THE DETERMINATION OF THE OPTIMUM OPERATING CONDITIONS OF AN EIGHT YEAR OLD, B. KEELER, 500 HORSEPOWER, THREE DRUM, BENT WATER TUBE STEAM GENERATING UNIT IN THE VIRGINIA POLYTECHNIC INSTITUTE CENTRAL HEATING AND POWER PLANT

by

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INTRODUCTION

In 1939, a fifth steam generating unit was added to the Virginia Polytechnic Institute Central Heating and Power Plant. This unit was an E. Keeler, 800 horsepower, three drum, bent water tube type boiler, fired by a Westinghouse five retort underfeed stoker with link-grate section.

Soon after the installation of this unit, W. F. Diamond and C. F. DeBusk made an investigation to determine the effects of various fuel bed depths on the efficiency of the unit. Approximately 6½ years have elapsed since their investigation was completed. No other tests have been conducted on the unit up to now. Consequently, its performance characteristics and maximum thermal efficiency at the present time are not accurately known. Even though Diamond and DeBusk made their investigation to determine the effect of various depths of fuel bed on the performance of the unit, the optimum percentage CO_2, and the range of load for maximum thermal efficiency, there is at the present time, a decided difference of opinion among the power plant personnel regarding these facts.

It is contemplated that a sixth unit will shortly be installed in the V.P.I. Power Plant. Therefore, it is necessary to know what maximum continuous load and what peak loads for short periods of time the No. five unit can be expected to carry now that it has been in operation for almost seven years.

During the past two or three years, the operation of the stoker on the No. five unit has not been satisfactory. Large coke trees (see Discussion of Results, page 67) are formed in the fuel bed at the front end of the

stoker where coal enters the furnace. These coke trees ride on the fuel bed as it moves from the front end of the furnace to the ash discharge orifice (see Fig 18), and are only partially consumed during combustion. When they reach the ash discharge orifice clogging results. This necessitates cleaning the orifice and ash discharge plates with a firing iron. Actual cases have been known to occur when a complete loss of load and a 50 per cent reduction in steam pressure have resulted from the clogging of the orifice.

REVIEW OF LITERATURE

Gebhardt[1] states that for any steam generating unit actual tests must be performed to determine the depth of fuel bed which will result in maximum efficiency. The large number of variables involved in the operation of a steam generating unit makes this statement true.

The A.S.M.E. Power Test Code for Stationary Steam Generating Units[2] establishes rules for conducting tests to determine performance items that might be necessary for: (1) checking the actual performance of a unit against the manufacturer's guarantee, (2) comparing these performance items with a standard of operation and (3) comparing different conditions or methods of operation.

When a steam generating unit is purchased and installed, the manufacturer furnishes the purchaser a boiler and superheater efficiency curve covering any reasonable range of ratings, and flue-gas temperature and CO_2 curves based on the use of a certain fuel and stoker. The furnace used in conjunction with the stoker, is designed for the stoker selected.[3] The stoker manufacturer likewise furnishes guaranteed performance data for the combustion apparatus.[4]

[1] G. F. Gebhardt, Steam Power Plant Engineering, Sixth Edition, p 160. John Wiley and Sons, Inc., 1928.

[2] A.S.M.E. Power Test Code for Stationary Steam Generating Units, p 6. American Society of Mechanical Engineers, 1946.

[3] Contract for Steam Boiler Equipment for the Virginia Polytechnic Institute, Blacksburg, Va. E. Keeler Company, Contractors, Williamsport, Pa., May 28, 1938.

[4] Contract for Stoker for the Virginia Polytechnic Institute, Blacksburg, Va. Westinghouse Electric and Manufacturing Company, Contractors, Philadelphia, Pa., June 1, 1938.

In 1933 R.M. Garrett and R. E. Philbeck[5] made a study of the operating characteristics of the No. three unit in the Virginia Polytechnic Institute Central Heating and Power Plant. The unit was equipped with a Detroit Type U underfeed stoker having four retorts and an actual grate surface area of 68 sq ft. Their results show that, for outputs up to 10,000 pounds of steam per hour (90 per cent rating), a low fuel bed gives higher efficiencies than a medium or high fuel bed. For outputs from 10,000 to 17,000 pounds per hour (90 to 150 per cent rating) a medium fuel bed results in higher efficiencies than a low or high fuel bed.

In 1940, W. F. Diamond and C. F. DeBusk made a sudy of the operating characteristics of a new Keeler 500 horsepower steam generating unit in the same plant. Their conclusions were:[6]

> 1. For good efficiency together with ease of control use a medium fuel bed for all loads between 19,000 pounds per hour and 37,500 pounds per hour.
> 2. The high fuel bed gives best efficiency at higher loads, but should not be used for it is difficult to control and may result in closed fire lanes.
> 3. Because of low efficiency thin fuel beds should never be used.

[5] R. M. Garrett and R. E. Philbeck, An Investigation of the Influence of Depth of Fuel Bed on the Efficiency and Operating Characteristics of the Casey Hedges 350 H.P. Boilers at the V.P.I. Plant. Thesis, V.P.I. (M.S.), 1933.

[6] W. F. Diamond and C. F. DeBusk, The Effects of Depth of Fuel Bed on the Operating Characteristics of the Keeler 500 H.P. Boiler. In the Virginia Polytechnic Institute Central Heating and Power Plant, p 39. Thesis, V.P.I. (M.S.), 1940.

PURPOSE AND PLAN OF INVESTIGATION

The No. five unit in the V.P.I. Power Plant is operated with a very thick fuel bed at outputs ranging from 23,000 to 30,000 pounds of steam per hour. The maximum continuous capacity of the unit is 36,000 pounds of steam per hour. The remainder of the steam load is carried by four low pressure boilers that have been in service 15 to 25 years. These boilers are operated at near full capacity while the No. 5 unit is operated below its rated capacity.

The thick fuel bed is used to avoid the frequent inspections that are necessary to maintain a constant medium or low fuel bed and to avoid loss of steam pressure in case a rapid increase in the load occurs. The unit is operated at outputs below 30,000 pounds of steam per hour to avoid clinkering of the fuel bed and the burning of grates that occur under this condition of fuel bed.

The object of this thesis is to determine the correct fuel bed thickness to be used in order to avoid clinkering, burning of grates and the loss of steam pressure when a rapid increase of the output occurs. More specifically, the thesis has the following purposes:

a. To determine the most efficient depth of fuel bed to be used over the operating range of 20,000 to 40,000 pounds of steam per hour output.

b. To determine the maximum gross thermal efficiency curve for the same range of output.

c. To determine the optimum percentage of CO_2 in the flue gases.

d. To determine the maximum output of the unit and the period of

time this output can be maintained.

e. To determine the cause and to find a remedy for the formation of coke trees in the fuel bed.

Twelve tests, conducted in close accordance with the A.S.M.E. Power Test Code for Stationary Steam Generating Units, were performed between October 1946 and January 1947. The tests were conducted for five different outputs of the unit for three different fuel bed conditions.

The coal fired during the tests was mined in Buchanan County, Virginia.

A complete heat balance was calculated for each test performed. The results of the heat balances and other miscellaneous data were plotted as curves. These curves were interpreted and conclusions were drawn from the interpretations.

APPARATUS

The apparatus used in this study consisted of the following:

Steam Generating Unit: (see Figs. 24, 25 and 26) The steam generating unit is designed to deliver 36,000 pounds of steam per hour continuously and 45,000 pounds of steam per hour for a two hour period. The steam conditions are 250 psig pressure and 100 degrees superheat (505 F total temperature).

The boiler is a Keeler, curved tube, water tube boiler rated at 500 boiler horsepower, one boiler horsepower being equivalent to the evaporation of 34.5 pounds of water per hour from 212 F. The boiler contains a total of 4089 sq ft of heating surface distributed as follows: convection and radiant heat absorbing surfaces, 4387 sq ft; convection-radiant superheater surface, 292 sq ft; bridge wall, 154 sq ft; and clinker chills, 56 sq ft.

The overall length of the boiler setting is 21' -5"; the overall width is 12'-10". The height from the floor line to the top of the steam nozzle on the rear drum is 28'-4½". The furnace is 9'-1" wide and 10'-7 7/8" long (see Fig. 25).

The boiler is supported by a structural steel framework independent of the brickwork. This allows for expansion and contraction without undue strain on either the boiler or the brickwork. The four corner columns extending to the basement floor and the other vertical columns are tied together with structural braces.

The boiler is a three drum type containing 19 tubes per section and is 18 sections wide. It is constructed in accordance with the A.S.M.E. Boiler

Code and is designed for a safe working pressure of 300 psi. The water and steam drums have a diameter of 42-in. and are 13-ft long; the mud drum has a diameter of 42-in. and is 9'-3" long. The plate thickness of the shell of the three drums is 1-9/32-in.; the plate thickness of the mushroom heads is 1-1/8-in. All of the drum joints are welded.

A manhole opening, size 11-in. by 15-in., located in one end of each drum, is internally flanged and reinforced.

The boiler tubes are fabricated of No. 9 BWG 3½-in. seamless steel tubing. The distance between the tube centers, measured along the drum length, is alternately wide and narrow; therefore any one tube may be removed without removing other tubes. The tubes are bent to an easy radius and are not more than 1/16-in. out of round at the bends.

The boiler is equipped with a Keeler, bare tube, interdeck, convection-radiant type superheater designed to deliver 100 degrees superheat (505 F total steam temperature) at 36,000 pounds of steam per hour output (250 psig pressure). When the boiler load fluctuates from 18,000 to 45,000 pounds per hour, the superheat will not vary more than plus or minus 10 F (Acceptance tests conducted at the completion of the installation of the boiler revealed that the superheat delivered varied from 116 degrees at 12,000 pounds per hour to 218 degrees at 28,000 pounds per hour. To correct this condition, the superheater surface was reduced by removing 11 of the 28 tubes; the holes in the headers were blanked off. Thus the total superheater surface was reduced from 401 sq ft to 292 sq ft.). The superheater elements or tubes are made of two in. No. 11 BWG seamless steel tubing with their ends expanded into eight in. extra heavy pipe headers. Openings in the headers, which are closed by key caps, are provided for access to the ends of the superheater

tubes. The inlet header is connected to the steam drum by eight 3½-in. No. 9 BWG seamless steel tubes.

The water cooled bridge wall consists of eighteen 3½-in. No. 9 BWG seamless steel tubes spaced on six in. centers. The upper ends terminate in the mud drum and the lower ends in a horizontal eight in. double extra heavy pipe header. Six 3½-in. No. 9 BWG seamless steel downcomer tubes connect the mud drum and the horizontal eight in. header. The header has a handhole at one end. A 1½-in. blow-down connection with a tandem blow-down valve is installed at the header midpoint. Cast iron block shoes are attached to the bridge wall tubes at the ash discharge to protect the tubes from abrasion. The rear side of the water wall tubes is covered by two in. of firebrick tile laid on edge in high temperature cement backed up by two in. of Johns-Manville Superex blocks (maximum service temperature is 1800 F). There is a two inch blanket of Eagle Picher Lead Company's insulating material behind these blocks. A No. 10 BWG steel paneled casing (removable from the outside) is installed to protect the insulation.

Clinker chills, consisting of seven rows of 3½-in. No. 9 BWG seamless steel tubes on six in. centers, are installed on each side of the furnace to a height of two ft above the stoker. The ends of the tubes terminate in eight in. extra heavy steel pipe vertical headers having handhole openings closed by key caps opposite the ends of the tubes. The top end of each front header is connected to the front upper drum by means of two 3½-in. No. 9 BWG seamless steel riser tubes. The bottom end of each rear, vertical header is connected to the mud drum by means of two 3½-in. No. 9 BWG seamless steel downcomer tubes. The two rear headers are provided with 1½-in. blow-down connections and 1½-in., tandem, blow-down valves. The clinker chill tubes are

equipped with Drake, cast-on armor blocks for a height of two ft, the blocks being applied to the four tubes nearest the surface of the stoker.

The front and side furnace walls are 22½-in. thick. They are constructed of nine in. of firebrick, nine in. of insulating brick, a two in. blanket of insulation, and a No. 10 BWG steel casing. A section of the front wall three feet high, and directly above the stoker retorts is constructed of nine in. of carborundum brick, nine in. of insulating brick, two in. of insulation, and a No. 10 BWG steel casing. The side walls have relieving arches to reduce the load on the lower portions of the brickwork. Three rows of 20-in. by nine in. by five in. special bonding tiles are laid in the walls at eight ft vertical intervals to tie the courses of the brickwork together (The 20-in. by nine in. face is in the horizontal plane). A 1½-in. expansion joint in each side wall extends vertically from the rear of the front drum to the bottom of the wind box. In addition to these two expansion joints, there is a vertical expansion joint in each of the four corners of the furnace. The rear wall is composed of 4½-in. of firebrick, nine in. of insulating brick, two in. of insulation, and a No. 10 BWG steel casing. The top of the furnace, between the front and rear drums, is made up of two in. of firebrick tile, two in. of insulation, a ½-in. layer of magnesia and cement, and a No. 12 BWG steel casing. This covering is supported by the steam circulating tubes between the front and rear drums. The front and rear drums are covered with two in. of insulation, a ½-in. layer of magnesia and cement, and a No. 12 BWG steel casing.

The following accessories are installed on the boiler:

One high and low water alarm column with a 3/4-in. water gage equipped with quick closing valves operated by chains from the firing floor line.

Two spring loaded pop type safety valves set to open at 275 psig steam pressure. One valve is installed on the rear or steam drum and the other valve on the exit end of the superheater outlet header. Each safety valve has a capacity of 10,500 pounds per hour of saturated steam at 275 psig pressure.

One blow-down valve connected to the bottom of the mud drum by a two in. line.

Five scotblowers utilizing steam at 165 psig pressure. The scotblowers are hand operated by chains from the firing floor line (see Fig. 24 for the location of the scotblowers in the furnace setting).

Stoker: The boiler is fired by a Westinghouse five retort underfeed stoker (see Figs. 1, 2, 3 and 4) with a mechanically driven link-grate overfeed section arranged for continuous ash discharge. The actual area of the fuel supporting surface of the stoker is equivalent to 102.6 sq ft. The projected furnace area is 96.7 sq ft. The stoker is driven by a five horsepower Westinghouse "C.S." constant-speed induction motor through a Reeves No. 1-E enclosed variable speed transmission. The transmission is designed for operation with automatic combustion control equipment.

The stoker has five retorts provided with tuyeres for distributing the air for combustion to the fuel and mechanisms for activating and controlling the fuel and ash discharge. This equipment consists essentially of the following: a fuel hopper (2000 pounds capacity); ram boxes and main rams; interlocking unit tuyeres and side wall extension tuyeres; fixed front wall support; removable air distributing boxes and wind box damper; link-grate overfeed section; two front observation doors, two side observation doors, two rear observation doors and two side furnace doors.

WESTINGHOUSE CONTINUOUS-ASH-DISCHARGE LINK-GRATE STOKER

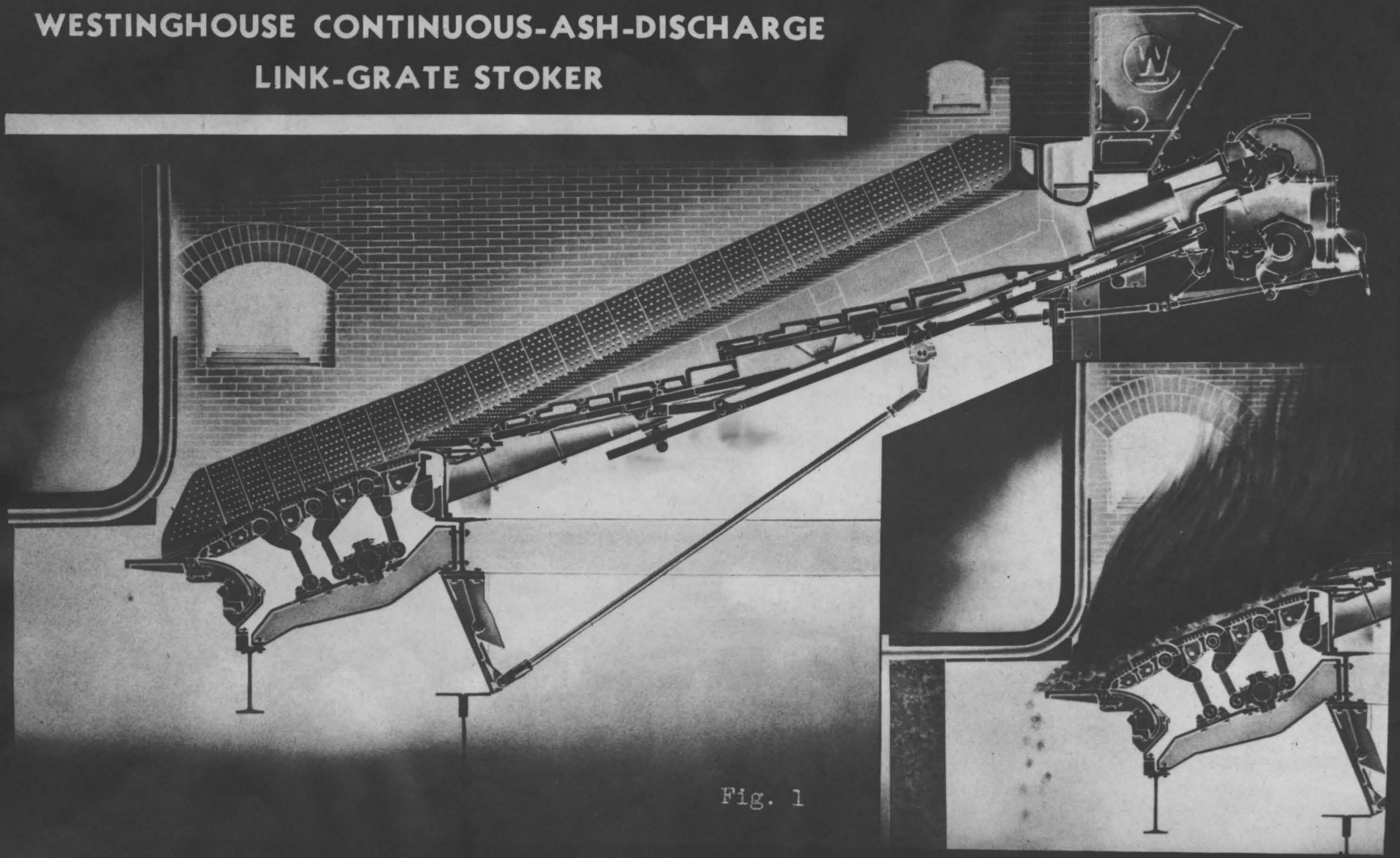


Fig. 1

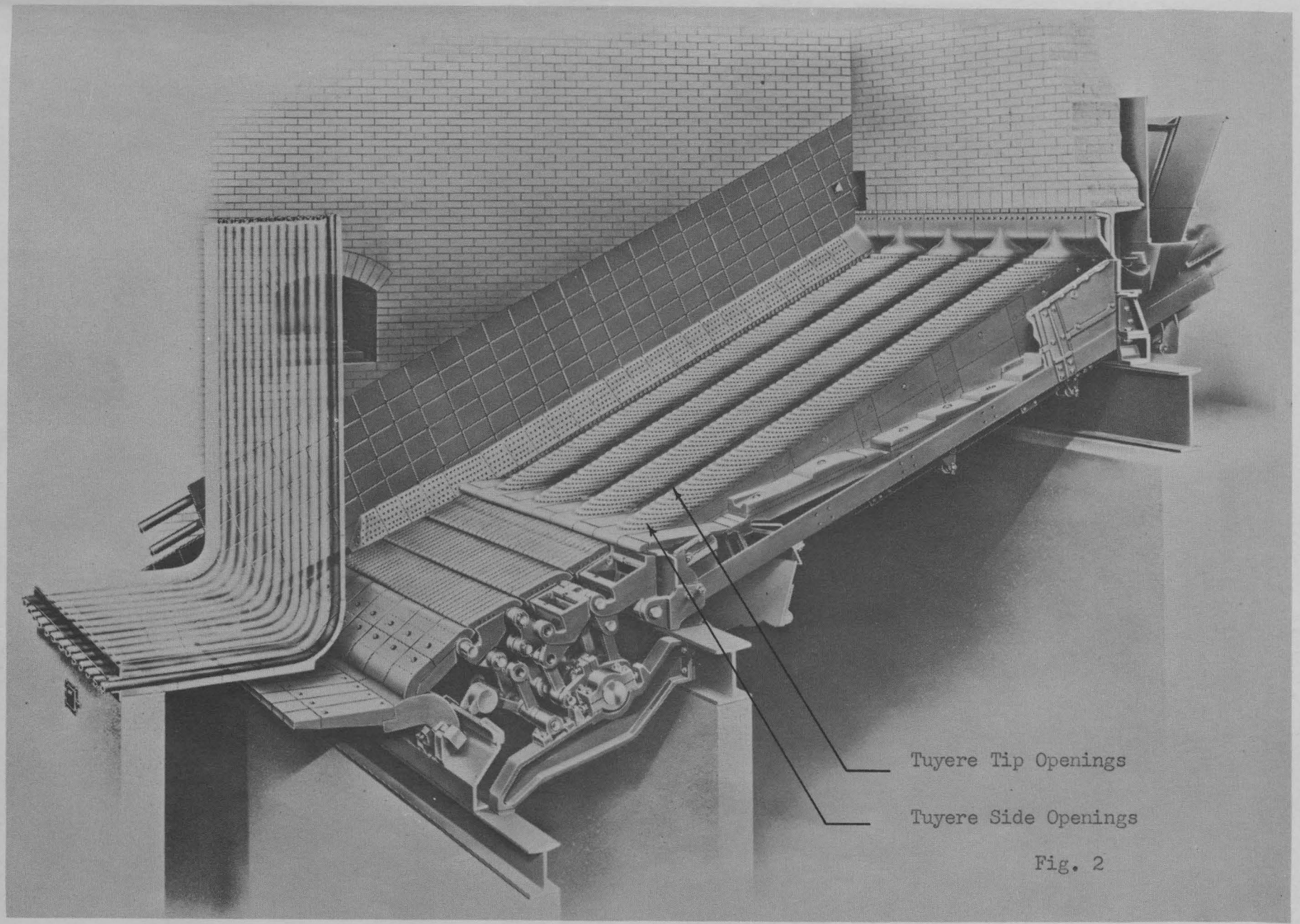


Fig. 2

WESTINGHOUSE STOKER

WESTINGHOUSE CONTINUOUS ASH DISCHARGE LINK GRATE STOKER

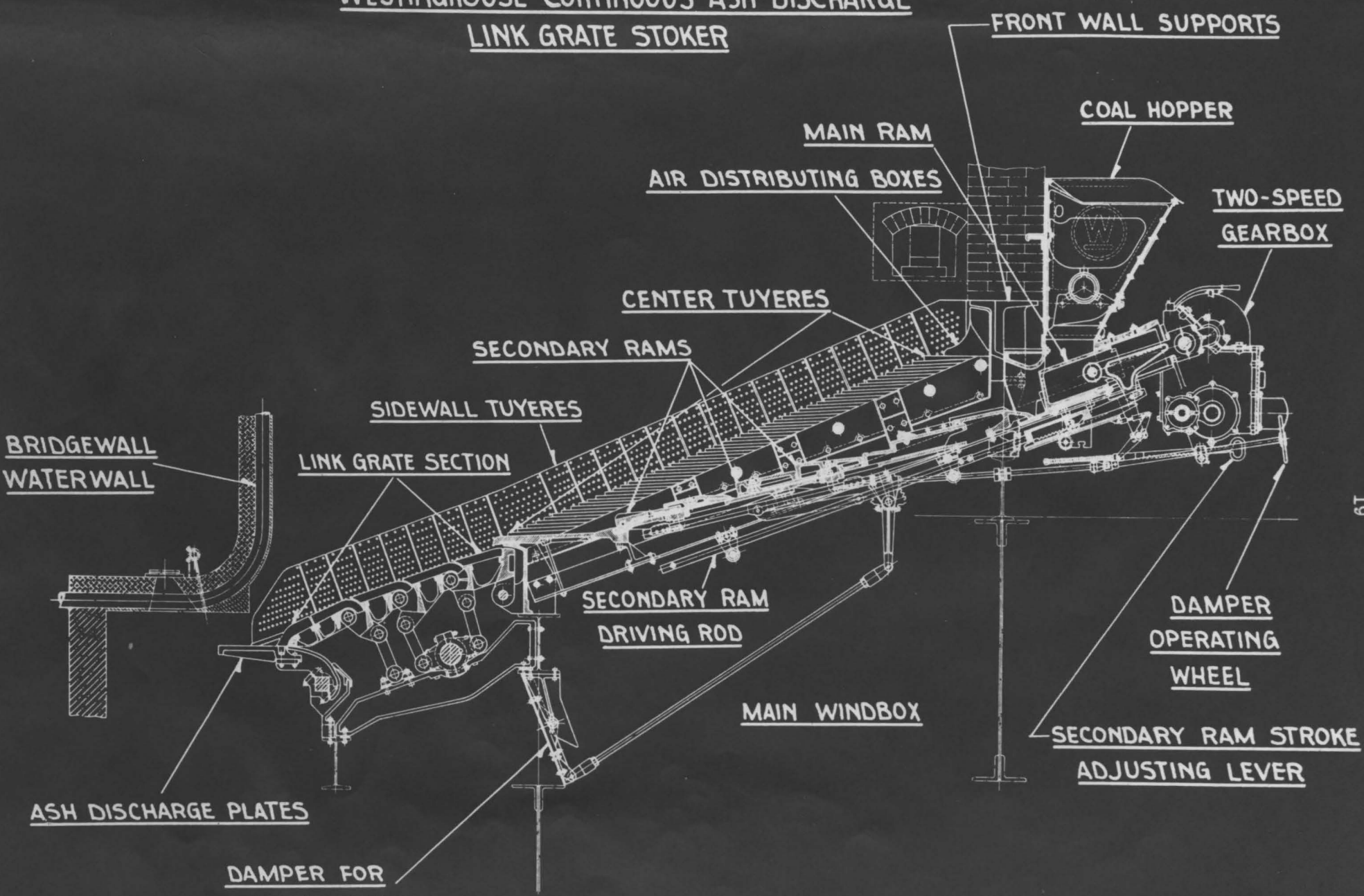
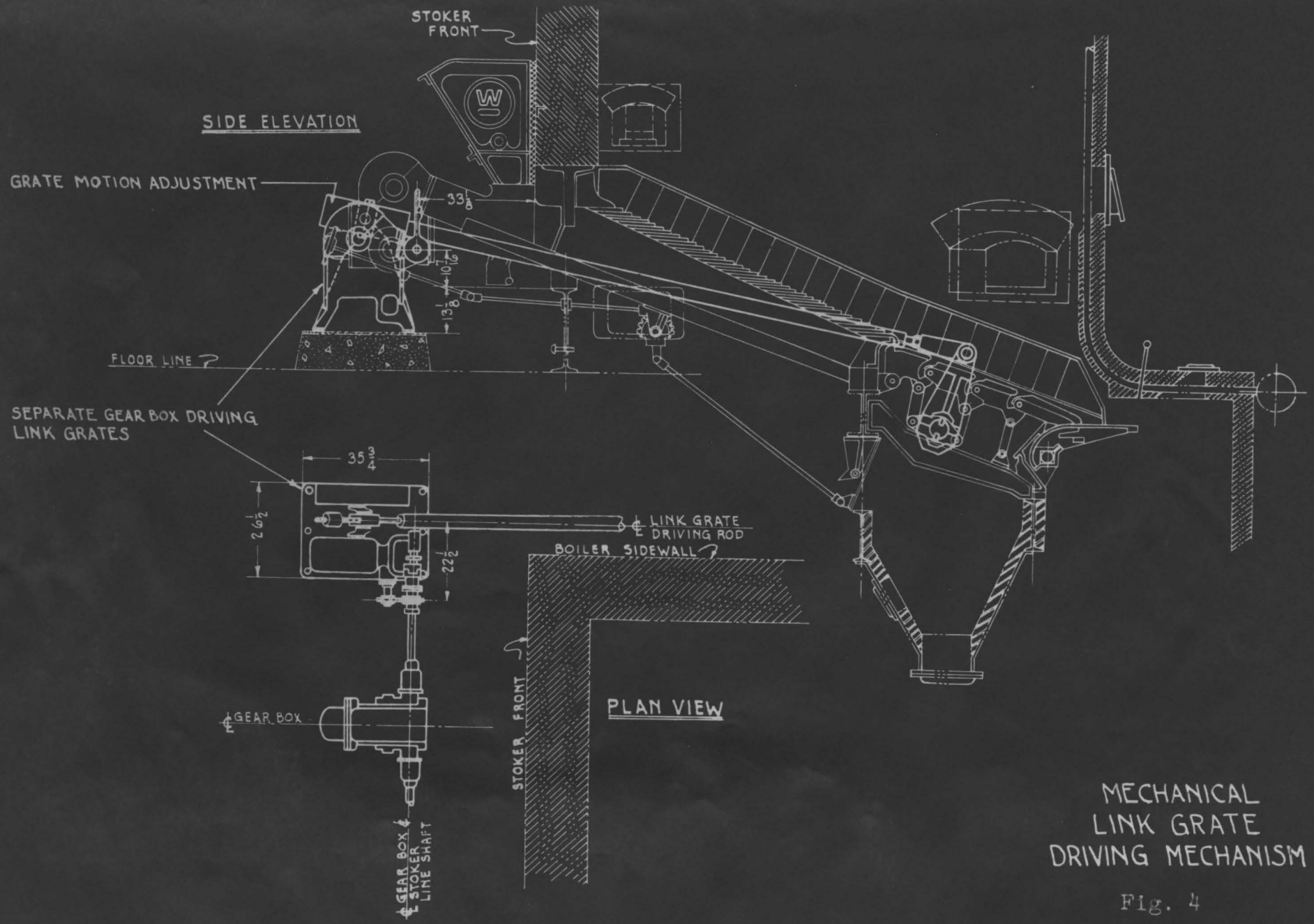


Fig. 3

STOKER LITHO NO. 71-A



20

MECHANICAL
LINK GRATE
DRIVING MECHANISM

Fig. 4

Continuous Blow-down: The continuous blow-down water is drawn off the water or front drum. The quantity of water drawn off is regulated manually by a valve in the blow-down line. The water is piped to a flash tank. A portion is flashed to steam which is piped to the open heater where it is used for feedwater heating. The residual blow-down water is passed through a heat exchanger before being discharged to a sewer. The heat exchanger heats soft water make-up for the feedwater heater.

Automatic Combustion Control: The automatic combustion control equipment used with the steam generating unit was manufactured and installed by the Hays Corporation. The control panel is divided into four parts: The master controller, the fuel feed controller, the air flow controller, and the outlet damper controller. The master controller receives its impulse from the steam pressure in the front drum. Through a system of relays, levers and mercury switches, the master controller actuates the fuel feed and outlet damper controllers. The fuel feed controller varies the stoker speed at the Reeves variable speed transmission (A manual adjustment on the fuel feed controller allows the operator to adjust the fuel bed thickness). The outlet damper controller opens and closes the outlet damper. The air flow controller is actuated by the air pressure within the furnace acting on a diaphragm. Through a system of relays, levers and mercury switches the movement of the diaphragm controls the vanes or dampers on the intake side of the forced draft fan. When the load on the boiler increases, the steam pressure decreases and the controls "open up". When the load decreases, the pressure increases, and the controls "shut down". When the controls "open up", the stoker increases its speed, thus feeding more fuel into the furnace. The outlet damper opens and the furnace pressure increases in negative value. The forced draft fan vanes or dampers then open to restore the furnace pressure to its correct set value (in this case, 0.05 in. of water). The com-

bustion control board can be changed from automatic to manual control by switching off the master controller. All of the controls are then operated manually by switches.

The combustion control board contains a Hays combustion meter which is composed of an automatic CO_2 and flue gas temperature recorder. The flue gas analyzer which determines the per cent CO_2 by volume in the flue gases is mounted on the rear of the steam generating unit. A nitrogen filled thermometer which indicates the flue gas temperature leaving the unit is mounted just inside the furnace near the exit from the last pass. A Cochrane steam flow recorder, included on the control board, indicates and records the instantaneous value of the steam demand on the unit and integrates the steam flow. This recorder is electrically operated. It receives its impulse from the pressure drop across a thin-plate orifice installed in the superheater header at the rear of the steam generating unit. Hays draft gages (front and rear wind box pressures, furnace draft and outlet draft pressures), a Cochrane recording steam drum pressure gage, a Reliance "Eye-Eye" water level gage, a Crosby indicating steam drum pressure gage and a Crosby indicating feedwater pressure gage complete the essential equipment on the board.

Feedwater Regulators: Feedwater regulation for the steam generating unit is accomplished by means of a two element differential pressure type regulator. The primary elements are located at the feedwater pumps. In the case of the electrically driven pump, a Copes regulator controls the discharge of the pump by maintaining a constant feedwater pressure differential over the superheated steam pressure. The steam flow to the turbine driving the auxiliary pump is controlled in the same manner by a Fisher governor. The secondary element is a thermostatic type Copes

regulator installed on the side of the boiler. It is actuated by the change in water level within the rear boiler drum.

Forced Draft Fan: A single forced draft fan supplies air to the front and rear wind boxes beneath the stoker. The fan was manufactured by the Clarage Fan Company and is equipped with vortex control. It will deliver 20,000 cfm of air at 70 F against five in. of water pressure. This fan is driven by a General Electric constant speed 25 horsepower induction motor.

Ash Disposal System: The ash disposal system was designed, manufactured and installed by the United Conveyor Corporation. The system operates on a vacuum principle. A steam ejector evacuates the air from a conveyor pipe. Refuse is pulled from the ash hopper at the base of the unit by hand and dropped into a hopper which discharges into the conveyor pipe. The refuse is "sucked" through the conveyor pipe into a cyclone separator. Here the refuse separates from the air being evacuated from the system and is periodically dumped into a storage silo below. Fly ash which falls into hoppers beneath the last pass of the boiler is removed by emptying the fly ash hoppers into the refuse or ash pit.

Coal Weighing: A Fairbanks Registering Beam traveling weigh larry was used to weigh and transfer the coal from the overhead coal storage bunkers to the hopper of the stoker. The weigh larry has a capacity of 2000 pounds.

Temporary Testing Equipment: A base metal thermocouple was installed in the entrance to the breeching at the exit of the last pass of the boiler to measure the temperature of the flue gases leaving the boiler. The thermocouple was connected to an indicating Brown pyrometer (range 0-2400 F) installed at the boiler room floor level.

A Fisher hand type glass Orsat analyzer was used to make analyses of

the flue gases. The gas sample for the Orsat apparatus was drawn from the sampling pipe of the Hays automatic CO_2 recorder. The sample was obtained from the last pass where a porous refractory soot filter filtered out all of the solids in the gas. Sulphurous mists and other corrosive compounds were eliminated in a condenser before the flue gas mixture entered the Orsat apparatus. An aspirator was used to withdraw the gas sample from the sampling tube.

A throttling calorimeter was installed on the rear drum to measure the moisture in the steam. The sampling tube for the calorimeter was located below the dry pan in the drum.

Thermometers of the mercury-filled etched-stem type were used to measure the following temperatures: wet and dry bulb temperatures of the combustion air at the inlet to the forced draft fan, the ambient temperature at the cold junction of the thermocouple (for flue gas temperature correction), the fuel temperature in the stoker hopper, and the room temperature at the firing floor line level. The following thermometers, installed in deep wells filled with 600W steam cylinder oil, were used to measure the following temperatures: the blow-down water temperature at the flash tank, the temperature of the feedwater leaving the open heater, the temperature of the feedwater entering the rear boiler drum, the steam temperature inside the calorimeter, and the temperature of the steam at the exit of the superheater outlet header.

Bourdon tube type pressure gages equipped with syphons were used for the following purposes: to measure the steam pressure in the rear steam drum and in the superheater header at the superheater outlet. The steam pressure in the throttling calorimeter and the flash tank was measured with mercury U-tube manometers.

Standard laboratory equipment was used to determine the methyl orange alkalinity of the feedwater and the blow-down water.

Fairbanks platform scales (1000 pounds capacity) were used to weigh the refuse and fly ash collected.

THE INVESTIGATION

Procedure

This study consists of a series of 12 boiler tests conducted in close conformity with the A.S.M.E. Power Test Code for Stationary Steam Generating Units. Each test was conducted at a constant steam output with a constant thickness and contour of the fuel bed. The duration of each test was 24 hours with the exception of the twelfth test. This test was conducted for only eight hours because the unit was operated at a rating above its maximum continuous capacity. The length of the test was shortened as a precaution against permanent damage to the furnace walls due to the high furnace temperatures.

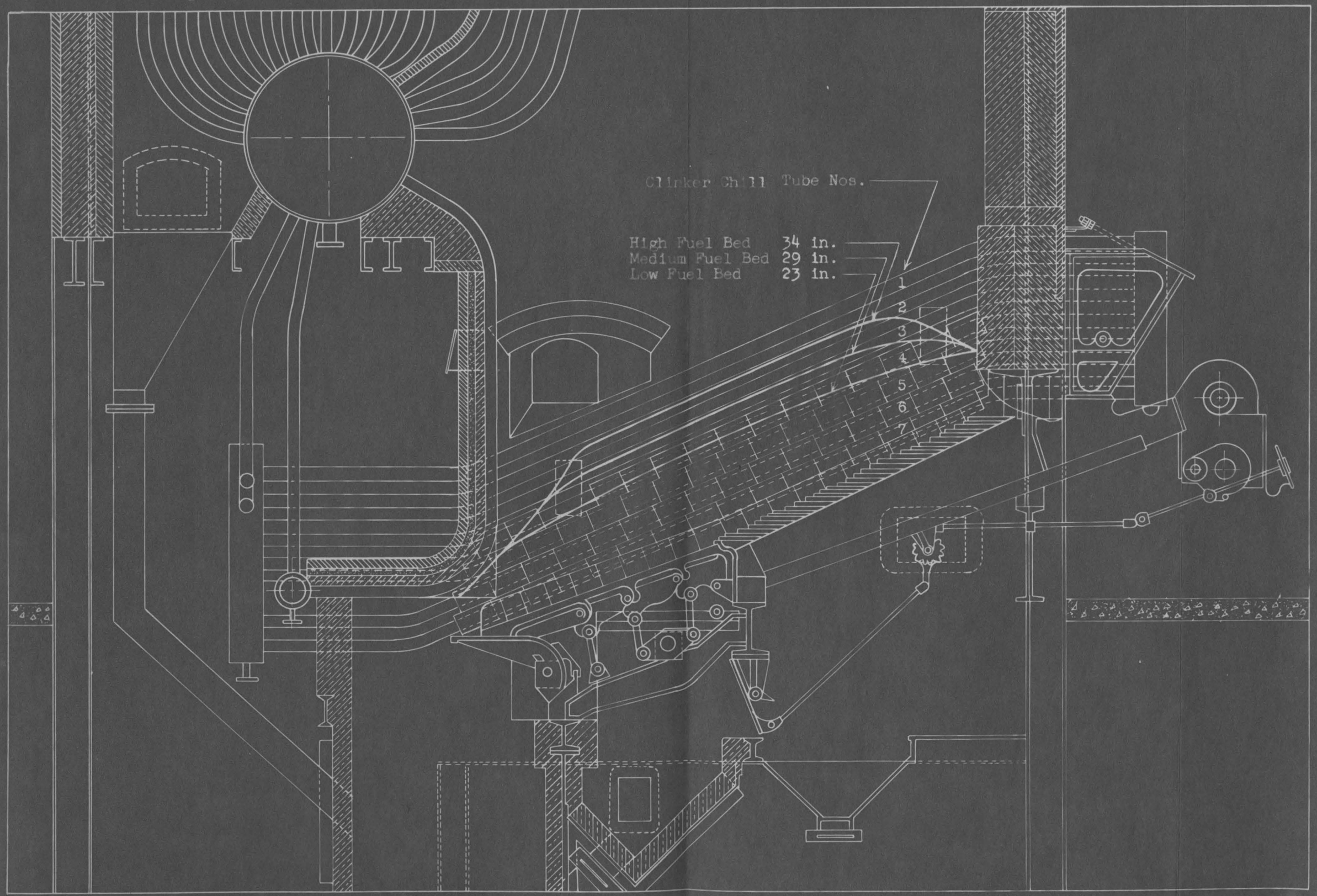
It was originally intended that the tests be conducted for three different fuel bed conditions for each of five different steam outputs. The outputs (pounds of steam per hour) were to be as follows: 20,000, 25,000, 30,000, 36,000 and 40,000. The fuel bed conditions were low, medium and high. The low fuel bed was established by determining the thinnest fuel bed that the stoker could maintain and yet have the steam generating unit maintain the steam pressure at the rated value with the given load. The high fuel bed was established by determining the thickest fuel bed that could be maintained by the stoker without matting and clinkering (see Discussion of Results, Page 65) in the fuel bed to such an extent as to cause loss of steam pressure and output. The thickness of the medium fuel bed was taken as the average thickness of the high and low beds. The fuel bed thicknesses are designated as H (high), M (medium) and L (low). The tests are designated by the first two digits of the hourly steam flow and a letter representing the

fuel bed condition. Thus, a test conducted for a steam output of approximately 30,000 pounds per hour with a thin fuel bed is designated as Test No. 30-L.

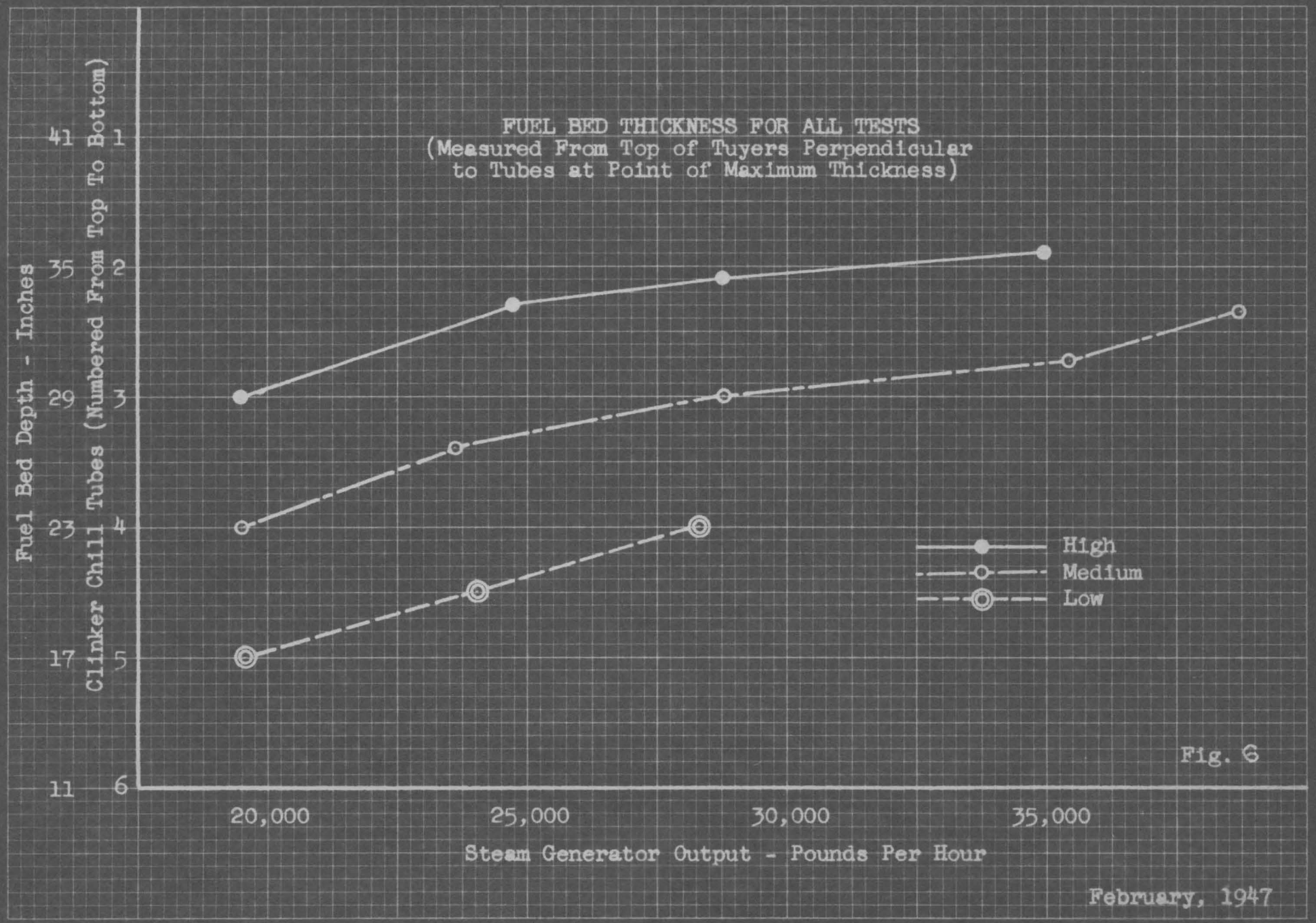
The following tests were conducted: 20-L, 20-M, 20-H, 25-L, 25-M, 25-H, 30-L, 30-M, 30-H, 36-M, 36-H and 40-M. Tests 35-L, 40-L and 40-H were not conducted. When the 36 series tests were performed, it was found that the high and low beds varied so little in thickness that a medium fuel bed between the two limits could not be attained. If a better grade of coal had been available for these 36 series tests, a fuel bed thinner than the lowest maintained could have been obtained. Therefore, the two fuel beds established were designated as high and medium. Only one fuel bed thickness was attained for the 40 series tests. The stoker was operated at its maximum capacity (The stoker was operated on manual control at maximum speed with the main rams in overdrive 50 per cent of the time.) and was just able to maintain the rated pressure on the unit. This bed was designated as a medium fuel bed (see Discussion of Results, page 54, for a more detailed discussion).

The fuel bed thicknesses were measured with respect to the bare clinker chill tubes located on each side of the furnace by observing the height of the fuel bed through the side furnace doors (refer to Figs. 5 and 6).

Each test was conducted at a constant load (see flow meter charts in Appendix); this constant load was maintained by: (1) throttling a constant weight of the steam generated by the unit through a reducing valve to a low pressure steam header and (2) maintaining a constant electrical load on a turbogenerator also supplied with steam directly from the unit being tested.



FUEL BED CONTOURS USED IN TESTS AT 30,000 POUNDS PER HOUR STEAM GENERATOR OUTPUT


FUEL BED THICKNESS FOR ALL TESTS
(Measured From Top of Tuyers Perpendicular
to Tubes at Point of Maximum Thickness)
Fuel Bed Depth - Inches
Clinker Chill Tubes (Numbered From Top To Bottom)
41 1
35 2
29 3
23 4
17 5
11 6
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
High
Medium
Low
Fig. 6
February, 1947

The authors were the sole operators of the unit for the tests comprising this study.

During each individual test, care was taken to insure uniform quality of the coal used. Since the tests were conducted over a period of three months, the quality of the fuel fired varied from test to test. Representative coal samples were taken for each test, a proximate analysis was made of each sample and the ultimate analysis was calculated from the proximate analysis (see Sample Calculations, page 135).

The fuel used in the tests was weighed in a traveling weigh larry. The larry was calibrated at the beginning and at the end of the study. A time record of the coal fired was maintained. The stoker hopper was filled to capacity before the start and at the end of each test in order to give a constant rate of fuel feed and to facilitate correct weighing of the coal. The temperature of the coal in the stoker hopper was measured with a mercury-filled thermometer buried in the coal.

In this report, it has been assumed that the coal used in the tests had the same analysis at the stoker hopper as when delivered to the plant. Therefore, the terms "as fired" and "as received" are used synonymously.

The quantity of fuel on the grates, the rate of fuel feed, combustion conditions, rate of feeding water, water level in the drums, excess air and controllable temperatures and pressures were, as nearly as possible, the same at the end of each test as at the beginning.

An investigation was made under test conditions to determine the time required to attain stabilization or equilibrium with respect to temperatures prior to starting a test. The investigation proved that, in general, (as

stated in the A.S.M.E. Power Test Code) at least three hours is required.

During normal operation of the unit, the sootblowers are used once during each eight-hour shift. In order to prevent an excessive collection of soot and fly ash on the tubes, it was deemed advisable to use the sootblowers prior to starting each test, twice during each test at eight-hour intervals, and once just before the completion of the test.

Due to the limited number of personnel conducting the tests and the large quantity of data to be recorded, the frequency of readings was changed from 15 minute intervals (as prescribed by the A.S.M.E. Test Code) to 20 minute intervals.

The output of the unit was measured with a Cochrane flow meter. The meter was calibrated before and after each test.

The blowing down of the boiler during the tests was accomplished by means of a continuous blow-down line installed on the front or water drum (intermittent blow-down was not used). The blow-down water was piped to a flash tank where its pressure was reduced so that a portion of its heat content was given up in the low pressure steam formed in the tank. The steam thus generated was piped to an open heater where it was used for feedwater heating. The remaining blow-down water in the flash tank was passed through a heat exchanger where it was used to heat the soft water make-up to the open heater. The blow-down water was then measured by a Hersey water meter and discharged into a sewer. The temperature of the blow-down water at the flash tank and the flash tank pressure were recorded so that the quantity of steam flashed could be calculated. (This quantity

of steam plus the quantity of blow-down water measured by the Venzey meter is equal to the total quantity of blow-down water withdrawn from the front drum.)

The methyl orange alkalinities (expressed as ppm of $CaCO_3$) of the blow-down water and feedwater were determined hourly during the tests. The samples of blow-down water were drawn from the blow-down line several feet ahead of the pressure reducing valve. The feedwater samples were drawn from the discharge side of the boiler feedwater pump. The alkalinities of the feedwater and the blow-down water were used to determine the percentage optimum blow-down based on the quantity of feedwater entering the rear drum.

Mercury-filled, etched-stem type thermometers were used to measure the superheated steam, feedwater, calorimeter steam and blow-down water temperatures. These thermometers were installed in insulated wells filled with 600-W steam cylinder oil. These thermometer wells were approximately four inches deep with the exception of the well in the superheater header which was eight inches deep. All of the thermometers were calibrated before and after the completion of the 12 tests.

The quality of the steam in the rear or steam drum was determined with the use of an insulated throttling calorimeter. The sampling pipe for the calorimeter, installed when the boiler was erected, was located below the dry pan in the steam drum. A tailpipe and condenser were not installed on the calorimeter; therefore, the pressure inside the calorimeter was almost always atmospheric. Nevertheless, a mercury U-tube manometer was used to indicate the pressure within this instrument. The drum pressure gage was installed on the sampling pipe between the calorimeter and the steam drum.

The pressure of the superheated steam was measured at the exit end

of the superheater outlet header.

