coal.

Description of Apparatus and Instruments:-

The coal was weighed in hand barrows holding 200# net on three small platform scales which had been calibrated. The ash and refuse was weighed on the same scales at the time of cleaning fires.

The water was measured by two tanks which were placed above the feed tanks. The feed tanks were connected to the pump suction. The measuring tanks had previously been calibrated so that with the number of tanks and the temperature of the water given the total weight of water could be secured.

All drafts were measured by Reliance differential draft gauges.

The temperature of the flue gases escaping from the Stirling boilers was taken by a standardized mercury pyrameter. This pyrameter after a certain length of time was placed in the escaping gases from the Marine boilers.

The pressure gauges were tested and corrected before the test.

Flue gas samples were collected over lengthy periods and analysized during the test.

Two throttling colorimeters were used to determine the quality of the steam. One was placed in the header from the Stirlings and the other in the header from the Marines.

Operating Conditions:-

The load on the boilers was governed entirely by the mill demand. No attempt was made to establish any certain test conditions. It was the intent to let the plant go along in the usual way that it ran from day to day.

The operation of the stamps is shown by the graphical log on page , also the total revolutions of the mill pump.

Method of Conducting Test:-

The continuous operation of the mill being very necessary at the time this test was run, it was thought best to start and stop the test in such a manner that it would in no way interfere with keeping the stamps going. The regular cleaning schedule was kept in force and on the morning on which it was planned to start the test, the time and rotation of cleaning the fires was taken and recorded. The condition of the fires was noted at the start of the test and an effort made to bring them back to the same condition at the close. The time interval between the cleaning of the fires was kept the

same throughout the test. The fires all being cleaned in the same rotation and the same length of time before closing as before starting.

The height of water in the gauge glasses was marked at the start and brought back to the same mark at the finish. Any discrepancy was allowed for by calculation.

A sample of coal was taken from every fifth barrow. In this way a sample of about 1000 pounds was collected which was quartered down in the boiler room to a suitable size for the laboratory. Special moisture samples were taken every four hours. These were broken up at once, taken to the sample room, weighed, and put in the dryer.

A sample of the ashes above the grate was secured by quartering down the total amount pulled each time. The ashes below the grate being more uniform in size, a shovelfull was taken from every can weighed. It was necessary to wet down the clinker from above the grate when cleaning fires so a moisture sample was taken on all this ash and a correction made in the final weight.

All readings were taken every fifteen minutes.

Discussion of Results:-

The results obtained from thistest may be considered as a good example of the daily performance of the Champion Mill Plant at the present time. The continuous operation of six stamps makes a demand on the boilers which they are in no shape to meet. The extremely high temperature of the gases escaping from the Stirling boilers indicates to some extent how they are being forced. Parts of the fire arch in all the Stirlings had fallen away, thus permitting the hot gases to escape contact with the lower section of the front bank of tubes. This would tend to raise the temperature of the gases at the boiler damper. An inspection of the gases from the furnace as they came through the first bank of tubes and over the baffle into the second pass showed that combustion was still taking place. The flames were red in color and it was impossible to see the middle wall of the setting, while in the Stirling boilers at the Baltic Mill the gases at this point are absolutely colorless. The product of complete combustion is without color.

A comparison of the evaporation F and A 212° per pound of dry coal between this test and an average of the six tests at the Baltic Mill is made in a separate report on the saving possible by duplicating the Baltic plant at the Champion Mill.

An attempt was made to calculate a heat balance to show if possible the cause of such a poor performance. The data used in this calculation is given in the following table. The items approximated are so marked.

Steam Pressure by Gauge - Pounds		162.2	Test.
Temperature of Feed Water - F°		216.1	"
Temperature of Boiler Room- F°		64.7	"
Temperature of Escaping Gases - F°		700.0	Approximate
Weight of coal used per Hour - Pounds		7854.0	Test
Moisture in Percent		5.2	"
Dry Coal per Hour	Pounds	7440.0	"
Ash and Refuse per Hour	"	555.8	"
Percent Combustible in Ash		26.9	"
Actual Evaporation per Hour	"	60122.0	"
Ultimate Analysis of Dry Coal	(C Per Cent	76.99	Approximate
	(H. " "	4.77	"
	(O. " "	not used	"
	(N. " "	"	"
	(Ash " "	"	"
	(Sulphur "	"	"
Heat Value per pound of dry coal	B.T.U.	14182	Test
Heat Value per pound of Combustible	"	15140	"
Flue Gas Analysis - - CO_2 Percent		7.5	Approximate

The percent of carbon and hydrogen used is an average of thirteen ultimate analyses of Pittsburgh coals.

The temperature of escaping gases in the result of an attempt to average the gases from both the Strilings and Marines.

The flue gas analysis is that taken at the entrance to the Stirling economizer.

The percent of oxygen and carbon monoxide as found during the test is not reliable, therefore, it is assumed that there was no CO in the gases. This assumption is only for purposes of calculating the heat balance.

Heat Balance.

	B.T.U.	Percent.
Heat absorbed by boiler	8170	57.6
Loss due to evaporation of moisture in fuel	70	.5
Loss due to burning of Hydrogen	578	4.09
Loss due to temperature of dry chimney gases	3734	26.3
Loss due to carbon in ash	284	2.01
Radiation and Unaccounted for losses	1346	9.5
Total	14182	100.0

The losses due to moisture in the fuel, the burning of hydrogen and combustible in the ash are not excessive. Radiation and unaccounted for losses are perhaps a little high. It might be possible to lower this 5% or 3.5% by installing bigger units. The burden of the poor performance must be borne by the loss due to the temperature of the escaping gases. This loss is made up of the loss due to excess air and air infiltration due to poor condition of brick work, etc. Assuming that with efficient combustion and a tight setting, we could get 12% CO_2 at the boiler dampers, and with proper damper regulation lower the temperature of the gases to 550° F., then the loss due to the temperature of escaping gases would be reduced to 1732 B.T.U. per pound of dry coal or 12.2% making a decrease of 14.2% which could be added directly to the combined efficiency of boiler, furnace and grate thus making it 71.8% instead of 57.6%.