A Fisher, glass type Orsat analyzer was used to determine the chemical analysis of the flue gases leaving the unit. The following reagents were used in the analyzer: a potassium hydroxide solution for the absorption of CO_2, an alkaline solution of pyrogallic acid for the absorption of O_2 and a cuprous chloride solution saturated with ammonia gas for the absorption of CO.[1]

An aspirator was used to collect the gas sample for the analyzer. The gas was bubbled through a water bath before it was analyzed to cool it to room temperature, to facilitate observation of its rate of flow to the analyzer and to saturate it with water. (When the gas sample was saturated with water and a certain volume of gas was removed by absorption, a proportionate amount of water vapor was condensed. Therefore, the results of the volumeteric analysis were exactly the same as though a dry gas had been analyzed.)

The flue gas temperature was measured at the outlet of the last pass of the boiler with a base metal thermocouple connected to a Brown pyrometer (2400 F range); this pyrometer was installed at the boiler room floor level. A fan was used to circulate air from the boiler room floor level to the cold junction of the thermocouple in order to keep the temperature of the cold junction as near the boiler room temperature as possible.

The dry and wet bulb temperatures of the combustion air were measured at the inlet to the forced draft fan. Mercury-filled thermometers were used to measure these temperatures. A gauze wick, immersed in a bottle of water

[1] H. Diedrichs and W. C. Andrae, Experimental Mechanical Engineering, Vol. 1, Engineering Instruments, p 757-759. John Wiley and Sons, Inc., 1930.

was attached to the bulb of the wet bulb thermometer.

All of the doors and windows in the fan room, with the exception of one door, remained closed during the tests. The combustion air circulated through the basement of the plant and was slightly preheated before entering the forced draft fan.

The flue gas and combustion air quantities were calculated by means of combustion equations.

The stoker is of the continuous ash discharge type. Therefore, it was not necessary to clean the fire of refuse, but was only necessary to remove the refuse from the ash pit just before the start and at the end of each test so as to have the weight of refuse correspond to the weight of coal burned. The bridge wall tubes and the front wall above the stoker retorts were deslagged with a slice bar prior to the start of each test.

All of the refuse discharged into the ash pit during each test was weighed and a sample was taken from each portion weighed to make a representative sample of the refuse collected. The refuse sample was analyzed to determine the per cent combustible present.

The fly ash (Fly ash is composed of small particles of combined ash and carbon light enough to be airborne and swept from the fuel bed. A large portion of this fly ash is carried into the stack. The particles become cooled below the combustion temperature of carbon before leaving the furnace; all of the carbon is not burned.) was collected in a hopper at the bottom of the last pass, was removed through the ash pit at the end of each test and was weighed (The hopper was emptied before starting each test.). The amount of fly ash leaving the unit was determined by the ash-balance difference method (see page 140, Sample Calculations). A representa-

tive sample was collected and analyzed to determine the combustible in the fly ash.

The furnace temperature[2] directly above the surface of the fuel bed was determined for Test Nos. 20-M, 25-M, 30-M, 36-M and 40-M with the use of an optical pyrometer. The pyrometer was sighted through the three furnace doorways on one side and one doorway at the rear of the unit. The line of sight of the pyrometer was through the flames, which were projected outward from the fuel bed, but always above the fuel bed. Each of these four temperatures were determined several times during each test. The temperatures were averaged to give the furnace temperature for the particular test involved.

The gross thermal efficiency of the unit was determined for each test rather than the net efficiency as the power consumption of the auxiliaries was not measured.

[2] F.T. Morse, Power Plant Engineering and Design, Second Edition, p 408. D. Van Nostrand Company, Inc., 1942.

Instrumentation

Pressure Gages: Bourdon-tube pressure gages (protected with gage syphons) were used to measure the superheated steam and steam drum pressures. The gages were calibrated with a dead weight gage tester[1] before the first test, between each two tests and at the end of the twelfth test. The pre-test and post-test calibration data were averaged and a calibration curve was plotted for each individual test.

Thermometers: The thermometers used in this study were the mercury-filled etched-stem type. All of the thermometers were calibrated prior to and at the completion of the study. The calibration data was averaged and a calibration curve was plotted for each thermometer.

Calibration was accomplished by: (1) the use of a three-wire compensating resistance thermometer and Wheatstone bridge[2]; (2) checking at the melting or boiling points of various substances and (3) comparison with secondary standard thermometers which had been calibrated against standard instruments.

Five thermometers were calibrated with a resistance thermometer and Wheatstone bridge. The electrical resistance of the resistance thermometer was determined for the temperature of melting pure ice and boiling distilled water. These values of resistance and temperature were plotted to give a calibration curve for the resistance thermometer.[3] The mercury thermometers to be calibrated were placed in a bath with the resistance thermometer. The temperature of the mercury thermometers and the resistance of the

[1] H. Diedrich and W.C. Andrae, Experimental Mechanical Engineering, Vol. 1, Engineering Instruments, p 97 - 101. John Wiley and Sons, Inc., 1930.

[2] W. R. Wood and J.M. Cork, Pyrometery, p 93-96. McGraw-Hill Book Co., Inc.,1941.

[3] W.R. Wood and J.M. Cork, Pyrometery, Fig. 33, p 90. McGraw-Hill Book Co., Inc., 1941.

resistance thermometer were recorded at the melting point of ice, the boiling point of water and at five temperatures between these two linits. The recorded resistances were converted to corrected temperatures for the mercury thermometers by the use of the calibration curve for the resistance thermometer.

Two of the five previously mentioned thermometers were calibrated above the boiling point of water. Pure tin was melted (231.9 C) in a crucible. The bulbs of the two thermometers were immersed in the molten tin and moved around until the temperature became constant and, at the same time, a thin layer of solidified tin formed on the bulbs. The next and final calibration point was obtained by boiling pure benzophenone (305.9 C at 760 mm of Hg) in a boiling point apparatus[4] with the thermometers suspended in the apparatus.

Five other thermometers were calibrated with the use of melting ice, boiling water and heated turbine lubricating oil. A calibrated thermometer was used as a standard of comparison.

Thermocouple and Galvanometer: The seven ft long, base metal thermocouple, used to measure the flue gas temperature, was encased in a six ft length of one in. steel pipe. The pipe was inserted into the flue gas passage through a small hole cut in the breeching. In order to correct for any error due to heat transfer by conduction along the thermocouple away from the hot junction, 12-in. of the hot junction end of the couple was bent parallel to the gas flow. Any error caused by radiation was reduced to a minimum by covering the 12-in. section of the couple from the hot junction to the bend with a

[4] H. Diedrichs and W.C. Andrea, Experimental Mechanical Engineering, Vol. 1, Engineering Instruments, Fig. 5-12, p 116. John Wiley and Sons, Inc., 1930.

one in. diameter refractory protection tube. [5,6]

When the thermocouple was installed, the cross-section of the breeching was searched, i.e., the thermocouple was moved back and forth and up and down in the breeching, in order to find the average temperature zone of the flue gas passage at the point of installation.

The thermocouple and its galvanometer pyrometer were calibrated as a pyrometer unit. A calibrated, mercury-filled thermometer and the hot junction of the thermocouple, wrapped together with fine copper wire, were suspended inside a short section of refractory pipe placed over an electric heater. The thermocouple and galvanometer pyrometer were calibrated against the standard thermometer. The temperatures of the cold junction of the couple and the galvanometer pyrometer were kept constant at room temperature throughout the calibration test. A correction was applied to the pyrometer readings of the flue gas temperatures to compensate for the variation of the cold junction temperature during the boiler tests and the cold junction temperature for which the pyrometer was set.[7] The pyrometer was set for a cold junction temperature of 100 F during all of the tests.

The corrected average flue gas temperature for each test was determined by averaging all of the pyrometer flue gas temperature readings for the test and correcting this average temperature by the use of the calibration curve for the thermocouple and galvanometer pyrometer. A correction for the cold junction temperature of the couple was added to this corrected temperature.

[5] M. Jakob and G.A. Hawkins, Elements of Heat Transfer and Insulation, p 142-146. John Wiley and Sons, Inc., 1942.

[6] R. Royds, Heat Transmission By Radiation, Convection and Conduction, p 18-21. Constable and Co., Ltd., London, 1921.

[7] Catalogue No. 12, Brown Pyrometers, p 64. Brown Instrument Co.

The correction amounted to one deg Fah for every deg Fah the cold junction temperature was greater than the 100 F the pyrometer was set for.

Flow Meter: The Cochrane (electrical) flow meter, used to measure the steam output of the steam generating unit, was calibrated and checked at the beginning and at the conclusion of each test, i.e., the zero setting and the integrator were checked and adjusted. The following additional servicing was done to the meter between the sixth and seventh tests: the galvanometer boom was adjusted, the relay overtravel was checked and the meter was cleaned.[8] Prior to the study a meter mechanic from the factory cleaned and adjusted the meter.

Both the orifice used with the flow meter and the flow meter were designed to operate at 250 psig pressure and 502 F. Whenever the conditions of the steam differed from the design standards of the meter, pressure and temperature corrections were applied to the integrator and flow pen readings.[9]

The integrator has a multiplying factor of 500, i.e., the integrator reading must be multiplied by 500 to obtain the actual steam flow. When the integrator was checked, the error of its reading was determined and reported as the number of units in 30 units, fast or slow.

The total steam generated during a test was determined by the difference of the integrator readings at the end and the start of each test. This reading was multiplied by 500 and by pressure, temperature and integrator error correction factors to give the corrected weight of steam generated

[8,9] Directions for Installation, Adjusting and Operating Cochrane Flow Meters, Publication 2097, p 2386 to 2390 Incl. (8), p 2409 to 2409-3 Incl. (9). Cochrane Corp.

during a test.

Platform Scale: The Fairbanks platform scale used to calibrate the weigh larry and blow-down water meter and to weigh the refuse and fly ash was calibrated and adjusted before the first test.[1] The scale was checked at the end of the study and was found to be in adjustment.

Blow-down Water Meter: The Hersey vortex water meter was calibrated to determine its accuracy when measuring blow-down water containing large quantities of solids. The meter was calibrated at three different heads and three quantities of flow for each head. The water flowing through the meter was weighed in a tank on a platform scale. A time record was kept of the quantity of flow as recorded by the meter and as determined by actual weighing. A correction curve was plotted for the meter using this data.

Weigh Larry: The Fairbanks Registering Beam, traveling weigh larry, used to weigh and transfer coal from the overhead storage bunkers to the stoker hopper, was calibrated before the start and at the end of the study. When the larry was calibrated, it was filled with coal to full capacity. The coal in the larry was emptied into a half barrel in approximately 150 pound increments. Each increment was weighed by the larry and a platform scale. The pre-test and post-test data were averaged and calibration curve was plotted.

Draft Gages: Limp-diaphragm draft gages (Hays Corp.) were used to measure the front and rear wind box pressures, the furnace draft and the outlet draft in the last pass. These gages were sent to the manufacturer for reconditioning and adjustment prior to the start of the study.

[1] C.F. Shoop and G. L. Tuve, Mechanical Engineering Laboratory Practice, First Edition, p 34-36. McGraw-Hill Book Co., 1930.

Coal, Refuse and Fly Ash Sampling and Analysis

The proximate analysis, ash fusion temperature and higher heating value were determined for a representative sample of the coal fired during each test. These determinations were made in accordance with the A.S.T.M. Standards.[1]

The representative coal sample was obtained for each test as follows: Each time the hopper was filled, three pounds were taken from the center and from each end of the hopper, and placed in air tight jars. At the end of each test, the representative sample was taken from the combined contents of the jars according to A.S.T.M. Standards.

The refuse collected was weighed at the end of each test. Approximately five pounds were taken from each 100 pounds during weighing. A representative sample was taken from a mixture of the five pound portions according to A.S.T.M. Standards.

The fly ash which accumulated in the fly ash hoppers was measured at the end of each test and a representative sample was taken.

The combustible in the fly ash and refuse was determined in the laboratory in accordance with the A.S.T.M. Standards for determining the fixed carbon content of coal.

[1] Committee D-5, American Society for Testing Materials Standards on Coal and Coke. American Society for Testing Materials, 1944.

DISCUSSION OF RESULTS

One of the most important factors in obtaining the highest efficiency for any steam generating unit is the proper control of excess air. A low percentage of excess air causes incomplete combustion of the fuel and loss of efficiency, whereas a high percentage of excess air increases the loss to the dry flue gases, and thus lowers the efficiency. The percentage of excess air that will give the optimum efficiency lies somewhere between these two limits.

One of the purposes of the automatic combustion control equipment is to maintain the proper proportions of air and fuel and to give the optimum efficiency for all operating conditions. Since the air flow is controlled by small variations in steam pressure, excess air control can be accomplished only by varying the fuel feed and thickness of the fuel bed over the grate area. (A high rate of fuel feed and a thick fuel bed result in a low percentage of excess air; a low rate of fuel feed and a thin fuel bed result in a high percentage of excess air.) The average value of excess air was approximately 26 per cent for the thin fuel bed and approximately 5 per cent for the thick fuel bed. The average value for the medium fuel bed was between these two values and was approximately 16 per cent (see Fig. 7).

The approximate thickness of the fuel bed can be determined by visual inspection through the furnace doors. The combustion controls include a recording CO_2 meter to be used under normal operating conditions as an index for determining the optimum fuel bed thickness. However, the operator must know the proper values for CO_2 in order to maintain the proper thickness

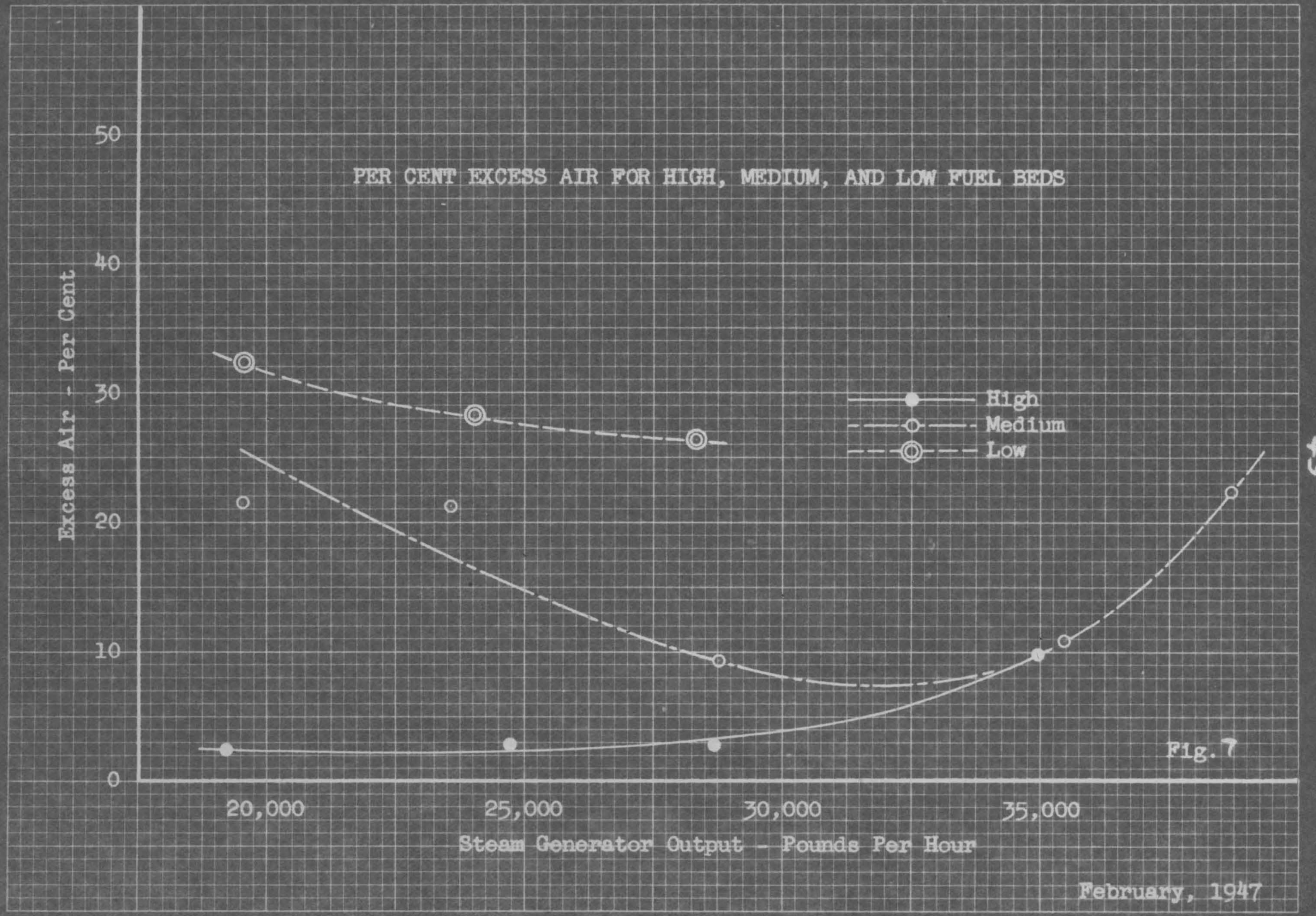

PER CENT EXCESS AIR FOR HIGH, MEDIUM, AND LOW FUEL BEDS
Excess Air - Per Cent
50
40
30
20
10
0
High
Medium
Low
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
February, 1947

Fig. 7

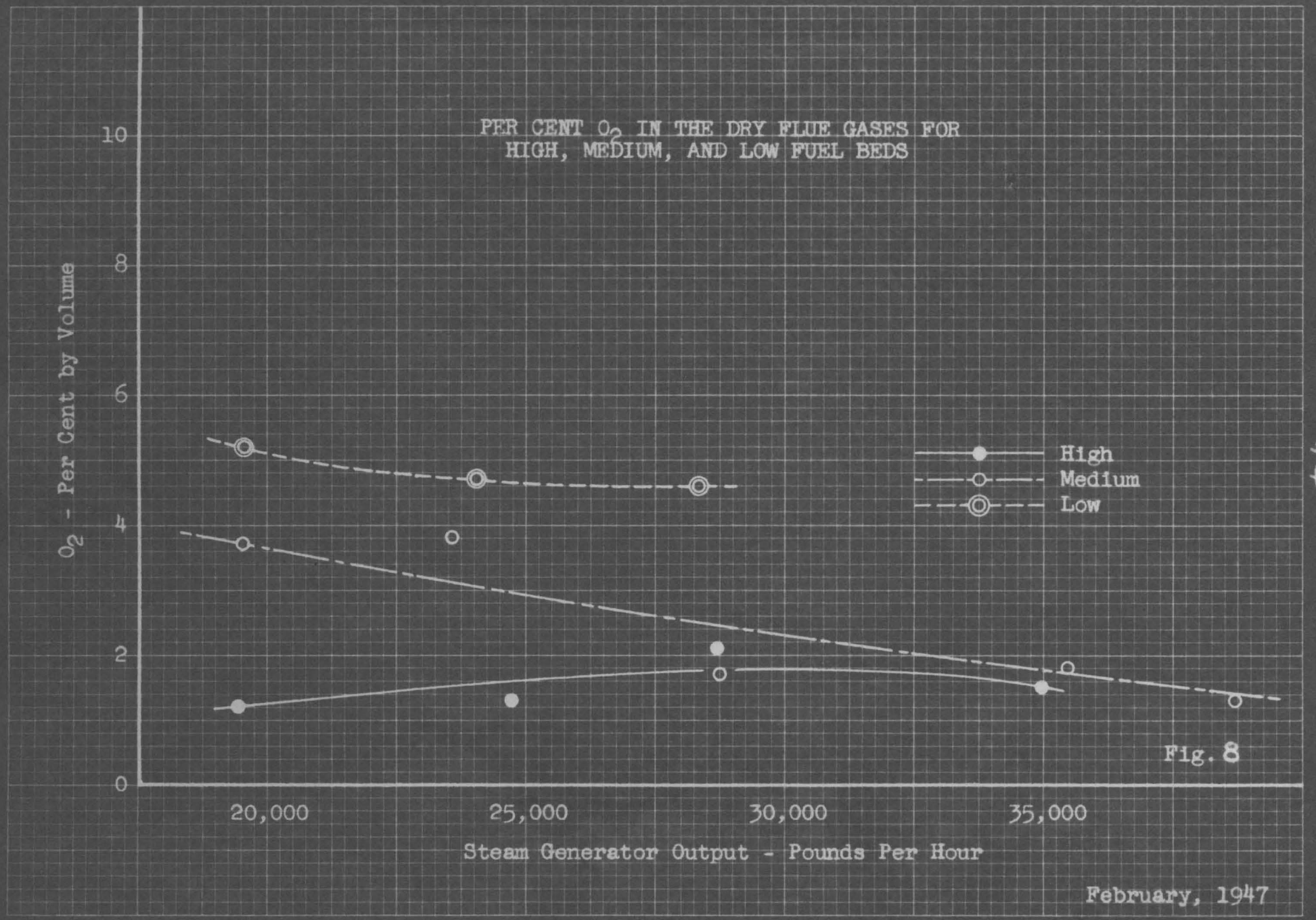

PER CENT O_2 IN THE DRY FLUE GASES FOR
HIGH, MEDIUM, AND LOW FUEL BEDS
O_2 - Per Cent by Volume
10
8
6
4
2
0
High
Medium
Low
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
February, 1947

Fig. 8

of the fuel bed by the use of the CO_2 meter; unfortunately, these optimum values change as the proximate analysis of the fuel fired changes. When the stoker was installed, the manufacturer furnished CO_2 data (see Table I) obtained with the use of a fuel of the following proximate analysis:

Per cent fixed carbon	54.0
Per cent volatile matter	34.5
Per cent ash	9.0
Per cent moisture	2.5
Per cent sulphur	0.8
Ash fusion temperature	2600 F
Higher heating value	13,500 Btu per pound

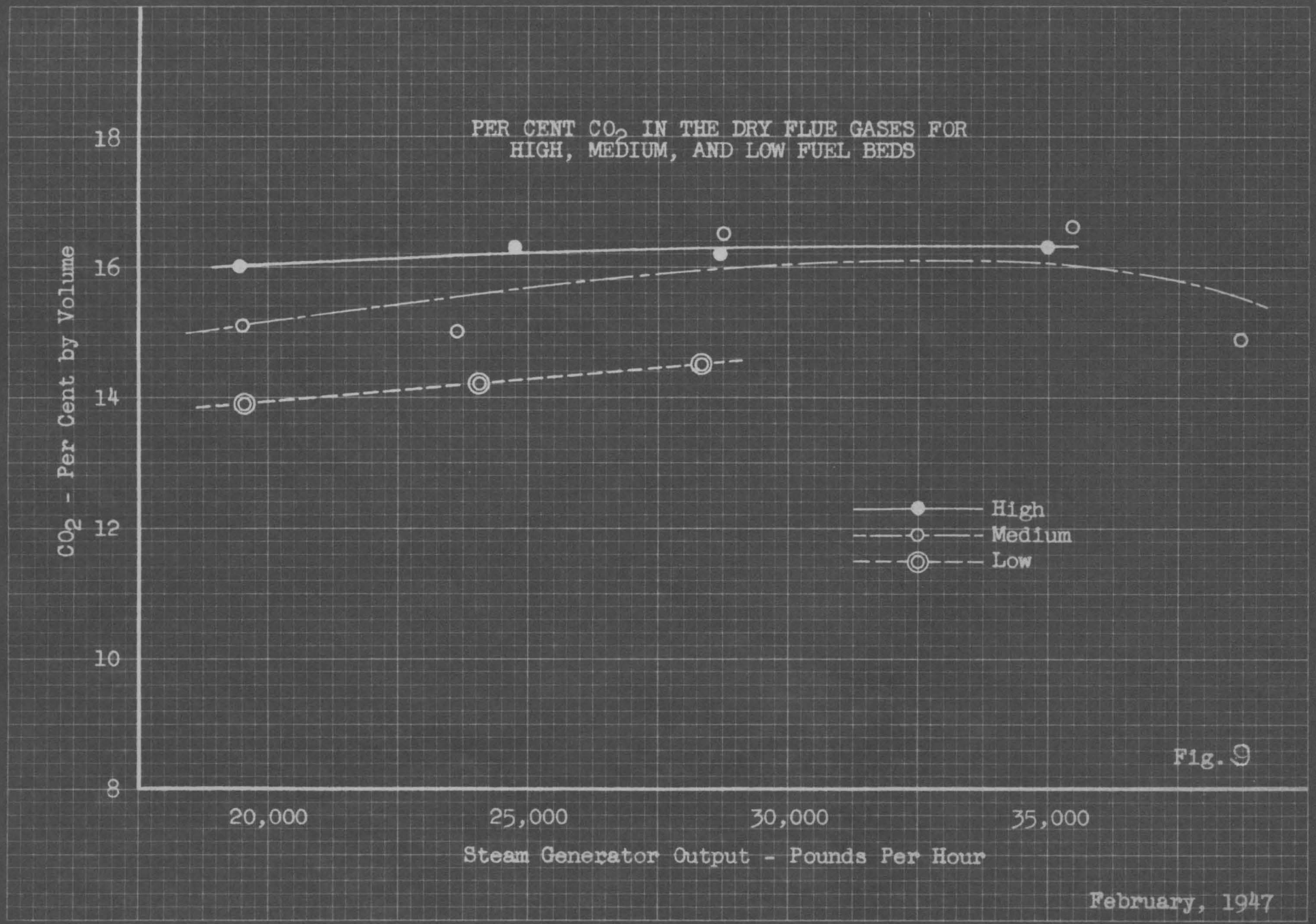
CO_2 values were not given for fuels of different compositions.

Table I

CO_2, Per Cent by Volume, Optimum Test Conditions

Output, Pounds of Steam per Hour	Manufacturer's Specifications CO_2	Diamond & DeBusk CO_2	Results of Investigation	
			CO_2	Fuel Bed
20,000	14.2	13.7	14.0	Low
25,000	14.6	13.8	14.3	Low
30,000	14.8	14.0	16.0	Medium
35,000	14.8	14.4	16.0	Medium
38,700	14.7	14.9	15.6	Medium

Table I and Fig. 9 show that the CO_2 values obtained for the thin fuel bed at low outputs were nearly the same as those given by the stoker manufacturer; values for the medium fuel bed varied considerably (actual values varied from 15.0 to 16.6 per cent), and were higher than the manufacturer's values. At loads between approximately 29,000 and 35,000 pounds of steam per hour, values for the high fuel bed were practically the same as those for the medium fuel bed. Table II shows the effect of CO in the flue gases on the CO_2 values. The CO_2 for the thick fuel bed would have been higher had there been less CO in the flue gases. This comparison of values shows that


PER CENT CO_2 IN THE DRY FLUE GASES FOR
HIGH, MEDIUM, AND LOW FUEL BEDS
CO_2 - Per Cent by Volume
18
16
14
12
10
8
High
Medium
Low
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
Fig. 9
February, 1947

with a thin fuel bed, the CO_2 meter may be used with reasonable accuracy for determining the fuel bed thickness. However, when the CO in the flue gases is high, the meter is not accurate for this determination. Therefore, no set values for CO_2 can be used as an accurate indication of fuel bed thickness for all conditions of operation. A comparison of Figs. 7 and 9 shows that

Table II

Flue Gas Analyses, Per Cent by Volume, for the Three Fuel Bed Conditions at the 30,000 Pounds of Steam per Hour Tests

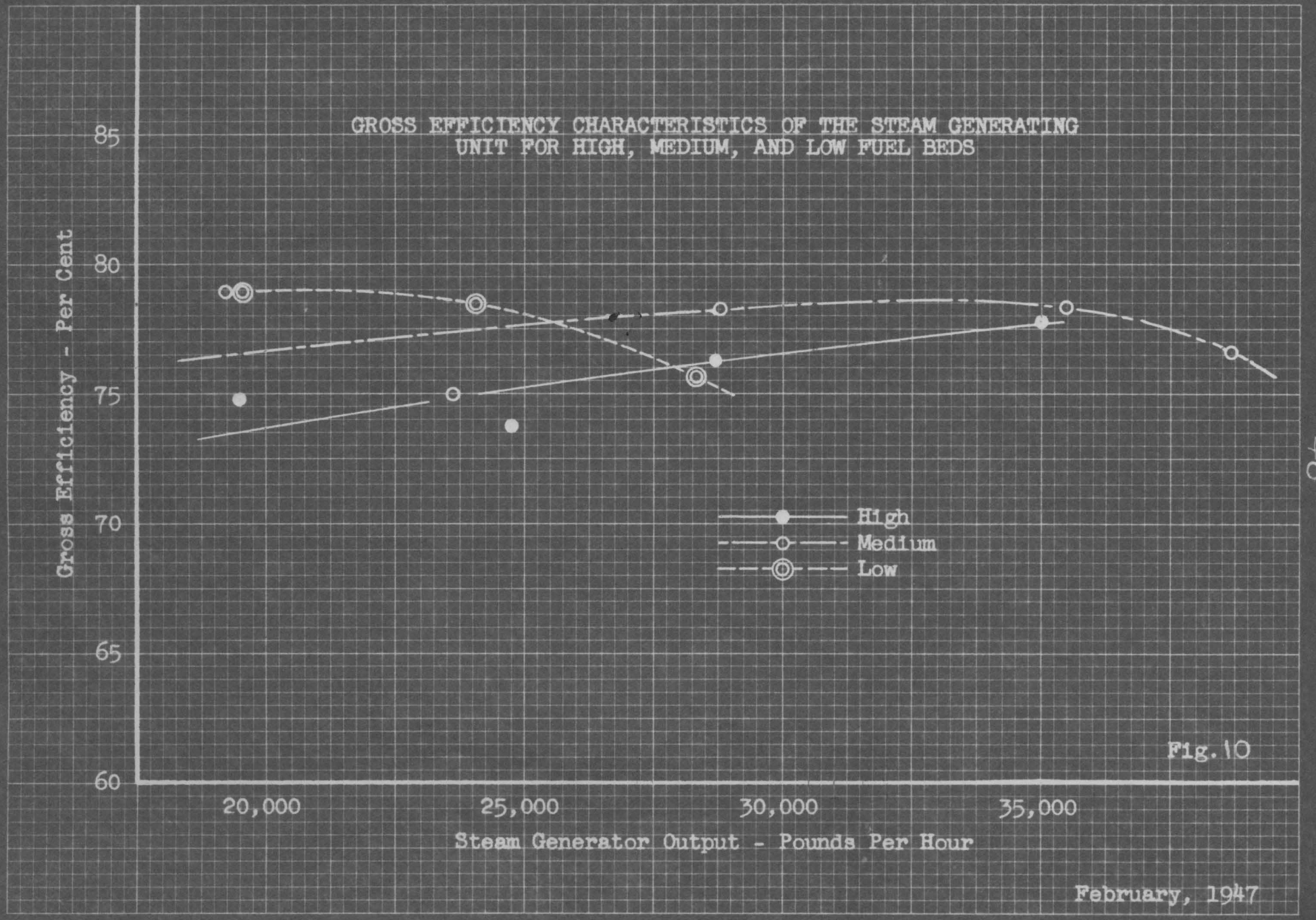
Type of Fuel Bed	CO_2	O_2	CO	N_2
Low	14.5	4.6	0.0	80.9
Medium	16.5	1.7	0.3	81.5
High	16.2	2.1	1.3	80.4

for all fuel bed thicknesses the per cent CO_2 varies inversely with the per cent excess air; therefore, the recording CO_2 meter is an indicator of increasing or decreasing the excess air, and in this respect is an aid to the proper operation of the unit.

The efficiency curves (Fig. 10) show that for all outputs of the steam generating unit considerably higher efficiencies were obtained for the low and medium fuel beds than for the high fuel bed. At low outputs, the low fuel bed gave the highest efficiency; at high outputs, the medium bed gave higher efficiencies than the thick fuel bed.

At outputs of 25,000 pounds per hour and below, the highest efficiencies were obtained with the use of the low fuel bed. The reasons for these higher efficiencies are:

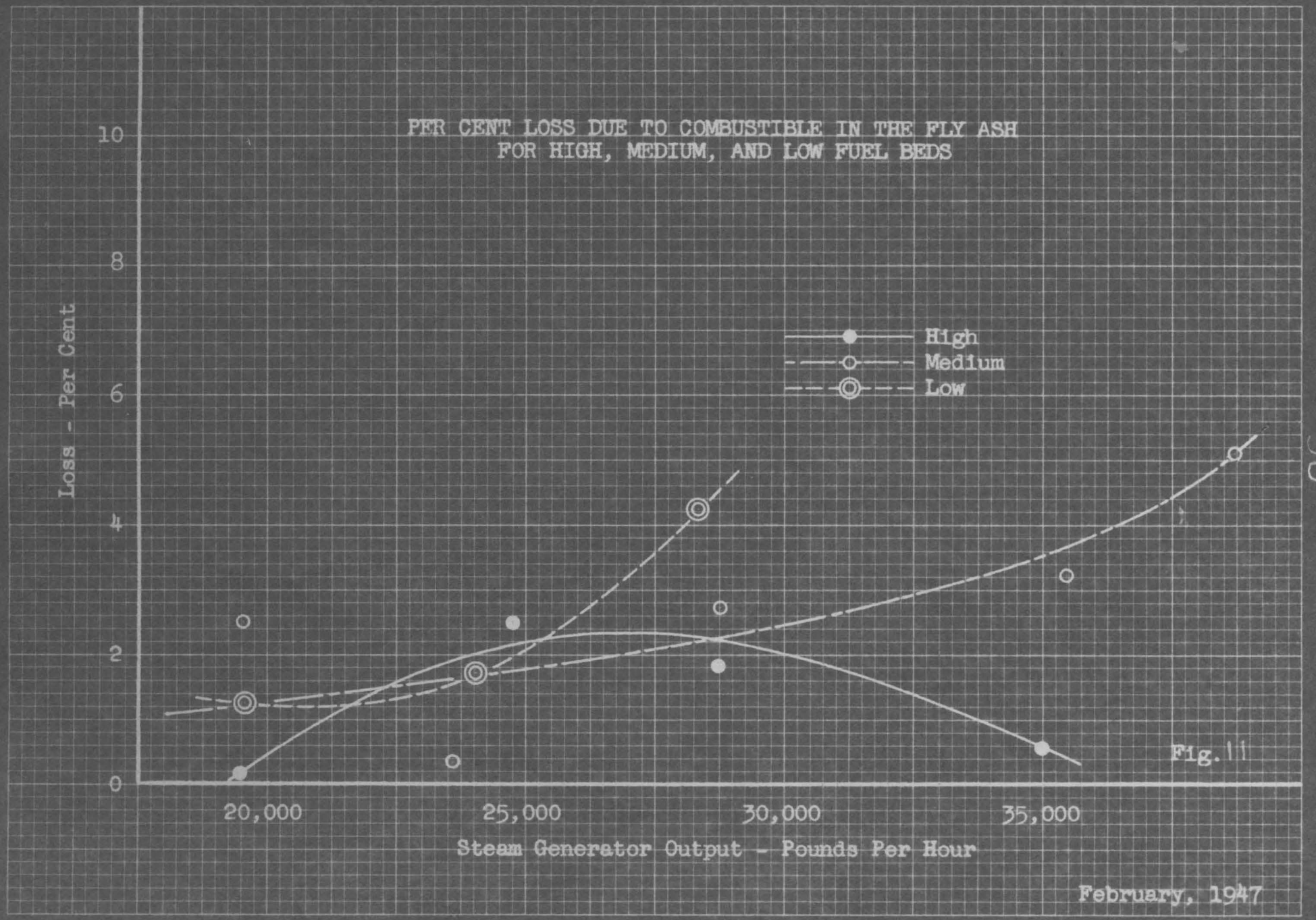
(1) The loss due to combustible in the fly ash was low at loads below 25,000 pounds per hour, but at higher loads this loss increased

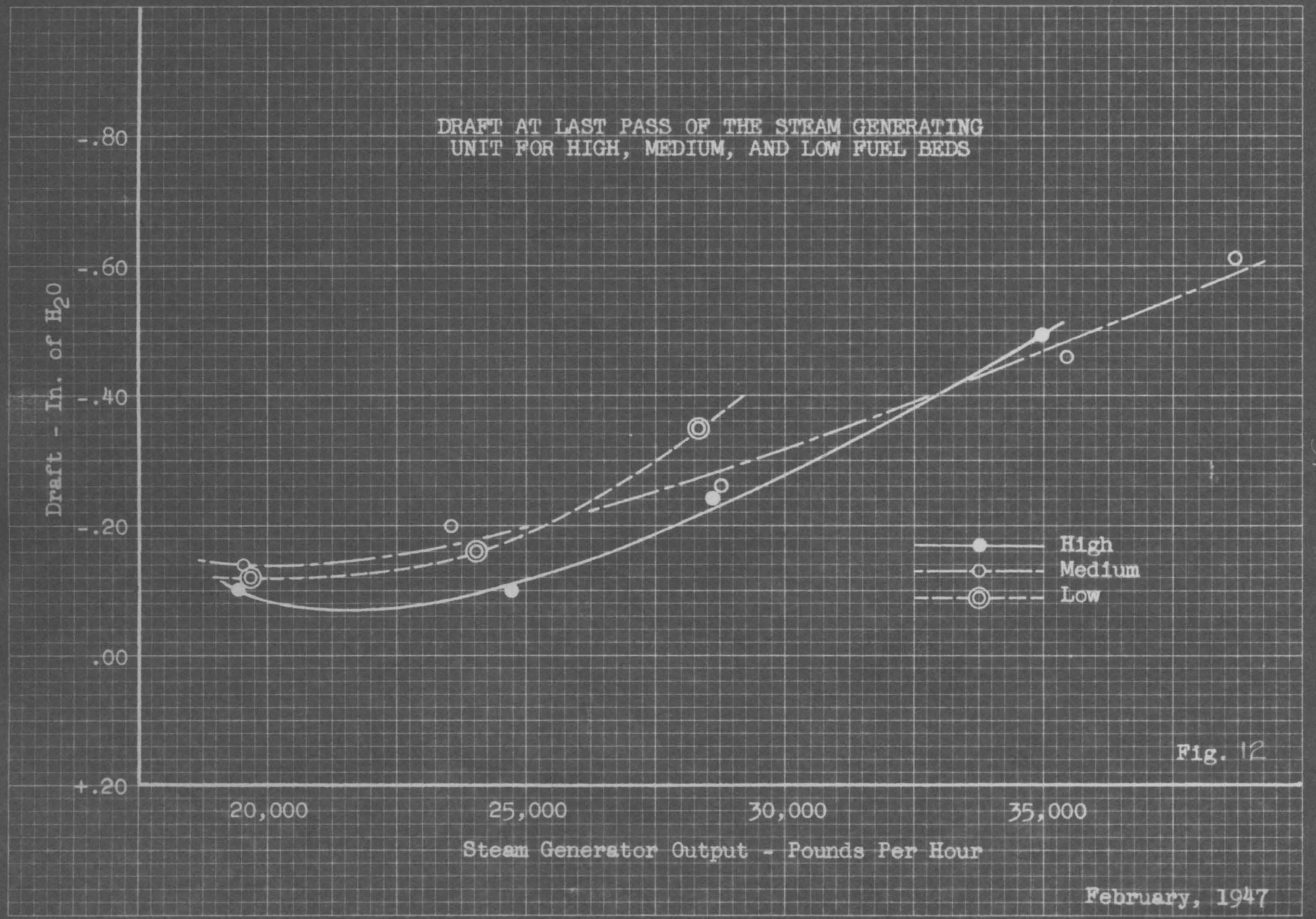

GROSS EFFICIENCY CHARACTERISTICS OF THE STEAM GENERATING UNIT FOR HIGH, MEDIUM, AND LOW FUEL BEDS
Gross Efficiency - Per Cent
85
80
75
70
65
60
High
Medium
Low
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
Fig. 10
February, 1947

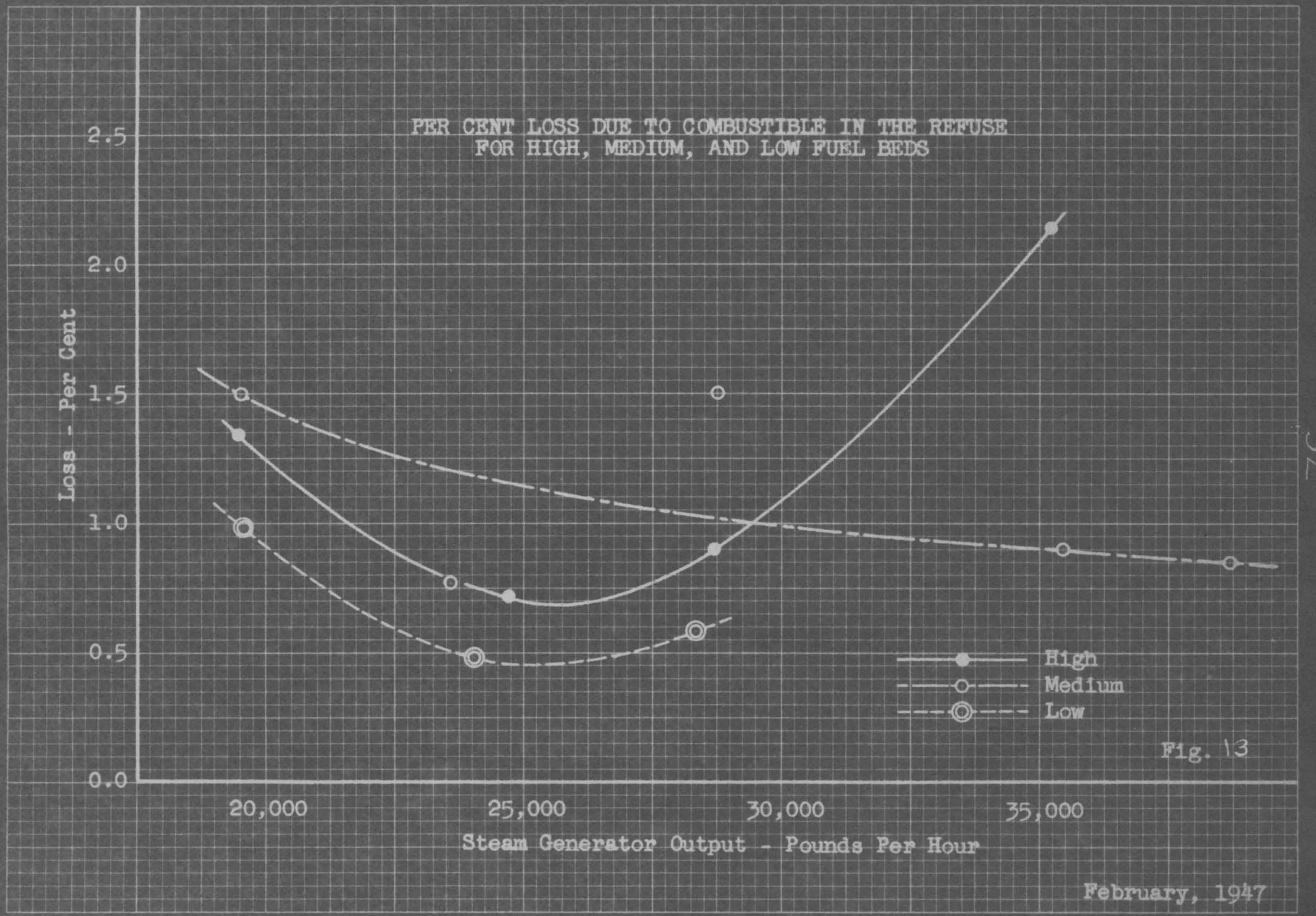
rapidly, as shown in Fig. 11. The reason for this lower loss at low outputs is that the furnace draft required was very low as shown in Fig. 12; the velocity of the gases passing through the fuel bed was low, and fewer particles of unburned carbon were carried out of the fuel bed and into the stack. As the output of the unit increased, the increased draft caused this loss to increase rapidly, and to become extremely high at outputs above 25,000 pounds per hour.

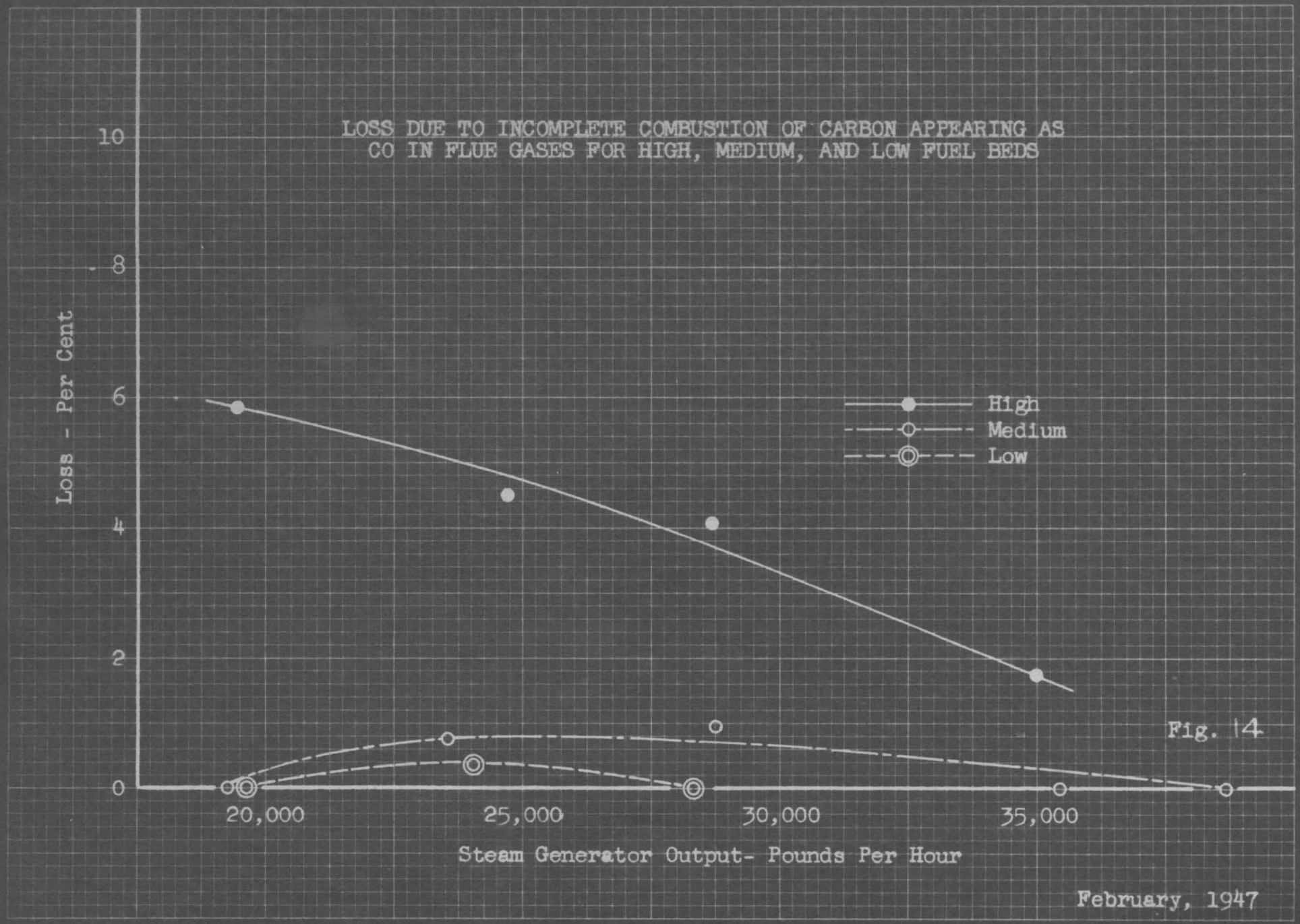
(2) The loss due to combustible in the refuse for the thin fuel bed was the lowest of the three fuel bed thicknesses, as shown in Fig. 13. The reason for this low loss is the higher percentage of excess air (see Fig. 7). When the per cent excess air is high, more complete burning of the fuel takes place, and the unburned carbon in the refuse is low.

(3) The loss due to CO in the flue gases (Fig. 14) was less for the low fuel bed than for the other two, an indication that the combustion was more complete. The loss for the high fuel beds at loads below 30,000 pounds per hour was extremely high as the per cent excess air obtained was not high enough to insure complete combustion. (Considerable difficulty was experienced with the determination of the percentage CO in the flue gases with the hand Orsat analyzer. The cuprous chloride solution used to absorb the CO oxidized so rapidly that it was very difficult to obtain correct readings throughout each test. For this reason an average was taken of the higher CO values recorded. These were considered by the authors to be correct. For the tests that gave only slight traces


PER CENT LOSS DUE TO COMBUSTIBLE IN THE FLY ASH
FOR HIGH, MEDIUM, AND LOW FUEL BEDS
Loss - Per Cent
10
8
6
4
2
0
High
Medium
Low
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
Fig. 11
February, 1947


DRAFT AT LAST PASS OF THE STEAM GENERATING
UNIT FOR HIGH, MEDIUM, AND LOW FUEL BEDS
-.80
-.60
-.40
-.20
.00
+.20
Draft - In. of H_2O
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
High
Medium
Low
Fig. 12
February, 1947

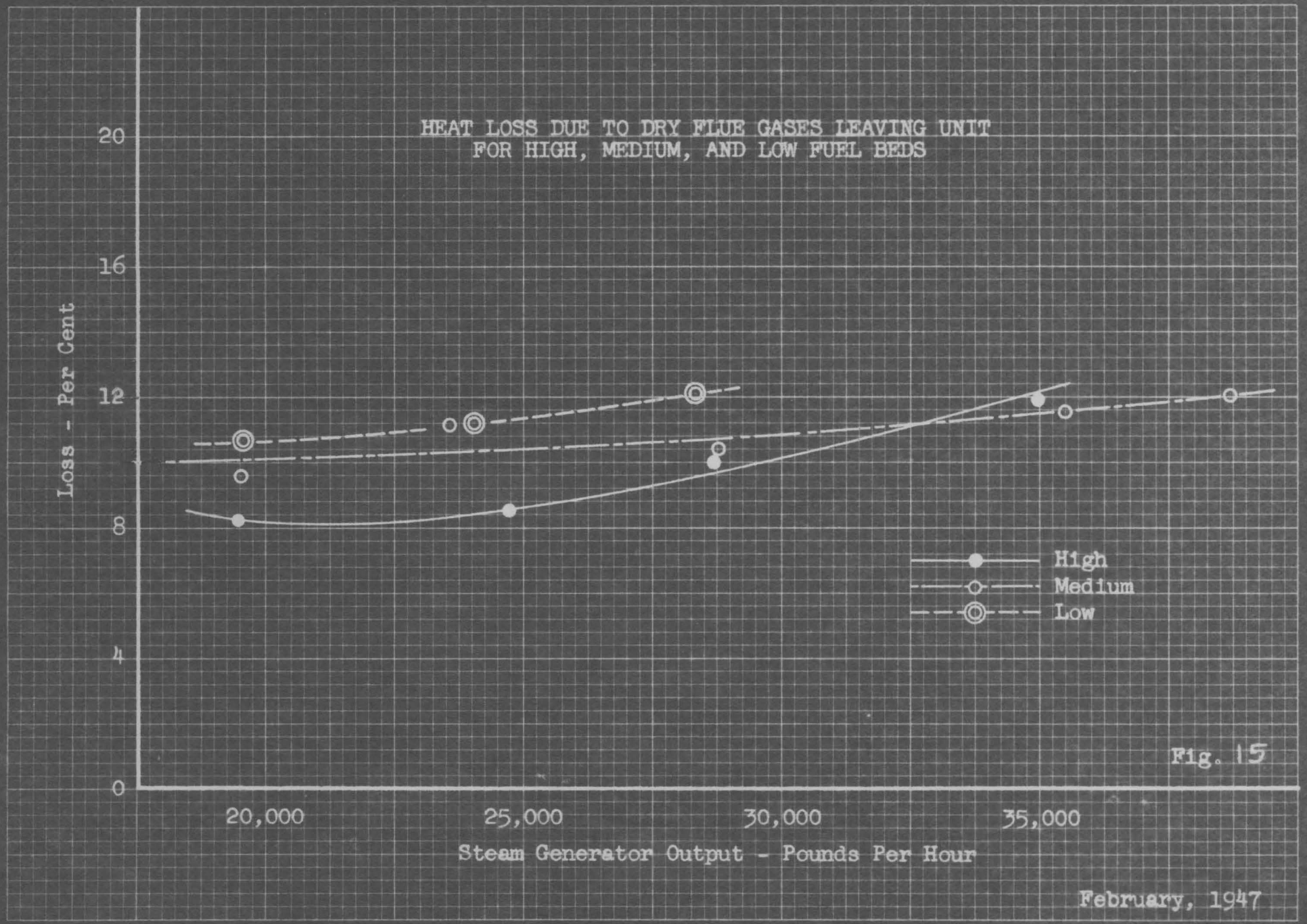

PER CENT LOSS DUE TO COMBUSTIBLE IN THE REFUSE
FOR HIGH, MEDIUM, AND LOW FUEL BEDS
Loss - Per Cent
2.5
2.0
1.5
1.0
0.5
0.0
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
High
Medium
Low
Fig. 13
February, 1947


LOSS DUE TO INCOMPLETE COMBUSTION OF CARBON APPEARING AS CO IN FLUE GASES FOR HIGH, MEDIUM, AND LOW FUEL BEDS
Loss - Per Cent
10
8
6
4
2
0
High
Medium
Low
20,000
25,000
30,000
35,000
Steam Generator Output- Pounds Per Hour
Fig. 14
February, 1947

of CO for only a few readings, the CO was taken to be zero).

(4) The loss due to dry flue gases (Fig. 15) was highest for the thin fuel bed, but its value was lower than the sum of the losses previously discussed for loads up to 25,000 pounds per hour. This was the largest loss; its value increased as the output increased to such an extent that very low efficiencies were obtained at 27,000 pounds per hour and above. (The loss due to dry flue gases depends chiefly on the temperature of the flue gases leaving the unit and the weight of air required for combustion. Fig. 16 shows that the flue gas temperatures were approximately equal for all fuel beds at outputs of 27,000 pounds per hour and below; as the output increased, the temperature increased. Therefore, the curves representing the losses to dry flue gases for the three fuel bed conditions should have approximately the same characteristic shapes as the curves showing the per cent excess air. Figs. 15 and 7 show this relationship to be true.)

Where thin fuel beds at outputs above 25,000 pounds per hour were used, the increase in the major losses previously discussed was so rapid that further increased loads on the unit would eventually result in the loss of steam pressure. When the fuel bed thickness had been reduced as far as possible without the loss of steam pressure at loads of 35,000 pounds per hour, the resulting fuel bed was too high to be designated as a low fuel bed. If a better grade of fuel had been available, the fuel bed could have been further lowered without the loss of steam pressure. For this reason, thin fuel bed tests were not conducted at 35,000 pounds per hour output or above.


HEAT LOSS DUE TO DRY FLUE GASES LEAVING UNIT
FOR HIGH, MEDIUM, AND LOW FUEL BEDS
Loss - Per Cent
20
16
12
8
4
0
High
Medium
Low
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
Fig. 15
February, 1947

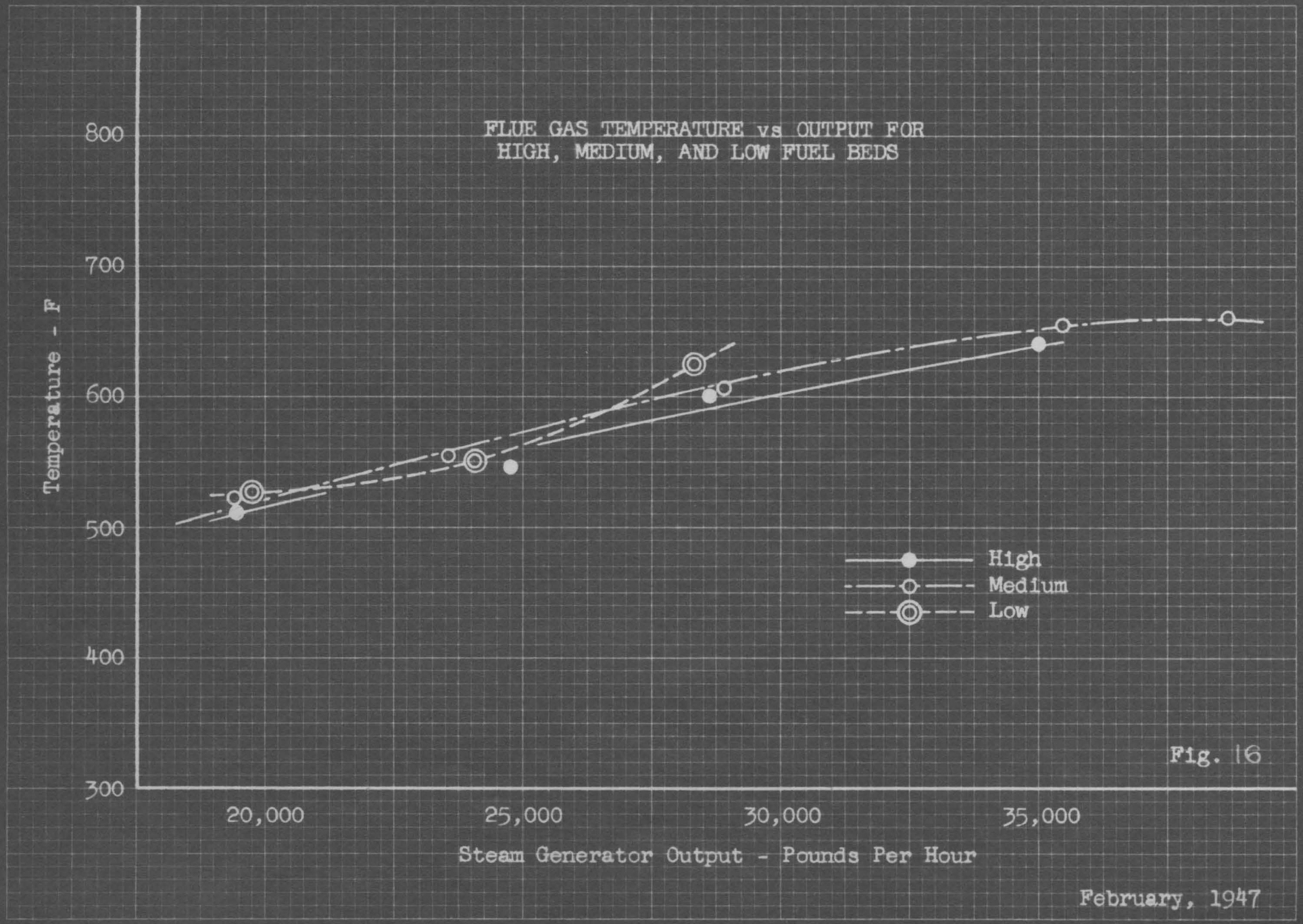

FLUE GAS TEMPERATURE vs OUTPUT FOR
HIGH, MEDIUM, AND LOW FUEL BEDS
Temperature - F
800
700
600
500
400
300
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
High
Medium
Low
Fig. 16
February, 1947

TABLE III

Ash Fusion Temperatures, Per Cent Ash in Coal and Combined Losses due to Combustible in the Fly Ash and Refuse for All Tests (Ash fusion temperatures are given in deg Fah)

Test No.	20-L	20-M	20-H	25-L	25-M	25-H	30-L	30-M	30-H	36-M	36-H	40-M
Ash Fusion Temperatures	2797	2391	2817	2675	2787	2550	2776	2431	2746	2452	2472	2762
Per Cent Ash in Coal	7.20	8.45	8.09	6.10	6.30	8.90	9.20	7.69	7.83	5.39	7.27	7.49
Combined Losses	2.22	4.01	1.50	2.21	1.08	3.20	4.80	4.24	2.70	4.11	2.72	5.93

The type of fuel bed used has much to do with the losses due to combustible in the fly ash and refuse. The per cent ash in the fuel and the ash fusion temperature also are factors affecting these losses. The percentage of ash in the fuel affects the quantity of refuse and fly ash. When the ash fusion temperature of the fuel is low, clinkers are readily formed. Since these clinkers contain a high quantity of unburned carbon in their centers, the loss due to combustible in the refuse becomes considerably higher than for high ash fusion temperature fuels. These three factors control the loss due to combustible in the refuse and fly ash. Table III shows values for ash fusion temperature and per cent ash in the fuel as compared with the combined losses due to combustible in the refuse and fly ash. Generally, these total losses had a tendency to increase as the per cent ash in the fuel increased and to decrease as the ash fusion temperature of the coal increased.

For outputs of the steam generating unit above 25,000 pounds per hour, the medium fuel bed was the most efficient (see Fig. 10). The efficiency rose slightly as the output increased up to 36,000 pounds per hour, and then dropped off sharply as the output further increased. The reasons for the higher efficiencies for the medium fuel bed as compared to the high fuel bed are:

(1) For all outputs of the unit up to approximately 30,000 pounds per hour, the loss to fly ash was approximately the same for the medium fuel bed as for the high fuel bed. At outputs above 30,000 pounds per hour, the loss to fly ash, as compared to the high fuel bed loss, increased. These variations were due to the increased draft necessary to carry the load at these outputs; more particles of unburned carbon were carried from the fuel bed by the increased velocity of the combustion air. The loss due to fly ash was considerably lower for the thick fuel bed at 35,000 pounds per hour than for the medium bed. This lower loss was caused by the excessive coking and clinkering that occurred with the use of the thick fuel bed at this output. (Coking and clinkering will be discussed later.)

(2) The loss due to combustible in the refuse at all outputs below 30,000 pounds per hour was higher for the medium fuel bed than for the other fuel beds. For loads above 30,000 pounds per hour, the loss was considerably lower for the medium fuel bed than for the high. The high loss that occurred at 35,000 pounds per hour for the thick fuel bed was due to coking and clinkering. Incomplete combustion of the fuel increased the unburned carbon in the refuse. This condition was not caused by a deficiency of

air for combustion. The curves (Fig. 7) show that the per cent excess air for the thick fuel bed was higher at 35,000 pounds per hour than at lower outputs. At 35,000 pounds per hour, this fuel bed coked up into large lumps over its entire surface. When these lumps of coke formed, only the outer surface burned completely; large amounts of unburned carbon in the centers of the lumps passed through the ash discharge orifice into the ash pit. Between these lumps, cracks and openings occurred through which the air for combustion passed without burning the fuel completely. This resulted in an indication of a high percentage of excess air.

(3) The loss to CO in the flue gases was considerably lower at all outputs of the unit for the medium fuel bed than for the high fuel bed as a result of the more complete combustion of the fuel.

(4) The loss due to dry flue gases for outputs below 33,000 pounds per hour was higher for the medium than for the thick fuel bed. This was due to the higher per cent of excess air supplied for the medium fuel bed (see Fig. 7). However, this loss was not as high as the sum of the other major losses encountered with the use of the medium bed, (Therefore,) and higher efficiencies were obtained for this fuel bed than for the thick fuel bed. The dry flue gas loss for loads above 33,000 pounds per hour was about the same for the thick fuel bed as for the medium since the per cent excess air (see Fig. 7) was about the same for both conditions.

All of the losses other than those previously discussed were so small, or so nearly constant for all tests, that they were considered as having negligible effect on the relative efficiencies for different fuel bed con-

ditions. The sum of these losses (see Table IV) varied from 5.61 to 6.39 per cent, a difference of only 0.78 per cent.

TABLE IV

Summation of Minor Losses for All Tests

Test Number	20-L	20-M	20-H	25-L	25-M	25-H	30-L	30-M	30-H	36-M	36-H	40-M
Loss to H_2O in Air	0.19	0.11	0.11	0.11	0.18	0.14	0.17	0.09	0.13	0.13	0.11	0.26
Loss to H_2O in Fuel	0.18	0.22	0.34	0.17	0.10	0.19	0.20	0.27	0.16	0.28	0.23	0.23
Loss to H_2 in Fuel	3.80	3.79	3.74	3.95	3.98	3.81	3.92	3.94	3.96	4.04	4.20	4.02
Loss to Radiation	2.20	2.20	2.20	1.75	1.80	1.70	1.50	1.50	1.40	1.20	1.20	1.10
Total Losses	6.37	6.32	6.39	5.98	6.06	5.84	5.79	5.80	5.65	5.65	5.74	5.61

The efficiency curves (Fig. 10) indicate that the efficiency for the high fuel bed was nearly as high as that for the medium fuel bed at 35,000 pounds per hour output. From the standpoint of the losses encountered, the thick fuel bed was nearly as efficient as the medium bed. However, from the operational standpoint, the use of the thick fuel bed at outputs of 35,000 pounds per hour and above was very objectionable. The chief operating difficulties encountered were: (a) clogging of the ash discharge orifice due to increased quantities of ash and unburned carbon passing through to the ash pit, and (b) the formation of large clinkers in the fuel bed due to the high furnace temperatures (see Fig. 17) that existed above the fuel bed. At these high loads, ash fusion existed for both the high and medium fuel beds due to the high fuel bed temperatures for both conditions of firing. Nevertheless, there was considerable difference in the size of the clinkers formed with the two different conditions. When the fuel bed was thick, the clinkers formed were so large that they could not pass through the ash discharge orifice into

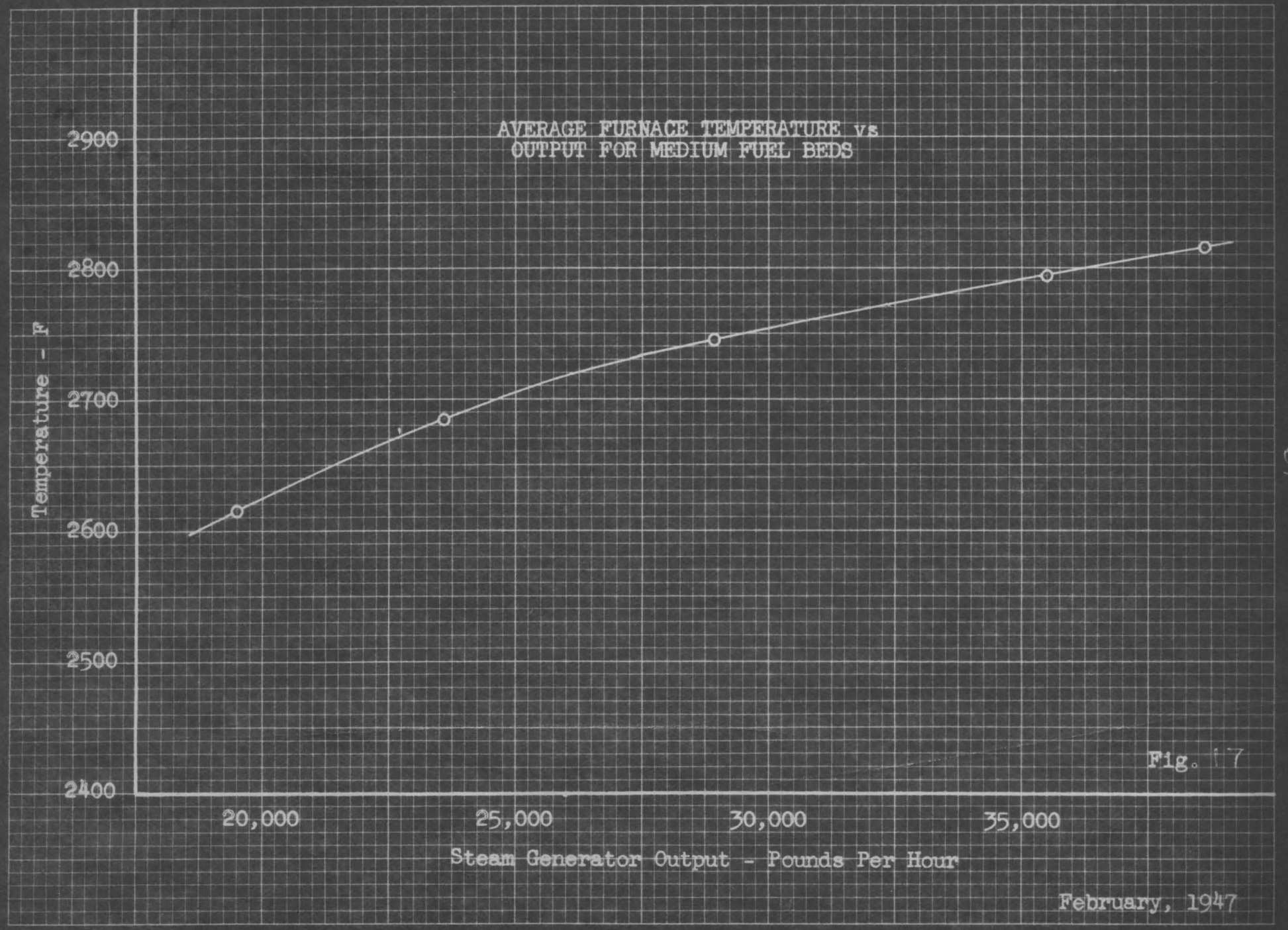
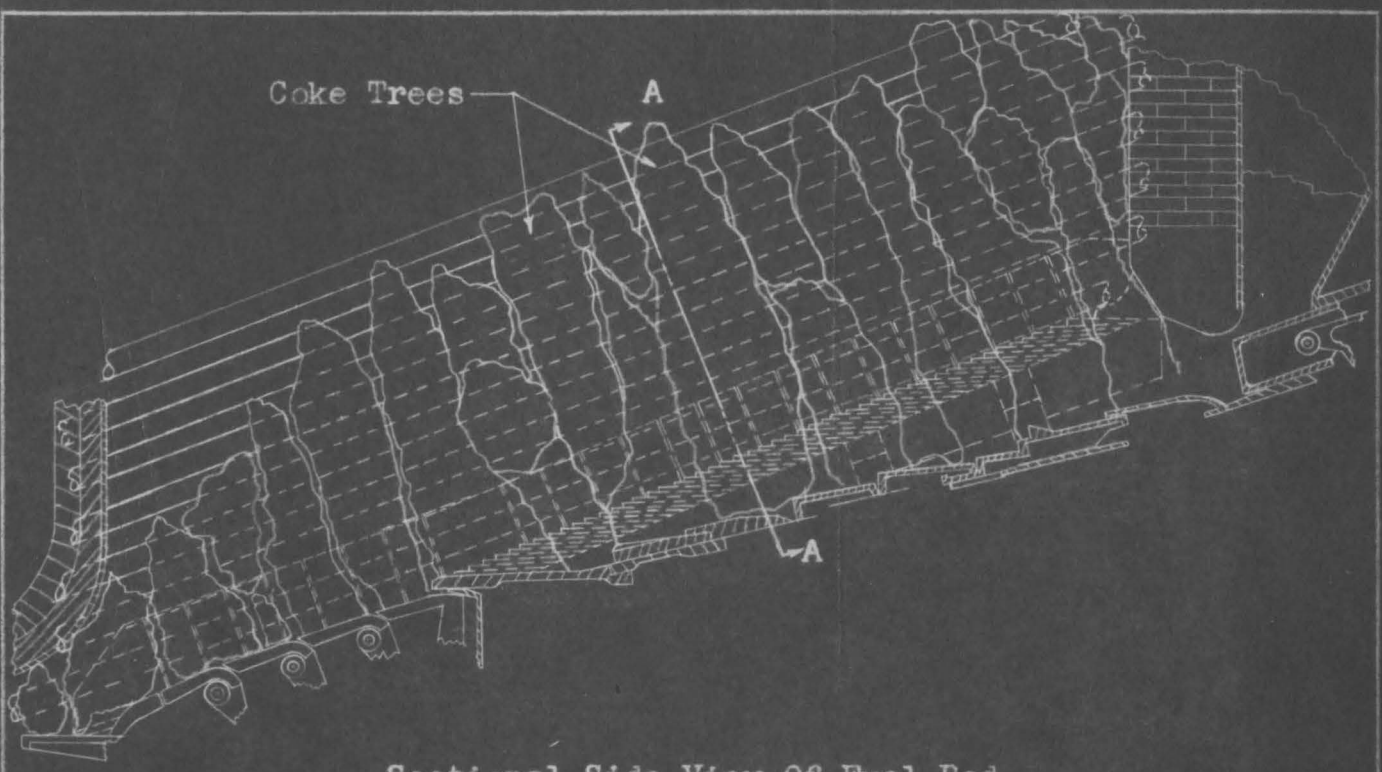

AVERAGE FURNACE TEMPERATURE vs
OUTPUT FOR MEDIUM FUEL BEDS
2900
2800
2700
2600
2500
2400
Temperature - F
20,000
25,000
30,000
35,000
Steam Generator Output - Pounds Per Hour
February, 1947

Fig. 17

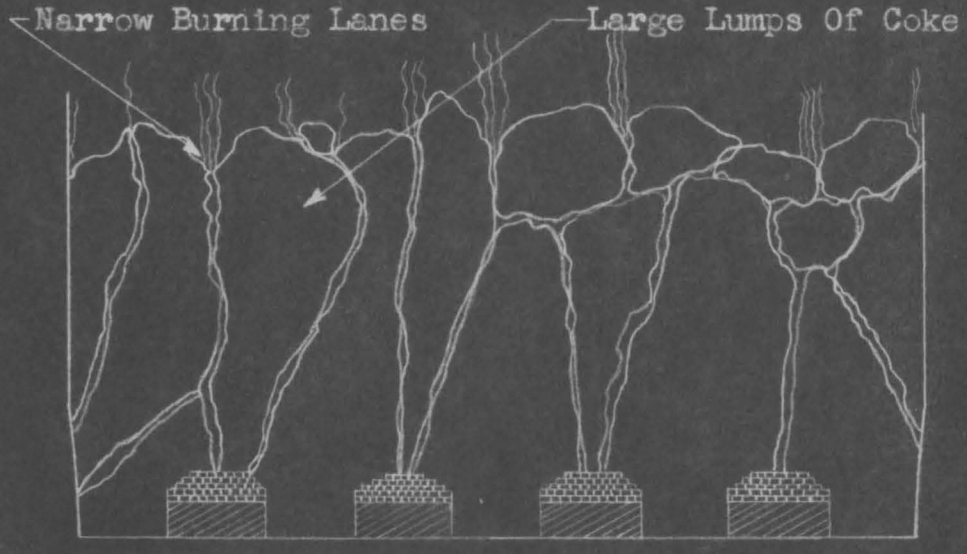
the ash pit. This clogging necessitated the use of a firing iron to break them up, a condition which was not true of the medium fuel bed. Fig. 13 shows that the loss to refuse was extremely high when the thick fuel bed was used at a 35,000 pounds per hour output. The quantity of refuse collected (8100 lb) was higher than for any other test conducted. The combustible in the refuse (22 per cent) was also higher than for any other test. The large clinkered lumps of refuse contained excessive quantities of unburned carbon in their centers.

The loss due to combustible in the fly ash, as shown in Fig. 11, was exceedingly low for the thick fuel bed as compared to the medium at 35,000 pounds per hour output. This low loss was further indication of the presence of large lumps of coke and clinker in the high fuel bed. When the fuel bed consisted of large lumps rather than finely divided particles distributed over the fuel bed area, the combustion air sweeping over the surface of these lumps carried particles from only the surface that was exposed to the air. Hence, the weight of fly ash carried out of the furnace into the stack was very much less for the thick fuel bed than for the medium. From the standpoint of the fly ash loss alone, the thick fuel bed was the most efficient, but the large lumps of coke and refuse contributed to the formation of large clinkers in the fuel bed and in the ash discharge orifice at high loads. For this reason, the thick fuel bed tests could not be run successfully for any output greater than 35,000 pounds per hour.

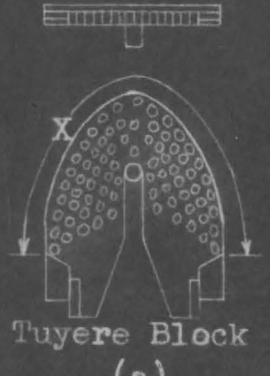
The use of the thick fuel bed was very undesirable for all outputs of the steam generating unit from the standpoints of operating difficulties and of efficiency (see Fig. 10); both of these depend chiefly on the coking and clinkering encountered. As evidenced by the high CO loss due to



Sectional Side View Of Fuel Bed

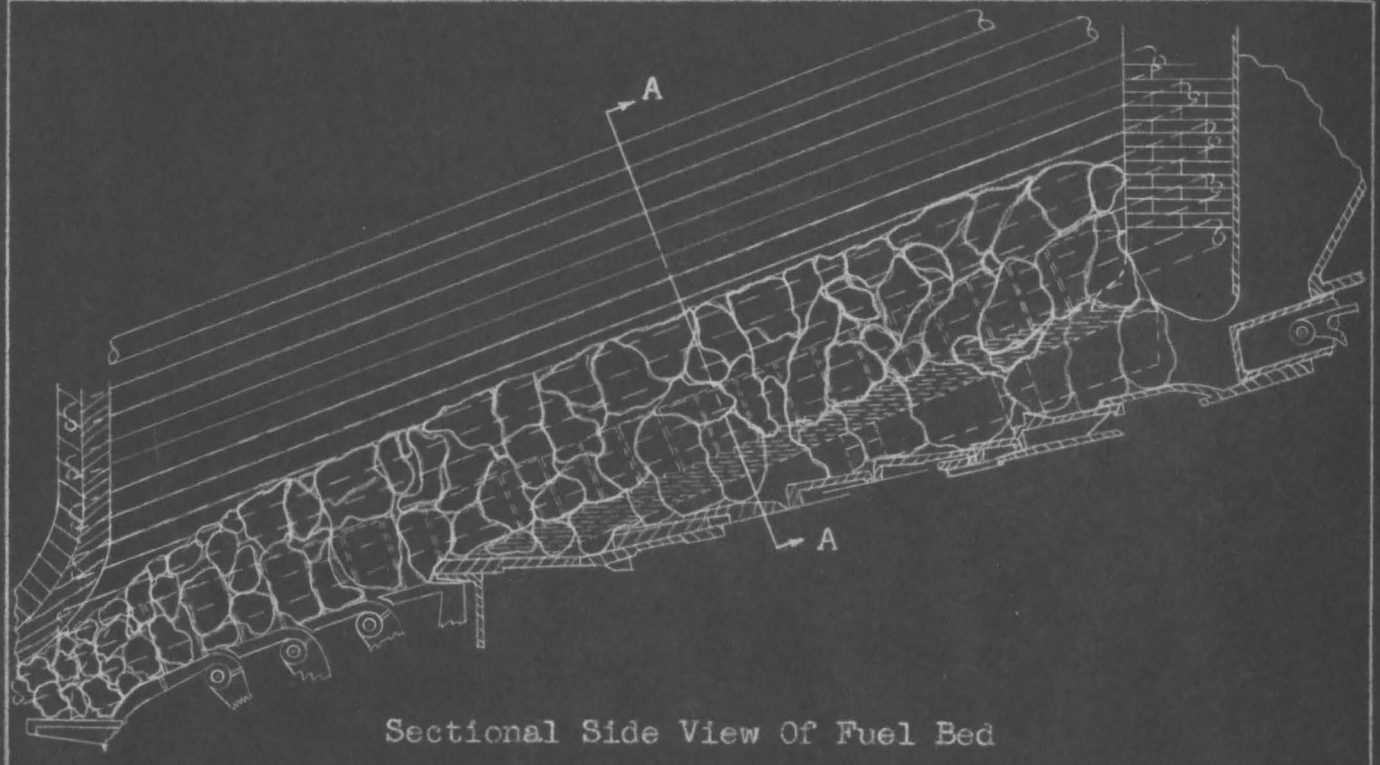


Section A-A

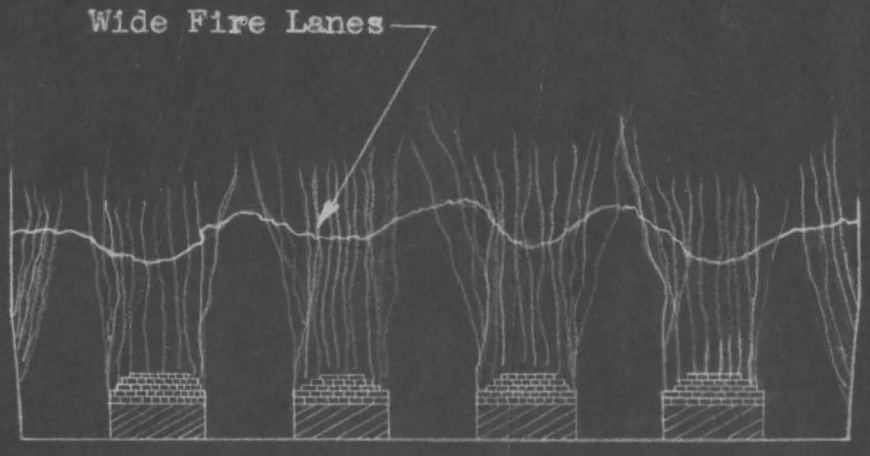


THE APPEARANCE OF A HIGH FUEL BED IN NO. FIVE UNIT SHOWING LARGE LUMPS OF COKE AND COKE TREES

Fig. 18



Sectional Side View Of Fuel Bed



Section A-A

THE APPEARANCE OF A LOW FUEL BED IN NO. FIVE UNIT SHOWING WIDE BURNING LANES

Fig. 19

the incomplete combustion of the fuel, large coke lumps were formed at low outputs. At high outputs, the coking was less marked, as shown by a considerable decrease of the CO loss. At higher loads, the coke lumps clinkered as a result of the high temperature of the fuel bed; very little clinkering occurred at low loads. This condition existed with the use of the thick fuel bed to a greater extent than for the medium and low beds for the following reasons:

(1) High moisture content of the fuel.

(2) High ash content of the fuel.

(3) Incorrect distribution of air through the tuyere openings.

(4) Incorrect thickness of fuel bed.

High moisture content causes the coal to be compressed into more compact lumps as it is forced by the main rams into the retort section of the stoker. The fuel does not break up into finely divided particles in this section. The degree to which the compression of the fuel takes place is determined largely by the height of the fuel bed above the entrance to the furnace opening.

Higher ash content of the fuel renders the thick fuel bed undesirable. The large lumps of coke present do not burn completely as they travel over the grate surface. When they reach the ash discharge orifice, they may prevent the proper discharge of ash, particularly where the ash quantity is high.

The incorrect distribution of the air through the tuyere openings causes narrowing of fire lanes and matting of the fuel bed (see Fig. 18). (The absence of open burning lanes is called matting. The importance of keeping the burning lanes open at all times cannot be too strongly emphasized. If the fuel bed is allowed to become so thick that it mats, i.e., the lanes are closed

anywhere on the stoker, the grate beneath the matted area may become overheated and damaged, or clinkers may stick to the overheated area.) Too much of the combustion air passes through the tip of the tuyere; the air supply to the side openings is depleted (see Fig. 2). The distribution of the air in this manner is due to the narrow fire lanes that are formed directly above the tuyere rows which offer the path of least resistance to the air flow. If the quantity of flow through the tips of the tuyeres is reduced, a widening of the fire lanes takes place and the sizes of the lumps of coke formed are smaller. This widening results in a more complete combustion of the fuel.

The thickness of the fuel bed used is the most important factor to be considered with respect to coking and clinkering because the degree to which the three previously discussed factors influence these conditions is determined to a large extent by the thickness of the fuel bed used. Although the high fuel bed has no relation to the moisture and ash content of the fuel and is not directly related to the distribution of the air through the tuyeres, the undesirable conditions involving these three factors are seriously aggravated by the use of a thick fuel bed. Figs. 18 and 19 show how the thick fuel bed tends to bring about these conditions. The figures show the appearances of the two different fuel beds. With the steam generating unit operating at the same output, the coal fired in pounds per hour per sq ft of grate area was very nearly the same for both the thick and medium fuel beds. In order for the rate of firing to be equal for the two conditions, the thin fuel bed must move faster over the grate surface of the stoker. Since the main rams (see Fig. 3) operate at approximately the same rate of speed for both thick-

nesses, the fuel, immediately after leaving the ram boxes, tends to have more travel in the vertical direction than in the horizontal direction in the case of the thick fuel bed. This condition is particularly true of fuel beds with a high moisture content. The main rams consist of round pistons which move back and forth in cylindrical ram boxes. As the fuel is fed in by these rams, it is extruded into a cylindrical shape when its moisture content is high. If the thick fuel bed is used, this extruded shape encounters greater pressure as it is forced on to the stoker grate surface and becomes more compact. Since this fuel bed is not traveling as rapidly as thinner fuel beds, the fuel builds up in a vertical direction and forms peaks or coke trees that are compressed too tightly to break up with the normal amount of agitation that can be furnished by the secondary rams (see Fig. 3). These peaks travel to the overfeed section with their original shape and position. As they pass over the link-grate section, the amount of agitation and breaking up is increased by the motion of the link-grate. They start burning on this section of the grate surface. When most of the burning of the carbon in the fuel takes place near the ash discharge orifice, extremely high temperatures exist in this zone and large clinkers are formed which clog the orifice. When these conditions exist, the rear wind box pressure must be kept at a minimum to reduce the fuel bed temperature to a value at which clinker formation will be a minimum. The ash discharge plates (see Fig. 3) must be lowered to allow the clinkers to pass through the orifice into the ash pit.

The rear wind box pressure was reduced by closing the damper between the front and rear wind boxes as far as possible (see Fig. 3). When this damper was closed to prevent the coke in the ash discharge orifice from clinkering, the air pressure became extremely high in the front wind box

directly beneath the tuyere rows (see Fig. 3). This high pressure caused the combustion air to have extremely high velocity through the tuyere tips in a horizontal direction toward the rear bridge wall and large quantities of fly ash were blown out of the fuel bed at the lower end of the underfeed section of the stoker. This fly ash reached a molten state because of the high combustion temperature in this zone of burning and a portion was deposited on the rear bridge wall tubes. This slagging occurred for all three fuel bed conditions, but was considerably higher for thin and medium fuel beds than for the high fuel beds.

Fig. 18(a) shows that, with equal resistance to flow of air around the tuyere tip through the distance X, the flow of air at all points will be approximately equal. When excessive coking of the fuel takes place, the air does not distribute itself properly through the bed to form the fire lanes as shown in Fig. 19. Instead, it passes through the cracks and holes that develop between the large lumps of coke and proper burning of the fuel does not take place. When the thin fuel bed is used, the fuel consists of well-distributed finer particles and the air is allowed to pass through the side tuyere openings. This air distribution develops wider fire lanes resulting in a much greater burning area for the fuel bed in the zone near the front of the furnace. This condition is illustrated in Fig. 19.

During each test, the correct fuel bed thickness was maintained by varying the speed of the main and secondary rams. The contour of the fuel bed was maintained as smooth as possible and with a gradual slope toward the rear of the furnace; this shaping was accomplished by adjustment of the movement of the link grate section and by adjustment of the length of stroke of the secondary rams. Unfortunately, these adjustments could not be maintained

the same for any appreciable length of time; it was necessary to vary the length of stroke for both the link-grate section and the secondary rams at frequent intervals during each test.

For different outputs of the unit and for coals of varying analysis encountered in different tests, maintenance of the correct fuel bed contour required varying adjustments, both for the link-grate section and for the secondary rams. Generally speaking, with the use of a fuel of high moisture and ash content, an added amount of agitation was necessary to keep the fuel broken up and burning freely; consequently, the length of stroke of the link grates was increased.

Where a medium or high fuel bed was used, it was necessary to increase the length of stroke of the secondary rams above that required for a low fuel bed. This change was due to the added weight on the grate area; a greater force was required to move the fuel over the retort section of the stoker. The length of stroke of the link-grate section was also increased as increased agitation was necessary to keep the large coke lumps broken up and burning freely.

These fuel bed characteristics were found to exist as a result of careful observation of the fuel bed at frequent intervals (approximately every 15 minutes) during each test period.

The No. five unit was operated at approximately its designed maximum continuous output for 24 hours (Test 36-M). The unit gave satisfactory operation during this entire period. Softening of the refractory walls and of the slag coating on the bridge wall tubes did not occur. This output could have been maintained continuously under these conditions.

The unit was operated at 38,700 pounds of steam per hour for 11 hours with a medium fuel bed (Test 40-M. Three hours were required to reach the

desired fuel bed condition and secure an equilibrium of temperatures and eight hours were required for the performance of the test). Softening of the refractory walls and of the slag coating on the bridge wall tubes did not take place; operation of the unit was satisfactory.

For a period of approximately 20 minutes the unit was operated at an output of 42,000 pounds of steam per hour. Softening of the refractory walls and of the slag coating on the bridge wall tubes did not occur, and operation was satisfactory.

At outputs slightly below 36,000 pounds of steam per hour, operation of the unit with a thick fuel bed resulted in softening of the slag on the bridge wall tubes. At periodic intervals the slag actually melted and flowed down the wall. For this reason, loads above 36,000 pounds of steam per hour could not be maintained for appreciable lengths of time with the use of this fuel bed thickness.

A comparison of the optimum efficiencies obtained for the five outputs (as shown in Table V) indicates that the No. five unit gives from one to two per cent lower efficiency at the present time than at the time of installation. In 1940, Diamond and DeBusk[1] obtained practically the same efficiencies as those given in the manufacturer's specifications. The optimum efficiencies determined in this present investigation show that the No. five unit is still giving satisfactory service provided correct operating conditions are maintained.

[1] W.F. Diamond and C. F. DeBusk, The Effects of Depth of Fuel Bed on the Operating Characteristics of the Kesler 800 HP Boiler in the Virginia Polytechnic Institute Central Heating and Power Plant, Thesis, V.P.I., 1940.

The efficiency of this unit is lower at the present time than at the time of installation as a result of the increased loss to radiation through the furnace walls and the increased loss to the flue gases. Prior to the first test, when the unit was out of operation, an examination of the furnace side of the walls revealed that they had deteriorated considerably during the past 6½ years of service. Large cracks were located in the walls above the clinker chill tubes and in the front wall directly above the underfeed retort section. Very wide cracks were also found in the arches above each of the side furnace doors. The increased radiation loss (due to the deterioration of the walls) over the values given by the A.S.M.E. charts was included in the unaccounted for losses.

TABLE V Gross Thermal Efficiencies

Output, Pounds of Steam Per Hour	Manufacturer's Specifications Gross Thermal Eff.	Diamond and DeBusk Max Gross Thermal Eff.	Results of Investigation	
			Max Gross Thermal Eff.	Fuel Bed Used
20,000	80.80	79.30	79.00	Low
25,000	80.55	80.30	78.50	Low
30,000	79.99	80.70	78.50	Medium
35,000	79.41	80.60	78.50	Medium
38,700	78.39	79.50	76.60	Medium

The values in Table VI show a comparison of the flue gas temperatures obtained for this investigation with those given by Diamond and DeBusk, and the boiler manufacturer. Throughout this investigation the recorded flue gas temperatures were from 30 to 65 degrees higher than those stated in the manufacturer's specifications for the range of loading from 20,000 to 38,700 pounds of steam per hour. Since the installation of the unit, 11 superheater tubes have been removed to reduce the total steam temperature. The flue gas temperature is now higher because of this reduction in heat absorbing surface area.

The flue gas temperatures recorded for these present tests were approximately 3 to 50 degrees higher than those given by Diamond and DeBusk. Since they conducted their investigation after the removal of the superheater tubes, there is an indication that the high flue gas temperatures obtained for the tests in this present investigation were due in part to soot and slag deposits on the heat absorbing surface that could not be readily removed by the use of sootblowers.

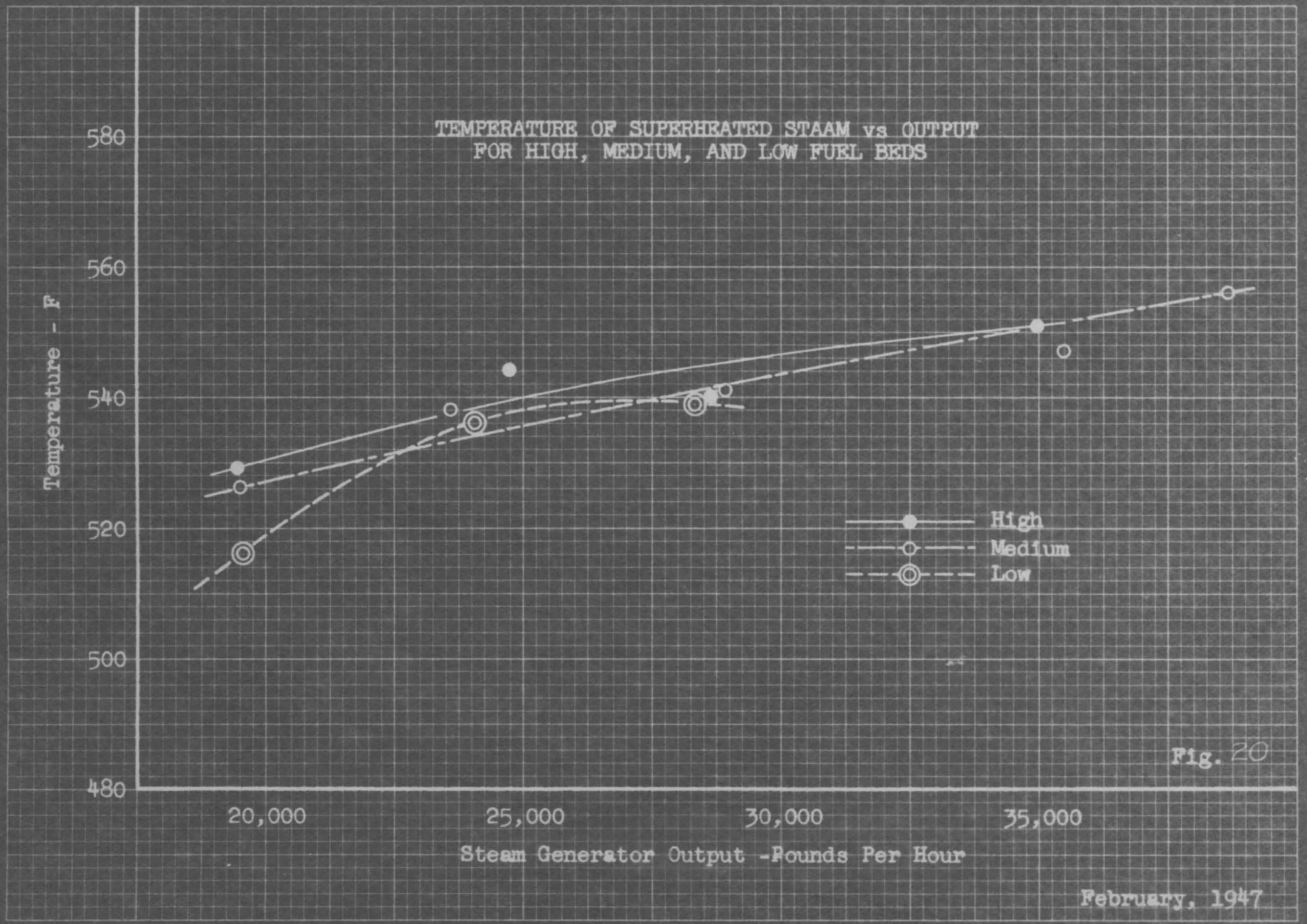
This rise of flue gas temperature resulting in a lowering of efficiency for all outputs was due to the higher quantities of heat leaving the unit in the flue gases.

TABLE VI Flue Gas and Total Steam Temperatures at Optimum Test Conditions

Output, Pounds of Steam Per Hour	Results of Investigation			Mfg Specifications		Diamond & DeBusk	
	Type of Fuel Bed	Flue Gas Temp, F	Steam Temp, F	Flue Gas Temp, F	Steam Temp, F	Flue Gas Temp, F	Steam Temp, F
20,000	Low	530	520	500	496	533	546
25,000	Low	560	538	530	500	550	550
30,000	Medium	620	544	555	502	570	552
35,000	Medium	650	550	585	505	598	552
38,700	Medium	650	556	605	504	632	548

Table VI gives values for total steam temperatures obtained in this investigation and those given in the boiler specifications and by Diamond and DeBusk. The temperatures recorded in this investigation were from 2 to 26 degrees F lower than those obtained by Diamond and DeBusk for all outputs except 38,700 pounds of steam per hour. At this output, Diamond and DeBusk's values were eight degrees F lower.

The total steam temperatures given in the boiler specifications are from 24 to 52 degrees F lower than those obtained in this investigation. Acceptance tests performed on this unit at the completion of its instal-


TEMPERATURE OF SUPERHEATED STAAM vs OUTPUT
FOR HIGH, MEDIUM, AND LOW FUEL BEDS
Temperature - F
580
560
540
520
500
480
20,000
25,000
30,000
35,000
Steam Generator Output -Pounds Per Hour
High
Medium
Low
Fig. 20
February, 1947

lation revealed that the total steam temperatures were above those called for in the specifications; the difference varied from 16 F at 17,000 pounds of steam per hour output to 118 F at 28,000 pounds of steam per hour output. Consequently, 11 of the 28 superheater tubes were removed to lower the temperature. (The limiting factor on the total steam temperature is the existing piping and equipment in the plant which cannot withstand the high temperatures encountered. The removal of the 11 tubes lowered the temperature to a safe value.)

TABLE VII Firing Rates

Output, Pounds of Steam per Hour	Type of Fuel Bed	Lb of Coal per Hour per Sq Ft of Actual Grate Area		Lb of Coal per Hour per Sq Ft of Projected Grate Area	
		Results of Investigation	Mfg Specifications	Results of Investigation	Mfg Specifications
35,000	*High	36.59	34.30	38.82	36.50
35,400	'Medium	34.97	34.80	37.10	36.90
38,700	'Medium	39.25	38.50	41.64	41.00

* Inefficient operating conditions
' Optimum operating conditions

The values in Table VII show that with the use of the medium fuel bed the firing rates obtained in this investigation were very nearly the same as those stated in the stoker manufacturer's specifications. With the use of the high fuel bed, operation of the unit was inefficient; the firing rate was two pounds of coal per hour per sq ft of actual or projected grate area higher than the values obtained for the optimum operating condition. In order for the stoker to maintain these high rates of firing at high outputs it must be operated on manual control at its highest speed approximately 50 per cent of the time. Whenever the unit is operated inefficiently at a high output, the rate of firing must be increased above that required for optimum operating conditions.

With this added burden, the stoker must be kept on manual control at its highest speed practically all of the time; approximately half of the time the speed of the primary and secondary rams must be further increased with the use of the overdrive (see Fig. 3).

CONCLUSIONS

(1) The maximum gross thermal efficiency varied from 78.93 per cent at 19,596 pounds per hour output to 78.30 per cent at 35,417 pounds of steam per hour. As the output of the unit increased beyond this range the efficiency dropped to 76.67 per cent at 38,677 pounds of steam per hour.

(2) The optimum fuel bed thickness for the No. five unit varies from 17 inches at 20,000 pounds of steam per hour to 35 inches at an output of 40,000 pounds per hour (See Fig. 21). (When the fuel bed is 17 inches thick, the top is even with the center of the fifth clinker chill tube; when the thickness is 35 inches the top of the fuel bed is even with the center of the second clinker chill tube.)

(3) The optimum values of CO_2 increased from 14 per cent at 20,000 pounds per hour to 16 per cent at 30,000 and 35,000 pounds per hour output and then decreased to 15.6 per cent at 40,000 pounds of steam per hour (See Fig. 22). The per cent CO_2 in the flue gases can not be used as an accurate guide for good combustion, fuel bed thickness or excess air supplied because values below the optimum can be the result of either an excess of air or a deficiency of air (High CO_2 values indicate small amounts of excess air, but do not necessarily indicate good combustion as CO may be present in the flue gases.). Optimum O_2 values decreased from 5.2 to 1.4 per cent as the load increased from 20,000 to 40,000 pounds of steam per hour (See Fig. 23). Therefore, the per cent O_2 in the flue gases is a better indicator of proper combustion than the per cent CO_2.