Considering the Stirlings alone, the average CO_2 at the end of the first pass for the tests was 10.4%, which corresponds to 100% of excess air. The percent of CO_2 in the flue back of the Stirling was 7.5 which corresponds to 175% of excess air. From this it is evident that 75% of excess air comes from leaky settings, doors, etc.

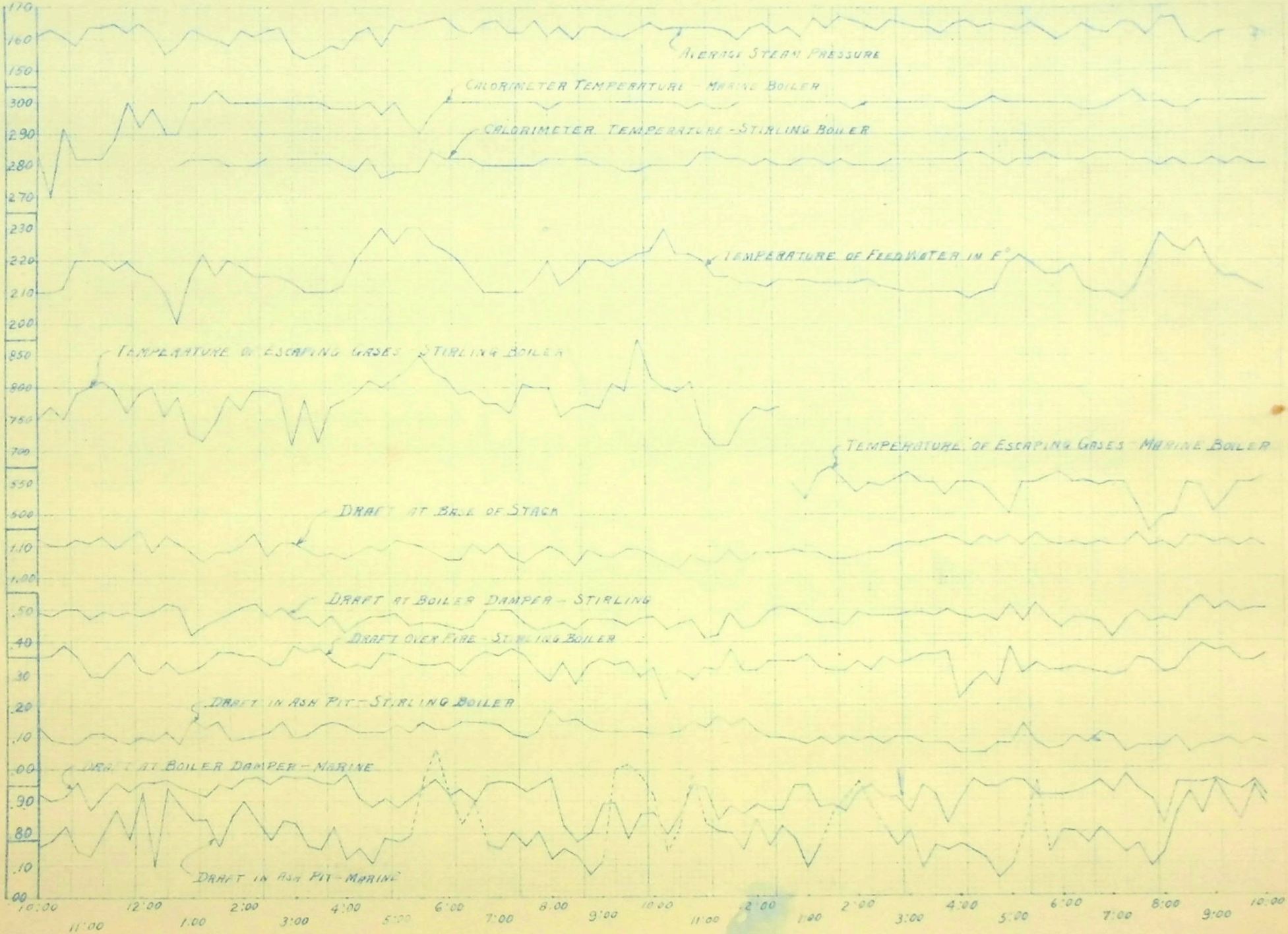
Conclusions:-

Since this test was made the 4" Venturi tube and Type M register-indicator-recorder from the Baltic Mill has been installed at the Champion Mill and a daily check kept on the coal and water. The coal weights are approximations, but can be taken as accurate within one percent, which is as close as the meter can be relied upon.

The totals given below are from April 4th to April 14th, inclusive.

Weight of Coal As Fired.	Weight of Water Fed to Boilers.	Actual Evaporation.
226,850	1,485,500	6.55
197,700	1,523,000	7.70
216,100	1,467,000	6.80
252,350	1,373,000	5.44
165,150	1,690,000	10.20
180,900	1,491,000	8.20
191,150	1,401,000	7.33
193,850	1,419,000	7.32
189,290	1,369,000	7.23
279,970	860,000	3.07
	Total	69.90
	Average	6.99

CHAMPION MILL BOILER HOUSE – PLANT TEST – MARCH 23, 24, 1916



CHAMPION MILL - LOG OF OPERATION OF STAMPS AND MILL PUMP

AVERAGE SPEED OF MILL PUMP - 51 R.P.M. - TOTAL REVOL: 24 HOURS = 73488