(4) The No. five unit can be operated satisfactorily at an output of 36,000 pounds of steam per hour continuously, at an output of 38,700 pounds

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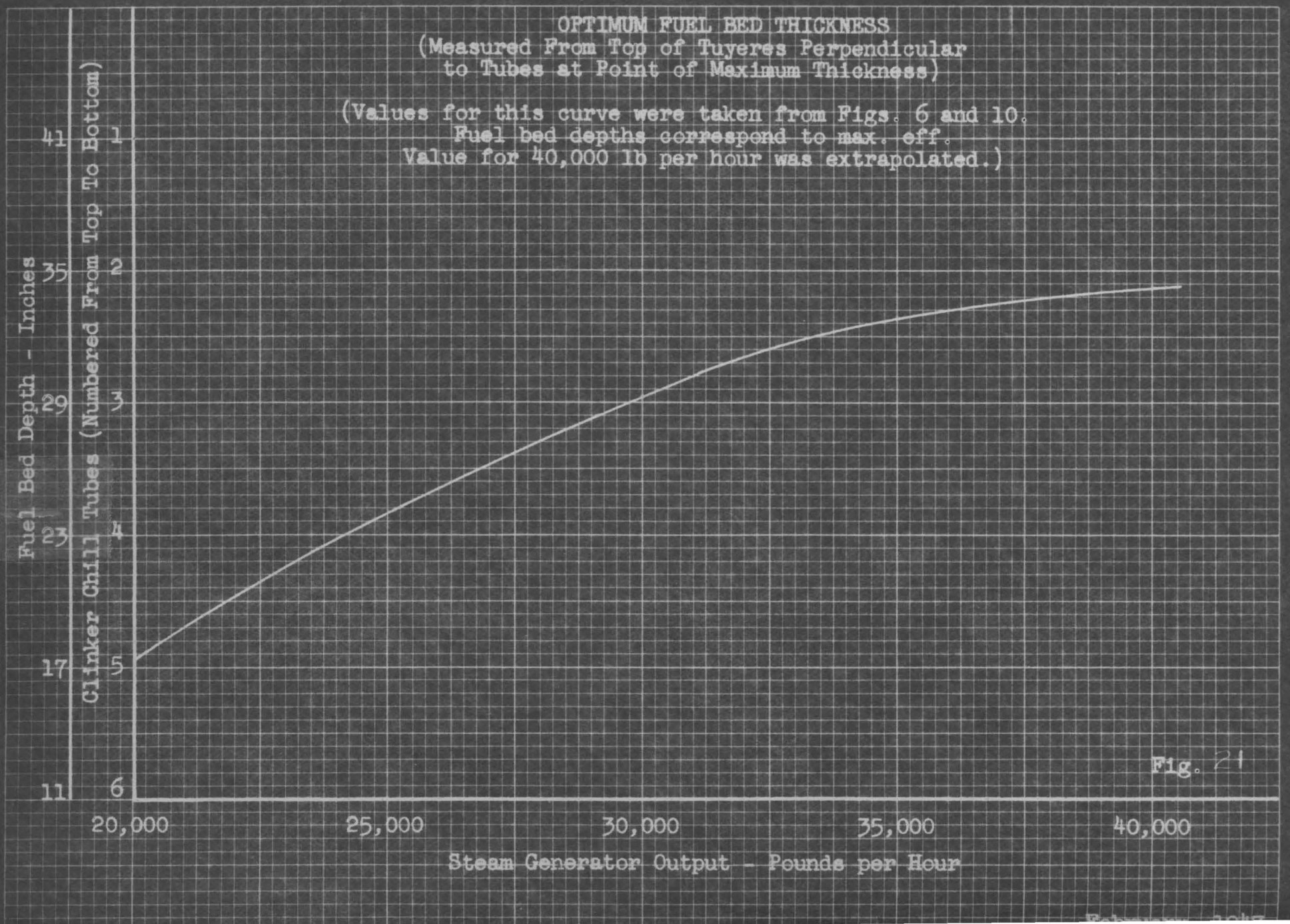
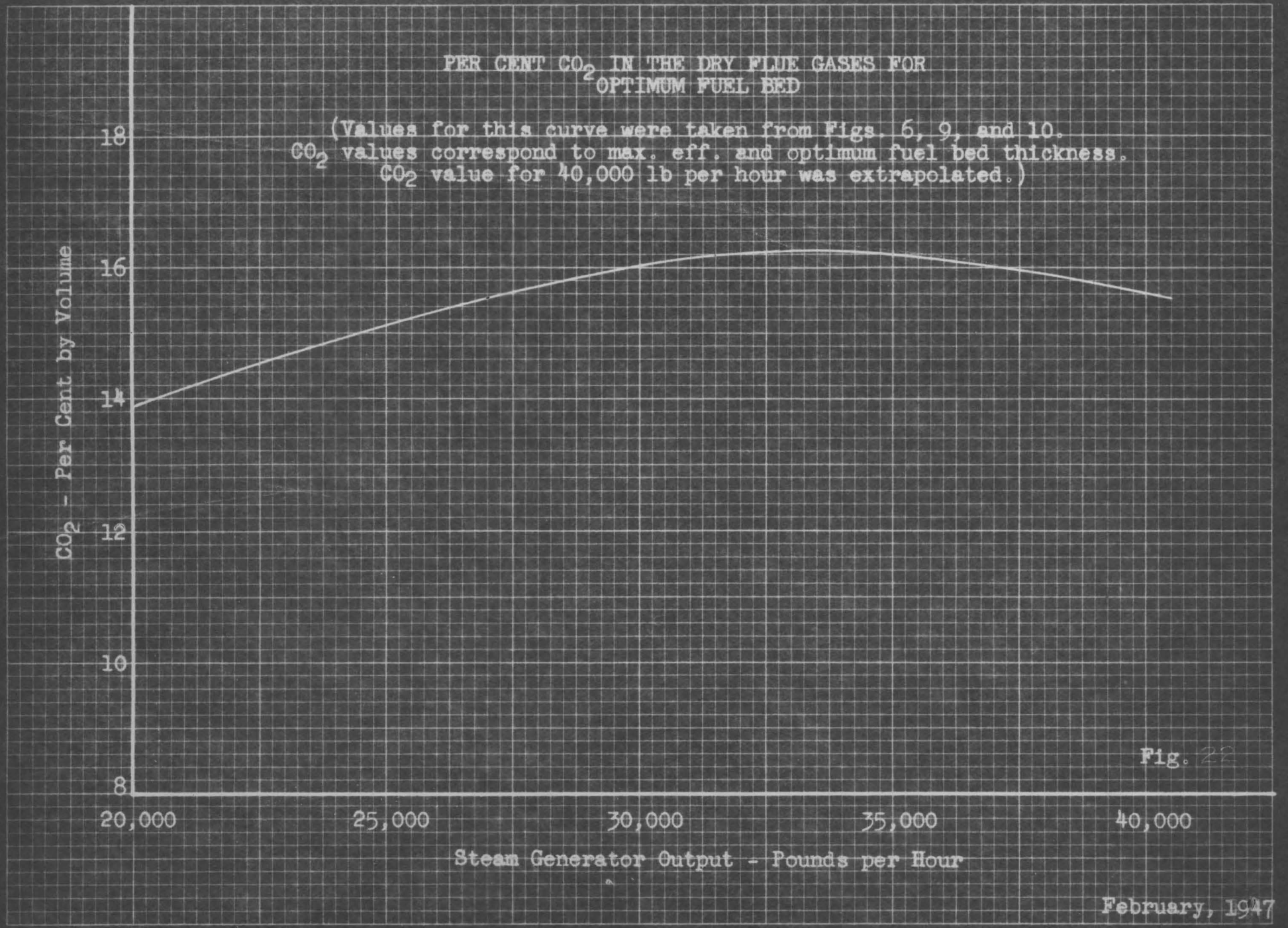
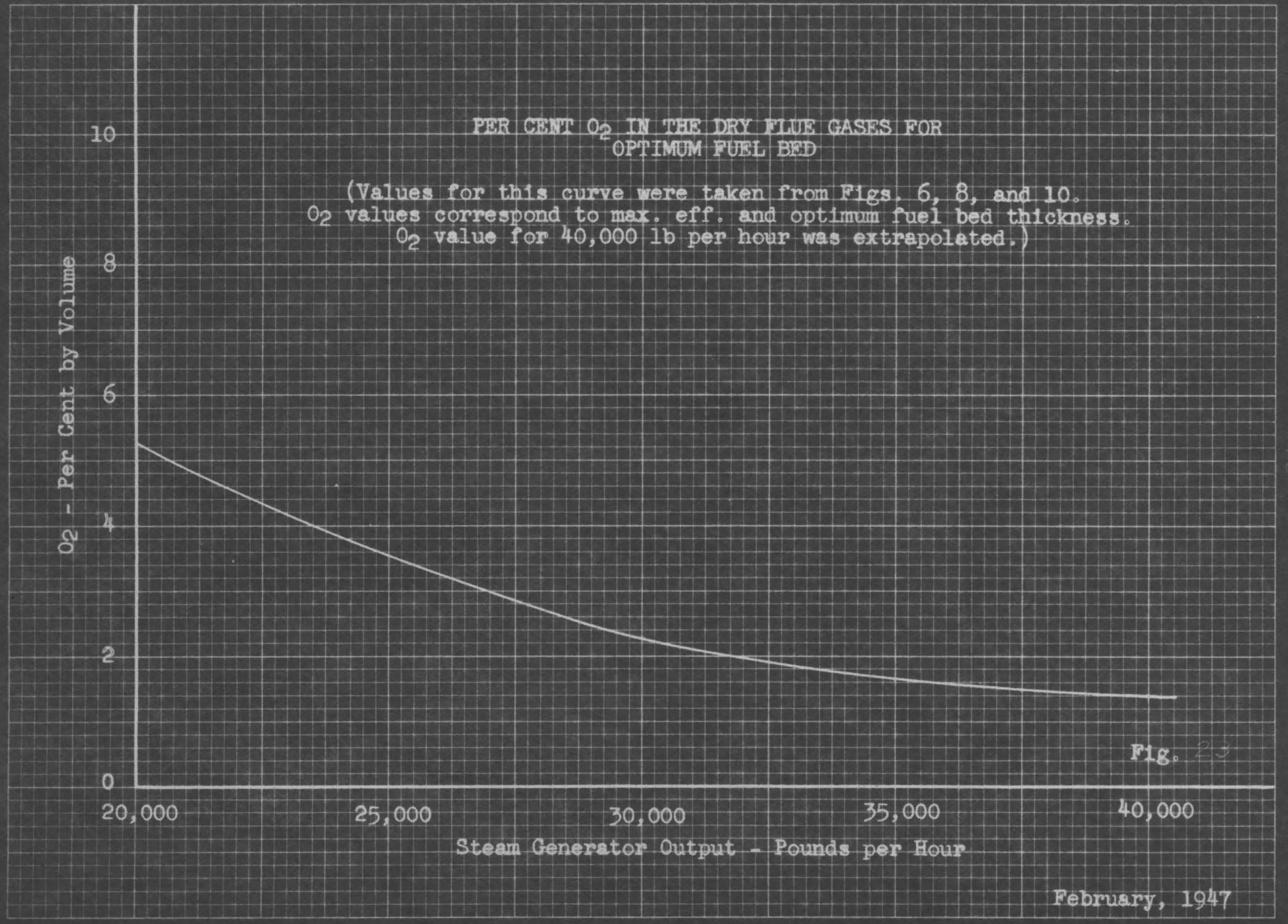


Fig. 21


PER CENT CO_2 IN THE DRY FLUE GASES FOR OPTIMUM FUEL BED
(Values for this curve were taken from Figs. 6, 9, and 10.
CO_2 values correspond to max. eff. and optimum fuel bed thickness.
CO_2 value for 40,000 lb per hour was extrapolated.)
CO_2 - Per Cent by Volume
18
16
14
12
10
8
20,000
25,000
30,000
35,000
40,000
Steam Generator Output - Pounds per Hour
Fig. 27
February, 1947


PER CENT O_2 IN THE DRY FLUE GASES FOR OPTIMUM FUEL BED
(Values for this curve were taken from Figs. 6, 8, and 10. O_2 values correspond to max. eff. and optimum fuel bed thickness. O_2 value for 40,000 lb per hour was extrapolated.)
O_2 - Per Cent by Volume
10
8
6
4
2
0
20,000
25,000
30,000
35,000
40,000
Steam Generator Output - Pounds per Hour
Fig. 23
February, 1947

per hour for 11 hour periods and up to 42,000 pounds per hour for 15 to 20 minute intervals, provided thick fuel beds are not used and the slag on the refractory and bridge walls do not reach the fusion stage.

(5) The formation of coke trees can be caused by: (1) the use of a thick fuel bed, (2) improper distribution of air between the front and rear wind boxes, (3) high ash content of the coal and (4) high moisture content of the coal. This formation of coke trees can be minimized by: (1) operating the unit with a proper thickness of fuel bed (as shown in Fig. 21), (2) proper regulation of the quantity of ash in the discharge orifice and proper adjustment of the front and rear wind-box pressures (at a 2 to 1 ratio), (3) the use of a coal having an ash content not greater than 8 per cent on an "as fired" basis and an ash fusion temperature above 2600 F (See Table 3, page 57) and (4) maintaining the moisture content of the coal between 2 and 3 per cent on an "as fired" basis (as given in stoker specifications).

SUMMARY OF RESULTS

1. The percentage of excess air supplied for combustion in the No. five unit can be varied only by varying the thickness of the fuel bed.

2. Optimum CO_2 values change considerably as the ultimate analysis of the fuel fired changes; these values cannot be relied upon to accurately indicate fuel bed thickness, excess air, or efficiency of combustion.

3. The unit operates most efficiently with a thin fuel bed at outputs of 25,000 pounds per hour and below. The reasons are as follows:

   a. Low loss due to combustible in the fly ash.

   b. Low loss due to combustible in the refuse.

   c. Low loss due to incomplete combustion of carbon appearing as CO in the flue gases.

   d. The loss due to the heat in the flue gases is not excessively high.

4. When the thin fuel bed is used at outputs above 25,000 pounds of steam per hour, the unit is very inefficient due to rapid increase of the loss of heat to the flue gases and the loss due to combustible in the fly ash.

5. For all outputs of the unit above 25,000 pounds of steam per hour, the highest efficiency is obtained with the medium fuel bed. The reasons are as follows:

   a. The loss due to combustible in the refuse is low.

   b. The loss due to incomplete combustion appearing as CO in the flue gases is low.

6. The thick fuel bed gives very low efficiency for the unit at all outputs for the following reasons:

a. Combustion is incomplete.

b. Coke trees and large lumps of unburned coke are formed in the fuel bed.

c. At high outputs large clinkers are formed.

d. The loss due to unburned carbon in the refuse is high.

7. The formation of coke trees and large lumps of coke resulting in excessive clinkering in the thick fuel bed is due to:

a. High moisture content of the fuel.

b. High ash content of the fuel.

c. Incorrect distribution of air through the tuyere openings.

d. Incorrect thickness of fuel bed.

8. The maximum gross thermal efficiencies for the No. five unit at all outputs are now only one or two per cent lower than they were at the time of installation.

9. The flue gas temperature for the No. five unit is from 3 to 50 F higher now (depending upon the output and operating conditions) than at the time of installation.

10. The total steam temperature is now 24 to 52 F higher (depending upon the output) than originally specified for this unit, but is within the safe operating range for the existing piping and equipment in the plant.

11. The stoker is capable of maintaining the high rates of firing that are necessary at high outputs of the unit. However it must be operated manually part of the time in order to maintain these high firing rates at outputs above the maximum continuous rating (36,000 pounds of steam per hour).

12. The No. five unit operated satisfactorily for 24 hours at its contin-

uous rating of 36,000 pounds of steam per hour, for eleven hours at 38,700 pounds of steam per hour, and for 15 to 20 minutes at 42,000 pounds of steam per hour without fusion of the refractory walls or of the slag coating on the rear bridge wall tubes.

13. With the thick fuel bed, the fusion temperature of the slag on the bridge wall tubes may be reached at outputs below 36,000 pounds of steam per hour.

14. The loss due to combustible in the fly ash and refuse shows a tendency to increase as the per cent ash in the fuel increased and to decrease as the ash fusion temperature of the fuel increased.

RECOMMENDATIONS

(1) When the total steam demand of the power plant is high, the No. five unit should be required to carry 30,000 to 35,000 pounds of steam per hour, not to exceed 36,000 unless it is necessary to meet a peak load requirement, and the remainder carried by the low pressure units.

(2) Make frequent visual inspections through the furnace doors on both sides of the unit to determine the fuel bed condition.

(3) Never operate the No. five unit with a thick fuel bed. Use Fig. 21 as a guide to proper fuel bed thickness.

(4) Adjust the secondary rams of the stoker to maintain an even contour of the fuel bed, but do not change the adjusting levers more than one notch at a time.

(5) Place the coal in the center of the hopper in 1500 pound quantities when firing the No. five unit. This will aid in the maintenance of an even contour of the fuel bed.

(6) Make frequent checks of the ash pit in order to be sure that combustion of the fuel is complete.

(7) Raise the ash discharge plates, and allow the ash to build up in the discharge orifice (see Fig. 1). After ash has built up, adjust the front and rear wind-box pressures at a 2 to 1 ratio (Attempts to make this adjustment will not be successful if the ash has not been allowed to build up first).

(8) Do not purchase coal having an ash content in excess of eight per cent (on an "as ~~fired~~ received" basis).

(9) Install coal drying equipment to keep the moisture content of the fuel between two and three per cent (on an "as fired" basis).

(10) Decrease the loss in the dry flue gases by the use of preheated air (this will result in better combustion for wet and poor grades of coal). An air preheater should be installed on the No. five unit, but in the meantime the temperature of the combustion air should be maintained as high as possible by keeping the windows and doors of the basement closed.

(11) Replace the CO_2 meter on the No. five unit with an O_2 meter. Install an O_2 meter on the proposed No. six unit.

(12) Have the Hays combustion control equipment on the No. five unit serviced at least once each year by a factory representative.

(13) Reset the valve in the blow-down line of the No. five unit at least once every three days in order to prevent freezing and clogging.

(14) Blowdown the flowmeter lines between the orifice in the steam header and the transmitter at least once each week.

(15) The lines between the sampling pipe and the CO_2 meter, including the condenser and its piping, should be cleaned once each month. The water bottle on the meter should be checked daily and refilled as necessary. The cardisorber solution level should be checked weekly.

(16) The No. five unit may be relied upon to carry 36,000 pounds of steam per hour continuously, 38,700 pounds per hour for eleven hours and 42,000 pounds per hour for 15 to 20 minute periods. The required capacity of the proposed No. six unit may be calculated with the use of this data.

APPENDIX

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HEAT BALANCE

Test Number: 20-L

Date: October 30,31, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	11,206	78.93
Heat loss to dry flue gases.....	1,514	10.66
Heat loss due to moisture in the fuel.....	25	.18
Heat loss due to moisture in the air for combustion.....	27	.19
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	539	3.80
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	0	.00
Unconsumed combustible in the refuse.....	140	.98
Unconsumed combustible in the fly ash.....	175	1.24
Heat loss due to radiation.....	312	2.20
Unaccounted for losses (by difference).....	260	1.82
Higher heating value of the coal, Btu per pound, as fired.....	14,198	100.00

HEAT BALANCE

Test Number: 20-M

Date: November 9,10, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	11,094	78.96
Heat loss to dry flue gases.....	1,343	9.56
Heat loss due to moisture in the fuel.....	31	.22
Heat loss due to moisture in the air for combustion.....	16	.11
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	533	3.79
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	0	.00
Unconsumed combustible in the refuse.....	210	1.50
Unconsumed combustible in the fly ash.....	353	2.51
Heat loss due to radiation.....	309	2.20
Unaccounted for losses (by difference).....	161	1.15
Higher heating value of the coal, Btu per pound, as fired.....	14,050	100.00

HEAT BALANCE

Test Number: 20-H

Date: November 6,7, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit	10,406	74.81
Heat loss to dry flue gases	1,148	8.25
Heat loss due to moisture in the fuel	47	.34
Heat loss due to moisture in the air for combustion	15	.11
Heat loss due to water formed from the combustion of hydrogen in the fuel	520	3.74
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas	810	5.82
Unconsumed combustible in the refuse	186	1.34
Unconsumed combustible in the fly ash	23	.16
Heat loss due to radiation	306	2.20
Unaccounted for losses (by difference)	449	3.23
Higher heating value of the coal, Btu per pound, as fired	13,910	100.00

HEAT BALANCE

Test Number: 25-L

Date: October 12,13, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	11,015	78.45
Heat loss to dry flue gases.....	1,572	11.20
Heat loss due to moisture in the fuel.....	24	.17
Heat loss due to moisture in the air for combustion.....	16	.11
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	554	3.95
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	55	.39
Unconsumed combustible in the refuse.....	68	.48
Unconsumed combustible in the fly ash.....	243	1.73
Heat loss due to radiation.....	246	1.75
Unaccounted for losses (by difference).....	248	1.77
Higher heating value of the coal, Btu per pound, as fired.....	14,041	100.00

HEAT BALANCE

Test Number: 25-M

Date: October 19,20, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	10,461	74.99
Heat loss to dry flue gases.....	1,557	11.16
Heat loss due to moisture in the fuel.....	14	.10
Heat loss due to moisture in the air for combustion.....	25	.18
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	555	3.98
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	106	.76
Unconsumed combustible in the refuse.....	107	.77
Unconsumed combustible in the fly ash.....1	44	.32
Heat loss due to radiation.....	251	1.80
Unaccounted for losses (by difference).....	830	5.95
Higher heating value of the coal, Btu per pound, as fired.....	13,950	100.00

HEAT BALANCE

Test Number: 25-H

Date: October 7, 8, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	10,371	73.76
Heat loss to dry flue gases.....	1,204	8.56
Heat loss due to moisture in the fuel.....	27	.19
Heat loss due to moisture in the air for combustion.....	20	.14
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	535	3.81
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	630	4.48
Unconsumed combustible in the refuse.....	102	.72
Unconsumed combustible in the fly ash.....	348	2.48
Heat loss due to radiation.....	239	1.70
Unaccounted for losses (by difference).....	584	4.16
Higher heating value of the coal, Btu per pound, as fired.....	14,060	100.00

HEAT BALANCE

Test Number: 30-L

Date: October 16,17, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	10,546	75.60
Heat loss to dry flue gases.....	1,688	12.10
Heat loss due to moisture in the fuel.....	28	.20
Heat loss due to moisture in the air for combustion.....	24	.17
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	547	3.92
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	0	.00
Unconsumed combustible in the refuse.....	82	.58
Unconsumed combustible in the fly ash.....	588	4.22
Heat loss due to radiation.....	209	1.50
Unaccounted for losses (by difference).....	238	1.71
Higher heating value of the coal, Btu per pound, as fired.....	13,950	100.00

HEAT BALANCE

Test Number: 30-M

Date: November 18,19, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	10,959	78.28
Heat loss to dry flue gases.....	1,453	10.38
Heat loss due to moisture in the fuel.....	38	.27
Heat loss due to moisture in the air for combustion.....	12	.09
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	552	3.94
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	133	.95
Unconsumed combustible in the refuse.....	210	1.49
Unconsumed combustible in the fly ash.....	384	2.75
Heat loss due to radiation.....	210	1.50
Unaccounted for losses (by difference).....	49	.35
Higher heating value of the coal, Btu per pound, as fired.....	14,000	100.00

HEAT BALANCE

Test Number: 30-H

Date: October 23,24, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	10,652	76.29
Heat loss to dry flue gases.....	1,401	10.03
Heat loss due to moisture in the fuel.....	23	.16
Heat loss due to moisture in the air for combustion.....	18	.13
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	553	3.96
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	571	4.09
Unconsumed combustible in the refuse.....	125	.90
Unconsumed combustible in the fly ash.....	252	1.80
Heat loss due to radiation.....	195	1.40
Unaccounted for losses (by difference).....	172	1.24
Higher heating value of the coal, Btu per pound, as fired.....	13,962	100.00

HEAT BALANCE

Test Number: 36-M

Date: November 20,21, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	11,119	78.30
Heat loss to dry flue gases.....	1,637	11.53
Heat loss due to moisture in the fuel.....	19	.13
Heat loss due to moisture in the air for combustion.....	40	.28
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	574	4.04
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	0	.00
Unconsumed combustible in the refuse.....	128	.90
Unconsumed combustible in the fly ash.....	456	3.21
Heat loss due to radiation.....	170	1.20
Unaccounted for losses (by difference).....	-57	-.41
Higher heating value of the coal, Btu per pound, as fired.....	14,200	100.00

HEAT BALANCE

Test Number: 36-H

Date: December 17,18, 1946

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	10,495	77.74
Heat loss to dry flue gases.....	1,601	11.86
Heat loss due to moisture in the fuel.....	31	.23
Heat loss due to moisture in the air for combustion.....	15	.11
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	567	4.20
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	235	1.74
Unconsumed combustible in the refuse.....	289	2.14
Unconsumed combustible in the fly ash.....	78	.57
Heat loss due to radiation.....	162	1.20
Unaccounted for losses (by difference).....	27	.20
Higher heating value of the coal, Btu per pound, as fired.....	13,500	100.00

HEAT BALANCE

Test Number: 40-M

Date: January 16, 1947

	Btu	Per Cent
Heat absorbed by the steam generating unit.....	10,810	76.67
Heat loss to dry flue gases.....	1,698	12.04
Heat loss due to moisture in the fuel.....	32	.23
Heat loss due to moisture in the air for combustion.....	37	.26
Heat loss due to water formed from the combustion of hydrogen in the fuel.....	567	4.02
Heat loss due to the incomplete combustion of carbon:		
CO in the flue gas.....	0	.00
Unconsumed combustible in the refuse.....	120	.85
Unconsumed combustible in the fly ash.....	716	5.08
Heat loss due to radiation.....	155	1.10
Unaccounted for losses (by difference).....	-35	-.25
Higher heating value of the coal, Btu per pound, as fired.....	14,100	100.00

CALCULATED DATA

Test Number: 20-L

Date: October 30,31, 1946

Pounds of coal burned per hour per sq ft of actual grate area	18.94
Pounds of coal burned per hour per sq ft of projected grate area	20.09
Pounds of carbon burned per pound of fuel as fired	.76
Pounds of dry flue gas per pound of fuel as fired	13.99
Pounds of theoretical dry air required per pound of fuel as fired	10.24
Pounds of dry air actually supplied per pound of fuel as fired	13.53
Excess air, per cent	32.18
Optimum blowdown, per cent of feedwater supplied	9.09
Actual blowdown, per cent of feedwater supplied	7.47
Steam quality in steam drum, per cent	93.95
Actual evaporation, pounds of steam per pound of fuel as fired	10.09
Equivalent evaporation, pounds of steam per pound of fuel as fired	11.38
Factor of evaporation	1.128

CALCULATED DATA

Test Number: 20-M

Date: November 9,10, 1946

Pounds of coal burned per hour per sq ft of actual grate area	19.12
Pounds of coal burned per hour per sq ft of projected grate area	20.29
Pounds of carbon burned per pound of fuel as fired	.73
Pounds of dry flue gas per pound of fuel as fired	12.35
Pounds of theoretical dry air required per pound of fuel as fired	9.82
Pounds of dry air actually supplied per pound of fuel as fired	11.92
Excess air, per cent	21.47
Optimum blowdown, per cent of feedwater supplied	8.92
Actual blowdown, per cent of feedwater supplied	6.39
Steam quality in steam drum, per cent	94.10
Actual evaporation, pounds of steam per pound of fuel as fired	9.96
Equivalent evaporation, pounds of steam per pound of fuel as fired	11.29
Factor of evaporation	1.134
Furnace temperature, degrees Fahrenheit	2615

CALCULATED DATA

Test Number: 20-H

Date: November 6, 7, 1946

Pounds of coal burned per hour per sq ft of actual grate area	20.16
Pounds of coal burned per hour per sq ft of projected grate area	21.39
Pounds of carbon burned per pound of fuel as fired	.75
Pounds of dry flue gas per pound of fuel as fired	10.75
Pounds of theoretical dry air required per pound of fuel as fired	10.06
Pounds of dry air actually supplied per pound of fuel as fired	10.30
Excess air, per cent	2.35
Optimum blowdown, per cent of feedwater supplied	7.56
Actual blowdown, per cent of feedwater supplied	4.53
Steam quality in steam drum, per cent	94.65
Actual evaporation, pounds of steam per pound of fuel as fired	9.39
Equivalent evaporation, pounds of steam per pound of fuel as fired	10.63
Factor of evaporation	1.132

CALCULATED DATA

Test Number: 25-L

Date: October 12,13, 1946

Pounds of coal burned per hour per sq ft of actual grate area	23.68
Pounds of coal burned per hour per sq ft of projected grate area	25.13
Pounds of carbon burned per pound of fuel as fired	.77
Pounds of dry flue gas per pound of fuel as fired	13.76
Pounds of theoretical dry air required per pound of fuel as fired	10.35
Pounds of dry air actually supplied per pound of fuel as fired	13.29
Excess air, per cent	28.46
Optimum blowdown, per cent of feedwater supplied	8.33
Actual blowdown, per cent of feedwater supplied	5.72
Steam quality in steam drum, per cent	96.50
Actual evaporation, pounds of steam per pound of fuel as fired	9.91
Equivalent evaporation, pounds of steam per pound of fuel as fired	11.24
Factor of evaporation	1.134

CALCULATED DATA

Test Number: 25-M

Date: October 19,20, 1946

Pounds of coal burned per hour per sq ft of actual grate area	24.54
Pounds of coal burned per hour per sq ft of projected grate area	26.04
Pounds of carbon burned per pound of fuel as fired	.79
Pounds of dry flue gas per pound of fuel as fired	13.32
Pounds of theoretical dry air required per pound of fuel as fired	10.60
Pounds of dry air actually supplied per pound of fuel as fired	12.84
Excess air, per cent	21.18
Optimum blowdown, per cent of feedwater supplied	9.09
Actual blowdown, per cent of feedwater supplied	5.06
Steam quality in steam drum, per cent	98.35
Actual evaporation, pounds of steam per pound of fuel as fired	9.37
Equivalent evaporation, pounds of steam per pound of fuel as fired	10.67
Factor of evaporation	1.139
Furnace temperature, degrees Fahrenheit	2685

CALCULATED DATA

Test Number: 25-H

Date: October 7, 8, 1946

Pounds of coal burned per hour per sq ft of actual grate area	26.01
Pounds of coal burned per hour per sq ft of projected grate area	27.60
Pounds of carbon burned per pound of fuel as fired	.74
Pounds of dry flue gas per pound of fuel as fired	10.60
Pounds of theoretical dry air required per pound of fuel as fired	9.89
Pounds of dry air actually supplied per pound of fuel as fired	10.17
Excess air, per cent	2.84
Optimum blowdown, per cent of feedwater supplied	9.63
Actual blowdown, per cent of feedwater supplied	6.31
Steam quality in steam drum, per cent	97.25
Actual evaporation, pounds of steam per pound of fuel as fired	9.27
Equivalent evaporation, pounds of steam per pound of fuel as fired	10.56
Factor of evaporation	1.139

CALCULATED DATA

Test Number: 30-L

Date: October 16,17, 1946

Pounds of coal burned per hour per sq ft of actual grate area	29.25
Pounds of coal burned per hour per sq ft of projected grate area	31.03
Pounds of carbon burned per pound of fuel as fired	.72
Pounds of dry flue gas per pound of fuel as fired	12.72
Pounds of theoretical dry air required per pound of fuel as fired	9.74
Pounds of dry air actually supplied per pound of fuel as fired	12.30
Excess air, per cent	26.31
Optimum blowdown, per cent of feedwater supplied	6.70
Actual blowdown, per cent of feedwater supplied	5.75
Steam quality in steam drum, per cent	98.10
Actual evaporation, pounds of steam per pound of fuel as fired	9.46
Equivalent evaporation, pounds of steam per pound of fuel as fired	10.76
Factor of evaporation	1.137

CALCULATED DATA

Test Number: 30-M

Date: November 18,19, 1946

Pounds of coal burned per hour per sq ft of actual grate area	28.62
Pounds of coal burned per hour per sq ft of projected grate area	30.36
Pounds of carbon burned per pound of fuel as fired	.73
Pounds of dry flue gas per pound of fuel as fired	11.21
Pounds of theoretical dry air required per pound of fuel as fired	9.87
Pounds of dry air actually supplied per pound of fuel as fired	10.78
Excess air, per cent	9.27
Optimum blowdown, per cent of feedwater supplied	7.95
Actual blowdown, per cent of feedwater supplied	5.20
Steam quality in steam drum, per cent	94.80
Actual evaporation, pounds of steam per pound of fuel as fired	9.80
Equivalent evaporation, pounds of steam per pound of fuel as fired	11.18
Factor of evaporation	1.141
Furnace temperature, degrees Fahrenheit	2745

CALCULATED DATA

Test Number: 30-M

Date: October 23,24, 1946

Pounds of coal burned per hour per sq ft of actual grate area	29.35
Pounds of coal burned per hour per sq ft of projected grate area	31.14
Pounds of carbon burned per pound of fuel as fired	.76
Pounds of dry flue gas per pound of fuel as fired	11.10
Pounds of theoretical dry air required per pound of fuel as fired	10.15
Pounds of dry air actually supplied per pound of fuel as fired	10.64
Excess air, per cent	4.87
Optimum blowdown, per cent of feedwater supplied	6.93
Actual blowdown, per cent of feedwater supplied	5.58
Steam quality in steam drum, per cent	98.70
Actual evaporation, pounds of steam per pound of fuel as fired	9.53
Equivalent evaporation, pounds of steam per pound of fuel as fired	10.85
Factor of evaporation	1.139

CALCULATED DATA

Test Number: 36-M

Date: November 20, 21, 1946

Pounds of coal burned per hour per sq ft of actual grate area	34.97
Pounds of coal burned per hour per sq ft of projected grate area	37.10
Pounds of carbon burned per pound of fuel as fired	.75
Pounds of dry flue gas per pound of fuel as fired	11.68
Pounds of theoretical dry air required per pound of fuel as fired	10.14
Pounds of dry air actually supplied per pound of fuel as fired	11.23
Excess air, per cent	10.79
Optimum blowdown, per cent of feedwater supplied	8.19
Actual blowdown, per cent of feedwater supplied	5.06
Steam quality in steam drum, per cent	94.55
Actual evaporation, pounds of steam per pound of fuel as fired	9.87
Equivalent evaporation, pounds of steam per pound of fuel as fired	11.34
Factor of evaporation,	1.149
Furnace temperature, degrees Fahrenheit	2795

CALCULATED DATA

Test Number: 36-H

Date: December 17, 18, 1946

Pounds of coal burned per hour per sq ft of actual grate area	36.59
Pounds of coal burned per hour per sq ft of projected grate area	38.82
Pounds of carbon burned per pound of fuel as fired	.77
Pounds of dry flue gas per pound of fuel as fired	11.83
Pounds of theoretical dry air required per pound of fuel as fired	10.35
Pounds of dry air actually supplied per pound of fuel as fired	11.36
Excess air, per cent	9.73
Optimum blowdown, per cent of feedwater supplied	7.26
Actual blowdown, per cent of feedwater supplied	3.40
Steam quality in steam drum, per cent	94.20
Actual evaporation, pounds of steam per pound of fuel as fired	9.52
Equivalent evaporation, pounds of steam per pound of fuel a s fired	10.75
Factor of evaporation	1.153

CALCULATED DATA

Test Number: 40-M

Date: January 16, 1947

Pounds of coal burned per hour per sq ft of actual grate area	39.25
Pounds of coal burned per hour per sq ft of projected grate area	41.64
Pounds of carbon burned per pound of fuel as fired	.72
Pounds of dry flue gas per pound of fuel as fired	12.28
Pounds of theoretical dry air required per pound of fuel as fired	9.70
Pounds of dry air actually supplied per pound of fuel as fired	11.87
Excess air, per cent	22.31
Optimum blowdown, per cent of feedwater supplied	9.56
Actual blowdown, per cent of feedwater supplied	3.62
Steam quality in steam drum, per cent	93.99
Actual evaporation, pounds of steam per pound of fuel as fired	9.60
Equivalent evaporation, pounds of steam per pound of fuel as fired	11.06
Factor of evaporation	1.152
Furnace temperature, degrees Fahrenheit	2815

FUEL DATA

Test Number: 30-L

Date: October 30,31, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	29.13	Carbon	78.56
Fixed carbon	61.66	Hydrogen	4.75
Ash	7.20	Oxygen	5.42
Moisture	2.01	Nitrogen	1.37
	100.00	Sulphur	.69
		Ash	7.20
		Moisture	2.01
			100.00

Higher heating value, Btu per pound, as fired	14,198
Ash fusion temperature, degrees Fahrenheit	2,797
Weight of refuse collected, pounds	5,300
Per cent combustible in the refuse	13.55
Weight of fly ash leaving furnace (calculated), pounds	1,038
Weight of fly ash collected, pounds	27
Total weight of fly ash leaving the fuel bed, pounds	1,065
Per cent combustible in the fly ash	52.76

FUEL DATA

Test Number: 20-K

Date: November 9, 10, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	29.71	Carbon	76.81
Fixed carbon	59.37	Hydrogen	4.69
Ash	8.43	Oxygen	5.53
Moisture	2.49	Nitrogen	1.36
	100.00	Sulphur	.69
		Ash	8.43
		Moisture	2.49
			100.00

Higher heating value, Btu per pound, as fired	14,050
Ash fusion temperature, degrees Fahrenheit	2,391
Weight of refuse collected, pounds	5,500
Per cent combustible in the refuse	19.37
Weight of fly ash leaving furnace (calculated), pounds	2,278
Weight of fly ash collected, pounds	15
Total weight of fly ash leaving the fuel bed, pounds	2,293
Per cent combustible in the fly ash	50.00

FUEL DATA

Test Number: 20-H

Date: November 6,7, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	27.17	Carbon	76.61
Fixed carbon	61.04	Hydrogen	4.59
Ash	8.09	Oxygen	4.99
Moisture	3.70	Nitrogen	1.35
	100.00	Sulphur	.67
		Ash	8.09
		Moisture	3.70
			100.00

Higher heating value, Btu per pound, as fired	13,910
Ash fusion temperature, degrees Fahrenheit	2,817
Weight of refuse collected, pounds	4,500
Per cent combustible in the refuse	14.03
Weight of fly ash leaving furnace (calculated), pounds	185
Weight of fly ash collected, pounds	38
Total weight of fly ash leaving the fuel bed, pounds	223
Per cent combustible in the fly ash	34.87

FUEL DATA

Test Number: 25-L

Date: October 12, 13, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis per cent by weight)	
Volatile matter	30.60	Carbon	79.35
Fixed carbon	61.40	Hydrogen	4.84
Ash	6.10	Oxygen	5.75
Moisture	1.90	Nitrogen	1.37
	100.00	Sulphur	.69
		Ash	6.10
		Moisture	1.90
			100.00

Higher heating value, Btu per pound, as fired	14,041
Ash fusion temperature, degrees Fahrenheit	2,675
Weight of refuse collected, pounds	2,463
Per cent combustible in the refuse	11.10
Weight of fly ash leaving furnace (calculated), pounds	2,253
Weight of fly ash collected, pounds	85
Total weight of fly ash leaving the fuel bed, pounds	2,338
Per cent combustible in the fly ash	41.50

FUEL DATA

Test Number: 25-M

Date: October 19,20, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter.....	31.08	Carbon.....	80.28
Fixed carbon.....	61.55	Hydrogen.....	4.84
Ash.....	6.30	Oxygen.....	5.43
Moisture.....	1.07	Nitrogen.....	1.39
	100.00	Sulphur.....	.69
		Ash.....	6.30
		Moisture.....	1.07
			100.00

Higher heating value, Btu per pound, as fired.....13,950

Ash fusion temperature, degrees Fahrenheit..... 2,787

Weight of refuse collected, pounds..... 4,040

Per cent combustible in the refuse.....10.98

Weight of fly ash leaving furnace (calculated), pounds..... 359

Weight of fly ash collected, pounds..... 35

Total weight of fly ash leaving the fuel bed, pounds..... 394

Per cent combustible in the fly ash..... 46.31

FUEL DATA

Test Number: 25-H

Date: October 7, 8, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	29.79	Carbon	76.67
Fixed carbon	59.16	Hydrogen	4.68
Ash	8.90	Oxygen	5.55
Moisture	2.15	Nitrogen	1.37
	100.00	Sulphur	.68
		Ash	8.90
		Moisture	2.15
			100.00

Higher heating value, Btu per pound, as fired	14,060
Ash fusion temperature, degrees Fahrenheit	2,550
Weight of refuse collected, pounds	3,900
Per cent combustible in the refuse	11.40
Weight of fly ash leaving furnace (calculated), pounds	3,643
Weight of fly ash collected, pounds	130
Total weight of fly ash leaving the fuel bed, pounds	3,773
Per cent combustible in the fly ash	40.50

FUEL DATA

Test Number: 30-L

Date: October 16,17, 1946

Proximate Analysis (As received basis per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	28.00	Carbon	76.88
Fixed carbon	60.70	Hydrogen	4.63
Ash	9.20	Oxygen	5.14
Moisture	2.10	Nitrogen	1.37
	100.00	Sulphur	.68
		Ash	9.20
		Moisture	2.10
			100.00

Higher heating value, Btu per pound, as fired	13,950
Ash fusion temperature, degrees Fahrenheit	2,776
Weight of refuse collected, pounds	3,650
Per cent combustible in the refuse	10.99
Weight of fly ash leaving furnace (calculated), pounds	6,157
Weight of fly ash collected, pounds	122
Total weight of fly ash leaving the fuel bed, pounds	6,279
Per cent combustible in the fly ash	46.20

FUEL DATA

Test Number: 30-M

Date: November 18,19, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	28.60	Carbon	77.41
Fixed carbon	60.85	Hydrogen	4.68
Ash	7.69	Oxygen	5.30
Moisture	2.86	Nitrogen	1.36
	100.00	Sulphur	.68
		Ash	7.69
		Moisture	2.88
			100.00

Higher heating value, Btu per pound, as fired	14,000
Ash fusion temperature, degrees Fahrenheit	2,451
Weight of refuse collected, pounds	5,585
Per cent combustible in the refuse	18.11
Weight of fly ash leaving furnace (calculated), pounds	2,625
Weight of fly ash collected, pounds	66
Total weight of fly ash leaving the fuel bed, pounds	2,691
Per cent combustible in the fly ash	68.75

FUEL DATA

Test Number: 30-H

Date: October 23,24, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	28.94	Carbon	78.28
Fixed carbon	61.49	Hydrogen	4.73
Ash	7.83	Oxygen	5.36
Moisture	1.74	Nitrogen	1.37
	100.00	Sulphur	.69
		Ash	7.83
		Moisture	1.74
			100.00

Higher heating value, Btu per pound, as fired 13,962

Ash fusion temperature, degrees Fahrenheit 2,746

Weight of refuse collected, pounds 4,914

Per cent combustible in the refuse 12.60

Weight of fly ash leaving furnace (calculated), pounds 2,435

Weight of fly ash collected, pounds 180

Total weight of fly ash leaving the fuel bed, pounds 2,615

Per cent combustible in the fly ash 47.75

FUEL DATA

Test Number: 36-M

Date: November 20,21, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	28.84	Carbon	79.42
Fixed carbon	63.79	Hydrogen	4.78
Ash	5.39	Oxygen	5.39
Moisture	2.98	Nitrogen	1.56
	100.00	Sulphur	.68
		Ash	5.39
		Moisture	2.98
			100.00

Higher heating value, Btu per pound, as fired	14,200
Ash fusion temperature, degrees Fahrenheit	2,452
Weight of refuse collected, pounds	4,200
Per cent combustible in the refuse	17.94
Weight of fly ash leaving furnace (calculated), pounds	3,758
Weight of fly ash collected, pounds	124
Total weight of fly ash leaving the fuel bed, pounds	3,882
Per cent combustible in the fly ash	69.22

FUEL DATA

Test Number: 36-H

Date: December 17,18, 1946

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	29.92	Carbon	79.99
Fixed carbon	60.46	Hydrogen	4.74
Ash	7.27	Oxygen	5.59
Moisture	2.35	Nitrogen	1.37
	100.00	Sulphur	.69
		Ash	7.27
		Moisture	2.35
			100.00

Higher heating value, Btu per pound, as fired	13,500
Ash fusion temperature, degrees Fahrenheit	2,472
Weight of refuse collected, pounds	8,100
Per cent combustible in the refuse	22.03
Weight of fly ash leaving furnace (calculated), pounds	517
Weight of fly ash collected, pounds	199
Total weight of fly ash leaving the fuel bed, pounds	716
Per cent combustible in the fly ash	67.20

FUEL DATA

Test Number: 40-M

Date: January 16, 1947

Proximate Analysis (As received basis, per cent by weight)		Ultimate Analysis (As received basis, per cent by weight)	
Volatile matter	30.31	Carbon	77.61
Fixed carbon	59.77	Hydrogen	4.74
Ash	7.49	Oxygen	5.68
Moisture	2.43	Nitrogen	1.37
	100.00	Sulphur	.68
		Ash	7.49
		Moisture	2.43
			100.00

Higher heating value, Btu per pound, as fired	14,100
Ash fusion temperature, degrees Fahrenheit	2,726
Weight of refuse collected, pounds	2,100
Per cent combustible in the refuse	12.65
Weight of fly ash leaving furnace (calculated), pounds	2,010
Weight of fly ash collected, pounds	150
Total weight of fly ash leaving the fuel bed, pounds	2,160
Per cent combustible in the fly ash	73.18

Time	Combustion Air		Draft, Inches of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1640	78	63	1.2	0.2	.04	.13	7036125	404	0.0	213	208	252	214	0.0	0.0	245	520	580	119	74	28.17	93	12.6	6.8	0.0	80.6		
1700	80	64	1.2	0.2	.04	.14	7036360	404	0.0	213	207	255	214	0.0	0.0	246	524	560	118	70	28.17	92	13.8	5.1	0.0	81.1	170	1750
1720	79	63	1.2	0.2	.04	.11	7036570	404	0.0	213	207	254	212	0,0	0.0	246	518	560	116	70	28.17	92	14.0	5.1	0.0	80.9		
1740	78	63	1.2	0.2	.04	.13	7036950	404	0.0	213	208	255	213	0.0	0.0	247	514	540	114	72	28.16	92	14.1	5.0	0.0	80.9		
1800	78	63	1.1	0.1	.04	.14	7037265	404	0.0	212	208	257	214	0.0	0.0	244	514	600	112	72	28.16	92	13.6	5.6	0.0	80.8	170	1760
1820	79	64	0.9	0.2	.04	.13	7037630	403	0,0	212	208	255	212	0.0	0.0	245	520	585	112	72	28.16	92	13.7	5.3	0.0	81.0		
1840	77	63	1.3	0.2	.04	.16	7038000	402	0.0	212	207	254	212	0.0	0.0	245	520	580	112	74	28.16	91	13.6	5.6	0.0	80.8		
1900	77	63	1.4	0.3	.04	.13	7038370	401	0.0	212	206	256	212	0.0	0.0	249	520	540	112	70	28.16	90	13.6	5.6	0.0	80.0	180	1760
1920	77	63	0.9	0.1	.04	.11	7038730	400	0.0	213	208	256	212	0.0	0.0	246	518	570	110	72	28.16	89	14.2	4.7	0.1	81.0		
1940	76	62	1.0	0.3	.04	.18	7039120	403	0.0	213	208	255	213	0.0	0.0	245	518	600	110	74	28.16	89	13.0	6.8	0.0	81.2		
2000	75	62	1.4	0.2	.04	.15	7039500	404	0.3	212	206	258	213	0.0	0.0	245	518	580	108	70	28.15	89	12.3	6.1	0.0	81.6	130	1770
2020	75	62	1.4	0.2	.04	.15	7039800	405	0.0	213	206	259	212	0.0	0.0	245	518	565	108	70	28.16	89	13.4	5.9	0.0	80.7		
2040	74	62	1.6	0.2	.04	.15	7040140	404	0.0	214	207	259	213	0.0	0.0	245	516	580	106	72	28.16	88	12.8	6.3	0.0	80.9		
2100	74	62	1.3	0.3	.04	.16	7040400	403	0.3	214	206	261	214	0.0	0.0	246	518	570	106	72	28.16	88	12.4	6.8	0.0	80.8	200	1750
2120	74	62	1.1	0.3	.04	.11	7040800	402	0.3	214	206	255	214	0.0	0.0	247	514	550	105	74	28.16	88	13.8	5.2	0.0	81.0		
2140	73	62	1.1	0.2	.04	.16	7041000	402	0.3	213	206	255	214	0.0	0.0	247	520	580	104	70	28.16	89	12.4	7.0	0.0	80.6		
2200	72	62	1.2	0.3	.04	.13	7041370	400	0.0	213	206	259	214	0.0	0.0	245	514	570	108	70	28.16	86	13.0	5.4	0.0	81.6	170	1780
2220	72	62	1.3	0.3	.04	.14	7041620	395	0.0	213	205	261	214	0.0	0.0	247	518	560	110	72	28.15	85	14.3	4.3	0.0	81.4		
2240	71	61	1.2	0.2	.04	.11	7041930	398	0.0	213	205	260	213	0.0	0.0	246	514	570	108	70	28.15	86	14.2	4.7	0.0	81.1		
2300	70	61	1.8	0.4	.04	.21	7042330	404	0.0	214	205	262	212	0.0	0.0	248	518	600	108	67	28.15	86	14.6	4.3	0.1	81.0	140	1720
2320	70	60	1.2	0.2	.04	.13	7042600	404	0.3	214	205	262	211	0.0	0.0	247	513	560	107	66	28.15	86	14.4	4.0	0.2	81.4		
2340	70	60	1.2	0.3	.04	.12	7042920	404	0.3	214	207	258	213	0.0	0.0	247	509	560	106	66	28.15	85	13.5	4.7	0.0	81.8		
2400	70	61	1.0	0.4	.04	.20	7043240	403	2.0	217	205	262	212	0.0	0.0	247	516	590	108	67	28.15	85	13.0	5.8	0.0	81.2	140	1720
0020	70	61	0.8	0.1	.04	.09	7043700	397	2.0	217	209	262	213	0.0	0.0	248	510	510	106	68	28.14	85	13.6	5.4	0.0	81.0		
0040	70	61	0.8	0.2	.04	.10	7043940	401	2.0	217	210	258	213	0.0	0.0	247	506	540	104	66	28.14	85	13.3	5.3	0.0	81.2		
0100	70	62	1.5	0.3	.04	.15	7044270	397	2.0	217	208	262	213	0.0	0.0	248	514	560	103	67	28.14	85	13.6	5.2	0.0	81.2	150	1730
0120	69	61	1.4	0.2	.04	.14	7044600	402	2.3	217	207	260	212	0.0	0.0	247	513	570	106	68	28.14	85	14.8	4.0	0.2	81.0		
0140	69	61	1.2	0.2	.04	.12	7044900	395	2.3	217	208	260	212	0.0	0.0	247	511	540	105	68	28.14	85	14.5	4.0	0.1	81.4		
0200	69	61	0.7	0.1	.04	.08	7045200	397	2.3	218	208	262	212	0.0	0.0	248	510	520	105	68	28.14	84	14.3	5.2	0.0	80.5	180	1750
0220	70	62	1.0	0.2	.04	.12	7045520	397	2.3	217	208	261	212	0.0	0.0	247	510	560	102	67	28.14	84	13.1	6.4	0.0	80.5		
0240	69	61	0.9	0.1	.04	.13	7045770	402	2.3	218	208	258	212	0.0	0.0	245	511	560	102	68	28.14	84	12.2	7.4	0.0	80.4		
0300	69	61	1.2	0.2	.04	.16	7046080	395	2.3	218	209	261	212	0.0	0.0	247	511	540	107	68	28.14	84	13.0	6.3	0.0	80.7	160	1750
0320	69	61	1.6	0.2	.04	.17	7046400	401	2.3	217	209	261	213	0.0	0.0	247	513	570	108	68	28.14	82	13.8	5.6	0.0	80.6		
0340	68	61	0.8	0.1	.04	.09	7046660	401	2.3	217	210	261	212	0.0	0.0	247	505	500	108	68	28.13	83	14.3	4.6	0.1	81.0		
0400	68	60	1.0	0.2	.04	.12	7047000	404	2.3	218	208	262	212	0.0	0.0	248	512	540	108	69	28.13	82	13.2	6.0	0.0	80.8	170	1770
0420	68	60	1.1	0.2	.04	.13	7047360	405	2.5	218	209	258	212	0.0	0.0	245	507	530	104	67	28.14	82	14.0	5.5	0.0	80.5		
0440	67	60	0.8	0.1	.04	.10	7047620	403	2.5	218	210	257	212	0.0	0.0	244	503	520	104	67	28.14	82	12.8	6.5	0.0	80.7		
0500	67	60	0.8	0.1	.04	.10	7048000	402	2.5	218	207	258	213	0.0	0.0	246	505	520	104	70	28.15	82	13.8	5.2	0.0	81.0	170	1830
0520	67	60	0.7	0.1	.04	.16	7048320	404	2.5	218	204	260	212	0.0	0.0	247	512	515	101	74	28.15	82	13.1	6.5	0.0	80.4		
0540	67	60	0.7	0.1	.04	.10	7048759	403	2.5	218	204	261	212	0.0	0.0	248	510	540	100	66	28.15	82	13.8	5.6	0.0	80.6		
0600	68	60	1.3	0.2	.04	.14	7049000	404	2.5	218	204	259	212	0.0	0.0	247	513	560	101	68	28.15	82	13.8	5.0	0.0	81.2	170	1850
0620	67	60	0.7	0.1	.04	.08	7049400	405	2.3	218	204	259	212	0.0	0.0	247	510	510	102	72	28.15	82	14.0	5.4	0.0	80.6		
0640	66	59	0.4	0.2	.04	.13	7049700	405	2.3	217	204	260	212	0.0	0.0	247	510	540	102	68	28.15	82	15.2	3.7	0.1	81.0		
0700	66	59	0.9	0.2	.04	.12	7050000	400	2.5	218	204	259	212	0.0	0.0	248	505	535	102	71	28.15	82	15.4	3.5	0.1	81.0	180	1940
0720	67	59	1.0	0.2	.04	.11	7050800	399	2.5	218	205	261	212	0.0	0.0	249	510	550	100	73	28.15	82	15.0	4.0	0.1	80.9		
0740	67	59	1.0	0.1	.04	.09	7051500	399	2.3	218	205	260	212	0.0	0.0	248	513	540	100	75	28.15	82	13.4	5.7	0.0	80.9		
0800	68	59	1.1	0.1	.04	.14	7052800	402	2.3	218	205	260	212	0.0	0.0	247	511	550	100	71	28.16	82	13.5	5.5	0.0	81.0	120	1750
0820	70	62	0.8	0.1	.04	.10	7054200	402	0.3	213	202	260	214	0.0	0.0	246	515	570	104	72	28.16	82	13.0	6.6	0.0	80.4		
0840	68	62	0.8	0.2	.04	.14	7054905	402	0.5	213	202	261	215	0.0	0.0	248	520	550	104	73	28.16	82	12.6	6.8	0.0	80.6		
0900	70	62	0.7	0.2	.04	.15	7055652	403	0.5	213	202	261	216	0.0	0.0	250	518	550	104	73	28.16	83	14.0	5.2	0.0	80.8	150	1590
0920	72	63	0.4	0.1	.04	.08	7057100	403	0.5	213	202	262	216	0.0	0.0	249	518	510	105	72	28.16	84	14.0	4.8	0.0	81.2		
0940	73	64	1.0	0.1	.04	.11	7057800	402	0.3	214	202	262	216	0.0	0.0	248	523	550	106	70	28.16	84	15.3	3.0	0.2	81.5		
1000	74	64	0.8	0.2	.04	.08	7058910	403	0.5	214	202	262	216	0.0	0.0	250	521	510	110	66	28.16	86	15.0	3.7	0.1	81.2	140	1590
1020	76	64	1.3	0.3	.04	.13	7059900	404	0.3	212	203	264	216	0.0	0.0	250	523	550	111	67	28.16	88	15.3	3.5	0.1	81.1		
1040	77	64	1.5	0.4	.04	.14	7060970	404	0.3	213	204	262	216	0.0	0.0	250	523	550	111	67	28.16	89	14.4	4.8	0.0	80.8		
1100	79	65	1.4	0.3	.04	.11	7061400	404	0.0	213	202	261	216	0.0	0.0	248	520	515	120	66	28.16	89	14.2	5.0	0.0	80.8	130	1500
1120	79	65	1.0	0.3	.04	.14	7063300	403	0.0	213	203	260	217	0.0	0.0	250	522	550	120	68	28.15	90	13.6	5.6	0.0	80.8		
1140	79	65	1.1	0.2	.04	.10	7664960	403	0.0	212	203	262	215	0.0	0.0	248	522	540	120	70	28.15	92	15.1	4.3	0.1	80.5		
1200	79	65	1.0	0.3	.04	.10	7065000	403	0.0	213	204	268	216	0.0	0.0	248	520	515	118	71	28.15	92	14.4	4.9	0.0	80.7	140	1370
1220	79	65	1.0	0.2	.04	.10	7066160	404	0.0	213	204	259	216	0.0	0.0	248	521	510	118	68	28.14	92	15.4	3.6	0.1	80.9		
1240	80	64	1.3	0.3	.04	.13	7067100	403	0.0	213	204	258	216	0.0	0.0	249	522	560	118	68	28.14	92	13.8	5.5	0.0	80.7		
1300	81	64	1.0	0.3	.04	.10	7068130	404	0.3	212	204	259	216	0.0	0.0	249	520	540	120	71	28.13	94	14.4	4.6	0.0	81.0	160	1360
1320	81	64	1.1	0.3	.04	.14	7069300	403	0.0	212	203	258	216	0.0	0.0	249	522	550	120	71	28.13	94	14.2	4.8	0.0	81.0		
1340	81	64	1.2	0.3	.04	.11	7069500	403	0.0	213	203	260	215	0.0	0.0	250	520	550	121	71	28.13	94	14.3	4.7	0.0	81.0		
1400	81	64	1.3	0.4	.04	.13	7071000	403	0.0	212	204	261	215	0.0	0.0	248	522	555	115	70	28.12	95	14.8	4.2	0.0	81.0	150	1300
1420	82	65	1.1	0.3	.04	.12	7072210	404	0.0	212	204	260	215	0.0	0.0	249	520	540	114	70	28.12	95	14.4	4.8	0.0	80.8		
1440	81	64	0.8	0.2	.04	.09	7073240	402	0.0	212	204	260	216	0.0	0.0	247	524	520	115	69	28.12	96	14.7	4.3	0.0	81.0		
1500	82	64	1.5	0.2	.04	.11	7074180	402	0.0	212	204	262	216	0.0	0.0	248	525	540	115	69	28.11	96	14.8	4.4	0.0	80.8	130	1270
1520	81	64	0.7	0.1	.04	.08	7075220	404	0.0	213	203	261	216	0.0	0.0	247	527	540	117	70	28.11	97	14.0	5.0	0.0	81.0		
1540	81	64	1.1	0.2	.04	.11	7075830	405	0.0	212	204	259	216	0.0	0.0	247	523	540	118	71	28.10	96	14.5	4.8	0.0	80.7		
1600	81	64	1.4	0.1	.04	.11	7076450	405	0.0	212	204	260	216	0.0	0.0	247	528	525	115	71	28.10	96	14.8	4.6	0.0	80.6	100	1230
1620	81	63	0.9	0.1	.04	.12	7077150	405	0.0	212	204	258	216	0.0	0.0	246	528	545	115	72	28.09	95	14.0	5.4	0.0	80.6		
1640	81	63	1.0	0.1	.04	.09	7077635	405	0.0	212	205	258	217	0.0	0.0	245	522	540	114	72	29.09	95	14.3	5.1	0.0	80.6		
Avg	74	62	1.1	0.2	.04	.12	-------	402	0.9	214	206	259	214	0.0	0.0	247	516	550	109	70	28.15	88	13.9	5.2	0.0	80.9	150	1650
Corr Avg	74	63	1.1	0.2	.04	.12	-------	391	1.0	216	209	250	215	0.0	0.0	245	516	515	109	70	28.15	88	13.9	5.2	0.0	80.9	150	1650

Type of fuel bed	Low
Coal fired (as received basis)	45,735 pounds
Corrected coal fired (as received basis)	46,630 pounds
Corrected average hourly rate of coal consumption (as received basis)	1,943 pounds per hour
Blow-down water through heat exchanger	41,510 pounds
Corrected blow-down water through heat exchanger	30,720 pounds
Corrected total blow-down water	37,950 pounds
Corrected average hourly rate of blow-down	1,581 pounds per hour
Weight of steam generated	478,800 pounds
Corrected weight of steam generated	470,269 pounds
Corrected average hourly rate of steam generation	19,596 pounds per hour
Corrected average flue gas temperature	525 degrees Fahrenheit

TEST NUMBER: 20-L OBSERVED DATA DATE: OCTOBER 30,31, 1946

Time	Combustion Air		Draft, Inches of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction					CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown water
1300	72	58	0.9	0.1	.04	.12	7352285	400	2.3	217	207	265	214	0.2	2.8	251	525	555	127	64	28.01	81	15.0	3.4	0.0	81.6	160	1710
1320	73	58	0.7	0.1	.04	.11	7352800	401	2.4	217	207	264	214	0.2	2.8	251	522	530	124	63	28.01	84	16.5	2.5	0.0	81.0		
1340	74	57	0.9	0.0	.04	.13	7353600	402	2.8	217	206	264	214	0.2	2.8	250	526	555	122	65	28.02	85	16.8	1.8	0.0	81.4		
1400	77	58	0.9	0.1	.04	.14	7354600	403	2.9	217	207	264	214	0.2	2.8	250	524	570	124	64	28.02	85	16.2	3.0	0.0	80.8	160	1700
1420	77	58	0.6	0.0	.04	.13	7355075	405	2.3	217	206	261	216	0.2	2.8	250	526	550	126	66	28.02	86	16.0	2.0	0.0	82.0		
1440	76	57	0.4	0.0	.04	.11	7355550	405	2.4	216	206	260	216	0.2	2.8	247	522	510	122	67	28.02	89	16.3	2.8	0.0	80.9		
1500	77	57	0.4	0.0	.04	.12	7356100	405	2.4	216	206	260	216	0.2	2.8	247	518	540	123	66	28.02	89	15.2	3.6	0.0	81.2	120	1670
1520	77	56	0.9	0.1	.04	.14	7356900	405	2.1	216	207	261	216	0.2	2.8	247	526	570	128	66	28.02	92	16.4	2.5	0.0	81.1		
1540	76	56	1.5	0.1	.04	.20	7357400	404	2.1	216	207	261	216	0.2	2.8	248	529	600	126	66	28.03	92	15.3	3.7	0.0	81.0		
1600	76	56	0.8	0.0	.04	.15	7358200	404	2.1	216	206	264	216	0.2	2.8	249	522	580	124	64	28.03	90	16.2	2.8	0.0	81.0	150	1630
1620	76	56	0.9	0.0	.04	.17	7358400	404	2.3	216	206	265	216	0.2	2.8	248	525	550	124	63	28.03	92	15.7	3.3	0.0	81.0		
1640	78	55	0.8	0.0	.04	.15	7359300	404	2.2	216	207	264	216	0.2	2.8	247	528	580	123	64	28.04	91	15.3	3.9	0.0	80.8		
1700	78	55	0.8	0.0	.04	.14	7360000	404	2.4	216	206	264	216	0.2	2.8	248	524	560	123	63	28.04	89	16.4	2.8	0.0	80.8	140	1590
1720	77	55	1.2	0.2	.04	.20	7360530	404	1.8	216	205	262	218	0.2	2.8	247	527	570	132	60	28.04	89	14.4	5.1	0.0	80.5		
1740	74	55	0.7	0.1	.04	.15	7361200	404	2.0	216	204	260	218	0.2	2.8	245	526	580	133	61	28.04	88	14.6	4.5	0.0	80.9		
1800	72	54	0.7	0.1	.04	.13	7361790	403	2.0	217	204	262	218	0.2	2.8	246	528	600	132	61	28.03	83	15.0	4.2	0.0	80.8	120	1580
1820	70	54	1.1	0.2	.04	.16	7362340	403	2.8	217	205	262	219	0.2	2.8	245	529	560	133	65	28.03	84	15.1	3.9	0.0	81.0		
1840	70	53	1.3	0.3	.04	.20	7363080	403	2.1	216	205	264	219	0.2	2.8	247	529	590	131	64	28.03	85	14.0	4.0	0.0	82.0		
1900	68	53	1.3	0.3	.04	.16	7363680	403	2.1	216	203	262	219	0.2	2.8	245	526	530	128	65	28.03	83	14.2	4.4	0.0	81.4	120	1550
1920	66	52	1.0	0.2	.04	.15	7364320	403	2.1	216	203	262	218	0.2	2.8	245	524	540	128	66	28.03	83	13.6	5.0	0.0	81.4		
1940	66	53	1.8	0.5	.04	.22	7364930	403	2.0	216	203	265	217	0.2	2.8	247	531	560	130	68	28.03	81	14.4	4.4	0.0	81.2		
2000	66	53	1.2	0.2	.04	.15	7365450	403	2.3	216	203	263	216	0.2	2.8	247	529	560	127	65	28.03	82	14.3	4.9	0.0	80.8	130	1500
2020	66	52	1.6	0.3	.04	.16	7366110	404	2.0	216	203	262	216	0.2	2.8	247	530	560	127	64	28.03	83	15.4	3.1	0.0	81.5		
2040	63	51	1.5	0.3	.04	.15	7366750	403	2.0	216	203	263	216	0.2	2.8	247	530	530	128	64	28.04	80	15.1	3.5	0.0	81.4		
2100	63	50	1.4	0.3	.04	.14	7367180	403	2.2	216	203	262	216	0.2	2.8	247	525	540	124	65	28.04	78	14.3	5.1	0.0	80.6	110	1510
2120	62	50	1.5	0.3	.04	.16	7367820	404	2.4	216	203	262	216	0.2	2.8	245	526	550	126	64	28.04	78	14.6	4.2	0.0	81.2		
2140	61	50	1.7	0.3	.04	.18	7368500	404	2.5	217	204	265	216	0.2	2.8	247	530	540	108	66	28.04	76	14.4	4.5	0.0	81.1		
2200	69	52	1.3	0.3	.04	.15	7369080	404	2.5	217	205	262	217	0.2	2.8	245	522	550	112	64	28.04	78	15.2	2.8	0.0	82.0	140	1480
2220	68	52	1.5	0.3	.04	.15	7369520	404	2.5	217	205	262	216	0.2	2.8	247	530	590	100	62	28.03	76	16.1	2.7	0.0	81.4		
2240	64	51	1.2	0.2	.04	.14	7370090	404	2.6	217	205	262	213	0.2	2.8	247	526	550	109	65	28.03	76	16.0	2.2	0.0	81.8		
2300	64	52	1.0	0.3	.04	.13	7370830	403	2.5	217	205	263	212	0.2	2.8	248	527	540	103	67	28.05	81	16.0	2.5	0.0	81.5	150	1460
2320	64	52	0.8	0.2	.04	.13	7371360	404	2.7	217	205	262	213	0.2	2.8	247	527	600	108	68	28.05	81	16.0	2.8	0.0	81.2		
2340	65	52	1.0	0.2	.04	.12	7371860	404	2.7	218	205	262	216	0.2	2.8	247	526	540	117	68	28.05	78	15.8	2.9	0.0	81.3		
2400	63	52	1.5	0.3	.04	.12	7372320	403	2.6	218	206	265	217	0.2	2.8	249	522	500	120	68	28.04	74	15.0	3.8	0.0	81.2	140	1450
0020	63	52	0.5	0.3	.04	.11	7372750	404	2.5	218	206	263	218	0.2	2.9	249	531	530	120	70	28.04	74	16.0	1.8	0.0	82.2		
0040	64	52	0.9	0.3	.04	.16	7373360	404	2.7	218	206	264	218	0.2	2.9	249	530	560	120	70	28.05	77	16.6	1.5	0,0	81.9		
0100	64	52	0.8	0.3	.04	.11	7373700	404	2.8	218	206	264	218	0.2	2.9	249	528	520	120	72	28.06	78	16.0	2.7	0.0	81.3	190	1530
0120	63	52	1.0	0.3	.04	.13	7374100	404	2.7	218	206	264	218	0.2	2.9	248	530	520	120	74	28.06	77	16.6	2.4	0.0	81.0		
0140	63	52	1.0	0.3	.04	.12	7374500	404	2.8	218	205	265	218	0.2	2.9	250	531	540	120	73	28.06	78	16.5	2.0	0.0	81.5		
0200	64	54	0.6	0.1	.04	.15	7375700	404	2.7	218	205	265	218	0.2	2.9	250	529	560	119	71	28.06	78	15.2	4.2	0.0	80.6	190	1530
0220	63	53	0.7	0.0	.04	.12	7374500	404	2.9	218	206	266	218	0.2	2.9	249	528	570	118	70	28.06	78	15.2	3.6	0.0	81.2		
0240	63	53	1.2	0.1	.04	.15	7375700	405	3.0	218	217	266	218	0.2	2.9	250	528	580	118	64	28.07	78	15.4	2.9	0.0	81.7		
0300	63	53	0.9	0.0	.04	.15	7376300	405	2.9	219	207	267	217	0.2	2.9	248	526	600	117	66	28.07	77	13.8	5.3	0.0	80.9	190	1600
0320	63	52	1.0	0.1	.04	.17	7376650	404	2.9	218	207	266	217	0.2	2.9	249	532	610	116	68	28.07	78	14.0	5.2	0.0	80.8		
0340	62	52	0.5	0.0	.04	.14	7377350	404	3.0	219	208	268	218	0.2	2.9	250	530	560	116	65	28.07	77	14.5	4.5	0.0	81.0		
0400	62	52	0.6	0.0	.04	.13	7377600	404	3.0	219	208	267	218	0.2	2.9	250	528	560	116	65	28.07	77	13.9	4.9	0.0	81.2	180	1560
0420	60	51	0.9	0.0	.04	.16	7378350	404	3.3	219	208	268	218	0.2	2.9	249	528	580	117	66	28.07	73	13.5	5.9	0.0	80.6		
0440	60	51	0.9	0.0	.04	.16	7378675	404	3.3	218	208	267	217	0.2	2.9	249	529	560	116	66	28.07	75	13.6	5.6	0.0	80.8		
0500	60	51	1.0	0.0	.04	.16	7379000	404	3.3	218	208	267	217	0.2	2.9	250	530	540	115	66	28.07	76	13.8	5.2	0.0	81.0	170	1570
0520	60	51	0.7	0.0	.04	.13	7379250	404	3.4	218	208	267	217	0.2	2.9	249	529	530	115	66	28.07	76	14.0	5.0	0.0	81.0		
0540	59	50	1.2	0.1	.04	.13	7379850	404	2.4	220	209	267	220	0.2	2.9	250	524	540	124	66	28.06	75	15.1	3.4	0.0	81.5		
0600	58	50	0.9	0.1	.04	.14	7380350	405	3.3	220	209	267	220	0.2	2.9	249	530	570	125	70	28.06	75	14.7	4.3	0.0	81.0	170	1600
0620	59	49	0.7	0.0	.04	.10	7380700	404	3.7	220	208	266	220	0.2	2.9	250	532	510	124	71	28.06	74	15.2	3.9	0.0	80.9		
0640	59	49	0.8	0.1	.04	.12	7381100	404	3.9	220	208	268	220	0.2	2.9	250	524	510	124	68	28.06	72	16.0	3.2	0.0	80.8		
0700	58	49	0.8	0.1	.04	.12	7381600	404	3.8	219	207	268	220	0.2	2.9	250	526	550	126	70	28.06	68	16.8	2.7	0.0	80.5	180	1530
0720	58	49	0.9	0.1	.04	.14	7382000	404	3.2	219	207	268	220	0.2	2.9	249	528	560	126	72	28.06	66	14.6	4.3	0.0	81.0		
0740	58	49	0.8	0.2	.04	.11	7382500	404	3.2	220	209	267	220	0.2	2.9	250	520	560	123	71	28.06	67	14.4	4.4	0.0	81.2		
0800	58	49	0.9	0.1	.04	.13	7385500	404	3.3	220	209	268	216	0.2	2.9	250	522	475	120	72	28.07	67	14.9	4.1	0.0	81.0	160	1630
0820	62	52	1.3	0.2	.04	.14	7383000	399	3.2	219	209	262	217	0.2	2.9	247	517	550	118	67	28.07	69	14.5	4.7	0.0	80.8		
0840	62	52	1.4	0.2	.04	.16	7383310	397	3.1	219	210	262	217	0.2	2.9	247	517	580	117	67	28.07	69	14.4	4.6	0.0	81.0		
0900	63	53	1.0	0.2	.04	.14	7383700	400	2.8	218	210	260	217	0.2	2.9	245	516	560	120	64	28.08	72	14.5	4.5	0.0	81.0	90	1640
0920	64	54	0.9	0.2	.04	.13	7384000	400	2.7	218	209	263	217	0.2	2.9	247	516	520	117	62	28.08	74	15.6	2.4	0,0	82.0		
0940	68	56	2.0	0.3	.04	.19	7384310	397	2.4	217	208	265	217	0.2	2.9	248	524	620	120	63	28.09	76	14.8	4.3	0.0	80.9		
1000	67	56	1.5	0.3	.04	.15	7384580	395	2.5	216	208	262	217	0.2	2.9	245	523	600	120	63	28.09	76	14.2	5.0	0.0	81.0	80	1590
1020	67	56	1.3	0.2	.04	.14	7384880	395	2.4	216	209	262	217	0.2	2.9	247	519	600	121	63	28.09	77	14.5	4.7	0.0	80.8		
1040	70	57	1.0	0.2	.04	.14	7385180	396	2.1	216	209	263	217	0.2	2.9	247	519	590	122	64	28.09	78	14.7	4.3	0.0	81.0		
1100	69	56	1.2	0.3	.04	.14	7385410	397	2.2	216	208	260	218	0.2	2.9	245	521	570	125	64	28.09	80	15.0	4.0	0.0	81.0	90	1580
1120	70	58	1.0	0.3	.04	.14	7385810	403	2.0	216	206	262	218	0.2	3.0	247	519	560	122	61	28.08	80	15.1	3.9	0.0	81.0		
1140	72	58	1.7	0.5	.04	.17	7386100	401	2.0	2.5	206	262	218	0.2	3.0	247	522	580	121	61	28.08	80	15.3	2.9	0.0	81.6		
1200	73	60	1.3	0.3	.04	.15	7386400	404	2.0	216	206	264	218	0.2	3.0	248	524	580	123	62	28.07	82	15.6	3.0	0.0	81.4	110	1550
1220	74	60	1.2	0.2	.04	.15	7386800	405	1.9	215	206	264	218	0.2	3.0	248	524	560	121	62	28.07	83	15.4	3.6	0.0	81.0		
1240	78	63	1.1	0.3	.04	.14	7387190	397	1.9	215	206	260	218	0.2	3.0	248	522	590	122	62	28.06	85	15.5	3.1	0.0	81.4		
1300	74	61	1.8	0.3	.04	.16	7387430	395	1.9	215	206	264	218	0.2	3.1	248	522	550	122	62	28.05	86	15.6	3.2	0.0	81.2	120	1560
Avg	67	54	1.1	0.2	.04	.14	-------	403	2.6	217	206	264	217	0.2	2.9	248	526	560	121	66	28.05	79	15.1	3.7	0.0	81.2	140	1570
Corr Avg	67	55	1.1	0.2	.04	.14	-------	392	2.6	219	209	253	219	0.2	2.9	248	526	500	121	66	28.05	79	15.1	3.7	0.0	81.2	140	1570

Type of fuel bed	Medium
Coal fired (as received basis)	44,470 pounds
Corrected coal fired (as received basis)	47,080 pounds
Corrected average hourly rate of coal consumption (as received basis)	1,962 pounds per hour
Blow-down water through heat exchanger	35,145 pounds
Corrected blow-down water through heat exchanger	26,010 pounds
Corrected average hourly rate of blow-down	1,333 pounds per hour
Corrected total blow-down water	31,990 pounds
Weight of steam generated	479,450 pounds
Corrected weight of steam generated	468,934 pounds
Corrected average hourly rate of steam generation	19,539 pounds per hour
Corrected average flue gas temperature	520 degrees Fahrenheit

TEST NUMBER: 20-M OBSERVED DATA DATE: NOVEMBER 9,10, 1946

Time	Combustion Air		Draft, Inches of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction					CO_2	O_2	CO	N_2	Boiler Feed-Water	Blow-down water
1600	74	57	0.5	0.0	.04	.08	7284760	405	1.6	214	205	262	221	0.0	0.0	247	529	520	141	67	28.17	93	15.0	1.6	0.7	82.7	140	1790
1620	73	57	1.7	0.4	.04	.13	7285120	404	1.6	214	206	264	221	0.0	0.0	246	528	520	121	65	28.17	91	15.7	1.0	0.0	83.3		
1640	73	56	0.7	0.4	.04	.07	7285450	404	1.6	214	206	263	221	0.0	0.0	246	526	520	122	75	28.17	91	15.0	1.6	0.2	83.2		
1700	71	55	0.5	0.0	.04	.11	7285900	404	1.7	214	206	263	220	0.0	0.0	244	525	540	118	70	28.17	89	15.9	2.3	0.0	81.8	100	1760
1720	70	55	0.8	0.2	.04	.09	7286185	404	1.6	214	206	262	225	0.0	0.0	244	524	520	120	67	28.17	88	15.6	1.7	0.0	82.7		
1740	69	54	1.7	0.4	.04	.14	7286500	404	1.6	214	205	264	219	0.0	0.0	244	527	540	117	65	28.17	88	15.8	1.8	0.0	82.4		
1800	68	54	1.3	0.3	.04	.11	7286880	404	1.7	214	206	263	222	0.0	0.0	243	525	530	115	65	28.18	89	16.1	1.7	0.0	82.2	100	1730
1820	67	54	1.1	0.2	.04	.11	7287230	404	1.7	214	207	263	221	0.0	0.0	242	525	530	113	67	28.18	90	15.4	3.0	0.0	81.6		
1840	68	54	0.5	0.1	.04	.11	2287560	404	1.7	214	210	266	222	0.0	0.0	245	520	520	115	66	28.18	90	16.7	1.7	0.0	81.6		
1900	66	53	0.4	0.1	.04	.12	7287900	404	1.9	215	209	265	223	0.0	0.0	245	526	540	109	65	28.17	89	16.5	1.8	0.0	81.7	100	1840
1920	65	53	0.4	0.0	.04	.10	7288230	404	1.9	215	210	268	222	0.0	0.0	246	524	500	110	64	28.17	89	16.6	2.1	0.0	81.3		
1940	62	51	0.7	0.1	.04	.10	7288610	404	1.7	214	209	262	223	0.0	0.0	243	520	490	108	64	28.17	88	16.6	1.9	0.0	81.5		
2000	64	52	1.0	0.2	.04	.10	7288960	404	1.7	214	207	264	223	0.0	0.0	243	521	480	110	65	28.17	85	16.1	0.9	1.4	81.6	110	1730
2020	64	52	1.0	0.2	.04	.10	7289370	404	1.8	215	205	266	223	0.0	0.0	245	531	500	110	63	28.16	82	15.8	0.5	1.9	81.8		
2040	64	53	0.8	0.1	.04	.10	7289680	404	1.6	215	205	265	222	0.0	0.0	245	529	540	113	63	28.16	84	15.6	0.6	1.8	82.0		
2100	63	52	0.8	0.2	.04	.10	7290040	405	1.8	215	208	266	224	0.0	0.0	246	524	480	110	66	28.15	82	15.5	0.8	1.7	82.0	110	1680
2120	64	52	0.9	0.2	.04	.09	7290350	404	1.7	215	207	265	224	0.1	0.1	244	528	510	113	62	28.15	82	15.9	0.6	1.5	82.0		
2140	63	53	0.5	0.0	.04	.08	7290660	404	2.0	214	207	263	224	0.1	0.0	243	526	540	112	63	28.15	82	15.8	1.2	1.2	81.8		
2200	63	52	1.1	0.2	.04	.11	7291040	404	2.0	215	206	266	223	0.1	0.0	247	532	520	111	62	28.14	81	14.8	0.6	2.8	81.8	120	1670
2220	63	52	1.0	0.4	.04	.10	7291400	404	1.7	215	208	265	224	0.1	0.0	246	530	540	111	64	28.14	79	15.6	0.9	1.7	81.8		
2240	63	53	1.3	0.4	.04	.13	7291800	405	2.0	215	207	266	223	0.1	0.0	246	530	570	110	63	28.14	78	15.9	1.1	1.0	82.0		
2300	63	52	1.0	0.2	.04	.10	7292000	404	1.8	215	207	265	223	0.1	0.0	246	532	520	110	62	28.12	80	16.3	0.7	0.6	82.4	110	1640
2320	63	52	1.0	0.2	.04	.10	7292500	404	1.9	215	207	265	224	0.1	0.0	246	528	505	110	63	28.12	80	16.4	0.9	0.6	82.1		
2340	62	52	1.3	0.3	.04	.14	7293000	404	1.9	215	206	265	222	0.1	0.0	247	530	550	111	63	28.12	80	16.4	0.6	0.8	82.2		
2400	61	52	0.5	0.0	.04	.08	7293300	404	1.8	215	206	265	222	0.1	0.0	247	532	500	111	63	28.11	76	15.5	0.5	2.0	82.0	120	1640
0020	60	51	1.5	0.4	.04	.14	7293700	404	1.9	216	210	266	223	0.2	0.0	247	532	540	110	64	28.09	74	15.3	0.7	2.3	81.7		
0040	60	51	1.1	0.3	.04	.10	7294000	404	1.9	216	210	266	224	0.2	0.0	247	530	540	110	64	28.09	74	15.7	0.7	1.6	82.0		
0100	60	51	0.4	0.1	.04	.06	7294200	404	1.9	216	209	266	223	0.2	0.0	246	528	500	111	63	28.09	74	15.8	1.0	1.0	82.2	200	1740
0120	60	50	0.8	0.1	.04	.08	7294700	404	2.0	216	211	265	224	0.2	0.0	246	524	500	110	63	28.08	76	15.5	0.7	1.4	82.4		
0140	60	50	0.8	0.2	.04	.10	7294900	405	2.0	216	210	265	224	0.2	0.0	246	526	500	110	64	28.08	76	15.9	1.7	0.0	82.4		
0200	60	50	0.9	0.2	.04	.10	7295400	405	2.3	216	210	267	221	0.2	0.0	246	530	520	110	70	28.08	78	15.5	0.9	0.0	82.6	190	1730
0220	61	50	1.2	0.3	.04	.12	7295700	405	2.0	216	210	266	220	0.2	0.0	246	530	540	111	70	28.08	78	15.5	0.5	1.4	82.6		
0240	60	50	0.8	0.1	.04	.08	7296000	405	2.0	216	211	266	220	0.2	0.0	248	526	480	110	72	28.08	78	16.0	0.8	0.0	82.2		
0300	60	50	0.8	0.1	.04	.08	7296400	405	2.1	216	211	267	222	0.2	0.0	247	524	500	113	72	28.07	78	15.2	1.5	0.7	82.6	180	1740
0320	61	51	1.4	0.3	.04	.11	7296700	405	2.0	216	211	267	222	0.3	0.0	246	530	540	114	70	28.07	78	15.2	0.6	1.6	82.6		
0340	61	51	1.1	0.3	.04	.08	7297200	405	2.1	216	210	268	222	0.2	0.0	246	520	480	114	68	28.07	78	16.6	0.6	0.4	82.4		
0400	61	51	1.9	0.4	.04	.10	7297400	405	2.1	216	211	268	224	0.2	0.0	247	524	530	114	67	28.05	77	16.5	0.8	0.0	82.7	180	1770
0420	61	51	0.9	0.1	.04	.09	7297600	405	2.1	216	211	268	224	0.2	0.0	246	522	520	114	66	28.05	77	15.8	1.4	0.0	82.8		
0440	61	51	0.5	0.2	.04	.11	7297900	404	2.1	216	212	266	222	0.2	0.0	246	524	560	116	62	28.04	77	16.2	1.6	0.0	82.2		
0500	61	52	1.0	0.2	.04	.05	7298300	402	2.1	216	211	263	224	0.2	2.8	243	524	510	116	63	28.04	78	16.6	1.0	0.0	82.4	210	1760
0520	61	51	0.9	0.2	.04	.08	7298560	395	1.9	216	212	265	221	0.2	2.8	247	527	530	114	64	28.03	78	16.2	1.6	0.0	82.4		
0540	61	52	0.5	0.1	.04	.07	7298870	400	2.0	216	211	261	228	0.2	2.9	243	524	490	113	63	28.03	78	15.8	1.7	0.0	82.5		
0600	62	52	1.7	0.5	.04	.12	7299200	404	2.0	216	212	265	228	0.2	2.9	246	528	510	113	63	28.02	77	16.2	0.8	0.0	83.0	140	1750
0620	60	51	1.2	0.6	.04	.10	7299500	403	2.1	216	212	265	227	0.2	2.9	245	522	520	114	64	28.02	78	16.4	1.2	0.0	82.4		
0640	60	52	1.0	0.2	.04	.10	7299780	403	2.1	216	212	262	227	0.2	2.9	244	523	520	114	63	28.02	78	16.4	1.2	0.0	82.4		
0700	62	51	2.5	0.8	.04	.15	7300100	404	2.2	216	212	265	226	0.2	2.9	245	525	520	112	64	28.02	78	15.8	1.3	0.0	82.9	170	1800
0720	61	51	0.7	0.2	.04	.08	7300430	404	2.0	216	213	263	224	0.2	2.9	244	522	500	112	62	28.02	76	16.4	1.9	0.0	81.7		
0740	61	51	1.0	0.3	.04	.09	7300730	404	1.9	216	211	263	224	0.2	2.9	245	523	520	110	65	28.01	78	16.4	1.4	0.3	82.7		
0800	62	52	0.9	0.3	.04	.08	7301020	404	1.9	215	210	262	224	0.2	2.9	243	520	500	110	64	28.01	82	16.0	0.6	0.4	83.0	120	1810
0820	63	53	1.2	0.4	.04	.09	7301430	403	2.1	216	208	263	225	0.2	2.9	245	531	540	110	62	28.01	80	15.8	0.5	0.8	82.9		
0840	64	52	1.2	0.4	.04	.09	7301500	404	2.2	215	209	263	225	0.2	2.9	245	531	535	111	62	28.01	82	15.6	0.4	1.9	82.1		
0900	64	52	1.2	0.4	.04	.09	7301680	404	2.0	215	209	263	225	0.2	2.9	245	531	530	111	62	28.01	82	17.0	0.5	0.0	82.5	110	1800
0920	64	52	0.8	0.2	.04	.08	7302040	404	1.8	215	209	263	226	0.2	2.9	245	524	510	111	63	28.01	83	16.7	1.1	0.0	82.2		
0940	64	53	0.8	0.2	.04	.08	7302400	405	1.9	215	208	265	226	0.2	2.9	246	524	520	113	64	28.01	85	16.1	0.9	0.3	82.7		
1000	66	54	1.5	0.5	.04	.08	7303050	404	1.5	215	208	265	229	0.2	2.9	245	526	500	116	63	28.02	88	17.0	0.6	0.0	82.4	100	1740
1020	68	55	1.8	0.5	.04	.13	7303420	404	2.2	215	208	264	230	0.2	2.9	245	530	530	119	64	28.02	89	16.0	0.7	0.5	82.8		
1040	68	55	0.9	0.2	.04	.07	7303670	405	1.7	214	209	265	231	0.2	2.9	246	533	500	118	63	28.02	89	16.4	0.9	0.0	82.7		
1100	69	56	1.2	0.3	.04	.10	7303960	405	1.8	214	206	263	232	0.2	3.0	244	531	550	118	63	28.01	90	16.0	1.2	0.0	82.8	100	1710
1120	70	58	1.8	0.4	.04	.14	7304390	404	1.7	214	208	263	232	0.2	3.0	245	534	560	121	64	28.00	90	16.7	1.7	0.0	81.6		
1140	70	60	1.5	0.3	.04	.12	7304700	404	1.8	214	210	265	234	0.2	3.0	245	538	590	124	66	28.00	90	17.0	1.4	0.0	81.6		
1200	69	61	1.5	0.3	.04	.10	7305060	404	1.7	214	210	266	236	0.2	3.0	246	537	540	126	63	27.98	90	15.4	0.8	1.3	82.5	90	1690
1220	69	60	1.8	0.4	.04	.12	7305330	404	1.7	214	208	266	235	0.2	3.0	245	533	520	120	64	27.97	91	15.3	0.8	1.3	82.5		
1240	68	60	1.2	0.2	.04	.08	7305640	404	1.4	214	208	263	233	0.2	3.0	245	538	570	119	65	27.96	92	16.5	1.2	0.0	82.3		
1300	69	60	1.7	0.3	.04	.12	7306010	405	1.8	214	209	264	234	0.2	3.0	245	536	570	118	64	27.95	92	16.3	0.9	0.8	82.0	90	1640
1320	69	60	1.0	0.2	.04	.09	7306280	405	1.7	214	209	263	236	0.2	3.0	243	535	550	118	65	27.95	91	16.8	0.8	0.0	82.4		
1340	71	61	1.4	0.2	.04	.12	7306670	405	1.7	214	207	267	235	0.2	3.0	247	540	570	124	65	27.93	91	16.3	0.7	1.0	82.0		
1400	70	62	0.9	0.1	.04	.08	7307030	404	1.8	214	210	263	240	0.2	3.0	243	537	550	116	66	27.93	91	16.8	1.2	1.0	82.0	90	1630
1420	69	63	1.3	0.2	.04	.12	7307380	404	2.9	214	210	265	240	0.2	3.2	244	539	590	117	68	27.93	91	16.3	1.1	0.4	82.2		
1440	69	62	1.2	0.2	.04	.11	7307780	403	1.8	214	210	265	240	0.2	3.2	244	533	570	115	67	27.93	92	16.2	1.8	0.0	82.0		
1500	68	61	1.2	0.1	.04	.11	7307970	404	1.7	214	209	263	243	0.2	3.2	243	538	560	118	68	27.93	92	16.4	1.5	0.1	82.0	100	1610
1520	71	61	1.0	0.2	.04	.11	7308320	404	1.8	214	209	262	241	0.2	3.2	243	537	600	116	67	27.92	90	16.2	2.0	0.1	81.7		
1540	69	62	1.2	0.2	.04	.13	7308620	405	1.8	214	210	266	242	0.2	3.2	245	533	550	117	68	27.92	91	16.0	2.5	0.1	81.4		
1600	71	62	2.0	0.3	.04	.15	7308990	405	1.7	214	209	265	240	0.2	3.2	244	534	610	118	67	27.90	92	17.1	1.2	0.0	81.7	100	1670
Avg	65	54	0.9	0.2	.04	.10	-------	404	1.9	215	209	265	227	0.1	1.4	245	529	530	115	65	28.06	84	16.0	1.2	0.6	82.2	130	1720
Corr Avg	65	55	0.9	0.2	.04	.10	-------	393	1.9	217	212	255	228	0.1	1.4	245	529	495	115	65	28.06	84	16.0	1.2	1.9	80.9	130	1720

Type of fuel bed	High
Coal fired (as received basis)	48,675 pounds
Corrected coal fired (as received basis)	49,620 pounds
Corrected average hourly rate of coal consumption (as received basis)	2,068 pounds per hour
Blow-down water through heat exchanger	24,230 pounds
Corrected blow-down water through heat exchanger	17,930 pounds
Corrected total blow-down water	22,135 pounds
Corrected average hourly rate of blow-down	922 pounds per hour
Weight of steam generated	480,000 pounds
Corrected weight of steam generated	465,976 pounds
Corrected average hourly rate of steam generation	19,416 pounds per hour
Corrected average flue gas temperature	510 degrees Fahrenheit

TEST NUMBER: 20-H OBSERVED DATA DATE: NOVEMBER 6,7, 1946

Time	Combustion Air		Draft, Inches of Water				Blow-down			Feed Water Temp F	Water Temp F	Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction					CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1600	70	54	1.8	0.4	.04	.12	6535880	404	1.0	214	207	247	240	0.0	0.0	245	530	580	101	70	27.94	80	13.8	4.3	0.3	81.6	140	2000
1620	73	57	1.7	0.4	.04	.15	6536068	403	1.0	215	206	250	240	0.0	0.0	245	545	580	103	70	27.94	78	14.3	4.5	0.0	81.2		
1640	72	56	1.7	0.4	.04	.15	6536400	404	1.5	215	207	246	239	0.0	0.0	244	540	600	98	70	27.94	88	14.4	4.5	0.3	80.8		
1700	72	56	1.4	0.2	.04	.11	6536750	405	1.0	215	207	246	241	0.0	0.0	245	538	580	101	69	27.95	78	13.3	5.3	0.0	81.4	200	1940
1720	72	57	1.7	0.5	.04	.17	6537175	402	1.3	215	208	245	242	0.0	0.0	242	535	610	102	67	27.96	79	13.8	5.0	0.2	81.0		
1740	71	56	1.5	0.4	.04	.15	6537545	404	1.3	215	208	247	242	0.0	0.0	245	530	580	101	67	27.96	77	13.6	5.2	0.2	81.0		
1800	71	55	1.8	0.5	.04	.17	6538000	404	1.8	215	208	246	243	0.0	0.0	243	535	600	100	70	27.97	79	14.4	4.4	0.1	81.1	140	1960
1820	70	56	1.2	0.4	.04	.12	6538425	404	1.5	215	208	247	242	0.0	0.0	242	539	580	98	70	27.97	79	12.0	7.4	0.4	80.2		
1840	69	54	1.7	0.5	.04	.16	6538500	402	1.5	216	208	248	243	0.0	0.0	245	539	620	98	66	27.98	78	14.2	4.6	0.2	81.0		
1900	70	54	1.8	0.5	.04	.18	6539220	402	2.0	216	208	248	240	0.0	0.0	242	527	585	98	68	28.00	76	14.0	4.9	0.2	80.9	140	1970
1920	68	55	2.3	0.5	.04	.26	6539822	402	2.0	216	207	247	237	0.0	0.0	245	533	600	99	67	28.00	74	13.2	5.5	0.1	81.2		
1940	69	55	2.0	0.5	.04	.23	6540315	402	2.0	216	206	245	237	0.0	0.0	242	533	610	102	70	28.00	75	14.0	5.6	0.3	80.1		
2000	69	54	1.8	0.5	.04	.20	6540745	402	2.0	216	207	247	238	0.0	0.0	242	534	610	100	64	28.00	73	13.4	5.0	0.0	81.6	130	2000
2020	68	53	2.0	0.5	.04	.17	6541200	402	2.0	216	208	247	240	0.0	0.0	245	529	565	98	68	28.00	75	15.4	3.3	0.0	81.3		
2040	68	52	1.8	0.5	.04	.15	6541900	402	2.0	216	207	250	238	0.0	0.0	245	537	600	101	70	28.02	75	14.8	3.5	0.3	81.4		
2100	67	52	1.2	0.3	.04	.11	6542320	402	2.0	216	207	250	237	0.0	0.0	247	539	580	108	72	28.03	74	15.5	3.1	0.2	81.2	140	1880
2120	67	52	1.5	0.3	.04	.14	6542880	402	2.0	216	207	247	239	0.0	0.0	242	534	580	97	70	28.04	78	13.8	5.0	0.1	81.1		
2140	66	51	1.6	0.4	.04	.14	6543410	402	2.0	217	208	248	237	0.0	0.0	244	536	575	100	68	28.04	77	15.0	3.6	0.0	81.4		
2200	66	50	1.5	0.6	.04	.12	6544570	402	2.0	216	208	248	234	0.0	0.0	243	529	600	101	68	28.05	78	13.7	4.5	0.2	81.6	160	1880
2220	59	47	1.5	0.5	.04	.15	6545170	403	2.0	217	208	247	236	0.0	0.0	242	538	610	100	66	28.05	77	14.8	4.8	0.0	80.4		
2240	65	50	2.1	0.7	.04	.21	6545470	402	2.0	216	208	246	238	0.0	0.0	243	536	595	103	70	28.06	78	14.3	3.6	0.0	82.1		
2300	72	53	1.6	0.5	.04	.20	6545730	402	2.0	216	209	246	240	0.0	0.0	242	530	620	100	66	28.07	78	13.6	5.6	0.2	80.6	130	1870
2320	74	54	2.0	0.5	.04	.22	6546268	402	2.0	217	209	246	242	0.0	0.0	242	537	640	102	70	28.07	79	12.9	6.1	0.0	81.0		
2340	74	54	2.7	0.8	.04	.18	6546840	401	2.3	218	209	246	244	0.0	0.0	243	539	600	108	73	28.07	74	14.0	5.0	0.1	80.9		
2400	72	54	2.1	0.6	.04	.22	6547300	402	3.0	218	210	247	244	0.0	0.0	244	544	620	109	64	28.08	74	14.2	5.0	0.1	80.7	140	1840
0020	71	53	1.5	0.5	.04	.16	6547800	403	3.0	218	210	250	246	0.0	0.0	245	540	580	110	68	28.08	75	14.7	3.7	0.0	81.6		
0040	72	54	2.5	0.5	.04	.15	6548410	402	2.5	218	211	249	246	0.0	0.0	245	536	620	102	68	28.08	76	14.4	4.0	0.0	81.6		
0100	74	54	1.0	0.3	.04	.17	6549120	401	2.8	218	210	248	245	0.0	0.0	245	540	620	108	75	28.09	72	14.0	4.8	0.0	81.2	140	1820
0120	73	54	1.1	0.4	.04	.14	6549500	402	3.0	219	210	250	258	0.0	0.0	245	541	580	101	70	28.09	74	14.0	4.0	0.2	81.8		
0140	73	54	1.5	0.5	.04	.14	6550100	401	3.0	219	210	249	255	0.0	0.0	245	538	590	103	74	28.09	70	14.4	4.4	0.4	80.8		
0200	75	56	1.9	0.6	.04	.16	6550800	404	3.0	220	212	249	264	0.0	0.0	245	538	620	107	65	28.09	68	14.6	2.2	0.4	80.8	170	1770
0220	74	58	1.5	0.5	.04	.15	6551310	403	3.0	220	218	250	272	0.0	0.0	245	535	600	106	72	28.09	69	14.8	4.0	0.0	81.2		
0240	72	57	1.5	0.5	.04	.15	6551870	403	2.5	220	214	250	273	0.0	0.0	245	535	580	108	70	28.10	72	15.8	2.6	0.2	81.4		
0300	72	56	1.5	0.5	.04	.15	6552460	404	3.0	219	213	249	270	0.0	0.0	245	540	595	106	71	28.10	72	15.4	3.6	0.0	81.0	200	1820
0320	73	58	1.5	0.5	.04	.13	6553090	403	3.0	219	212	250	270	0.0	0.0	245	540	585	105	74	28.13	72	15.0	3.0	0.0	82.0		
0340	73	57	1.5	0.5	.04	.15	6553900	404	2.5	218	213	251	270	0.0	0.0	246	538	590	106	69	28.13	72	14.6	4.4	0.1	80.9		
0400	70	56	1.4	0.5	.04	.13	6554500	403	2.8	218	213	251	270	0.0	0.0	245	540	590	106	64	28.14	71	15.3	4.3	0.0	80.4	180	1980
0420	72	56	1.5	0.5	.04	.14	6555100	402	3.0	218	212	251	273	0.0	0.0	246	543	590	106	65	28.14	73	15.7	2.5	0.2	81.6		
0440	72	55	1.6	0.6	.04	.16	6555590	402	3.0	219	208	248	266	0.0	0.0	242	544	630	102	68	28.14	70	15.2	4.1	0.0	80.7		
0500	72	55	1.6	0.6	.04	.16	6556250	402	2.5	218	209	248	266	0.0	0.0	244	546	620	104	71	28.14	69	13.5	5.3	0.1	81.1	170	1890
0520	71	55	1.6	0.5	.04	.19	6556770	402	3.0	218	209	250	261	0.0	0.0	245	540	600	108	71	28.14	70	14.2	5.1	0.1	80.6		
0540	71	55	1.2	0.5	.04	.16	6557290	403	3.0	218	209	250	262	0.0	0.0	245	540	600	104	72	28.14	69	14.1	4.3	0.2	81.4		
0600	70	55	1.7	0.5	.04	.16	6557960	403	3.0	219	209	250	263	0.0	0.0	245	541	600	102	68	28.15	69	15.4	3.4	0.0	81.2	150	1750
0620	69	54	1.0	0.2	.04	.11	6558500	402	3.0	219	209	250	264	0.0	0.0	243	534	600	96	58	28.15	72	15.0	4.5	0.1	80.4		
0640	71	55	1.8	0.6	.04	.15	6559170	403	3.0	219	208	250	265	0.0	0.0	245	545	580	96	62	28.16	69	15.0	3.7	0.0	81.3		
0700	72	56	1.1	0.4	.04	.14	6559900	403	3.0	218	208	251	262	0.0	0.0	245	544	610	98	64	28.15	73	15.4	3.8	0.4	80.4	150	1710
0720	73	56	1.8	0.5	.04	.16	6560340	402	2.8	218	210	250	264	0.0	0.0	245	540	600	100	78	28.17	69	14.0	5.0	0.0	81.0		
0740	72	55	1.7	0.4	.04	.17	6560820	403	2.5	218	209	250	269	0.0	0.0	243	536	590	109	74	28.18	79	12.8	6.2	0.2	80.8		
0800	74	57	1.2	0.3	.04	.16	6561380	403	2.5	218	210	248	269	0.0	0.0	243	534	570	104	66	28,21	82	14.0	5.0	0.2	80.8	140	1730
0820	76	58	1.3	0.4	.04	.16	6562050	403	2.3	217	209	250	267	0.0	0.0	244	534	610	104	78	28.22	66	13.6	5.0	0.0	81.4		
0840	77	58	1.7	0.4	.04	.18	6562510	403	2.0	216	209	250	266	0.0	0.0	242	533	630	106	60	28.19	63	14.2	4.8	0.2	80.8		
0900	78	58	1.6	0.3	.04	.19	6563010	403	3.5	220	210	250	270	0.0	0.0	243	537	640	108	70	28.20	66	13.0	6.0	0.0	81.0	140	1720
0920	80	60	1.5	0.3	.04	.19	6563530	403	3.5	221	213	250	272	0.0	0.0	242	532	610	108	64	28.20	66	13.6	5.6	0.2	80.6		
0940	80	59	1.3	0.3	.04	.18	6564020	403	3.5	221	213	248	272	0.0	0.0	242	537	630	108	68	28.22	70	12.6	6.4	0.0	81.0		
1000	82	60	1.4	0.4	.04	.19	6564540	403	4.5	220	213	250	274	0.0	0.0	243	534	610	114	68	28.22	68	12.8	5.2	0.0	82.0	130	1710
1020	81	59	1.4	0.4	.04	.18	6565080	403	4.5	220	212	251	274	0.0	0.0	244	536	610	114	70	28.21	68	14.0	5.0	0.0	81.0		
1040	83	60	1.3	0.4	.04	.19	6565650	403	3.0	219	212	250	274	0.0	0.0	242	532	620	116	68	28.21	70	13.6	5.4	0.0	81.0		
1100	80	56	1.4	0.4	.04	.18	6566250	403	3.0	220	212	250	268	0.0	0.0	243	528	600	110	64	28.21	73	14.0	5.4	0.0	80.6	120	1670
1120	82	55	1.8	0.5	.04	.19	6566750	403	3.0	219	212	250	270	0.0	0.0	242	535	610	114	60	28.22	74	14.2	4.8	0.3	80.7		
1140	80	55	1.6	0.5	.04	.18	6567200	403	3.0	219	213	249	269	0.0	0.0	243	530	600	115	62	28.22	78	14.0	5.0	0.0	81.0		
1200	81	56	1.9	0.5	.04	.21	6567750	403	3.3	220	213	250	273	0.0	0.0	243	537	620	114	70	28.22	78	13.5	5.7	0.0	80.8	140	1680
1220	82	56	2.2	0.7	.04	.21	6568270	403	3.0	220	211	250	267	0.0	0.0	243	534	600	114	70	28.22	78	14.8	4.2	0.2	80.8		
1240	81	56	1.7	0.5	.04	.18	6568840	403	3.0	219	211	250	269	0.0	0.0	243	534	600	114	70	28.21	78	14.2	5.0	0.0	80.8		
1300	83	58	1.8	0.5	.04	.19	6569270	403	3.0	219	211	250	270	0.0	0.0	242	533	600	112	71	28.21	80	13.6	5.6	0.2	80.6	120	1610
1320	82	58	1.9	0.7	.04	.16	6569850	403	3.0	219	210	250	270	0.0	0.0	242	535	600	114	66	28.21	80	14.6	4.4	0.0	81.0		
1340	82	56	1.5	0.5	.04	.11	6570400	403	3.0	219	210	250	268	0.0	0.0	242	533	600	110	70	28.21	81	15.4	3.6	0.0	81.0		
1400	81	56	1.5	0.5	.04	.15	6571010	403	3.0	219	211	251	262	0.0	0.0	245	539	610	110	72	28.21	86	14.4	4.5	0.0	81.1	140	1570
1420	82	57	1.4	0.4	.04	.15	6571710	403	3.0	219	212	251	259	0.0	0.0	245	533	600	110	70	28.22	87	13.8	5.2	0.0	81.0		
1440	83	57	1.5	0.4	.04	.16	6572260	403	3.0	219	212	250	259	0.0	0.0	243	534	620	109	70	28.22	89	14.8	4.5	0.0	80.7		
1500	83	57	1.7	0.5	.04	.18	6572815	403	3.0	219	212	248	260	0.0	0.0	242	532	620	110	75	28.22	91	13.7	5.5	0.1	80.7	170	1680
1520	83	58	1.5	0.4	.04	.16	6573365	403	3.0	219	212	251	259	0.0	0.0	245	538	600	110	74	28.23	89	14.4	4.6	0.2	80.8		
1540	82	57	2.0	0.5	.04	.18	6573900	403	2.5	218	210	250	259	0.0	0.0	242	534	600	109	64	28.23	91	13.0	6.0	0.0	81.0		
1600	80	58	2.0	0.5	.04	.16	6574400	403	2.5	218	210	248	259	0.0	0.0	242	535	600	110	64	28.23	90	14.0	5.0	0.0	81.0	150	1570
Avg	74	55	1.6	0.5	.04	.16	-------	403	2.6	218	210	249	256	0.0	0.0	244	536	600	105	69	28.11	76	14.2	4.7	0.1	81.0	150	1800
Corr Avg	74	56	1.6	0.5	.04	.16	-------	392	2.6	220	215	250	258	0.0	0.0	244	536	545	105	71	28.11	77	14.2	4.7	0.1	81.0	150	1800

Type of fuel bed	Low
Coal fired (as received basis)	57,315 pounds
Corrected coal fired (as received basis)	58,330 pounds
Corrected average hourly rate of coal consumption (as received basis)	2,430 pounds per hour
Blow-down water through heat exchanger	38,520 pounds
Corrected blow-down water through heat exchanger	28,505 pounds
Corrected total blow-down water	35,055 pounds
Corrected average hourly rate of blow-down	1,460 pounds per hour
Weight of steam generated	601,300 pounds
Corrected weight of steam generated	577,758 pounds
Corrected average hourly rate of steam generation	24,073 pounds per hour
Corrected average flue gas temperature	550 degrees Fahrenheit

TEST NUMBER: 25-L OBSERVED DATA DATE: OCTOBER 12,13, 1946

Time	Combustion Air		Draft, Inches of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Flue Gas Temp Outlet F				Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1840	62	53	2.0	0.5	.04	.20	6716485	402	0.5	212	202	253	255	0.0	0.0	238	542	600	111	63	28.10	90	15.9	2.1	0.0	82.0		
1900	60	52	1.8	0.4	.04	.15	6717290	403	0.5	212	202	251	254	0.0	0.0	238	538	570	109	61	28.10	90	15.6	2.8	0.0	81.6	100	1700
1920	63	53	1.7	0.5	.04	.19	6717940	403	0.3	212	202	252	252	0.0	0.0	238	542	580	110	63	28.12	89	15.0	3.6	0.0	81.4		
1940	58	52	1.7	0.3	.04	.18	6718700	402	0.0	212	202	252	254	0.0	0.0	238	539	580	110	61	28.10	88	16.0	3.0	0.0	81.0		
2000	60	52	1.5	0.3	.04	.17	6719465	402	0.0	212	202	252	252	0.0	0.0	237	543	570	109	65	28.10	88	14.2	3.6	0.0	82.2	110	1600
2020	59	52	1.8	0.4	.04	.18	6720005	400	0.0	212	202	249	252	0.0	0.0	237	546	580	112	64	28.12	84	15.0	3.8	0.0	81.2		
2040	59	52	1.7	0.3	.04	.19	6720825	402	1.0	214	203	249	252	0.0	0.0	237	545	580	110	65	28.12	82	14.0	4.5	0.0	81.5		
2100	67	55	1.8	0.3	.04	.21	6721750	402	1.5	215	205	249	252	0.0	0.0	237	548	605	109	67	28.12	84	14.6	3.9	0.0	81.5	140	1570
2120	67	55	1.8	0.5	.04	.18	6722335	404	1.5	214	205	250	257	0.0	0.0	236	547	600	108	67	28.12	83	15.2	3.4	0.0	81.4		
2140	68	55	1.7	0.4	.04	.18	6723165	403	1.5	215	204	250	259	0.0	0.0	236	545	585	109	65	28.12	86	14.8	3.6	0.0	81.6		
2200	66	55	2.0	0.4	.04	.25	6723900	404	1.5	214	204	251	259	0.0	0.0	239	541	600	110	67	28.12	88	14.8	3.6	0.0	81.6	140	1560
2220	66	55	2.0	0.4	.04	.20	6724580	402	1.0	214	205	251	258	0.0	0.0	237	544	600	110	69	28.12	87	15.5	3.6	0.0	81.1		
2240	66	55	1.7	0.4	.04	.20	6725240	402	1.0	215	205	252	257	0.0	0.0	237	544	600	110	69	28.12	87	15.5	3.6	0.0	81.1		
2300	66	56	2.2	0.3	.04	.23	6726000	403	1.0	215	205	252	258	0.0	0.0	237	546	600	112	67	28.11	88	14.2	5.2	0.0	80.6	180	1560
2320	68	56	1.9	0.5	.04	.24	6726605	404	1.0	215	205	250	258	0.0	0.0	237	544	605	114	65	28.11	89	15.1	4.0	0.0	80.9		
2340	70	58	1.5	0.3	.04	.18	6727265	403	1.3	215	205	250	258	0.0	0.0	237	544	590	114	72	28.11	85	15.2	3.7	0.0	81.1		
2400	69	58	1.5	0.3	.04	.20	6728040	403	1.3	215	206	251	257	0.0	0.0	237	542	595	115	68	28.11	84	15.1	3.5	0.0	81.4	140	1500
0020	69	59	1.6	0.3	.04	.35	6728750	403	1.3	215	206	250	259	0.0	0.0	237	540	590	116	73	28.10	84	14.2	4.8	0.0	81.0		
0040	68	58	1.5	0.3	.04	.18	6729310	402	1.3	215	205	251	259	0.0	0.0	237	541	570	115	68	28.10	85	14.9	3.9	0.0	81.2		
0100	66	58	2.0	0.3	.04	.25	6729925	403	1.8	215	205	250	259	0.0	0.0	237	542	580	118	70	28.10	85	14.7	4.3	0.0	81.0	210	1580
0120	68	58	2.0	0.3	.04	.26	6730630	403	1.8	215	206	250	259	0.0	0.0	237	543	590	117	68	28.10	82	14.2	4.8	0,0	81.0		
0140	66	57	1.6	0.2	.04	.19	6731300	403	2.0	215	206	251	258	0.0	0.0	238	540	555	112	70	28.10	85	15.9	3.1	0.0	81.0		
0200	68	58	1.6	0.3	.04	.17	6731800	402	2.0	216	206	252	258	0.0	0.0	237	544	540	115	65	28.10	84	15.6	3.3	0.1	81.0	140	1510
0220	67	58	1.5	0.3	.04	.18	6732600	402	2.0	216	205	250	259	0.0	0.0	237	542	570	114	65	28.09	83	15.2	3.8	0.0	81.0		
0240	68	58	1.8	0.3	.04	.22	6733300	402	2.0	216	205	250	257	0.0	0.0	237	547	580	114	64	28.10	84	14.4	4.6	0.0	80.8		
0300	68	59	1.9	0.3	.04	.21	6734000	402	2.0	215	206	250	258	0.0	0.0	237	542	580	113	68	28.09	83	14.0	5.3	0.0	80.7	130	1500
0320	68	58	1.7	0.3	.04	.16	6734580	402	2.0	216	206	251	259	0.0	0.0	238	543	560	112	70	28.09	85	15.0	4.0	0.0	81.0		
0340	68	58	2.1	0.4	.04	.20	6735210	402	2.0	216	205	250	255	0.0	0.0	237	543	580	112	68	28.09	84	15.8	3.1	0.0	81.1		
0400	68	59	1.7	0.3	.04	.18	6735850	403	2.0	216	205	251	256	0.0	0.0	238	542	580	112	68	28.10	83	16.4	2.5	0.0	81.1	110	1510
0420	68	58	1.8	0.3	.04	.20	6736470	402	2.0	216	205	250	254	0.0	0.0	237	540	600	115	70	28.11	83	15.4	3.6	0.0	81.0		
0440	65	57	1.5	0.3	.04	.18	6737260	402	2.0	216	207	252	260	0.0	0.0	237	544	580	116	70	28.12	81	14.6	4.2	0.0	81.2		
0500	67	59	2.0	0.4	.04	.22	6737830	402	2.0	216	207	250	260	0.0	0.0	237	538	580	120	70	28.11	81	15.6	3.1	0.0	81.3	150	1500
0520	66	58	2.3	0.5	.04	.26	6738430	403	2.0	216	206	250	259	0.0	0.0	238	539	600	120	76	28.11	81	15.8	3.0	0.0	81.2		
0540	67	58	2.0	0.5	.04	.26	6739030	403	2.0	216	206	250	258	0.0	0.0	237	544	590	118	75	28.13	80	14.8	4.1	0.0	81.1		
0600	66	58	1.6	0.3	.04	.19	6739680	402	2.0	216	205	250	257	0.0	0.0	239	543	590	122	77	28.13	80	14.7	4.5	0.2	80.6	170	1510
0620	65	58	1.7	0.3	.04	.18	6740400	402	2.0	217	207	251	260	0.0	0.0	237	541	570	120	76	28.13	83	15.2	3.6	0.0	81.3		
0640	67	59	1.8	0.5	.04	.16	6741000	402	2.0	217	206	252	260	0.0	0.0	238	542	580	121	75	28.13	82	16.0	3.0	0.0	81.0		
0700	65	58	1.3	0.3	.04	.15	6741500	404	2.0	216	207	253	258	0.0	0.0	240	542	560	120	68	28.13	83	15.6	3.1	0.1	81.2	170	1540
0720	68	59	1.8	0.3	.04	.21	6742030	403	2.0	216	208	250	258	0.0	0.0	238	538	600	112	66	28.13	84	15.4	3.9	0.1	80.6		
0740	67	58	1.7	0.3	.04	.18	6742580	403	2.0	216	207	250	257	0.0	0.0	239	538	570	114	64	28.14	83	14.5	4.8	0.0	80.7		
0800	64	58	1.3	0.3	.04	.22	6743030	403	2.0	216	207	250	257	0.0	0.0	237	540	590	118	65	28.14	85	14.0	5.0	0.1	80.9	150	1570
0820	65	59	1.7	0.4	.04	.19	6743380	403	2.0	216	207	252	256	0.0	0.0	237	538	585	115	66	28.14	86	15.0	4.0	0.0	81.0		
0840	65	58	1.8	0.3	.04	.19	6743740	403	2.0	216	206	252	253	0.0	0.0	237	535	570	119	65	28.14	84	15.1	4.1	0.0	80.8		
0900	67	58	1.7	0.3	.04	.15	6744080	403	2.0	216	207	252	254	0.0	0.0	237	530	560	118	69	28.14	85	14.8	3.8	0.1	81.3	140	1580
0920	56	58	1.5	0.3	.04	.15	6744300	404	2.0	216	206	252	250	0.0	0.0	238	530	550	117	69	28.14	84	15.0	3.3	0.1	80.6		
0940	67	59	2.1	0.4	.04	.25	6744540	403	2.0	216	206	252	248	0.0	0.0	237	532	600	118	69	28.14	86	14.0	5.1	0.2	80.7		
1000	67	59	2.0	0.3	.04	.23	6744800	403	2.0	216	206	251	252	0.0	0.0	237	540	580	120	68	28.14	86	15.3	3.7	0.2	80.8	160	1650
1020	67	59	2.0	0.4	.04	.20	6745020	403	1.5	216	206	252	250	0.0	0.0	237	540	590	119	67	28.14	86	15.0	4.1	0.1	80.8		
1040	67	59	1.9	0.4	.04	.22	6745300	403	1.8	216	206	251	249	0.0	0.0	239	533	590	116	75	28.14	87	15.4	3.7	0.1	80.8		
1100	70	60	1.8	0.3	.04	.23	6745400	403	1.5	216	206	251	251	0.0	0.0	237	540	600	114	75	28.14	88	15.0	4.0	0.0	81.0	180	1660
1120	70	61	2.0	0.4	.04	.25	6745700	404	1.0	215	206	250	249	0.0	0.0	237	534	600	112	74	28.14	85	15.1	4.0	0.1	80.8		
1140	69	60	1.8	0.4	.04	.21	6745900	403	1.5	215	206	250	249	0.0	0.0	237	539	595	116	74	28.14	89	14.3	4.9	0.0	80.8		
1200	70	61	1.9	0.4	.04	.26	6746100	403	1.0	215	206	250	249	0.0	0.0	237	532	590	116	70	28.14	90	13.6	5.8	0.2	80.4	180	1650
1220	71	61	1.2	0.3	.04	.18	6746300	403	1.0	214	207	251	250	0.0	0.0	238	529	570	120	72	28.13	89	14.2	5.0	0.0	80.8		
1240	72	61	1.9	0.4	.26	.26	6746500	404	1.0	214	207	251	250	0.0	0.0	239	535	600	118	73	28.13	90	14.8	4.2	0.2	80.8		
1300	72	61	2.0	0.4	.04	.28	6746700	403	1.0	214	206	251	249	0.0	0.0	238	542	610	118	74	28.12	89	15.1	4.9	0.0	81.0	120	1670
1320	73	62	1.9	0.4	.04	.23	6746900	403	1.0	215	207	250	250	0.0	0.0	237	531	600	118	75	28.12	89	14.2	4.8	0.0	81.0		
1340	73	62	1.9	0.4	.04	.26	6747000	403	1.0	214	207	251	249	0.0	0.0	237	531	610	118	75	28.12	89	14.6	4.3	0.0	81.1		
1400	71	62	1.9	0.3	.04	.21	6747230	403	1.0	215	205	252	249	0.0	0.0	237	532	600	118	76	28.12	89	15.0	3.8	0.0	81.2	170	1810
1420	70	61	1.7	0.3	.04	.20	6747370	402	1.0	214	206	251	248	0.0	0.0	237	528	600	118	75	28.12	88	15.0	4.0	0.1	80.9		
1440	70	61	1.5	0.2	.04	.20	6747520	403	1.0	215	206	250	249	0.0	0.0	237	533	610	118	74	28.12	88	14.3	5.1	0.0	80.6		
1500	68	60	1.4	0.2	.04	.15	6747700	402	1.0	215	207	250	250	0.0	0.0	237	521	580	118	74	28.12	89	15.2	3.8	0.0	81.0	130	1900
1520	68	59	1.1	0.2	.04	.14	6747830	402	1.0	215	207	252	248	0.0	0.0	238	525	560	118	67	28.13	86	16.0	3.0	0.1	80.9		
1540	68	59	1.0	0.2	.04	.19	6747960	402	1.0	215	206	251	247	0.0	0.0	237	530	580	117	68	28.13	86	14.8	4.2	0.0	81.0		
1600	68	59	0.7	0.2	.04	.15	6748070	402	1.0	215	207	251	248	0.0	0.0	238	523	560	117	68	28.13	85	14.4	3.8	0.0	81.8	140	1920
1620	68	59	1.8	0.5	.04	.21	6748200	403	1.0	215	206	251	247	0.0	0.0	237	531	600	116	74	28.13	85	14.7	3.7	0.0	81.6		
1640	67	58	2.0	0.4	.04	.22	6748310	397	1.0	215	206	252	247	0.0	0.0	237	537	600	117	78	28.13	84	15.0	3.8	0.2	81.0		
1700	68	59	2.0	0.5	.04	.18	6748420	397	1.5	216	207	253	250	0.0	0.0	238	531	580	116	76	28.14	83	14.8	3.7	0.3	81.2	150	1950
1720	67	58	2.0	0.5	.04	.21	6748555	405	1.5	216	207	252	250	0.0	0.0	238	537	590	116	70	28.15	83	14.2	4.6	0.2	81.0		
1740	69	58	2.0	0.5	.04	.18	6748815	404	1.5	216	206	254	250	0.0	0.0	238	537	585	114	74	28.15	82	16.2	1.6	0.6	81.6		
1800	69	58	1.0	0.5	.04	.13	6749060	404	1.5	217	206	252	250	0.0	0.0	238	532	580	114	76	28.16	82	16.4	1.2	0.4	81.4	170	2000
1820	68	58	1.5	0.5	.04	.12	6749310	405	1.5	215	206	252	251	0.0	0.0	238	530	540	114	80	28.16	82	16.6	1.8	0.2	81.4		
1840	67	58	2.0	0.4	.04	.15	6749550	405	1.5	215	207	253	251	0.0	0.0	239	539	540	114	73	28.17	83	16.8	1.8	0.2	81.2		
Avg	67	58	2.0	0.4	.04	.15	6748---	403	1.4	215	206	251	254	0.0	0.0	237	538	585	115	70	28.12	84	15.0	3.8	0.0	81.2	150	1650
Corr Avg	68	59	1.7	0.4	.04	.20	-------	392	2.0	217	211	251	255	0.0	0.0	242	538	540	115	70	28.12	85	15.0	3.8	0.2	81.0	150	1650

Type of fuel bed	Medium
Coal fired (as received basis)	59,320 pounds
Corrected coal fired (as received basis)	60,430 pounds
Corrected average hourly rate of coal consumption (as received basis)	2,518 pounds per hour
Blow-down water through heat exchanger	33,065 pounds
Corrected blow-down water through heat exchanger	24,470 pounds
Corrected total blow-down water	30.160 pounds
Corrected average hourly rate of blow-down	1,257 pounds per hour
Weight of steam generated	595,950 pounds
Corrected weight of steam generated	566,448 pounds
Corrected average hourly rate of steam generation	23,602 pounds per hour
Corrected average flue gas temperature	555 degrees Fahrenheit

TEST NUMBER 25-M OBSERVED DATA DATE: OCTOBER 19,20, 1946

Time	Combustion Air		Draft, Inches of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm As $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction					CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1940	75	61	1.5	.50	.04	.08	6418225	403	2.0	216	208	248	260	0.0	0.0	245	538	560	100	70	28.01	91	16.4	1.9	1.4	80.3		
2000	73	60	2.0	.70	.04	.09	6418970	400	1.8	215	208	248	260	0.0	0.0	245	544	590	98	70	28.01	92	16.8	1.9	1.5	79.8	200	2000
2020	74	60	2.0	.75	.04	.09	6419686	403	1.5	214	207	250	261	0.0	0.0	245	545	600	98	72	28.01	91	16.8	1.0	1.2	81.0		
2040	73	60	2.8	1.00	.04	.11	6420385	400	1.8	215	207	248	261	0.0	0.0	245	546	620	102	70	28.00	90	16.0	1.0	1.0	82.0		
2100	72	60	1.3	.50	.04	.06	6420965	404	1.8	215	208	248	264	0.0	0.0	246	538	545	102	71	28.00	90	15.5	0.5	1.0	83.0	150	2070
2120	72	60	1.7	.50	.04	.07	6421690	403	1.8	215	208	250	263	0.0	0.0	250	543	565	98	70	28.00	89	17.0	1.0	1.4	80.6		
2140	71	60	1.8	.70	.04	.09	6422295	403	2.0	215	207	250	262	0.0	0.0	250	545	595	104	71	28.00	89	15.5	1.3	0.0	83.2		
2200	72	60	1.7	.60	.04	.07	6422285	404	2.0	215	208	251	265	0.0	0.0	250	545	560	104	70	28.00	88	17.6	1.2	1.5	79.7	180	2070
2220	72	60	1.7	.75	.04	.07	6423455	403	1.5	215	208	250	265	0.0	0.0	245	539	575	104	70	28.00	89	16.5	1.3	0.0	82.2		
2240	71	60	1.8	.70	.04	.07	6424290	403	2.0	215	208	252	263	0.0	0.0	250	545	565	104	70	28.00	90	16.0	1.6	0.0	82.4		
2300	70	60	1.8	.70	.04	.07	6424905	402	2.0	215	208	248	270	0.0	0.0	250	540	555	98	72	28.00	88	16.2	0.2	0.0	83.6	160	1900
2320	70	60	1.8	.70	.04	.08	6425600	402	3.0	218	210	250	270	0.0	0.0	250	538	580	97	71	27.90	89	16.2	0.2	0.3	83.3		
2340	70	60	1.7	.70	.04	.08	6426255	403	3.0	217	210	249	268	0.0	0.0	249	544	570	97	73	27.90	89	16.3	0.9	0.0	82.8		
2400	70	60	1.8	.70	.04	.08	6426925	402	3.0	217	209	249	268	0.0	0.0	250	542	590	99	69	27.90	88	17.0	0.8	1.8	80.4	220	1900
0020	70	60	1.5	.60	.04	.08	6427600	401	3.0	217	210	248	270	0.0	0.0	246	540	565	98	69	27.96	88	16.4	1.6	0.2	81.8		
0040	70	60	1.8	.70	.04	.08	6428545	402	6.5	221	209	250	268	0.0	0.0	250	550	585	98	69	27.96	86	16.4	1.4	0.0	82.2		
0100	69	59	1.5	.50	.04	.08	6429075	402	4.0	221	213	250	269	0.0	0.0	250	550	580	101	68	27.96	88	16.4	1.6	0.0	82.0	210	1910
0120	69	59	2.3	.80	.04	.11	6429635	402	3.8	220	212	247	268	0.0	0.0	245	550	620	100	70	27.95	88	16.4	2.5	0.0	81.1		
0140	69	60	2.2	.80	.04	.12	6430505	402	4.0	220	212	246	267	0.0	0.0	246	545	625	98	69	27.94	88	14.9	3.4	0.0	81.7		
0200	69	60	1.8	.60	.04	.10	6431170	402	4.5	220	211	246	268	0.0	0.0	247	545	605	100	69	27.93	86	16.4	2.4	1.2	80.0	200	1850
0220	68	60	2.5	.90	.04	.12	6431815	403	3.5	219	210	248	268	0.0	0.0	245	550	580	99	68	27.93	85	16.9	1.0	1.0	81.1		
0240	68	60	1.8	.70	.04	.08	6432445	402	3.5	219	211	249	267	0.0	0.0	246	553	580	95	69	27.93	85	16.7	1.2	0.0	82.1		
0300	68	61	1.7	.70	.04	.06	6433150	402	3.5	219	211	250	267	0.0	0.0	250	545	550	98	70	27.92	85	16.2	1.4	0.0	82.4	200	1940
0320	68	60	1.8	.75	.04	.07	6433775	401	3.5	220	211	250	267	0.0	0.0	248	539	540	99	70	27.92	83	16.1	1.0	0.0	82.9		
0340	68	59	1.8	.70	.04	.07	6434510	401	3.5	220	210	250	267	0.0	0.0	250	545	560	100	71	27.92	84	16.7	1.5	0.0	81.8		
0400	69	60	2.2	.80	.04	.13	6435285	401	3.5	219	211	248	268	0.0	0.0	247	540	600	101	68	27.92	84	16.7	2.0	1.3	80.0	200	1930
0420	68	59	1.4	.50	.04	.06	6435765	401	3.5	220	211	250	266	0.0	0.0	248	536	560	100	68	27.92	82	16.9	1.3	1.0	80.8		
0440	68	59	1.6	.50	.04	.08	6436680	401	3.3	220	211	248	268	0.0	0.0	247	543	600	100	70	27.89	84	16.1	2.2	0.8	80.9		
0500	68	58	1.2	.40	.04	.07	6437100	401	3.8	220	211	250	267	0.0	0.0	249	545	550	102	69	27.89	84	16.8	2.2	0.6	80.4	200	1920
0520	68	59	1.5	.50	.04	.08	6437650	401	2.5	218	211	250	267	0.0	0.0	248	535	580	101	70	27.89	84	17.0	1.6	1.6	79.8		
0540	68	59	1.8	.60	.04	.08	6438240	401	2.5	217	208	248	268	0.0	0.0	248	548	580	101	70	27.90	83	16.0	1.0	1.2	81.8		
0600	68	60	2.6	.80	.04	.13	6438820	401	2.5	217	209	248	268	0.0	0.0	247	546	600	101	70	27.90	83	16.2	1.3	0.8	81.7	180	1950
0620	68	60	1.3	.40	.04	.06	6439400	401	2.5	216	208	252	267	0.0	0.0	250	542	535	103	70	27.89	83	16.8	1.2	1.4	80.6		
0640	68	60	2.8	.90	.04	.14	6440200	401	2.5	216	209	250	268	0.0	0.0	247	537	580	102	70	27.91	83	14.5	1.4	0.4	83.7		
0700	70	59	2.5	.90	.04	.13	6440900	401	2.5	216	208	248	267	0.0	0.0	247	540	580	104	70	27.92	84	16.7	2.1	1.2	80.0	150	1850
0720	70	58	2.9	.80	.04	.12	6441300	401	2.5	216	209	248	268	0.0	0.0	248	540	570	103	71	27.92	85	16.4	0.4	0.0	83.2		
0740	73	58	1.9	.70	.04	.06	6441730	404	2.5	216	208	250	268	0.0	0.0	250	545	590	105	71	27.92	84	16.0	1.0	1.2	81.8		
0800	73	58	1.8	.70	.04	.07	6442400	403	2.0	216	209	249	268	0.0	0.0	250	544	570	104	71	27.93	86	16.4	0.6	0.0	83.0	150	1790
0820	75	59	2.0	.75	.04	.08	6443070	402	2.0	216	209	249	270	0.0	0.0	249	537	540	100	70	27.94	87	15.7	0.8	0.0	83.5		
0840	78	59	2.4	.80	.04	.13	6443620	403	2.0	215	208	249	270	0.0	0.0	245	548	600	99	70	27.94	87	17.2	1.8	1.8	79.2		
0900	76	58	1.9	.70	.04	.09	6444200	405	2.0	215	209	250	271	0.0	0.0	250	545	580	102	70	27.95	88	15.8	2.1	1.3	80.8	160	1840
0920	80	59	2.2	.70	.04	.08	6444800	404	2.0	215	208	249	271	0.0	0.0	250	542	600	102	70	27.95	89	17.5	3.3	1.0	78.2		
0940	75	60	2.1	.80	.04	.07	6445500	403	2.0	215	208	250	270	0.0	0.0	250	540	580	102	71	27.94	89	16.3	1.7	1.4	80.6		
1000	76	61	1.8	.70	.04	.05	6448080	403	2.0	214	209	250	271	0.0	0.0	250	540	560	103	71	27.93	88	14.6	1.4	0.0	84.0	170	1890
1020	76	62	1.4	.50	.04	.07	6446730	401	2.0	215	208	251	270	0.0	0.0	250	542	560	109	68	27.93	89	16.2	1.5	0.0	82.3		
1040	76	61	1.8	.60	.04	.12	6447330	404	2.0	215	208	251	270	0.0	0.0	250	544	600	105	70	27.91	90	16.4	2.5	1.0	80.1		
1100	75	61	1.6	.50	.04	.08	6448100	404	2.0	216	209	250	270	0.0	0.0	250	546	570	101	70	27.90	90	16.7	3.3	1.0	79.0	170	1830
1120	73	61	1.9	.60	.04	.08	6448730	404	2.0	216	209	250	270	0.0	0.0	250	546	610	104	70	27.88	90	16.7	2.5	1.0	79.8		
1140	75	61	2.3	.80	.04	.11	6449330	403	3.0	216	209	250	270	0.0	0.0	250	546	600	106	68	27.85	91	16.7	1.5	1.0	80.8		
1200	79	61	1.8	.70	.04	.08	6449800	402	2.0	216	209	250	270	0.0	0.0	250	548	590	108	68	27.83	90	16.7	0.8	1.0	81.5	160	1820
1220	77	61	1.8	.70	.04	.08	6450430	402	2.0	216	209	250	271	0.0	0.0	250	546	590	106	68	27.85	90	16.3	0.8	0.0	82.9		
1240	75	61	1.8	.65	.04	.08	6450930	403	2.0	216	209	250	271	0.0	0.0	250	546	600	104	69	27.87	90	16.0	0.6	0.0	83.4		
1300	73	61	1.9	.60	.04	.08	6451060	404	2.0	216	210	250	271	0.0	0.0	250	545	610	102	70	27.88	90	15.9	0.6	0.1	83.4	160	1830
1320	74	61	2.0	.65	.04	.09	6451660	404	2.0	216	210	250	271	0.0	0.0	250	544	610	102	70	27.87	90	15.9	1.0	1.0	82.1		
1340	75	61	2.1	.70	.04	.10	6452290	403	2.5	216	210	250	271	0.0	0.0	250	542	600	104	69	27.86	90	16.0	1.8	1.1	81.1		
1400	75	61	2.3	.80	.04	.11	6453400	403	3.0	216	210	249	272	0.0	0.0	250	541	600	104	68	27.85	91	16.0	2.5	0.0	81.5	160	1780
1420	76	61	2.2	.80	.04	.10	6454000	403	3.0	216	210	249	272	0.0	0.0	250	542	600	102	68	27.84	90	16.0	2.0	0.0	82.0		
1440	78	61	2.0	.75	.04	.09	6454630	402	2.5	216	210	249	272	0.0	0.0	250	542	590	102	68	27.83	90	16.0	1.0	0.0	83.0		
1500	79	61	1.8	.70	.04	.08	6455200	402	2.0	216	209	250	271	0.0	0.0	250	542	590	100	68	27.83	90	16.0	1.0	0.0	83.0	180	1720
1520	79	61	1.7	.70	.04	.09	6455830	402	2.0	216	209	250	271	0.0	0.0	250	542	590	100	68	27.82	90	15.8	0.2	0.0	82.0		
1540	78	61	1.5	.70	.04	.10	6456460	402	2.0	217	209	250	271	0.0	0.0	250	542	600	102	68	27.80	90	15.8	0.4	0.0	83.8		
1600	78	62	1.3	.70	.04	.12	6457000	402	2.0	216	209	250	272	0.0	0.0	249	542	610	104	68	27.79	90	15.6	0.6	0.0	83.8	200	1670
1620	78	62	1.4	.70	.04	.11	6457600	402	2.0	216	209	250	272	0.0	0.0	249	542	600	104	69	27.79	90	15.8	0.8	0.8	82.6		
1640	78	62	1.6	.70	.04	.10	6458200	402	2.0	216	209	250	272	0.0	0.0	249	542	600	106	69	27.79	90	17.0	1.0	1.4	80.6		
1700	78	62	1.7	.70	.04	.09	6458820	402	2.0	216	209	250	271	0.0	0.0	248	542	590	106	69	27.79	90	17.0	1.0	1.2	80.8	190	1900
1720	78	62	1.9	1.00	.04	.12	6459420	402	2.0	216	209	250	271	0.0	0.0	248	545	610	106	69	27.79	90	16.5	1.1	1.0	81.4		
1740	78	62	4.0	1.60	.04	.19	6460020	402	2.0	216	209	250	271	0.0	0.0	249	548	630	105	68	27.79	90	16.0	1.2	0.1	82.7		
1800	79	63	5.1	2.00	.04	.29	6460200	403	2.0	216	209	250	271	0.0	0.0	250	550	650	105	68	27.78	90	15.2	1.2	0.1	83.5	180	1700
1820	78	63	4.9	2.00	.04	.25	6468800	403	2.0	216	209	250	271	0.0	0.0	250	548	640	105	68	27.78	90	15.5	1.0	0.1	83.4		
1840	78	63	4.5	1.75	.04	.20	6461300	403	2.0	216	209	250	271	0.0	0.0	250	546	640	105	68	27.78	89	15.7	0.8	0.0	83.5		
1900	78	62	4.2	1.50	.04	.15	6461600	402	2.0	216	210	250	272	0.0	0.0	249	545	640	105	68	27.78	89	15.9	0.7	0.0	83.4	190	1830
1920	78	62	3.8	1.25	.04	.12	6462000	402	2.0	216	210	250	272	0.0	0.0	248	543	630	105	68	27.78	89	16.1	0.6	0.0	83.3		
1940	78	62	3.0	1.00	.04	.10	6462205	401	2.0	216	210	250	273	0.0	0.0	247	540	630	106	68	27.78	89	16.4	0.6	1.0	82.0	200	1960
Avg	72	60	2.1	.77	.04	.10	-------	402	2.5	217	209	249	269	0.0	0.0	249	544	590	102	69	27.90	88	16.3	1.3	0.6	81.8	180	1870
Corr Avg	72	61	2.1	.77	.04	.10	-------	391	2.5	219	214	250	271	0.0	0.0	247	544	545	102	71	27.90	89	16.3	1.3	1.5	80.9	180	1870

Type of fuel bed		High
Coal fired (as received basis)	62,990	pounds
Corrected coal fired (as received basis)	64,050	pounds
Corrected average hourly rate of coal consumption (as received basis)	2,669	pounds per hour
Blow-down water through heat exchanger	43,980	pounds
Corrected blow-down water through heat exchanger	32,545	pounds
Corrected total blow-down water	39,990	pounds
Corrected average hourly rate of blow-down	1,666	pounds per hour
Weight of steam generated	623,000	pounds
Corrected weight of steam generated	594,010	pounds
Corrected average hourly rate of steam generation	24,750	pounds per hour
Corrected average flue gas temperature	545	degrees Fahrenheit

TEST NUMBER: 25-H OBSERVED DATA DATE: OCTOBER 7, 8, 1946

Time	Combustion Air		Draft Inches Of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm As $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb Of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1640	84	62	2.0	.50	.04	.30	6646730	401	3.3	212	202	250	256	0.0	0.0	234	540	690	118	63	28.10	91	14.7	4.7	0.2	80.4	110	2180
1700	84	62	2.0	.25	.04	.30	6647090	403	3.3	212	205	249	259	0.0	0.0	235	542	690	124	69	28.11	91	14.2	5.2	0.0	80.6		
1720	82	61	2.2	.50	.04	.26	6647455	403	3.0	212	205	251	256	0.0	0.0	235	539	660	122	66	28.11	88	15.3	3.6	0.0	81.1		
1740	80	60	2.2	.70	.04	.27	6647760	403	3.3	212	204	252	265	0.0	0.0	236	540	650	123	64	28.11	88	15.2	3.8	0.0	81.2		
1800	80	61	2.1	.60	.04	.26	6648100	402	3.0	212	204	251	263	0.0	0.0	236	540	640	123	66	28.12	88	15.2	3.8	0.0	81.0	100	2200
1820	78	61	2.2	.70	.04	.33	6648430	401	3.0	216	204	250	269	0.0	0.0	236	540	660	123	70	28.12	88	14.4	3.8	0.4	81.4		
1840	76	60	2.2	.70	.04	.32	6648732	401	3.0	216	210	251	268	0.0	0.0	234	544	675	123	62	28.12	87	12.6	6.1	0.0	81.2		
1900	76	60	2.0	.50	.04	.25	6649030	402	3.0	216	210	252	279	0.0	0.0	236	540	620	123	63	28.12	87	15.7	3.0	0.2	81.1	100	2260
1920	76	60	2.1	.60	.04	.28	6649325	403	2.8	216	211	253	281	0.0	0.0	236	540	635	121	64	28.12	86	15.0	4.0	0.0	81.0		
1940	76	60	2.1	.60	.04	.30	6649610	402	2.5	216	211	253	281	0.0	0.0	235	540	640	123	66	28.12	84	14.6	4.2	0.2	81.0		
2000	75	60	1.9	.50	.04	.27	6649910	403	2.5	216	210	254	282	0.0	0.0	235	542	640	124	67	28.12	84	15.8	3.0	0.0	81.2	140	2130
2020	75	60	2.0	.50	.04	.32	6650340	401	2.5	217	212	251	283	0.0	0.0	235	540	645	124	65	28.12	86	14.2	5.0	0.0	80.8		
2040	75	60	2.2	.60	.04	.36	6650060	402	2.5	217	212	252	284	0.0	0.0	234	538	650	125	66	28.12	85	14.0	5.0	0.0	81.0		
2100	75	60	2.2	.60	.04	.37	6651375	402	2.3	218	212	251	284	0.0	0.0	233	537	660	126	62	28.12	84	14.5	4.9	0.0	80.6	120	2030
2120	75	59	2.2	.60	.04	.31	6651880	403	2.3	218	212	254	285	0.0	0.0	235	539	640	126	66	28.11	84	15.1	4.1	0.0	80.8		
2140	74	58	2.2	.50	.04	.33	6652430	402	2.2	218	212	253	285	0.0	0.0	234	540	660	125	65	28.11	84	15.2	4.1	0.0	80.7		
2200	72	58	2.2	.60	.04	.28	6653040	402	2.3	218	212	254	284	0.2	0.0	235	540	645	122	63	28.11	85	16.2	2.2	0.2	81.4	110	2030
2220	72	58	1.8	.50	.04	.22	6653490	403	2.2	218	213	257	282	0.2	0.0	237	538	610	122	64	28.11	84	14.8	3.6	0.1	81.5		
2240	69	57	2.4	.60	.04	.35	6653870	402	2.2	218	212	252	281	0.2	0.0	235	542	660	120	63	28.10	81	14.6	4.3	0.1	81.0		
2300	69	57	2.5	.70	.04	.40	6654225	402	2.2	218	211	250	282	0.2	0.0	234	544	670	119	64	28.09	80	14.8	3.8	0.1	81.3	110	2040
2320	70	58	2.0	.70	.04	.30	6654475	402	2.2	218	212	253	281	0.2	0.0	234	547	665	120	65	28.08	81	14.9	3.7	0.0	81.4		
2340	68	56	1.9	.60	.04	.24	6654800	403	2.0	219	213	253	283	0.2	0.0	235	536	610	121	65	28.09	80	15.1	3.6	0.2	81.1		
2400	68	56	1.8	.50	.04	.25	6655120	402	2.0	217	212	253	281	0.2	0.0	235	540	645	122	64	28.08	89	15.1	3.5	0.0	81.4	120	2020
0020	67	56	2.1	.60	.04	.30	6655375	402	2.0	218	210	254	281	0.2	0.0	236	541	645	120	65	28.08	89	14.5	4.5	0.0	81.0		
0040	66	55	2.2	.70	.04	.32	6655890	401	2.0	218	212	253	281	0.2	0.0	235	536	655	120	63	28.08	90	14.4	4.6	0.0	81.0		
0100	70	54	2.3	.70	.04	.31	6656370	400	2.0	218	212	252	281	0.2	0.0	235	539	660	120	64	28.08	84	15.0	4.0	0.0	81.0	130	2180
0120	69	55	2.2	.60	.04	.36	6656880	400	2.0	218	213	252	282	0.2	0.0	235	535	660	119	62	28.06	80	14.0	5.2	0.0	80.8		
0140	65	55	2.7	.70	.04	.45	6657880	400	2.0	218	211	252	282	0.1	0.0	233	535	690	120	63	28.06	80	14.0	4.6	0.0	81.4		
0200	65	56	2.5	.70	.04	.40	6658820	400	2.0	218	211	251	282	0.1	0.0	233	532	660	120	64	28.06	83	14.0	5.0	0.0	81.0	140	1840
0220	65	56	2.1	.70	.04	.35	6659850	400	2.0	219	209	251	283	0.1	0.0	233	532	630	119	63	28.05	79	14.0	5.0	0.0	81.0		
0240	64	55	2.5	.70	.04	.38	6660880	400	2.0	211	203	252	282	0.1	0.0	234	536	660	120	66	28.04	80	15.0	4.0	0.0	81.0		
0300	63	53	2.5	.80	.04	.37	6661720	400	2.0	217	208	254	280	0.1	0.0	233	534	660	119	64	28.03	79	14.6	4.2	0.0	81.2	150	1820
0320	63	54	2.5	.80	.04	.37	6662730	400	2.0	219	210	252	281	0.1	0.0	234	534	650	119	65	28.03	81	13.8	5.2	0.0	81.0		
0340	63	53	2.9	.80	.04	.44	6663670	400	2.0	221	211	251	281	0.1	0.0	233	535	700	118	64	28.05	79	13.6	5.4	0.0	81.0		
0400	63	54	2.3	.80	.04	.37	6664580	400	2.0	221	212	250	282	0.1	0.0	232	535	670	118	66	28.05	78	14.0	5.2	0.0	80.8	140	1750
0420	62	53	2.7	.80	.04	.42	6665500	400	2.0	217	212	252	281	0.1	0.0	233	536	690	118	66	28.05	78	13.6	5.6	0.0	80.8		
0440	62	53	2.7	.80	.04	.40	6666330	400	2.0	217	210	253	282	0.1	0.0	233	540	690	119	67	28.04	76	13.6	5.7	0.0	80.7		
0500	62	52	2.3	.80	.04	.32	6667140	400	2.0	217	209	253	280	0.1	0.0	234	532	670	123	64	28.05	79	14.6	5.5	0.0	80.9	120	1650
0520	62	53	2.0	.70	.04	.30	6668100	400	2.0	217	210	253	280	0.1	0.0	233	540	670	120	63	28.05	76	15.0	3.8	0.0	81.2		
0540	62	53	2.4	.70	.04	.36	6668880	400	2.0	218	209	254	280	0.0	0.0	235	539	640	119	64	28.05	75	16.0	2.5	0.0	81.5		
0600	61	52	2.5	.80	.04	.40	6669780	400	2.0	218	208	251	280	0.0	0.0	233	540	660	119	63	28.04	78	13.8	6.0	0.0	80.2	120	1760
0620	59	51	2.7	.80	.04	.46	6670620	400	2.0	218	209	251	280	0.0	0.0	232	538	690	118	64	28.04	82	12.2	5.4	0.0	82.4		
0640	60	52	2.4	.70	.04	.47	6671500	400	2.0	218	209	252	282	0.0	0.0	233	540	690	118	63	28.04	81	13.0	5.8	0.0	81.2		
0700	62	53	2.5	.70	.04	.37	6672380	400	2.0	217	209	253	283	0.0	0.0	233	537	690	117	61	28.06	82	14.0	5.0	0.0	81.0	120	1670
0720	61	52	2.3	.70	.04	.38	6673050	400	2.0	217	209	253	284	0.0	0.0	233	542	690	116	63	28.06	81	13.2	6.4	0.0	80.4		
0740	61	53	2.2	.80	.04	.39	6673850	400	2.0	217	208	252	284	0.0	0.0	233	542	670	123	64	28.06	80	14.2	5.1	0.0	80.7		
0800	63	53	2.0	.70	.04	.31	6674730	402	2.0	217	208	253	285	0.0	0.0	235	538	640	124	64	28.07	81	13.7	5.8	0.0	80.5	100	1580
0820	64	54	2.1	.70	.04	.38	6675500	402	2.0	216	208	252	289	0.0	0.0	233	542	670	124	64	28.06	82	13.2	6.3	0.0	80.5		
0840	65	54	2.5	.60	.04	.38	6676300	401	2.0	216	208	254	289	0.0	0.0	235	548	680	124	61	28.06	82	14.2	5.0	0.0	80.8		
0900	66	56	2.5	.60	.04	.36	6676800	401	2.0	214	208	253	288	0.0	0.0	235	544	670	124	74	28.07	82	14.0	5.2	0.0	80.8	100	1620
0920	69	58	2.5	.60	.04	.39	6677900	402	2.0	214	208	252	289	0.0	0.0	234	544	680	123	68	28.06	82	14.3	4.8	0.0	80.9		
0940	69	58	2.5	.60	.04	.39	6678500	401	2.0	213	206	252	290	0.0	0.0	234	548	680	123	69	28.06	84	14.4	4.6	0.0	81.0		
1000	72	58	2.6	.70	.04	.47	6679500	400	2.0	212	205	248	290	0.0	0.0	230	542	690	125	64	28.06	85	14.0	5.0	0.0	81.0	120	1480
1020	70	58	2.6	.70	.04	.40	6680160	400	2.0	212	206	250	290	0.0	0.0	231	540	680	126	64	28.06	86	14.0	5.0	0.0	81.0		
1040	73	58	3.0	.90	.04	.46	6680865	400	2.0	212	207	254	290	0.0	0.0	232	542	700	128	64	28.06	87	13.5	5.8	0.0	80.7		
1100	73	58	2.9	.80	.04	.45	6681700	400	2.0	214	207	253	290	0.0	0.0	233	541	690	127	66	28.06	88	15.6	3.0	0.0	81.4	130	1470
1120	76	60	2.9	.80	.04	.42	6682400	401	2.3	214	208	255	291	0.0	0.0	235	540	670	127	64	28.04	86	14.4	5.0	0.0	80.6		
1140	76	62	2.9	.80	.04	.41	6683140	400	2.3	213	208	254	292	0.0	0.0	235	538	690	128	68	28.04	91	14.6	4.6	0.0	80.8		
1200	79	62	2.8	.80	.04	.44	6684160	400	2.5	212	206	254	293	0.0	0.0	235	539	690	128	65	28.04	94	14.8	4.3	0.0	80.9	140	1470
1220	78	62	2.5	.70	.04	.38	6684700	401	2.3	212	207	256	292	0.0	0.0	235	540	680	129	65	28.02	93	15.0	4.0	0.0	81.0		
1240	78	61	2.5	.70	.04	.36	6685350	401	1.0	213	206	256	291	0.0	0.0	235	540	670	129	68	28.01	93	15.4	3.5	0.0	81.1		
1300	81	62	2.7	.80	.04	.41	6686210	401	1.0	212	207	254	292	0.2	0.0	233	541	665	136	67	27.98	94	15.0	4.1	0.0	80.9	170	1390
1320	81	61	2.5	.50	.04	.38	6686875	401	1.0	212	206	252	292	0.2	0.0	233	538	660	130	68	27.98	92	14.4	4.8	0.0	80.8		
1340	81	62	2.2	.50	.04	.33	6687535	401	1.5	213	206	256	290	0.2	0.0	234	542	690	136	67	27.98	96	14.5	4.5	0.0	81.0		
1400	80	61	2.7	.60	.04	.40	6688215	401	1.0	212	205	255	293	0.2	0.0	234	540	670	139	65	27.98	97	14.4	5.2	0.0	80.4	150	1390
1420	80	61	2.5	.70	.04	.32	6688935	402	2.0	216	210	256	292	0.2	0.0	235	538	660	141	64	27.97	98	14.7	4.3	0.0	81.0		
1440	82	61	2.6	.80	.04	.38	6689490	402	2.0	215	210	256	292	0.2	0.0	235	537	680	140	68	27.97	98	15.0	4.4	0.0	80.6		
1500	81	61	2.0	.60	.04	.30	6690045	402	2.0	216	210	256	292	0.2	0.0	235	535	660	137	67	27.96	99	15.0	4.0	0.0	81.0	100	1440
1520	81	60	2.5	.70	.04	.35	6690570	401	2.0	216	210	256	292	0.2	0.0	234	540	650	143	66	27.95	94	14.4	5.2	0.0	80.4		
1540	82	60	2.9	.70	.04	.42	6691115	401	2.0	217	210	254	289	0.2	0.0	234	542	675	138	65	27.94	95	13.4	6.2	0.0	80.4		
1600	82	60	2.9	.70	.04	.37	6691600	401	2.0	216	212	254	293	0.2	0.0	233	539	640	140	68	27.93	91	14.0	5.4	0.0	80.6	120	1550
1620	82	60	2.5	.70	.04	.35	6692030	402	2.0	216	212	256	294	0.2	0.0	234	544	660	141	67	27.93	92	14.7	4.3	0.0	81.0		
1640	82	60	2.5	.70	.04	.31	6692480	402	2.0	216	212	258	293	0.2	0.0	234	538	645	142	66	27.93	92	15.0	4.4	0.0	80.6		
Avg	72	58	2.4	.70	.04	.35	-------	401	2.2	216	209	253	283	0.1	0.0	234	539	665	125	65	28.05	86	14.5	4.6	0.0	80.9	120	1790
Corr Avg	72	59	2.4	.70	.04	.35	-------	390	2.4	218	214	248	285	0.1	0.0	239	539	600	125	67	28.05	87	14.5	4.6	0.0	80.9	120	1790

Type of fuel bed	Low
Coal fired (as received basis)	70,705 pounds
Corrected coal fired (as received basis)	72,035 pounds
Corrected average hourly rate of coal consumption (as received basis)	3,001 pounds per hour
Blow-down water through heat exchanger	45,750 pounds
Corrected blow-down water through heat exchanger	33,855 pounds
Corrected total blow-down water	41,550 pounds
Corrected average hourly rate of blow-down	1,731 pounds per hour
Weight of steam generated	714,350 pounds
Corrected weight of steam generated	681,170 pounds
Corrected average hourly rate of steam generation	28,382 pounds per hour
Corrected average flue gas temperature	625 degrees Fahrenheit

TEST NUMBER: 30-L OBSERVED DATA DATE: OCTOBER 16,17, 1946

Time	Combustion Air		Draft, Inches Of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb Of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction					CO_2	O_2	CO	N_2	Boiler Feedwater	Blow-down Water
1740	64	49	1.9	0.2	.04	.20	7520940	401	2.0	216	206	263	220	0.1	1.1	246	542	650	112	59	28.37	72	17.5	1.5	0.0	81.0		
1800	63	50	2.0	0.5	.04	.26	7521545	401	2.0	216	206	264	221	0.1	1.1	245	543	650	111	58	28.35	72	16.6	1.4	0.3	81.7	120	1580
1820	62	49	2.2	0.6	.04	.20	7522140	401	2.4	217	206	263	221	0.1	1.1	245	540	655	111	58	28.36	74	16.4	1.6	0.4	81.6		
1840	60	48	2.0	0.4	.04	.25	7522755	401	2.6	218	206	262	224	0.1	1.1	243	541	665	110	58	28.37	74	16.2	1.2	0.9	81.7		
1900	60	48	2.0	0.5	.04	.27	7523300	401	2.0	216	205	262	222	0.1	1.1	244	543	665	111	58	28.37	74	16.6	1.0	1.1	81.3		
1920	70	53	2.3	0.6	.04	.27	7523920	400	2.1	216	205	260	222	0.1	1.1	244	544	695	110	58	28.37	70	17.0	2.0	0.0	81.0	150	1580
1940	73	55	2.0	0.5	.04	.26	7524525	401	1.8	216	205	262	222	0.1	1.1	244	538	700	110	58	28.37	68	16.4	2.6	0.0	81.0		
2000	71	55	2.3	0.6	.04	.28	7525080	401	2.3	216	205	261	222	0.1	1.1	243	536	660	114	60	28.38	70	16.4	3.5	0.0	80.1		
2020	75	56	2.4	0.7	.04	.30	7525620	401	2.2	216	207	262	222	0.1	1.1	244	536	680	114	62	28.38	71	16.0	3.0	0.0	81.0	140	1630
2040	73	55	2.2	0.7	.04	.33	7526210	401	2.2	216	206	262	222	0.1	1.1	243	538	680	112	57	28.37	69	16.2	2.6	0.0	81.2		
2100	75	57	2.3	0.7	.04	.36	7526680	401	2.3	217	207	260	222	0.1	1.1	242	540	680	115	57	28.37	69	16.6	1.7	0.0	81.7	120	1630
2120	72	54	2.0	0.6	.04	.25	7527200	401	2.1	216	207	263	222	0.1	1.1	245	537	660	114	56	28.38	68	16.3	2.3	0.0	81.4		
2140	71	53	2.1	0.6	.04	.28	7427860	401	1.9	217	206	262	222	0.1	1.2	243	535	680	110	57	28.37	67	16.4	1.2	0.0	82.4		
2200	70	54	1.9	0.3	.04	.24	7528310	401	2.3	217	206	260	222	0.1	1.2	242	536	640	111	57	28.38	67	16.3	2.1	0.0	81.6	130	1630
2220	68	51	2.0	0.3	.04	.20	7528760	402	2.3	217	205	262	222	0.1	1.2	245	531	640	108	57	28.39	69	16.7	1.8	0.0	81.5		
2240	69	52	2.0	0.2	.04	.17	7529140	402	2.4	217	204	264	220	0.1	1.2	245	537	610	109	56	28.39	70	17.1	0.7	0.2	82.0		
2300	70	52	2.1	0.4	.04	.20	7529550	403	2.1	217	205	263	221	0.1	1.2	246	533	605	110	56	28.39	72	16.4	0.9	1.1	81.6	140	1640
2320	69	52	2.2	0.6	.04	.22	7530000	402	3.0	218	206	262	223	0.1	1.2	245	538	620	108	55	28.40	75	16.0	0.4	2.6	81.0		
2340	67	50	2.2	0.7	.04	.24	7530360	402	2.4	217	206	264	226	0.1	1.2	246	538	620	109	58	28.40	78	16.8	0.7	0.5	82.0		
2400	68	53	2.1	0.7	.04	.23	7540720	402	2.7	218	207	264	226	0.1	1.2	247	541	660	111	62	28.39	72	16.8	1.0	0.0	82.2	140	1740
0020	68	52	2.2	0.7	.04	.25	7531040	402	2.6	218	208	262	228	0.1	1.2	244	539	650	111	66	28.39	73	16.4	1.4	0.0	82.2		
0040	67	52	2.3	0.7	.04	.24	7531370	402	2.0	216	206	262	230	0.1	1.2	244	543	700	113	60	28.39	72	16.6	1.5	0.0	81.9		
0100	66	51	2.5	0.7	.04	.23	7531760	402	2.1	217	203	262	231	0.1	1.2	244	541	680	112	57	28.38	72	16.0	0.7	1.1	82.2	140	1810
0120	66	51	2.5	0.8	.04	.25	7532200	402	1.4	214	203	264	232	0.1	1.2	246	537	640	112	60	28.38	71	16.8	1.2	0.0	82.0		
0140	66	51	2.5	0.7	.04	.26	7532520	402	1.1	213	204	263	231	0.1	1.2	245	541	650	111	58	28.38	72	16.8	1.2	0.0	82.0		
0200	64	51	2.4	0.7	.04	.24	7533040	401	2.4	217	207	262	231	0.1	1.2	244	540	690	110	58	28.37	70	16.5	1.1	0.0	82.4	150	1870
0220	63	50	2.3	0.7	.04	.26	7533440	401	2.2	217	207	264	231	0.1	1.2	245	538	680	111	57	28.37	70	16.2	2.6	0.0	81.2		
0240	62	51	2.2	0.5	.04	.24	7533900	401	2.5	218	207	260	231	0.1	1.2	245	537	700	112	56	28.37	69	15.9	3.0	0.0	81.1		
0300	60	48	2.3	0.7	.04	.27	7534710	400	2.6	218	208	263	233	0.1	1.2	245	536	650	110	57	28.37	68	16.8	1.7	0.0	81.5	140	1910
0320	62	50	2.5	0.6	.04	.25	7535320	402	1.9	218	212	265	236	0.1	1.2	246	539	670	115	57	28.37	67	15.9	2.0	0.1	82.0		
0340	62	49	2.3	0.5	.04	.26	7535880	400	2.9	218	213	264	231	0.1	1.2	245	548	590	116	59	28.36	65	16.0	0.6	1.4	82.0		
0400	61	49	2.3	0.7	.04	.25	7536360	402	3.1	219	211	265	234	0.1	1.2	247	534	580	113	62	28.36	66	16.4	0.4	1.6	81.6	170	1960
0420	61	50	2.7	1.0	.04	.22	7536860	401	2.2	217	210	264	231	0.1	1.2	247	539	600	114	64	28.36	65	15.8	0.6	1.6	82.0		
0440	62	50	2.5	0.8	.04	.23	7537700	400	1.8	215	207	263	233	0.1	1.2	244	540	610	113	66	28.36	65	16.6	0.6	1.6	81.2		
0500	62	50	2.3	0.7	.04	.26	7538400	402	1.8	216	207	263	226	0.1	1.2	245	539	650	114	56	28.36	66	16.4	2.0	0.0	81.6	160	1930
0520	62	49	2.2	0.7	.04	.25	7539000	402	2.4	217	206	263	229	0.1	1.2	245	541	640	114	57	28.36	65	16.6	0.8	0.7	81.9		
0540	60	48	2.2	0.6	.04	.22	7539540	402	2.7	217	206	263	225	0.1	1.2	247	532	600	116	56	28.36	64	16.2	0.4	2.0	81.4		
0600	63	50	2.3	1.1	.04	.26	7540340	402	3.1	220	208	263	224	0.1	1.2	245	547	620	116	59	28.35	65	16.3	0.4	1.8	81.5	160	1960
0620	63	50	2.3	0.6	.04	.23	7541000	402	2.6	218	208	265	223	0.1	1.2	246	543	610	116	61	28.36	65	16.4	0.4	1.6	81.6		
0640	58	48	2.4	0.6	.04	.24	7542200	402	2.7	218	208	264	224	0.1	1.2	247	537	630	114	65	28.36	65	17.2	1.2	0.0	81.6		
0700	61	50	2.2	0.4	.04	.26	7543350	404	3.1	218	207	265	226	0.1	1.2	246	545	680	116	70	28.36	65	17.6	0.9	0.0	81.5	160	2010
0720	61	50	2.3	0.5	.04	.26	7544350	404	2.9	218	207	264	225	0.1	1.2	245	544	680	117	60	28.36	65	17.0	1.7	0.0	81.3		
0740	61	49	2.3	0.6	.04	.24	7545155	403	3.1	220	208	264	226	0.1	1.2	245	540	680	118	61	28.37	69	16.8	1.5	0.1	81.6		
0800	60	49	2.2	0.4	.25	.25	7545460	404	3.6	220	209	261	227	0.1	1.2	246	536	650	119	63	28.38	73	15.4	2.0	0.0	81.6	140	1890
0820	60	49	2.3	0.5	.04	.23	7545900	404	3.0	219	210	260	227	0.1	1.2	246	540	700	120	67	28.39	75	16.6	2.0	0.0	81.2		
0840	61	50	2.3	0.5	.04	.26	7546600	404	3.1	218	210	263	226	0.1	1.2	247	541	685	123	64	28.40	76	16.3	2.6	0.0	81.1		
0900	62	52	2.2	0.6	.04	.28	7547300	404	3.0	218	209	261	226	0.1	1.2	245	544	670	126	58	28.39	72	15.8	3.2	0.0	81.0	150	1830
0920	61	48	2.3	0.5	.04	.29	7548100	404	2.6	218	210	263	228	0.2	1.2	245	540	650	127	59	28.38	72	15.0	3.0	0.0	81.0		
0940	62	49	2.4	0.5	.04	.27	7548800	404	2.7	219	210	263	229	0.2	1.2	246	548	630	130	70	28.38	72	16.8	2.5	0.0	80.7		
1000	63	50	2.5	0.5	.04	.27	7549600	404	2.7	218	210	263	230	0.2	1.2	245	548	630	131	64	28.38	73	16.8	1.8	0.0	81.4	120	1730
1020	63	50	2.3	1.0	.04	.29	7500000	405	2.3	219	210	264	232	0.1	1.2	246	544	630	114	62	28.38	75	17.0	1.6	0.0	81.4		
1040	64	51	2.4	1.0	.04	.28	7550750	404	2.2	218	210	263	232	0.1	1.2	245	543	640	115	64	28.38	75	17.0	1.2	0.0	81.8		
1100	67	51	2.3	0.7	.04	.32	7551530	404	2.4	217	209	263	231	0.1	1.2	246	538	650	117	56	28.38	72	16.2	3.8	0.0	80.0	130	1710
1120	68	50	2.3	0.7	.04	.29	7552100	404	1.9	216	210	266	228	0.1	1.2	246	546	670	120	58	28.36	72	16.4	2.4	0.0	81.2		
1140	68	50	2.2	0.6	.04	.27	7552655	404	2.1	216	208	265	226	0.1	1.2	245	542	660	119	60	28.36	72	16.6	1.6	0.0	81.8		
1200	67	50	2.2	0.6	.04	.27	7553350	404	2.1	216	207	264	226	0.3	1.2	245	544	645	117	61	28.36	73	16.9	1.4	0.0	81.7	130	1730
1220	66	50	2.2	0.5	.04	.25	7553075	404	1.9	216	208	263	226	0.3	1.2	245	542	630	118	56	28.35	73	16.3	1.3	0.0	82.4		
1240	63	47	2.3	0.6	.04	.29	7554000	404	1,9	216	207	263	228	0.1	1.2	246	544	690	115	57	28.34	73	15.8	3.1	0.0	81.1		
1300	62	48	2.4	0.7	.04	.30	7555150	404	1.7	216	207	263	229	0.1	1.2	246	546	680	120	56	28.32	74	15.9	3.2	0.0	80.9	140	1700
1320	60	48	2.5	0.6	.04	.30	7555700	404	1.9	216	208	261	231	0.1	1.2	245	540	690	120	56	28.32	75	16.3	2.7	0.0	81.0		
1340	62	49	2.5	0.6	.04	.29	7556100	404	1.7	216	208	262	232	0.1	1.2	244	540	660	120	58	28.32	75	16.7	2.1	0.0	81.2		
1400	63	50	2.5	0.6	.04	.29	7556800	404	2.0	217	208	265	234	0.1	1.2	244	543	670	122	59	28.32	79	16.8	1.6	0.0	81.6	150	1690
1420	60	50	2.4	0.7	.04	.29	2557300	404	1.9	217	209	265	236	0.1	1.2	245	543	680	120	58	28.32	81	17.0	1.5	0.0	81.5		
1440	62	50	2.5	0.7	.04	.26	7557900	405	1.9	217	210	264	237	0.1	1.2	245	540	670	120	56	28.31	82	16.8	1.4	0.0	81.8		
1500	62	50	2.4	0.6	.04	.25	7558564	404	1.9	217	208	266	239	0.1	1.2	244	538	630	118	56	28.30	82	16.1	2.2	0.0	81.7	150	1780
1520	70	50	2.4	0.6	.04	.28	7559000	405	1.7	217	207	266	238	0.1	1.2	245	544	670	118	59	28.30	80	17.0	1.3	0.0	81.7		
1540	69	51	2.5	1.0	.04	.25	7559600	405	1.9	217	207	265	234	0.1	1.2	245	548	640	120	56	28.29	79	17.0	1.3	0.0	81.7		
1600	71	50	2.5	0.8	.04	.26	7560150	405	1.8	218	206	265	232	0.1	1.2	245	548	660	117	56	28.29	79	16.4	1.4	0.0	82.2	170	1660
1620	70	50	2.5	0.9	.04	.30	7560565	404	1.5	217	206	266	230	0.1	1.2	245	546	690	116	57	28.29	79	15.4	3.6	0.0	81.0		
1640	64	50	2.5	0.6	.04	.36	7561150	403	1.8	215	206	263	230	0.1	1.2	243	545	700	119	57	28.28	78	16.6	1.2	1.4	80.8		
1700	62	48	2.6	0.8	.04	.29	7561610	405	2.0	216	208	265	232	0.1	1.2	245	541	680	117	58	28.28	79	17.0	1.0	0.0	82.0	150	1720
1720	65	50	2.4	0.7	.04	.25	7562150	404	2.1	216	208	263	235	0.1	1.2	245	546	660	118	60	28.29	77	16.8	1.7	0.0	81.5		
1740	58	46	2.3	0.5	.04	.23	7562550	404	2.1	216	207	267	235	0.1	1.2	245	543	620	115	56	28.28	75	16.9	1.3	0.0	81.8		
Avg	65	50	2.3	0.6	.04	.26	-------	403	2.3	217	207	263	228	0.1	1.2	245	541	655	115	59	28.36	72	16.5	1.7	0.3	81.5	140	1760
Corr Avg	65	50	2.3	0.6	.04	.26	-------	392	2.3	219	210	255	230	0.1	1.2	249	541	590	115	59	28.36	72	16.6	1.7	0.3	81.5	140	1750

Type of fuel bed	Medium
Coal fired (as received basis)	69,050 pounds
Corrected coal fired (as received basis)	70,460 pounds
Corrected average hourly rate of coal consumption (as received basis)	2,936 pounds per hour
Blow-down water through heat exchanger	41,610 pounds
Corrected blow-down water through heat exchanger	30,790 pounds
Corrected total blow-down water	37,890 pounds
Corrected average hourly rate of blow-down	1,579 pounds per hour
Weight of steam generated	717,650 pounds
Corrected weight of steam generated	690,471 pounds
Corrected average hourly rate of steam generation	28,770 pounds per hour
Corrected average flue gas temperature	605 degrees Fahrenheit

TEST NUMBER: 30-M OBSERVED DATA DATE: NOVEMBER 18,19, 1946

Time	Combustion Air		Draft, Inches of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm As $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb Of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1600	76	58	2.5	0.8	.04	.24	6799525	404	0.0	212	205	251	218	0.1	0.0	238	534	665	130	71	28.16	90	15.0	2.2	0.1	82.7	150	2500
1620	75	58	2.4	0.8	.04	.18	6799820	404	0.0	211	206	251	216	0.0	0.0	239	538	620	130	72	28.16	89	15.8	2.7	0.0	81.5		
1640	74	57	2.5	0.8	.04	.20	6799920	405	0.0	212	206	252	212	0.0	0.0	239	536	620	129	76	28.16	89	16.0	2.0	0.0	82.0		
1700	72	56	3.5	1.2	.04	.37	6800480	404	0.0	212	206	248	216	0.0	0.0	236	538	640	130	76	28.16	90	15.3	2.3	0.0	82.4	140	2530
1720	71	57	2.6	0.8	.04	.27	6800765	404	0.0	213	207	250	218	0.0	0.0	236	538	650	130	74	28.16	90	15.2	2.0	0.4	82.4		
1740	74	58	2.3	0.8	.04	.24	6801365	403	0.0	214	207	251	215	0.0	0.0	236	539	620	130	74	28.16	90	16.6	1.2	0.2	82.0		
1800	73	57	2.7	0.8	.04	.22	6802265	402	0.0	213	206	254	222	0.0	0.0	238	540	600	132	74	28.17	88	16.8	1.2	0.0	82.0	120	2370
1820	73	57	2.2	0.8	.04	.20	6802945	402	0.0	214	207	253	224	0.0	0.0	238	535	600	131	74	28.17	88	16.8	1.8	0.0	81.4		
1840	70	57	2.0	0.6	.04	.20	6803535	403	0.3	214	206	252	236	0.0	0.0	237	536	620	130	66	28.18	86	16.4	2.6	0.0	81.0		
1900	66	56	2.5	0.7	.04	.24	6804160	404	0.3	214	206	254	240	0.0	0.0	236	539	640	130	68	28.18	84	15.9	3.1	0.0	81.0	110	2270
1920	66	56	2.3	0.6	.04	.22	6804805	403	0.5	214	206	250	242	0.0	0.0	237	538	620	132	70	28.18	85	16.7	2.2	0.1	81.0		
1940	74	60	2.4	0.7	.04	.23	6805565	403	0.3	215	206	255	241	0.0	0.0	238	540	640	135	66	28.18	83	16.5	2.7	0.0	80.8		
2000	75	60	2.5	0.5	.04	.35	6806215	402	0.5	215	207	249	250	0.0	0.0	234	536	650	133	67	28.18	83	14.2	5.0	0.0	80.8	140	2290
2020	78	60	2.5	0.6	.04	.29	6806810	403	0.5	215	208	254	252	0.0	0.0	236	538	640	130	69	28.17	85	14.9	5.0	0.0	80.1		
2040	72	59	2.3	0.6	.04	.24	6807380	401	0.8	216	205	254	252	0.0	0.0	237	534	610	128	72	28.17	80	15.7	2.3	0.5	81.5		
2100	73	59	2.2	0.6	.04	.25	6808375	400	1.0	216	205	253	252	0.0	0.0	236	536	635	131	67	28.17	82	16.6	2.4	0.1	80.9	170	2110
2120	72	59	2.2	0.6	.04	.22	6809165	400	1.0	216	207	251	254	0.0	0.0	237	536	630	130	64	28.17	80	16.7	1.6	0.1	81.6		
2140	72	59	2.4	0.7	.04	.28	6810990	403	1.2	216	206	255	254	0.0	0.0	237	536	620	130	67	28.17	82	15.3	3.8	0.0	80.9		
2200	71	59	2.6	0.8	.04	.28	6810640	401	1.5	216	206	254	256	0.0	0.0	238	538	625	130	66	28.17	82	15.2	3.8	0.0	81.0	130	1920
2220	70	58	2.5	0.7	.04	.27	6811440	402	1.5	216	206	254	253	0.0	0.0	237	540	610	133	68	28.17	81	15.9	3.0	0.0	81.1		
2240	73	58	2.3	0.7	.04	.24	6812260	403	2.0	217	206	253	253	0.0	0.0	237	540	620	124	66	28.17	79	15.6	3.4	0.0	81.0		
2300	68	57	2.7	0.9	.04	.23	6813010	403	2.5	218	208	256	258	0.0	0.0	238	540	600	122	67	28.16	78	16.4	1.8	0.4	81.4	130	2000
2320	68	57	2.0	0.7	.04	.17	6813540	402	2.5	218	208	254	252	0.0	0.0	237	538	620	125	66	28.16	77	16.0	2.2	0.4	81.4		
2340	68	57	2.6	1.0	.04	.21	6813920	403	2.5	218	208	256	250	0.0	0.0	238	536	600	121	66	28.15	76	16.3	1.2	0.8	81.7		
2400	70	57	2.0	0.7	.04	.20	6814350	403	2.5	218	207	254	250	0.0	0.0	237	538	600	122	64	28.15	76	16.2	2.0	0.2	81.6	130	1950
0020	69	57	2.3	0.8	.04	.21	6814610	403	2.5	219	205	253	245	0.0	0.0	238	538	600	120	67	28.14	75	16.6	0.6	0.5	82.3		
0040	70	57	2.4	0.8	.04	.19	6814900	403	2.5	219	206	253	242	0.0	0.0	237	538	590	121	64	28.14	76	16.6	0.4	1.0	82.0		
0100	69	57	2.1	0.8	.04	.16	6815300	404	2.5	219	208	256	248	0.0	0.0	238	532	550	118	66	28.14	76	16.0	0.4	1.6	82.0	100	2050
0120	68	57	2.2	0.8	.04	.17	6815580	404	2.5	219	207	257	239	0.0	0.0	238	532	590	120	66	28.14	74	16.0	1.0	0.8	82.2		
0140	67	57	2.2	0.8	.04	.14	6815910	404	3.0	220	208	255	249	0.0	0.0	238	534	570	117	64	28.13	79	16.6	0.7	0.3	82.3		
0200	67	56	2.8	1.2	.04	.18	6816280	404	3.0	220	210	257	245	0.0	0.0	238	540	600	120	63	28.13	78	15.5	0.4	1.5	82.6	160	2050
0220	67	55	3.5	1.3	.04	.20	6816600	404	3.0	220	210	256	234	0.0	0.0	237	537	600	119	64	28.13	77	16.0	0.6	0.1	83.3		
0240	66	56	3.0	1.2	.04	.18	6816880	404	3.0	220	210	256	233	0.0	0.0	237	536	610	121	64	28.13	78	15.8	0.4	1.3	82.5		
0300	66	56	3.8	1.5	.04	.24	6817180	404	3.0	220	210	250	234	0.1	0.0	237	538	600	120	62	28.14	78	15.7	0.9	1.2	82.2	120	2090
0320	67	56	4.2	1.7	.04	.23	6817500	404	3.0	220	210	258	228	0.1	0.0	238	540	610	122	64	28.14	78	16.4	0.7	0.7	82.2		
0340	66	56	3.2	1.7	.04	.18	6817820	405	3.0	220	211	257	234	0.1	0.0	237	538	600	124	64	28.14	76	15.9	0.5	0.9	82.7		
0400	66	56	2.2	1.1	.04	.16	6818130	404	3.0	220	209	258	234	0.1	0.0	238	542	600	121	65	28.14	78	16.2	1.0	0.3	82.5	120	2080
0420	67	56	2.0	1.0	.04	.21	6818480	404	3.0	220	211	255	229	0.1	0.0	238	532	630	122	63	28.14	78	16.8	1.2	0.0	82.0		
0440	66	54	2.0	1.2	.04	.17	6818820	404	3.2	220	211	254	233	0.1	0.0	231	538	620	125	65	28.14	76	16.8	1.4	0.0	81.8		
0500	66	55	2.4	1.2	.04	.22	6819160	404	3.2	221	210	254	235	0.1	0.0	237	539	650	125	65	28.14	77	16.2	1.8	0.0	82.0	140	2070
0520	67	56	2.8	1.0	.04	.25	6819480	404	3.3	221	210	257	245	0.1	0.0	238	540	610	127	64	28.14	76	16.5	1.5	0.0	82.0		
0540	65	56	2.6	0.8	.04	.23	6819880	404	3.3	221	210	256	244	0.0	0.0	237	545	640	128	64	28.14	75	16.0	2.4	0.0	81.6		
0600	64	53	3.1	1.0	.04	.32	6820000	403	3.0	219	209	255	230	0.0	0.0	237	543	660	130	65	28.14	75	15.4	3.8	0.0	80.8	130	2060
0620	67	55	2.5	0.8	.04	.29	6820360	402	3.0	218	208	253	244	0.1	0.0	235	544	680	133	66	28.14	75	15.1	3.7	0.0	81.2		
0640	66	54	2.2	0.7	.04	.30	6820610	404	2.3	218	207	256	240	0.1	0.0	236	541	660	132	65	28.14	75	16.0	2.7	0.0	81.3		
0700	65	54	1.8	0.6	.04	.23	6820950	405	2.3	218	207	257	243	0.2	0.0	239	540	640	138	64	28.14	78	16.9	1.7	0.0	81.4	160	2170
0720	66	56	2.3	0.4	.04	.31	6821200	404	2.3	218	206	256	242	0.2	0.0	237	540	680	136	65	28.15	78	16.3	2.6	0.0	81.1		
0740	66	56	2.3	0.5	.04	.31	6821700	404	2.2	218	207	257	242	0.0	0.0	237	530	660	140	65	28.15	79	16.1	2.8	0.0	81.1		
0800	67	56	2.3	0.6	.04	.26	6822800	404	2.2	218	208	257	246	0.0	0.0	239	534	620	135	66	28.16	79	15.8	3.1	0.0	81.1	120	1980
0820	67	56	2.4	0.6	.04	.32	6823700	403	2.3	218	207	256	244	0.0	0.0	238	542	640	136	67	28.16	80	16.0	3.0	0.0	81.0		
0840	70	58	2.0	0.7	.04	.28	6825120	400	2.2	217	206	254	252	0.0	0.0	237	542	680	126	65	28.16	80	16.6	2.2	0.0	81.2		
0900	73	59	2.0	0.7	.04	.31	6826160	400	2.0	216	206	256	251	0.0	0.0	237	546	660	129	65	28.16	82	16.2	2.8	0.0	81.0	130	1960
0920	72	60	2.0	0.7	.04	.25	6827200	400	1.0	213	204	256	251	0.0	0.0	237	547	640	133	64	28.16	83	16.2	2.8	0.0	81.0		
0940	74	60	2.5	0.8	.04	.27	6828200	400	1.0	213	203	252	250	0.0	0.0	237	544	630	132	66	28.16	85	16.2	2.8	0.0	81.0		
1000	75	61	2.0	0.7	.04	.25	6829270	400	1.0	213	203	256	245	0.0	0.0	237	548	640	136	65	28.16	86	16.4	2.2	0.0	81.4	150	1660
1020	76	62	2.2	0.8	.04	.21	6830340	400	1.0	214	204	257	248	0.0	0.0	238	541	630	129	70	28.16	86	16.6	2.2	0.0	81.2		
1040	78	63	2.5	0.8	.04	.21	6831480	402	1.0	213	204	258	249	0.0	0.0	237	543	600	133	68	28.16	86	15.6	0.9	0.3	83.2		
1100	82	65	2.3	0.7	.04	.21	6832700	403	0.3	212	203	258	249	0.0	0.0	237	546	600	136	67	28.15	90	16.1	1.2	0.1	82.6	140	1780
1120	85	64	2.4	0.6	.04	.25	6833720	403	0.3	212	205	256	250	0.0	0.0	237	546	640	133	67	28.14	88	16.6	1.5	0.0	81.9		
1140	88	64	2.8	0.9	.04	.29	6834650	403	0.3	212	206	256	247	0.1	0.0	237	547	630	134	64	28.12	90	16.2	1.9	0.0	81.9		
1200	85	64	2.8	0.8	.04	.24	6835375	404	0.0	212	204	255	252	0.1	0.0	237	544	620	132	65	28.12	91	15.7	2.6	0.0	81.7	130	1680
1220	85	64	2.2	0.8	.04	.23	6836160	404	0.0	212	205	256	252	0.1	0.0	238	542	625	134	69	28.12	91	16.5	2.0	0.0	81.5		
1240	85	62	2.9	0.8	.04	.27	6836930	403	0.3	212	207	257	252	0.1	0.0	239	544	620	135	67	28.11	92	15.9	2.4	0.0	81.7		
1300	88	63	2.0	0.5	.04	.20	6837555	403	0.3	213	207	258	252	0.0	0.0	240	550	615	136	65	28.11	92	16.0	2.4	0.0	81.6	170	1610
1320	87	63	2.8	0.8	.04	.23	6838340	403	0.3	213	207	258	252	0.0	0.0	239	548	620	135	66	28.09	91	16.5	2.2	0.2	81.1		
1340	90	64	2.4	0.8	.04	.20	6838960	404	0.3	213	206	257	252	0.0	0.0	238	547	620	147	69	28.09	92	17.0	1.8	0.6	81.6		
1400	80	60	2.8	0.9	.04	.23	6839805	404	0.3	213	207	257	252	0.0	0.0	240	546	635	136	66	28.09	92	16.5	2.2	0.2	81.1	120	1700
1420	88	62	2.5	0.8	.04	.22	6840420	404	2.0	213	207	258	252	0.0	0.0	240	544	640	137	67	28.08	91	17.5	1.8	0.8	79.9		
1440	88	62	2.6	1.2	.04	.23	6841100	403	0.0	213	206	258	250	0.0	0.0	237	544	630	135	66	28.07	91	17.0	2.0	0.6	80.4		
1500	90	63	2.8	1.0	.04	.21	6841860	403	0.0	213	204	257	248	0.0	0.0	238	542	640	137	74	28.07	91	17.0	2.0	0.6	80.4	140	1610
1520	90	63	2.7	1.1	.04	.22	6842700	403	0.0	213	206	257	252	0.0	0.0	237	539	660	135	69	28.07	92	16.8	2.2	0.6	80.4		
1540	90	62	3.8	1.3	.04	.31	6843330	403	0.0	212	205	258	250	0.0	0.0	237	547	660	137	70	28.07	91	16.6	2.2	0.5	80.7		
1600	90	62	2.6	1.0	.04	.22	6844080	403	0.0	212	205	257	252	0.0	0.0	237	542	640	137	70	28.07	90	16.4	2.2	0.5	80.9		
Avg	74	58	2.5	0.8	.04	.24	-------	403	1.4	216	207	255	243	0.0	0.0	237	540	625	130	67	28.14	83	16.2	2.1	0.3	81.4	140	2020
Corr Avg	74	59	2.5	0.8	.04	.24	-------	392	1.4	218	212	252	244	0.0	0.0	242	540	570	130	67	28.14	84	16.2	2.1	1.3	80.4	140	2020

Type of fuel bed	High
Coal fired (as received basis)	70,695 pounds
Corrected coal fired (as received basis)	72,275 pounds
Corrected average hourly rate of coal consumption (as received basis)	3,011 pounds per hour
Blow-down water through heat exchanger	44,555 pounds
Corrected blow-down water through heat exchanger	32,970 pounds
Corrected total blow-down water	40,725 pounds
Corrected average hourly rate of blow-down	1,697 pounds per hour
Weight of steam generated	712,900 pounds
Corrected weight of steam generated	688,945 pounds
Corrected average hourly rate of steam generation	28,706 pounds per hour
Corrected average flue gas temperature	600 degrees Fahrenheit

TEST NUMBER: 30-H OBSERVED DATA DATE: OCTOBER 23,24, 1946

Time	Combustion Air		Draft, Inches Of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Flue Gas Temp F Outlet				Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm As $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb Of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1700	70	53	2.7	1.0	.04	.33	7590030	402	2.3	216	202	266	223	0.0	0.0	242	544	730	116	60	28.18	83	16.7	1.5	0.0	81.8	160	1770
1720	75	55	3.0	1.0	.04	.40	7591120	402	2.2	217	206	265	225	0.0	0.0	242	548	730	116	60	28.18	81	16.7	1.5	0.0	81.8		
1740	72	53	3.0	1.0	.04	.38	7592000	402	2.1	218	205	264	226	0.0	0.0	242	548	720	115	59	28.18	80	16.6	2.0	0.0	81.4		
1800	72	53	2.8	1.0	.04	.40	7592920	402	2.4	218	203	264	226	0.0	0.0	242	550	720	116	56	28.16	79	16.5	2.0	0.0	81.5	100	1700
1820	72	54	3.2	1.0	.04	.50	7593780	402	2.7	218	201	263	225	0.0	0.0	242	552	740	110	58	28.16	74	16.8	1.6	0.0	81.6		
1840	72	54	2.8	0.8	.04	.40	7594600	402	2.6	218	204	264	225	0.0	0.0	242	545	720	110	58	28.16	74	16.8	1.5	0.0	81.7		
1900	69	52	2.7	0.8	.04	.42	7595460	402	2.8	219	205	263	225	0.0	0.0	242	547	720	109	57	28.15	74	16.8	1.5	0.0	81.7	120	1660
1920	72	54	3.4	1.0	.04	.50	7596380	402	3.4	220	206	263	226	0.0	0.0	240	548	720	112	57	28.15	72	16.0	2.3	0.0	81.6		
1940	70	52	2.8	0.9	.04	.38	7597245	403	3.5	220	205	264	225	0.0	0.0	240	548	720	112	57	28.15	72	16.0	2.3	0.0	81.6		
2000	70	53	2.7	0.7	.04	.45	7598250	402	3.7	220	206	265	226	0.0	0.0	243	546	740	112	57	28.16	74	16.8	2.0	0.0	81.4	150	1630
2020	68	52	2.7	0.8	.04	.42	7598790	403	3.4	220	205	265	224	0.0	0.0	242	539	710	110	58	28.15	75	16.8	2.6	0.0	80.6		
2040	68	51	3.2	0.9	.04	.48	7599270	402	3.6	221	205	264	225	0.0	0.0	242	547	740	111	58	28.17	76	16.6	2.4	0.0	81.0		
2100	64	50	2.7	0.7	.04	.43	7600000	404	1.0	212	198	265	224	0.0	0.0	245	544	730	108	59	28.18	77	16.6	2.4	0.0	81.0	140	1640
2120	67	50	2.6	0.8	.04	.41	7600760	403	1.3	213	198	264	225	0.0	0.0	242	543	710	108	58	28.18	74	16.4	1.9	0.0	81.7		
2140	67	51	2.5	0.8	.04	.49	7601180	402	2.6	216	200	265	222	0.0	0.0	242	546	750	110	58	28.17	72	16.8	1.9	0.0	81.3		
2200	67	52	2.8	0.9	.04	.52	7601730	402	2.3	216	202	264	222	0.0	0.0	242	546	750	108	58	28.18	73	16.0	2.6	0.0	81.4	120	1640
2220	71	54	2.9	0.8	.04	.50	7602240	402	2.1	216	203	264	223	0.0	0.0	242	543	750	108	58	28.18	74	16.4	2.2	0.0	81.4		
2240	70	54	2.8	0.7	.04	.50	7602715	403	1.1	214	202	264	223	0.0	0.0	242	545	750	109	56	28.18	74	16.0	2.6	0.0	81.4		
2300	66	51	2.5	0.8	.04	.47	7603320	403	2.0	215	199	265	224	0.0	0.0	242	545	760	108	58	28.17	75	16.4	2.2	0.0	81.4	120	1660
2320	70	53	2.8	0.8	.04	.49	7603860	403	1.9	215	202	264	225	0.0	0.0	242	544	760	112	57	28.17	76	16.8	1.5	0.0	81.7		
2340	71	53	3.0	1.0	.04	.48	7604340	403	0.9	212	200	265	225	0.0	0.0	242	541	770	117	60	28.17	76	16.7	1.5	0.0	81.8		
2400	70	52	2.8	1.0	.04	.50	7604700	403	1.7	216	198	265	225	0.0	0.0	242	543	780	117	60	28.17	77	16.4	1.9	0.0	81.7	120	1690
0020	69	52	2.3	0.7	.04	.58	7605000	403	0.7	212	198	265	225	0.0	0.0	242	552	700	118	58	28.18	78	16.4	1.2	0.2	82.2		
0040	76	55	2.8	0.8	.04	.53	7605400	404	1.8	215	200	265	225	0.0	0.0	242	548	730	116	59	28.18	78	16.6	2.0	0.0	81.4		
0100	75	56	2.7	0.8	.04	.45	7605650	404	1.8	215	200	266	226	0.0	0.0	242	549	700	115	59	28.17	77	17.3	1.2	0.0	81.5	150	1770
0120	75	56	2.7	0.8	.04	.40	7605900	397	3.3	218	202	266	225	0.0	0.0	243	541	710	115	58	28.17	77	16.0	1.0	0.0	83.0		
0140	75	57	2.6	0.8	.04	.46	7606050	392	1.9	215	200	264	226	0.0	0.0	242	551	730	115	59	28.17	78	16.9	1.4	0.0	81.7		
0200	73	56	2.8	0.8	.04	.47	7606200	391	2.4	219	205	263	225	0.0	0.0	240	545	700	114	59	28.16	76	15.8	3.2	0.0	81.0	150	1950
0220	73	56	3.0	0.8	.04	.57	7606570	401	2.6	218	202	265	225	0.0	0.0	242	548	720	112	58	28.16	75	16.0	3.0	0.0	81.0		
0240	66	51	2.9	0.9	.04	.46	7607580	402	1.8	216	202	267	223	0.0	0.0	243	546	700	114	58	28.16	76	17.0	0.8	0.0	82.2		
0300	65	51	3.0	1.0	.04	.49	7608270	402	2.8	216	198	266	224	0.0	0.0	242	550	710	114	58	28.16	77	16.4	1.4	0.0	82.2	150	1880
0320	72	54	2.6	0.9	.04	.41	7609150	402	1.9	215	198	265	225	0.0	0.0	242	550	710	114	59	28.16	76	16.6	1.4	0.0	82.0		
0340	74	56	2.8	0.8	.04	.47	7610860	402	2.5	218	201	263	225	0.0	0.0	242	545	730	114	58	28.16	76	16.7	1.5	0.0	81.8		
0400	75	56	2.7	0.9	.04	.41	7611760	402	1.9	215	200	265	224	0.0	0.0	241	547	720	114	59	28.16	75	16.8	1.8	0.0	81.4	140	1890
0420	65	51	2.7	0.8	.04	.44	7612700	402	1.9	216	200	266	224	0.0	0.0	242	547	710	114	58	28.15	74	16.9	0.7	0.4	82.0		
0440	70	52	2.4	0.8	.04	.42	7612875	402	1.8	215	201	266	225	0.0	0.0	243	552	720	114	58	28.15	69	16.4	1.6	0.0	82.0		
0500	74	56	2.2	0.8	.04	.40	7613050	402	1.7	215	201	265	225	0.0	0.0	242	550	720	115	58	28.16	74	16.1	1.7	0.0	82.2	150	1810
0520	73	55	2.2	0.7	.04	.43	7614400	402	1.1	213	201	265	225	0.0	0.0	242	544	720	113	58	28.15	73	16.0	2.3	0.0	81.7		
0540	75	55	3.0	1.0	.04	.50	7615140	402	1.4	216	201	267	225	0.0	0.0	243	544	730	114	58	28.16	74	16.2	2.0	0.0	81.8		
0600	75	55	3.2	0.9	.04	.50	7615970	402	1.2	216	201	266	225	0.0	0.0	244	545	720	114	58	28.16	74	16.5	1.9	0.0	81.6	150	1810
0620	73	55	3.0	1.0	.04	.45	7616800	404	4.0	214	207	265	224	0.0	0.0	245	542	700	116	58	28.17	74	16.4	2.1	0.0	81.5		
0640	74	54	2.9	0.7	.04	.53	7617350	403	3.3	220	207	265	224	0.0	0.0	246	546	700	116	64	28.18	74	17.0	1.9	0.0	81.1		
0700	74	55	2.8	0.7	.04	.46	7618450	403	2.0	218	208	265	223	0.0	0.0	245	548	710	114	58	28.18	72	16.7	1.7	0.0	81.6	140	1860
0720	68	49	2.8	0.7	.04	.50	7619550	404	2.4	217	208	265	222	0.0	0.0	245	550	710	112	59	28.18	71	16.8	1.9	0.0	81.3		
0740	62	46	2.9	0.6	.04	.53	7620000	402	2.3	217	207	267	223	0.0	0.0	246	550	710	111	64	28.18	71	16.8	1.8	0.0	81.4		
0800	58	46	2.7	0.8	.04	.46	7621000	403	2.2	216	206	267	224	0.0	0.0	244	547	700	112	62	28.18	72	16.8	1.8	0.0	81.4	140	1760
0820	63	50	3.0	0.8	.04	.43	7621540	405	4.0	221	205	266	225	0.0	0.0	245	549	695	112	61	28.18	74	16.5	1.1	0.2	82.2		
0840	62	50	2.9	1.0	.04	.42	7622300	404	3.6	221	205	265	224	0.0	0.0	245	548	700	113	60	28.18	72	17.4	1.0	0.0	81.6		
0900	62	50	2.8	1.0	.04	.41	7623200	404	2.4	218	204	266	222	0.0	0.0	241	549	700	115	63	28.17	76	15.8	2.0	0.0	82.2	120	1750
0920	62	50	2.8	1.0	.04	.43	7624150	404	3.0	218	204	266	222	0.0	0.0	241	548	700	115	60	28.17	67	15.9	2.1	0.0	82.0		
0940	68	55	3.0	1.0	.04	.47	7625100	404	1.8	216	203	265	222	0.0	0.0	241	550	710	120	57	28.18	68	16.0	2.2	0.0	81.8		
1000	68	55	2.8	0.9	.04	.44	7625600	403	1.3	214	202	265	222	0.0	0.0	240	548	700	120	58	28.19	74	16.0	2.6	0.0	81.4	120	1700
1020	70	56	3.1	1.1	.04	.52	7626400	403	2.3	218	203	265	224	0.0	0.0	240	547	710	122	58	28.18	71	16.7	1.3	0.0	82.0		
1040	73	58	3.0	1.0	.04	.45	7627500	403	2.0	216	202	269	224	0.0	0.0	241	550	705	123	62	28.19	76	16.8	1.4	0.0	81.8		
1100	73	58	2.9	1.0	.04	.44	7627900	403	2.3	216	204	268	224	0.0	0.0	242	549	705	124	58	28.20	79	17.2	1.1	0.0	81.7	120	1610
1120	72	58	2.9	1.0	.04	.42	7629000	402	3.4	218	206	268	224	0.0	0.0	243	547	700	118	58	28.20	82	17.2	1.3	0.0	81.5		
1140	72	56	3.0	0.6	.04	.41	7629400	404	3.3	219	206	268	224	0.0	0.0	244	548	700	119	58	28.20	80	17.2	1.2	0.0	81.6		
1200	72	56	2.9	0.8	.04	.46	7630500	403	3.1	219	205	268	222	0.0	0.0	244	550	715	120	58	28.19	81	16.8	1.0	0.0	82.2	140	1660
1220	72	56	2.9	0.7	.04	.44	7631158	404	2.7	219	204	268	221	0.0	0.0	245	553	720	122	58	28.18	82	16.7	1.5	0.0	81.8		
1240	76	58	2.6	0.7	.04	.45	7631815	403	2.6	218	204	268	222	0.0	0.0	244	551	740	122	57	28.18	82	16.8	1.6	0.0	81.6		
1300	62	62	2.6	0.5	.04	.45	7632600	404	2.0	218	205	268	222	0.0	0.0	243	548	710	123	57	28.18	85	16.5	2.1	0.0	81.4	150	1620
1320	75	60	3.0	0.6	.04	.56	7633350	404	2.3	218	206	266	223	0.0	0.0	244	550	750	122	58	28.17	86	16.7	2.1	0.0	81.2		
1340	75	60	2.4	0.6	.04	.46	7633900	404	2.5	217	205	266	223	0.0	0.0	243	551	710	122	58	28.17	87	16.5	2.1	0.0	81.4		
1400	75	60	3.5	0.7	.04	.45	7634550	403	2.3	217	207	266	222	0.0	0.0	245	545	710	122	58	28.16	87	16.4	2.1	0.0	81.7	180	1670
1420	71	58	2.6	0.6	.04	.42	7635200	403	2.5	216	206	266	222	0.0	0.0	244	548	720	122	59	28.16	84	16.8	1.4	0.0	81.8		
1440	72	58	2.8	0.7	.04	.43	7635500	404	2.9	216	204	266	223	0.0	0.0	245	547	720	123	60	28.16	86	17.0	1.7	0.0	81.3		
1500	72	58	2.7	0.7	.04	.42	7636400	403	2.3	216	203	267	224	0.0	0.0	243	544	705	120	60	28.16	88	17.0	1.9	0.0	81.1	170	1450
1520	72	58	3.2	0.9	.04	.46	7637000	403	2.4	217	202	268	224	0.0	0.0	244	551	770	120	58	28.16	83	17.0	1.9	0.0	81.1		
1540	71	58	3.7	1.0	.04	.52	7637500	402	1.0	214	202	265	224	0.0	0.0	240	544	750	120	58	28.16	81	16.5	2.5	0.0	81.0		
1600	71	58	3.3	0.9	.04	.46	7638200	402	1.9	215	202	266	224	0.0	0.0	240	548	740	120	59	28.15	82	17.2	1.3	0.0	81.5	150	1470
1620	73	60	3.3	1.1	.04	.47	7638900	403	1.8	215	204	269	224	0.0	0.0	244	545	720	121	59	28.15	82	15.9	3.1	0.0	81.0		
1640	73	60	3.3	1.0	.04	.45	7639340	404	1.5	215	204	269	226	0.0	0.0	245	551	710	120	58	28.15	83	16.0	2.6	0.0	81.4		
1700	73	60	4.1	1.3	.04	.40	7639835	404	1.4	215	204	268	226	0.0	0.0	246	552	670	120	58	28.15	82	17.4	0.8	0.0	81.8	160	1650
Avg	71	55	2.9	0.9	.04	.46	-------	402	2.3	217	203	266	224	0.0	0.0	243	547	720	116	59	28.17	77	16.6	1.8	0.0	81.6	140	1710
Corr Avg	71	56	2.9	0.9	.04	.46	-------	391	2.3	219	206	251	225	0.0	0.0	242	547	640	116	59	28.17	77	16.6	1.8	0.0	81.6	140	1710

Type of fuel bed	Medium
Coal fired (as received basis)	84,655 pounds
Corrected coal fired (as received basis)	86,115 pounds
Corrected average hourly rate of coal consumption (as received basis)	3,588 pounds per hour
Blow-down water through heat exchanger	49,805 pounds
Corrected blow-down water through heat exchanger	36,855 pounds
Corrected total blow-down water	45,310 pounds
Corrected average hourly rate of blow-down	1,888 pounds per hour
Weight of steam generated	894,700 pounds
Corrected weight of steam generated	850,000 pounds
Corrected average hourly rate of steam generation	35,417 pounds per hour
Corrected average flue gas temperature	655 degrees Fahrenheit

TEST NUMBER: 36-M OBSERVED DATA DATE: NOVEMBER 20,21, 1946

Time	Combustion Air		Draft, Inches Of Water				Blow-down			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm As $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb Of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown Water
1520	82	58	3.9	1.9	.05	.41	8595450	403	2.4	218	203	275	228	0.0	0.0	244	556	650	122	65	28.01	81	15.8	1.4	1.6	81.2	120	1120
1540	80	60	4.0	1.8	.05	.41	8596000	403	2.7	218	203	271	222	0.0	0.0	245	556	660	122	66	28.02	80	15.5	2.4	1.3	80.8		
1600	79	59	4.2	1.7	.05	.55	8596400	403	2.6	218	204	272	223	0.0	0.0	245	555	700	122	58	28.02	80	15.5	3.1	0.6	80.8		
1620	76	58	3.4	1.4	.05	.41	8596900	404	2.5	217	204	273	221	0.0	0.0	245	556	680	124	58	28.01	77	16.2	2.4	0.4	81.0		
1640	79	57	2.9	1.2	.05	.50	8597450	403	2.5	217	204	273	222	0.0	0.0	244	554	660	126	58	28.01	76	16.4	2.3	0.0	81.3		
1700	75	50	3.4	1.3	.05	.52	8598100	403	2.6	218	203	272	222	0.0	0.0	245	556	700	125	59	28.01	75	16.8	1.6	0.5	81.1	110	1300
1720	80	56	3.5	1.5	.05	.54	8598500	404	3.1	218	204	269	220	0.0	0.0	244	555	700	121	58	28.00	78	17.0	1.6	0.6	80.8		
1740	78	54	4.0	1.7	.05	.60	8598875	403	3.1	218	204	270	218	0.0	0.0	244	555	720	120	58	28.00	74	17.0	1.4	0.6	81.0		
1800	79	54	4.0	1.6	.05	.60	8599350	403	3.0	218	204	271	216	0.0	0.0	243	554	720	119	60	28.00	72	16.6	1.5	0.5	81.4	120	1310
1820	78	54	3.8	1.6	.05	.53	8599625	403	3.1	218	205	272	215	0.0	0.0	242	554	730	118	58	28.00	72	16.5	1.4	0.1	82.0		
1840	77	54	3.3	1.2	.05	.52	8600000	403	3.2	218	205	271	215	0.0	0.0	243	553	700	117	57	28.01	71	16.4	2.0	0.0	81.6		
1900	76	54	3.1	1.3	.05	.50	8600900	404	3.2	218	205	272	216	0.0	0.0	243	555	720	116	58	28.03	78	16.7	1.7	0.0	81.6	100	1360
1920	76	54	3.3	1.3	.05	.54	8601300	404	3.2	218	205	272	216	0.0	0.0	244	556	720	116	65	28.03	76	16.9	1.6	0.0	81.5		
1940	76	54	3.1	1.2	.05	.53	8601800	403	3.1	218	204	271	217	0.0	0.0	243	557	710	117	63	28.03	76	16.7	1.6	0.0	81.7		
2000	76	55	3.2	1.2	.05	.53	8602300	402	3.0	218	204	270	217	0.0	0.0	242	558	700	117	61	28.03	76	16.7	1.9	0.0	81.2	130	1560
2020	76	55	3.2	1.2	.05	.50	8602800	404	3.1	219	204	271	217	0.0	0.0	242	559	740	117	62	28.05	78	17.0	0.8	0.0	82.2		
2040	75	55	3.3	1.2	.05	.54	8603300	403	2.9	218	204	271	217	0.0	0.0	243	559	730	116	58	28.05	74	16.5	1.9	0.0	81.6		
2100	75	55	2.7	1.0	.05	.52	8603500	404	2.8	218	205	271	218	0.0	0.0	243	559	740	116	56	28.05	70	15.8	3.1	0.0	81.1	120	1310
2120	77	56	3.3	1.1	.05	.76	8604200	404	2.9	218	205	269	218	0.0	0.0	241	556	765	118	58	28.04	66	15.8	3.0	0.0	81.2		
2140	76	56	3.4	1.3	.05	.59	8604800	403	3.1	218	205	269	218	0.0	0.0	240	555	710	116	60	28.04	65	15.8	2.8	0.0	81.4		
2200	74	56	3.5	1.3	.05	.63	8605250	403	3.0	218	205	269	218	0.0	0.0	242	556	720	114	63	28.04	65	15.8	3.1	0.0	81.1	140	1550
2220	73	56	3.1	1.1	.05	.55	8605600	403	2.7	218	204	268	218	0.0	0.0	242	558	700	112	63	28.03	64	15.3	3.3	0.0	81.4		
2240	73	56	3.2	1.0	.05	.57	8606050	402	2.7	218	204	268	218	0.0	0.0	241	559	700	110	60	28.03	64	15.0	3.8	0.0	81.2		
2300	76	56	3.0	1.0	.05	.70	8606500	402	2.0	217	204	269	218	0.0	0.0	242	556	720	110	60	28.02	64	14.7	4.3	0.0	81.0	130	1400
2320	75	53	3.2	1.0	.05	.70	8606950	400	2.4	217	202	267	216	0.0	0.0	237	553	730	113	59	28.02	64	14.7	3.9	0.0	81.4		
2340	75	57	3.0	1.0	.05	.60	8607400	403	2.1	216	199	270	217	0.0	0.0	240	550	700	113	57	28.01	63	15.4	3.3	0.0	81.3		
2400	78	59	3.0	1.0	.05	.49	8607810	403	2.0	216	200	272	217	0.0	0.0	242	550	690	118	56	28.00	64	16.6	1.1	0.0	82.3	120	1460
0020	79	60	3.5	1.3	.05	.51	8608300	402	1.4	214	200	272	216	0.0	0.0	243	549	660	120	56	28.00	63	16.0	0.8	0.1	83.1		
0040	79	59	3.2	1.3	.05	.46	8608840	403	1.4	213	199	270	216	0.0	0.0	242	550	700	121	52	27.99	63	16.6	1.0	0.2	82.2		
0100	78	58	3.0	1.3	.05	.44	8609390	402	1.6	215	194	271	214	0.0	0.0	242	548	680	121	55	27.99	64	16.5	1.1	0.2	82.2	130	1580
0120	81	60	3.9	1.8	.05	.48	8609770	402	1.4	214	198	272	214	0.0	0.0	242	548	650	120	58	27.98	64	16.0	0.6	0.5	82.9		
0140	81	59	3.8	2.0	.05	.34	8610280	403	1.1	213	188	270	213	0.0	0.0	243	550	650	122	60	28.00	63	14.8	0.4	1.0	83.8		
0200	79	60	3.8	2.1	.05	.44	8610680	403	0.3	210	197	270	214	0.0	0.0	243	548	650	120	65	28.00	62	15.8	0.6	0.5	83.1	140	1610
0220	80	60	3.6	1.9	.05	.34	8610850	402	0.7	210	198	271	213	0.0	0.0	243	542	640	121	64	28.01	62	16.1	0.6	0.3	83.0		
0240	77	58	4.7	2.1	.05	.45	8611390	403	1.7	215	205	272	213	0.0	0.0	244	552	680	121	60	28.02	62	16.4	0.8	0.1	82.7		
0300	77	56	3.5	1.9	.05	.43	8611610	403	3.6	210	206	270	213	0.0	0.0	243	550	690	121	60	28.04	63	15.9	1.3	0.0	82.8	100	1790
0320	80	60	3.2	1.6	.05	.42	8611920	402	3.3	220	206	270	214	0.0	0.0	243	548	700	123	60	28.04	63	15.3	2.0	0.5	82.2		
0340	79	59	4.0	2.0	.05	.53	8612290	402	1.8	215	200	270	216	0.0	0.0	242	550	720	117	55	28.01	63	15.4	0.6	1.4	82.6		
0400	79	58	3.8	1.7	.05	.47	8612500	403	2.7	220	203	272	216	0.0	0.0	243	547	670	118	60	28.02	62	15.9	0.8	1.0	82.3	120	1920
0420	78	59	4.0	1.9	.05	.54	8612880	403	3.2	220	204	271	215	0.0	0.0	243	544	680	120	59	28.02	62	16.5	1.0	0.5	82.0		
0440	79	59	2.8	1.3	.05	.38	8613250	403	1.8	215	298	272	214	0.0	0.0	243	541	700	117	50	28.00	62	16.7	0.6	1.0	81.7		
0500	77	58	4.0	1.8	.05	.46	8613560	403	2.7	218	196	270	216	0.0	0.0	243	549	700	117	52	27.96	62	16.5	0.5	1.1	81.9	110	2000
0520	77	57	3.7	1.5	.05	.50	8613850	403	3.0	219	197	271	216	0.0	0.0	243	546	690	116	54	28.00	64	16.5	0.9	0.2	82.4		
0540	75	56	4.2	1.6	.05	.43	8614275	404	2.1	216	203	270	213	0.2	0.2	243	552	665	123	51	28.00	64	16.5	1.7	0.0	82.0		
0600	72	55	3.4	1.4	.05	.40	8614500	403	2.5	218	194	271	216	0.2	0.6	244	547	650	115	55	28.00	64	16.0	1.9	0.1	82.0	150	2100
0620	77	56	3.8	1.4	.05	.47	8614850	403	2.7	218	199	270	215	0.2	1.0	243	547	680	118	54	28.01	62	15.6	2.0	0.3	82.1		
0640	79	60	4.1	1.6	.05	.53	8615220	403	2.5	218	200	272	216	0.2	1.4	244	547	670	119	56	28.01	62	16.5	1.8	0.0	81.7		
0700	77	59	4.0	1.6	.05	.50	8615600	403	2.6	218	200	272	217	0.2	1.8	243	549	680	120	55	28.02	61	16.7	1.0	0.0	82.3	170	2240
0720	75	57	4.0	1.6	.05	.42	8616000	403	2.3	217	206	272	216	0.2	2.2	242	545	670	126	52	28.04	60	16.5	0.7	0.6	82.2		
0740	78	58	3.6	1.4	.05	.46	8616500	403	1.9	216	205	273	216	0.2	2.6	245	548	680	128	56	28.04	63	16.6	0.7	0.5	82.2		
0800	74	56	3.4	1.4	.05	.42	8616750	404	2.0	216	203	272	214	0.2	3.0	243	546	680	121	60	28.05	63	16.7	0.7	0.5	82.1	130	2230
0820	74	56	3.4	1.2	.05	.43	8617100	403	1.8	216	204	273	214	0.3	3.4	243	546	690	120	54	28.04	61	16.7	0.6	0.4	82.3		
0840	76	58	3.3	1.3	.05	.45	8617600	403	1.6	215	202	270	212	0.3	3.8	242	546	710	120	56	28.04	60	16.4	1.5	0.0	82.1		
0900	76	58	3.3	1.2	.05	.44	8617900	403	1.6	215	200	270	214	0.3	4.2	243	548	720	118	56	28.05	61	16.5	1.3	0.0	82.2	130	2250
0920	74	56	3.2	1.1	.05	.45	8618300	404	1.5	215	198	271	216	0.3	4.6	243	550	730	118	56	28.06	62	16.7	0.9	0.2	82.2		
0940	74	56	3.0	1.2	.05	.44	8618700	403	2.0	216	199	270	216	0.3	5.0	242	553	700	118	57	28.06	62	16.8	0.9	0.0	82.3		
1000	74	56	3.0	1.1	.05	.44	8619000	404	2.1	216	200	270	216	0.3	5.4	243	555	700	119	54	28.06	62	17.1	1.1	0.0	81.8	160	2170
1020	73	56	3.0	0.9	.05	.45	8619400	403	2.3	216	200	271	216	0.3	5.8	243	548	700	119	58	28.07	63	16.8	0.8	0.0	82.4		
1040	73	55	3.2	1.0	.05	.48	8620000	403	2.1	216	200	270	216	0.4	6.2	242	547	710	120	59	28.07	67	17.0	0.8	0.0	82.2		
1100	74	55	3.4	1.0	.05	.49	8620500	403	2.0	216	200	271	217	0.4	6.6	242	545	730	123	60	28.08	72	16.6	1.0	0.0	82.4	160	2260
1120	75	56	3.5	1.1	.05	.54	8620600	404	1.9	217	200	272	217	0.4	7.0	241	548	750	124	58	28.08	69	16.7	1.3	0.0	82.0		
1140	74	54	3.4	1.1	.05	.50	8621000	403	2.2	218	201	270	218	0.4	7.4	240	549	750	122	60	28.07	71	16.8	0.8	0.0	82.4		
1200	73	53	3.3	1.2	.05	.53	8621400	403	2.3	218	200	271	218	0.4	7.8	242	550	750	120	59	28.06	73	16.5	1.1	0.1	82.3	180	2250
1220	75	55	2.9	1.1	.05	.40	8621800	403	2.4	218	200	272	217	0.4	8.2	243	548	710	122	57	28.06	73	16.8	0.8	0.4	82.0		
1240	76	56	3.0	1.1	.05	.41	8622100	404	2.5	218	201	272	217	0.4	8.6	244	545	690	124	56	28.06	74	16.9	0.9	0.0	82.2		
1300	77	58	3.2	1.2	.05	.50	8623300	403	1.8	218	202	271	218	0.5	9.0	243	550	700	123	54	28.03	66	16.8	0.8	0.0	82.4	170	2260
1320	77	58	3.2	1.2	.05	.50	8623600	404	2.0	218	202	271	216	0.5	9.4	242	547	700	124	55	28.03	66	17.0	1.0	0.0	82.0		
1340	78	58	3.3	1.2	.05	.50	8623900	405	2.1	217	200	271	218	0.5	9.8	241	545	700	146	56	28.03	66	16.9	0.9	0.1	82.1		
1400	80	56	3.2	1.3	.05	.50	8624600	404	2.7	217	198	271	218	0.5	10.2	241	546	680	138	58	28.03	70	16.9	1.1	0.4	81.6	140	2230
1420	78	56	3.1	1.2	.05	.40	8625300	404	2.2	214	197	271	218	0.5	10.6	242	544	650	126	48	28.03	73	16.6	0.8	0.2	82.4		
1440	69	50	3.0	1.2	.05	.40	8626780	404	2.0	215	200	273	217	0.5	11.0	245	546	625	125	51	28.04	78	16.7	0.6	0.3	82.4		
1500	74	53	3.3	1.7	.05	.43	8627200	403	1.8	215	199	272	218	0.5	11.4	244	544	640	120	54	28.05	78	16.7	0.6	0.3	82.4		
1520	73	52	3.1	1.5	.05	.42	8627850	403	1.6	214	198	272	218	0.6	11.8	244	545	630	120	54	28.06	77	16.0	1.2	0.2	82.6		
Avg	76	56	3.4	1.4	.05	.49	-------	403	2.3	217	201	271	217	0.1	2.5	243	551	695	120	58	28.03	68	16.3	1.5	0.2	82.0	130	1790
Corr Avg	76	56	3.4	1.4	.05	.49	-------	392	2.3	219	204	255	219	0.1	2.5	245	551	620	120	57	28.03	68	16.3	1.5	0.5	81.7	130	1790

Type of fuel bed	High
Coal fired (as received basis)	88,645 pounds
Corrected coal fired (as received basis)	90,105 pounds
Corrected average hourly rate of coal consumption (as received basis)	3,754 pounds per hour
Blow-down water through heat exchanger	32,400 pounds
Corrected blow-down water through heat exchanger	23,980 pounds
Corrected total blow-down water	29,520 pounds
Corrected average hourly rate of blow-down	1,230 pounds per hour
Weight of steam generated	889,800 pounds
Corrected weight of steam generated	839,315 pounds
Corrected average hourly rate of steam generation	34,971 pounds per hour
Corrected average flue gas temperature	640 degrees Fahrenheit

TEST NUMBER: 36-H OBSERVED DATA DATE: DECEMBER 17,18, 1946

Time	Combustion Air		Draft, Inches of Water				Blowdown			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown water
1100	78	66	4.1	1.4	.07	.50	9611870	401	3.0	213	205	250	215	0.3	5.7	243	555	650	134	64	28.04	82	15.3	1.1	0.0	83.6	150	1360
1120	80	66	5.2	2.0	.07	.50	9613210	402	2.6	218	206	249	212	0.3	5.7	244	556	660	131	65	28.03	79	15.1	1.3	0.0	83.6		
1140	80	66	4.9	2.1	.07	.50	9614560	402	2.4	218	205	248	212	0.3	5.7	243	560	645	130	65	28.02	81	14.9	1.3	0.0	83.5		
1200	79	66	4.0	1.4	.05	.55	9615200	402	2.7	218	205	249	212	0.3	5.7	244	554	700	130	64	28.01	80	14.7	1.4	0.0	83.9	130	1260
1220	79	67	5.0	1.6	.06	.63	9615765	401	2.8	218	206	248	212	0.3	5.7	244	556	710	130	68	28.00	80	14.5	1.6	0.0	83.9		
1240	80	67	4.7	1.5	.06	.64	9616450	401	2.3	218	205	247	213	0.3	5.7	243	558	730	131	65	28.00	82	14.6	1.7	0.0	83.7		
1300	85	70	4.3	1.5	.05	.53	9617470	402	2.6	218	204	248	213	0.3	5.7	244	560	710	132	63	27.98	83	14.8	1.6	0.0	83.6	130	1240
1320	84	69	4.5	1.4	.06	.63	9618480	401	2.8	218	204	249	212	0.3	5.7	243	562	710	131	65	27.98	83	14.5	1.5	0.0	84.0		
1340	84	69	3.8	1.2	.05	.55	9619350	402	2.6	218	204	247	213	0.3	5.7	243	558	700	134	64	27.97	84	14.8	1.4	0.0	83.8		
1400	83	68	4.0	1.3	.07	.63	9619990	402	2.6	218	204	248	213	0.3	5.7	243	555	720	135	68	27.97	84	15.0	1.2	0.0	83.8	140	1290
1420	85	71	4.0	1.3	.06	.67	9620325	402	3.1	218	205	248	212	0.3	5.8	243	550	720	134	63	27.96	82	15.2	1.0	0.0	83.8		
1440	86	68	4.3	1.5	.05	.67	9620720	403	2.8	218	205	248	213	0.3	5.8	245	550	730	136	69	27.96	83	15.3	0.9	0.0	83.8		
1500	88	68	4.2	1.2	.05	.67	9621110	403	2.4	218	204	248	212	0.3	5.8	244	552	720	137	64	27.96	82	15.1	1.0	0.0	83.9	150	1390
1520	84	67	4.1	1.2	.05	.65	9621580	402	2.7	218	205	243	213	0.3	5.8	244	551	740	135	70	27.95	82	14.8	1.2	0.0	84.0		
1540	86	68	4.0	1.3	.05	.55	9621880	401	2.8	218	206	247	213	0.3	5.9	243	550	710	130	70	27.96	82	14.5	1.4	0.0	84.1		
1600	84	67	4.0	1.2	.07	.63	9622040	401	2.7	218	206	247	213	0.3	5.9	240	558	740	131	67	27.96	80	14.7	1.5	0.0	83.8	160	1430
1620	87	68	4.6	1.5	.06	.70	9622280	402	2.7	218	205	245	213	0.3	6.0	244	555	700	145	69	27.98	82	14.6	1.7	0.0	83.7		
1640	86	68	4.3	1.5	.05	.58	9622620	401	2.8	219	206	249	213	0.3	6.0	237	558	680	141	65	27.98	80	15.0	1.7	0.0	83.3		
1700	84	67	4.3	1.5	.05	.66	9622880	400	3.0	219	204	241	214	0.3	6.0	244	553	720	132	67	27.99	80	15.2	1.5	0.0	83.3		
1720	85	68	5.0	1.8	.05	.67	9623180	400	3.1	220	205	250	214	0.3	6.0	244	548	720	131	68	28.00	78	15.3	1.2	0.0	83.5	100	1450
1740	83	67	4.5	1.6	.07	.67	9623460	401	3.1	220	205	248	214	0.3	6.1	244	562	690	125	68	28.01	78	15.1	1.0	0.0	83.9		
1800	86	68	4.1	1.6	.06	.60	9623790	402	3.0	219	204	249	214	0.3	6.1	244	556	700	130	62	28.03	78	15.2	0.9	0.0	83.9		
1820	85	67	4.3	1.3	.07	.67	9624140	402	3.0	219	205	248	213	0.3	6.2	243	555	700	130	68	28.03	77	15.0	1.1	0.0	83.9	110	1480
1840	84	67	4.6	1.4	.05	.55	9624370	402	3.0	219	207	249	213	0.5	7.3	243	554	690	134	66	28.02	77	14.7	0.9	0.0	84.4		
1900	84	67	4.3	1.4	.07	.64	9624670	404	3.0	219	206	248	212	0.5	7.3	244	554	690	132	66	28.03	76	14.6	1.1	0.0	84.3		
Avg	84	68	4.4	1.5	.06	.61	-------	402	2.8	218	205	248	213	0.3	6.0	243	555	700	133	66	27.99	81	14.9	1.3	0.0	83.8	130	1360
Corr Avg	84	69	4.4	1.5	.06	.61	-------	391	2.8	220	208	248	214	0.3	6.0	245	556	625	133	66	27.99	81	14.9	1.3	0.0	83.8	130	1360

Type of fuel bed ---------- Medium
Coal fired (as received basis) ---------- 31,675 pounds
Corrected coal fired (as received basis) ---------- 32,215 pounds
Corrected average hourly rate of coal consumption (as received basis) ---------- 4,027 pounds per hour
Blowdown water through heat exchanger ---------- 12,800 pounds
Corrected blowdown water through heat exchanger ---------- 9,470 pounds
Corrected total blowdown water ---------- 11,624 pounds
Corrected average hourly rate of blowdown ---------- 1,453 pounds per hour
Weight of steam generated ---------- 325,500 pounds
Corrected weight of steam generated ---------- 309,414 pounds
Corrected average hourly rate of steam generation ---------- 38,677 pounds per hour
Corrected average flue gas temperature ---------- 660 degrees Fahrenheit

TEST NUMBER: 40-M OBSERVED DATA DATE: JANUARY 16, 1947

Time	Combustion Air		Draft, Inches of Water				Blowdown			Feedwater Temp F		Steam Drum Press psig	Calorimeter			Superheater Outlet		Flue Gas Temp F		Fuel Temp F	Bar Press In. Hg	Room Temp F	Dry Flue Gas Analysis Per Cent By Volume				M.O. Alkalinity ppm as $CaCO_3$	
	Dry Bulb Temp F	Wet Bulb Temp F	Front Wind Box (+)	Rear Wind Box (+)	Furnace (-)	Last Pass (-)	Meter Lb of Water	Line Temp F	Flash Tank Press psig	Leaving Open Heater	Entering Rear Drum		Temp F	Press In. Hg	Water Cor In. Water	Press psig	Temp F	Pyrometer	Thermocouple Cold Junction				CO_2	O_2	CO	N_2	Boiler Feedwater	Blowdown water
1100	78	66	4.1	1.4	.07	.50	9611870	401	3.0	213	205	250	215	0.3	5.7	243	555	650	134	64	28.04	82	15.3	1.1	0.0	83.6	150	1360
1120	80	66	5.2	2.0	.07	.50	9613210	402	2.6	218	206	249	212	0.3	5.7	244	556	660	131	65	28.03	79	15.1	1.3	0.0	83.6		
1140	80	66	4.9	2.1	.07	.50	9614560	402	2.4	218	205	248	212	0.3	5.7	243	560	645	130	65	28.02	81	14.9	1.3	0.0	83.5		
1200	79	66	4.0	1.4	.05	.55	9615200	402	2.7	218	205	249	212	0.3	5.7	244	554	700	130	64	28.01	80	14.7	1.4	0.0	83.9	130	1260
1220	79	67	5.0	1.6	.06	.63	9615765	401	2.8	218	206	248	212	0.3	5.7	244	556	710	130	68	28.00	80	14.5	1.6	0.0	83.9		
1240	80	67	4.7	1.5	.06	.64	9616450	401	2.3	218	205	247	213	0.3	5.7	243	558	730	131	65	28.00	82	14.6	1.7	0.0	83.7		
1300	85	70	4.3	1.5	.05	.53	9617470	402	2.6	218	204	248	213	0.3	5.7	244	560	710	132	63	27.98	83	14.8	1.6	0.0	83.6	130	1240
1320	84	69	4.5	1.4	.06	.63	9618480	401	2.8	218	204	249	212	0.3	5.7	243	562	710	131	65	27.98	83	14.5	1.5	0.0	84.0		
1340	84	69	3.8	1.2	.05	.55	9619350	402	2.6	218	204	247	213	0.3	5.7	243	558	700	134	64	27.97	84	14.8	1.4	0.0	83.8		
1400	83	68	4.0	1.3	.07	.63	9619990	402	2.6	218	204	248	213	0.3	5.7	243	555	720	135	68	27.97	84	15.0	1.2	0.0	83.8	140	1290
1420	85	71	4.0	1.3	.06	.67	9620325	402	3.1	218	205	248	212	0.3	5.8	243	550	720	134	63	27.96	82	15.2	1.0	0.0	83.8		
1440	86	68	4.3	1.5	.05	.67	9620720	403	2.8	218	205	248	213	0.3	5.8	245	550	730	136	69	27.96	83	15.3	0.9	0.0	83.8		
1500	88	68	4.2	1.2	.05	.67	9621110	403	2.4	218	204	248	212	0.3	5.8	244	552	720	137	64	27.96	82	15.1	1.0	0.0	83.9	150	1390
1520	84	67	4.1	1.2	.05	.65	9621580	402	2.7	218	205	243	213	0.3	5.8	244	551	740	135	70	27.95	82	14.8	1.2	0.0	84.0		
1540	86	68	4.0	1.3	.05	.55	9621880	401	2.8	218	206	247	213	0.3	5.9	243	550	710	130	70	27.96	82	14.5	1.4	0.0	84.1		
1600	84	67	4.0	1.2	.07	.63	9622040	401	2.7	218	206	247	213	0.3	5.9	240	558	740	131	67	27.96	80	14.7	1.5	0.0	83.8	160	1430
1620	87	68	4.6	1.5	.06	.70	9622280	402	2.7	218	205	245	213	0.3	6.0	244	555	700	145	69	27.98	82	14.6	1.7	0.0	83.7		
1640	86	68	4.3	1.5	.05	.58	9622620	401	2.8	219	206	249	213	0.3	6.0	237	558	680	141	65	27.98	80	15.0	1.7	0.0	83.3		
1700	84	67	4.3	1.5	.05	.66	9622880	400	3.0	219	204	241	214	0.3	6.0	244	553	720	132	67	27.99	80	15.2	1.5	0.0	83.3		
1720	85	68	5.0	1.8	.05	.67	9623180	400	3.1	220	205	250	214	0.3	6.0	244	548	720	131	68	28.00	78	15.3	1.2	0.0	83.5	100	1450
1740	83	67	4.5	1.6	.07	.67	9623460	401	3.1	220	205	248	214	0.3	6.1	244	562	690	125	68	28.01	78	15.1	1.0	0.0	83.9		
1800	86	68	4.1	1.6	.06	.60	9623790	402	3.0	219	204	249	214	0.3	6.1	244	556	700	130	62	28.03	78	15.2	0.9	0.0	83.9		
1820	85	67	4.3	1.3	.07	.67	9624140	402	3.0	219	205	248	213	0.3	6.2	243	555	700	130	68	28.03	77	15.0	1.1	0.0	83.9	110	1480
1840	84	67	4.6	1.4	.05	.55	9624370	402	3.0	219	207	249	213	0.5	7.3	243	554	690	134	66	28.02	77	14.7	0.9	0.0	84.4		
1900	84	67	4.3	1.4	.07	.64	9624670	404	3.0	219	206	248	212	0.5	7.3	244	554	690	132	66	28.03	76	14.6	1.1	0.0	84.3		
Avg	84	68	4.4	1.5	.06	.61	-------	402	2.8	218	205	248	213	0.3	6.0	243	555	700	133	66	27.99	81	14.9	1.3	0.0	83.8	130	1360
Corr Avg	84	69	4.4	1.5	.06	.61	-------	391	2.8	220	208	248	214	0.3	6.0	245	556	625	133	66	27.99	81	14.9	1.3	0.0	83.8	130	1360

Type of fuel bed ---------- Medium
Coal fired (as received basis) ---------- 31,675 pounds
Corrected coal fired (as received basis) ---------- 32,215 pounds
Corrected average hourly rate of coal consumption (as received basis) ---------- 4,027 pounds per hour
Blowdown water through heat exchanger ---------- 12,800 pounds
Corrected blowdown water through heat exchanger ---------- 9,470 pounds
Corrected total blowdown water ---------- 11,624 pounds
Corrected average hourly rate of blowdown ---------- 1,453 pounds per hour
Weight of steam generated ---------- 325,500 pounds
Corrected weight of steam generated ---------- 309,414 pounds
Corrected average hourly rate of steam generation ---------- 38,677 pounds per hour
Corrected average flue gas temperature ---------- 660 degrees Fahrenheit

TEST NUMBER: 40-M OBSERVED DATA DATE: JANUARY 16, 1947

H_{am} = 0.0457 + 0.0206V (where V is 0.16 or greater)

= 0.0457 + 0.0206(0.3326) = 0.0526

$S_{am} = S_m^* \times \frac{100 - M}{100 - M - A} = 0.007 \times \frac{100 - 1.90}{100 - 1.90 - 6.10}$

= 0.0075

$N_{am} = N_m^* \times \frac{100 - M}{100 - M - A} = 0.014 \times \frac{100 - 1.90}{100 - 1.90 - 6.10}$

= 0.0149

$O_{am} = 1 - (C_{am} + H_{am} + S_{am} + N_{am})$

= 1 - (0.8625 + 0.0526 + 0.0075 + 0.0149)

= 0.0625

(3). Conversion From "Ash-Moisture Free" Basis to "As Fired Basis:

C = C_{am} x (100 - A - M) = 0.8625 x (100 - 6.10 - 1.90) per cent

= 0.8625 x 92.00 per cent = .8625 x 92.00 = 79.35 per cent

Similarly:

H = 0.0526 x 92.00 per cent = .0526 x 92 = 4.84

O = 0.0625 x 92.00 " " = 5.75

N = 0.0149 x 92.00 " " = 1.37

S = 0.0075 x 92.00 " " = 0.69

From the proximate analysis:

A = 6.10

M = 1.90

Total = 100.00 per cent

*Values for Sulphur and Nitrogen are based on average values ("moisture-free" basis) for coal mined in Buchanan County, Virginia as given by the United States Bureau of Mines and the Virginia Geological Survey. Attempts to obtain these values in the laboratory were not successful; Sulphur values were inaccurate and facilities for determining Nitrogen were not available.

B. Heat Balance and Related Items:

The methods used in the calculation of the heat balance and related items, excepting items (2), (15), (e), and (3), are the same as those given on the A.S.M.E. Short Form Test Report-Data and Results of Boiler Test.*

(1). Symbols:

C, H, O, S, N, A and M are the same as in (1) A.

CO_2, CO, O_2 and N_2 are the per cents by volume of the dry flue gases that are Carbon Dioxide, Carbon Monoxide, Oxygen and Nitrogen respectively.

C_b is the weight of Carbon burned in lb. per lb. of "as fired" coal.

C_p is the specific heat of a substance at constant pressure in Btu per lb per deg Fah (For the dry flue gases, C_p is assigned a value of 0.24. For superheated water vapor at low pressures, C_p is assigned a value of 0.46 at temperatures below 575 F or 0.50 at temperatures above 575 F).

H_b is the total heat output in the blow-down water in kilo-Btu per hour.

HHV is the higher heating value of the "as fired" coal in Btu per lb (as determined in the laboratory).

h_f, h_{f2} and h_1 are the enthalpies of feedwater, saturated liquid at boiler drum pressure, and superheated steam; units are Btu per lb.

*A.S.M.E. Power Test Code for Stationary Steam Generating Units, American Society of Mechanical Engineers, 1946.

t_a, t_f and t_g are the temperatures, in deg Fah, of the combustion air, fuel and flue gases in that order.

W_r, W_{fa}, W_g and W_a are, in the order stated, the weights of refuse, fly ash, dry flue gases and dry air in lb per lb of "as fired" coal.

W_f is the <u>total</u> weight of the "as fired" coal in lb per test.

W_s is the weight of the steam generated in lb per hour.

W_{at} is the weight of theoretical air in lb per lb of "as fired" coal.

W_b is the corrected weight of the blow-down water in lb per hour.

(2). Corrected Weight of Blow-down Water:

$$W_b = \frac{\text{lb per hour of blow-down water through the heat exchanger}}{1 - \frac{h_{f3} - h_{f4}}{h_{fg}}}$$

where:

h_{f3} = enthalpy of saturated liquid at blow-down line temperature in Btu per lb

h_{f4} = enthalpy of saturated liquid at flash tank pressure in Btu per lb

h_{fg} = latent heat of vaporization at flash tank pressure in Btu per lb.

$$W_b = \frac{1180}{1 - \frac{366.33 - 186.30}{966.34}}$$

= 1460 lb per hour

(3). Corrected Weight of Steam Generated:

$$W_s = \frac{\text{total recorded lb of steam}}{\text{length of test in hours}} \times F_p \times F_s$$

from charts furnished by the flow meter manufacturer:

F_p = pressure correction factor

$$= \frac{\text{correction factor for actual superheat pressure}}{\text{correction factor for pressure for which meter was designed}}$$

$$= \frac{1.472}{1.495} = 0.9846$$

F_s = superheat correction factor

$$= \frac{\text{correction factor for actual degrees of superheat}}{\text{correction factor for degrees of superheat for which the meter was designed}}$$

$$= \frac{0.907}{0.927} = 0.9784$$

$$W_s = \frac{527,350}{24} \times 0.9846 \times 0.9784 = 24,073 \text{ lb per hour}$$

(4). Total Heat Output in the Boiler Blow-down Water, H_b:

$$H_b = W_b \times \frac{h_{sg} - h_f}{1000} = 1460 \times \frac{381.8 - 183.1}{1000}$$

$= .289$ kilo-Btu per hour

(5). Total Heat Input to the Unit, H_i:

$$H_i = \frac{W_f \times HHV}{\text{length of test in hours} \times 1000} = \frac{58,330 \times 14,041}{24 \times 1000}$$

$= 34,120$ kilo-Btu per hour

(6). Total Heat Output of the Unit, H_o:

$$H_o = \frac{W_s \times (h_1 - h_f)}{1000} + H_b = \frac{24,073 \times (1283 - 183.1)}{1000} + .289$$

$= 26,767$ kilo-Btu per hour

(7). Gross Thermal Efficiency of the Unit:

$$\text{Eff.} = \frac{\text{total heat output of the unit}}{\text{total heat input to the unit}} \times 100 = \frac{26,767}{34,120} \times 100$$

$$= 78.45 \text{ per cent}$$

(8). Weight of the Refuse:

$$W_r = \frac{\text{total lb of refuse}}{W_f} = \frac{2465}{58,330}$$

$$= 0.0422 \text{ lb per lb of "as fired" coal}$$

(9). Weight of the Fly ash:

$$W_{fa} = \frac{(W_f \times A) - (100 - \text{per cent combustible in refuse}) \text{ total lb refuse}}{(100 - \text{per cent combustible in fly ash})\, W_f}$$

$$= \frac{(58,330 \times 6.10) - (2465 \times 88.90)}{58,330 \times 58.50}$$ percent percent percent

$$= 0.0401 \text{ lb per lb of "as fired" coal}$$

(10). Weight of Carbon Burned:

$$C_b = \frac{C}{100} - \frac{W_r \times \text{per cent combustible in refuse}}{100} -$$

$$\frac{W_{fa} \times \text{per cent combustible in fly ash}}{100}$$

$$= \frac{79.26}{100} - \frac{0.0422 \times 11.10}{100} - \frac{0.0401 \times 41.50}{100}$$

$$= 0.7722 \text{ lb per lb of "as fired" coal}$$

(11). Weight of Dry Flue Gases:

$$W_g = \frac{11CO_2 + 8O_2 + 7(N_2 + CO)}{3(CO_2 + CO)} \times \left(C_b + \frac{S}{267}\right) + \frac{S}{160}$$

$$= \frac{11 \times 14.2 + 8 \times 4.7 + 7(81.0 + 0.1)}{3(14.2 + 0.1)} \times \left(0.7722 + \frac{0.69}{267}\right) + \frac{0.69}{160}$$

$$= 13.76 \text{ lb per lb of "as fired" coal}$$

(12). Weight of Theoretical Air:

$$W_{at} = 11.53 \times C_b + 34.36\left(\frac{H}{100} - \frac{O}{800}\right) + 4.32 \times \frac{S}{100}$$

$$= 11.53 \times 0.7722 + 34.36\left(\frac{4.84}{100} - \frac{5.75}{800}\right) + 4.32 \times \frac{0.69}{100}$$

$$= 10.35 \text{ lb per lb of "as fired" coal}$$

(13). Weight of Dry Air:

$$W_a = W_g + 8\left(\frac{H}{100} - \frac{O}{800}\right) - C_b - \frac{S}{100} - \frac{N}{100}$$

$$= 13.76 + 8\left(\frac{4.84}{100} - \frac{5.75}{800}\right) - 0.7722 - \frac{0.69}{100} - \frac{1.37}{100}$$

$$= 13.29 \text{ lb per lb of "as fired" coal}$$

(14). Per Cent Excess Air:

$$\text{per cent} = \frac{W_a - W_{at}}{W_{at}} \times 100 = \frac{13.29 - 10.35}{10.35} \times 100$$

$$= 28.46$$

(15). Heat Balance:

(a). Heat absorbed by the unit, H_a:

$$H_a = \frac{\text{gross efficiency} \times \text{NHV}}{100} = \frac{78.45 \times 14,041}{100}$$

$$= 11,015 \text{ Btu per lb of "as fired" coal}$$

(b). Heat loss in the dry flue gases, H_g:

$$H_g = W_g \times c_p (t_g - t_a)$$

$$= 13.76 \times 0.24(550 - 74)$$

$$= 1572 \text{ Btu per lb of "as fired" coal}$$

$$= \frac{1572}{14,041} \times 100 = 11.20 \text{ per cent}$$

(c). Heat loss due to moisture in the coal, H_{wc}:

$$H_{wc} = \frac{M}{100}(1089 - t_f + 0.46t_g) \quad \text{(where } t_g \text{ is less than 575 F)}$$

$$= \frac{M}{100}(1066 - t_f + 0.50t_g) \quad \text{(where } t_g \text{ is greater than 575 F)}$$

$$= \frac{1.90}{100}(1089 - 71 + 0.46 \times 550)$$

$$= 24 \text{ Btu per lb of "as fired" coal}$$

$$= \frac{24}{14,041} \times 100 = 0.17 \text{ per cent}$$

(d). Heat loss due to H_2O formed from the combustion of hydrogen in the coal, H_{wh}:

$$H_{wh} = 9 \times \frac{H}{100}(1089 - t_f + 0.46t_g) \quad \text{(where } t_g \text{ is less than 575 F)}$$

$$= 9 \times \frac{H}{100}(1066 - t_f + 0.50t_g) \quad \text{(where } t_g \text{ is greater than 575 F)}$$

$$= 9 \times \frac{4.84}{100}(1089 - 71 + 0.46 \times 550)$$

$$= 554 \text{ Btu per lb of "as fired" coal}$$

$$= \frac{554}{14,041} \times 100 = 3.95 \text{ per cent}$$

(e). Heat loss due to moisture in the combustion air, H_{wa}:

H_{wa} = lb of moisture per lb of dry air (as taken from a psychrometric chart) $\times W_a \times C_p (t_g - t_a)$

$$= 0.0054 \times 15.29 \times 0.46(550 - 74)$$

$$= 16 \text{ Btu per lb of "as fired" coal}$$

$$= \frac{16}{14,041} \times 100 = 0.11 \text{ per cent}$$

(f). Heat loss due to the incomplete combustion of carbon appearing as CO in the flue gases, H_{co}:

$$H_{co} = \frac{CO}{CO_2 + CO} \times 10{,}160 \times C_b$$

$$= \frac{0.1}{14.2 + 0.1} \times 10{,}160 \times 0.7722$$

= 55 Btu per lb of "as fired" coal

$$= \frac{55}{14{,}041} \times 100 = 0.39 \text{ per cent}$$

(g). Heat loss due to the incomplete combustion of carbon appearing as combustible in the refuse, H_r:

$$H_r = \frac{W_r \times 14{,}600 \times \text{per cent combustible in the refuse}}{100}$$

$$= \frac{0.0422 \times 14{,}600 \times 11.10}{100}$$

= 68 Btu per lb of "as fired" coal

$$= \frac{68}{14{,}041} \times 100 = 0.48 \text{ per cent}$$

(h). Heat loss due to the incomplete combustion of carbon appearing as combustible in the fly ash, H_{fa}:

$$H_{fa} = \frac{W_{fa} \times 14{,}600 \times \text{per cent combustible in the fly ash}}{100}$$

$$= \frac{0.0401 \times 14{,}600 \times 41.50}{100}$$

= 243 Btu per lb of "as fired" coal

$$= \frac{243}{14{,}041} \times 100 = 1.73 \text{ per cent}$$

(i). Heat loss due to radiation, H_R:

H_R = 1.75 per cent*

= HHV x 0.0175 = 14,041 x 0.0175

= 246 Btu per lb of "as fired" coal

(j). Unaccounted for losses (by difference), H_{ul}

$H_{ul} = HHV - (H_a + H_g + H_{we} + H_{wh} + H_{wa} + H_{co} + H_r + H_{fa} + H_R)$

$= 14,041 - (11,015 + 1572 + 24 + 554 + 16 + 55 + 68 + 243 + 246)$

$= 248$ Btu per lb of "as fired" coal

$= \frac{248}{14,041} \times 100 = 1.77$ per cent

C. Miscellaneous Items:

(1). Symbols:

The symbols used in this section are the same as in (1) A, or are explained where used.

(2). Rate of Fuel Burning Based on the Actual Grate Area, R_a:

$$R_a = \frac{W_f}{\text{Length of test in hours x sq ft of actual grate area}}$$

$\frac{58,330}{24 \times 102.6} = 23.68$ lb of "as fired" coal per sq ft of actual grate area per hour

(3). Rate of Fuel Burning Based on the Projected Grate Area, R_p:

$$R_p = \frac{W_f}{\text{Length of test in hours x sq ft of projected grate area}}$$

$= \frac{58,330}{24 \times 96.7} = 25.13$ lb of "as fired" coal per sq ft of projected grate area per hour

*A.S.M.E. Power Test Code for Stationary Steam Generating Units, A.B.M.A. Standard Radiation Loss Chart, Plate 5.

(4). Quality of Steam in the Steam Drum, X:

$$X = \frac{\text{enthalpy at calorimeter temperature and pressure} - h_{f2}}{\text{latent heat of vaporization at steam drum pressure}} \times 100$$

$$= \frac{1175 - 381.2}{820.2} \times 100$$

$$= 96.8 \text{ per cent}$$

(5). Actual Evaporation, E_a:

$$E_a = \frac{W_s \times \text{length of test in hours}}{W_f}$$

$$= \frac{24,073 \times 24}{58,530}$$

$$= 9.91 \text{ lb of steam per lb of "as fired" coal}$$

(6). Factor of Evaporation, f.e.:

$$f.e. = \frac{h_1 - h_f}{970.3} = \frac{1283 - 185.1}{970.3}$$

$$= 1.134$$

(7). Equivalent Evaporation, E_e:

E_e = f.e. x Actual Evaporation = 1.134 x 9.91

= 11.24 lb of steam per pound of "as fired" coal

(8). Optimum Blow-down, Per Cent of the Feedwater Supplied:

$$\text{Per Cent} = \frac{\text{M.O. alkalinity of feedwater, ppm as } CaCO_3}{\text{M.O. alkalinity of blow-down water, ppm as } CaCO_3} \times 100$$

$$= \frac{180}{1800} \times 100$$

$$= 8.33$$

(9). Actual Blow-down, Per Cent of the Feedwater Supplied:

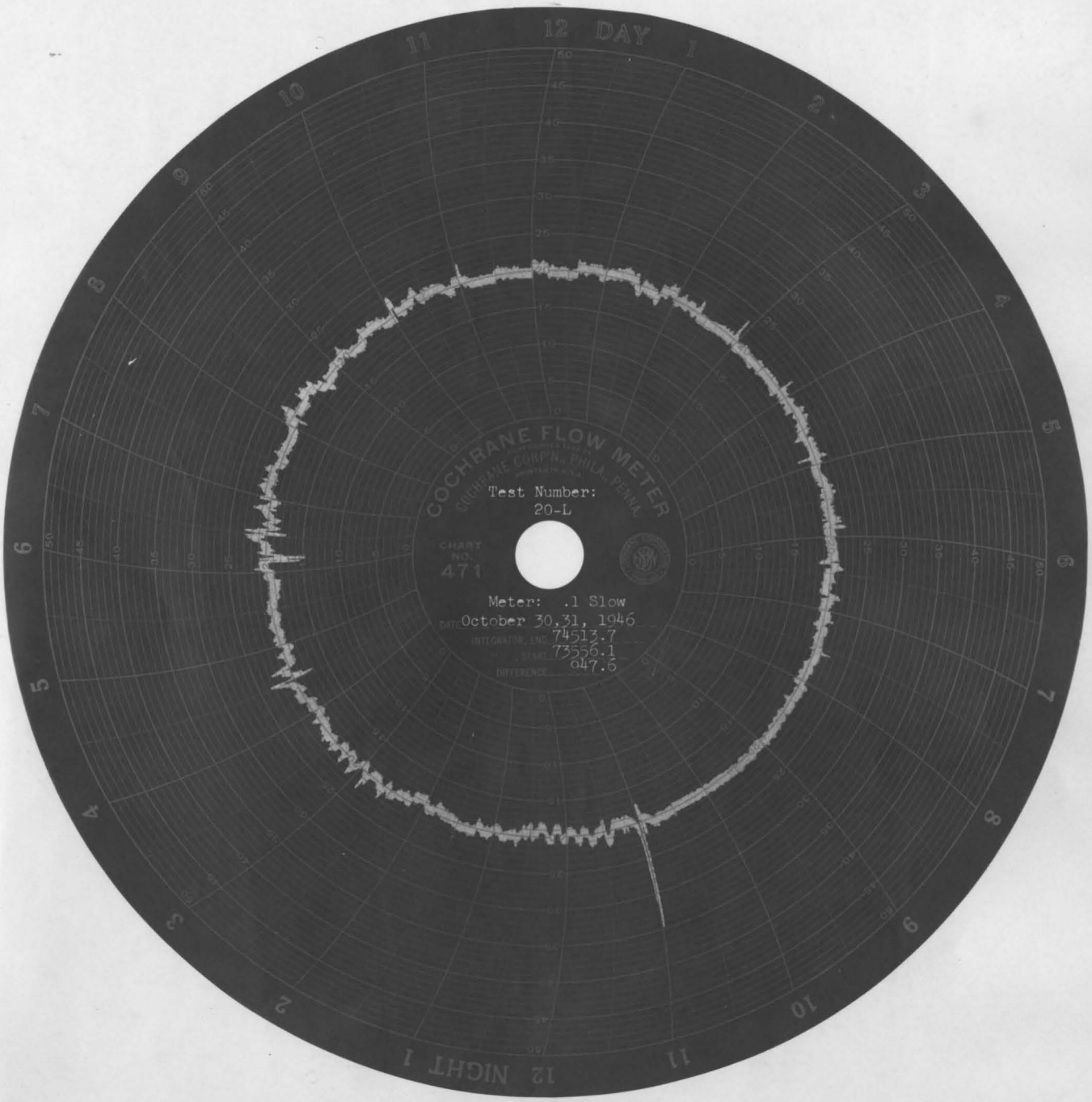
$$\text{Per Cent} = \frac{\text{lb of blow-down water per hour}}{\text{lb of Blow-down water per hour} + W_s} \times 100$$

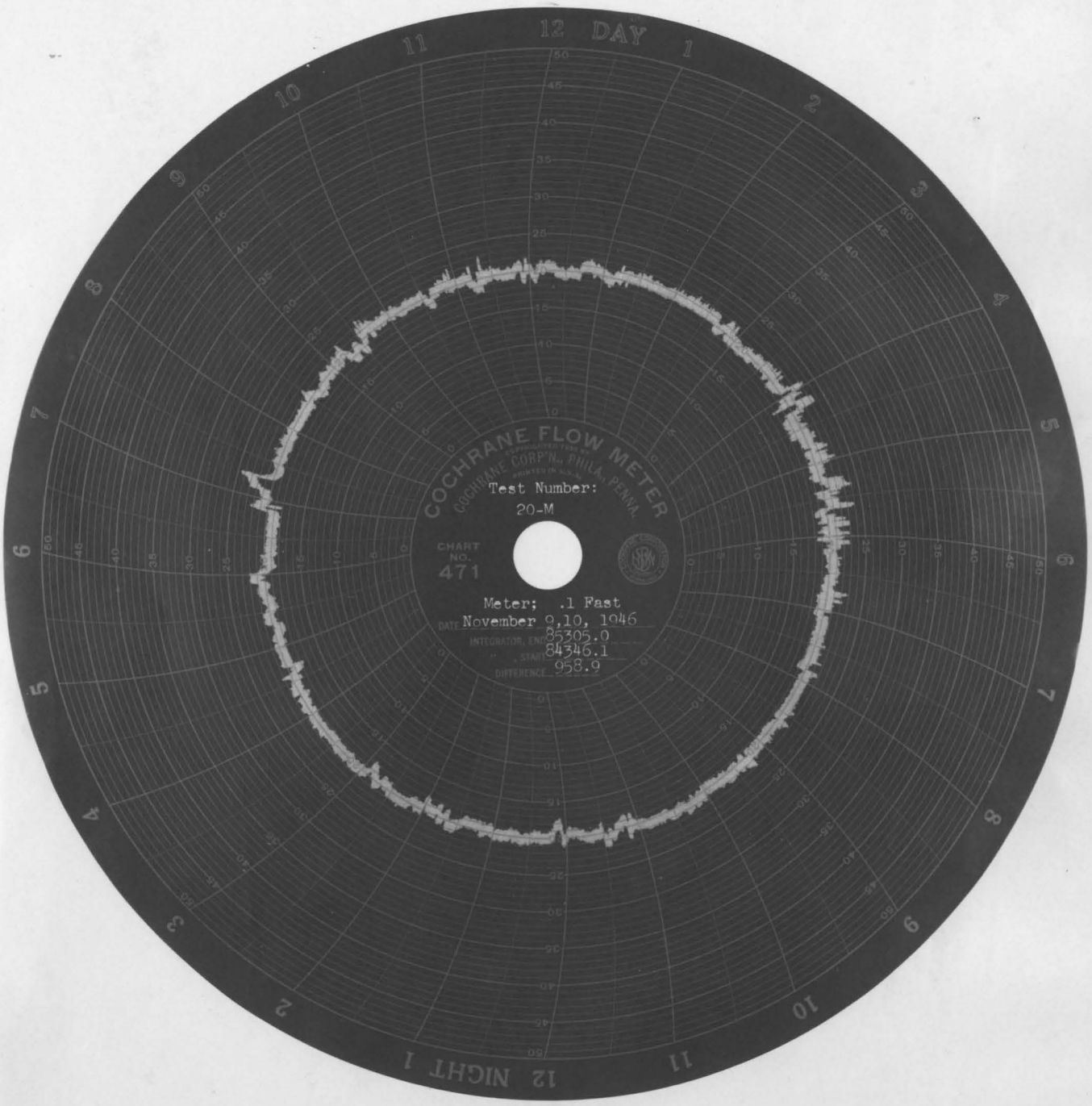
$$= \frac{1460}{1460 + 24,073} \times 100$$

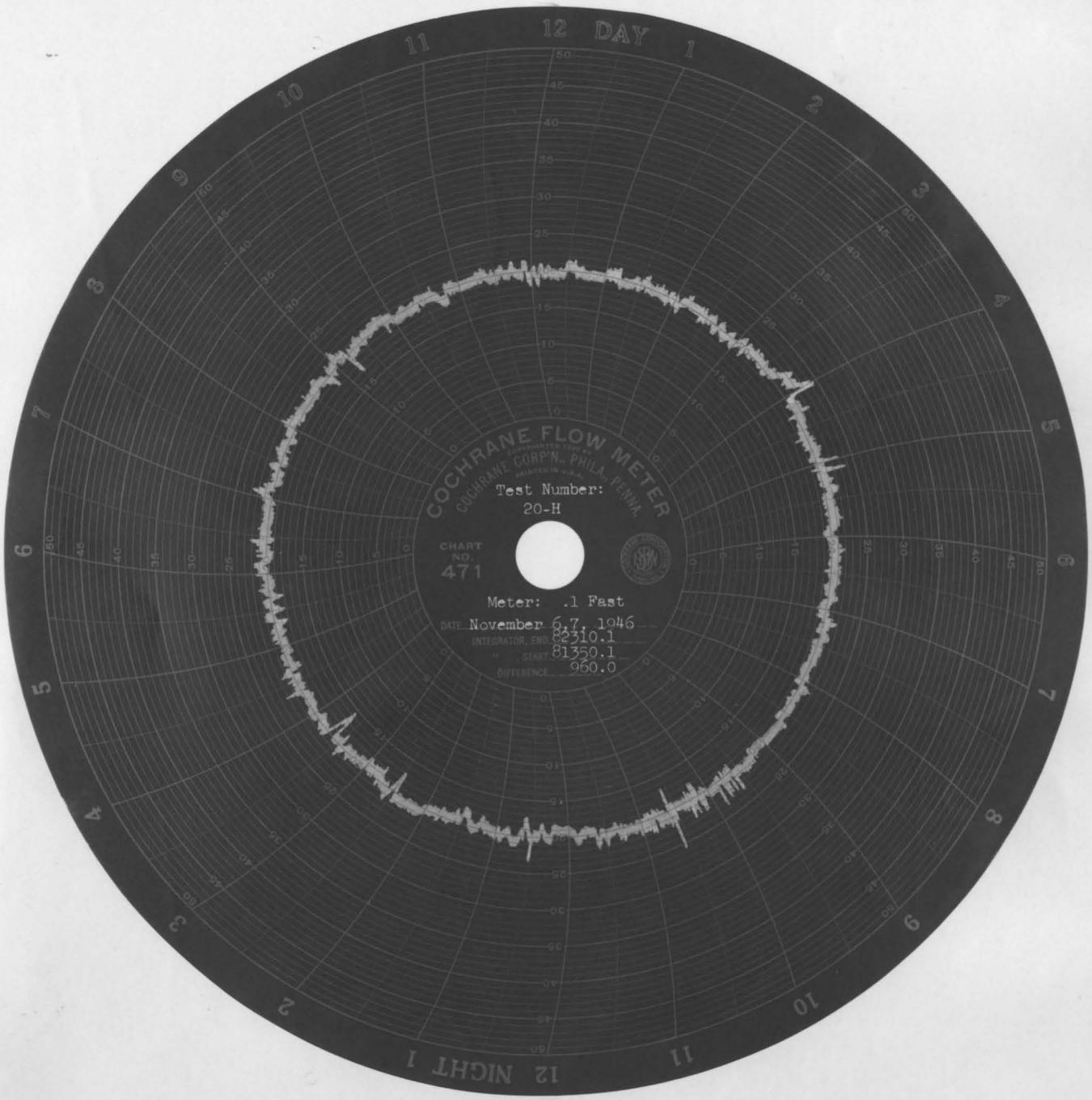
$$= 5.72$$

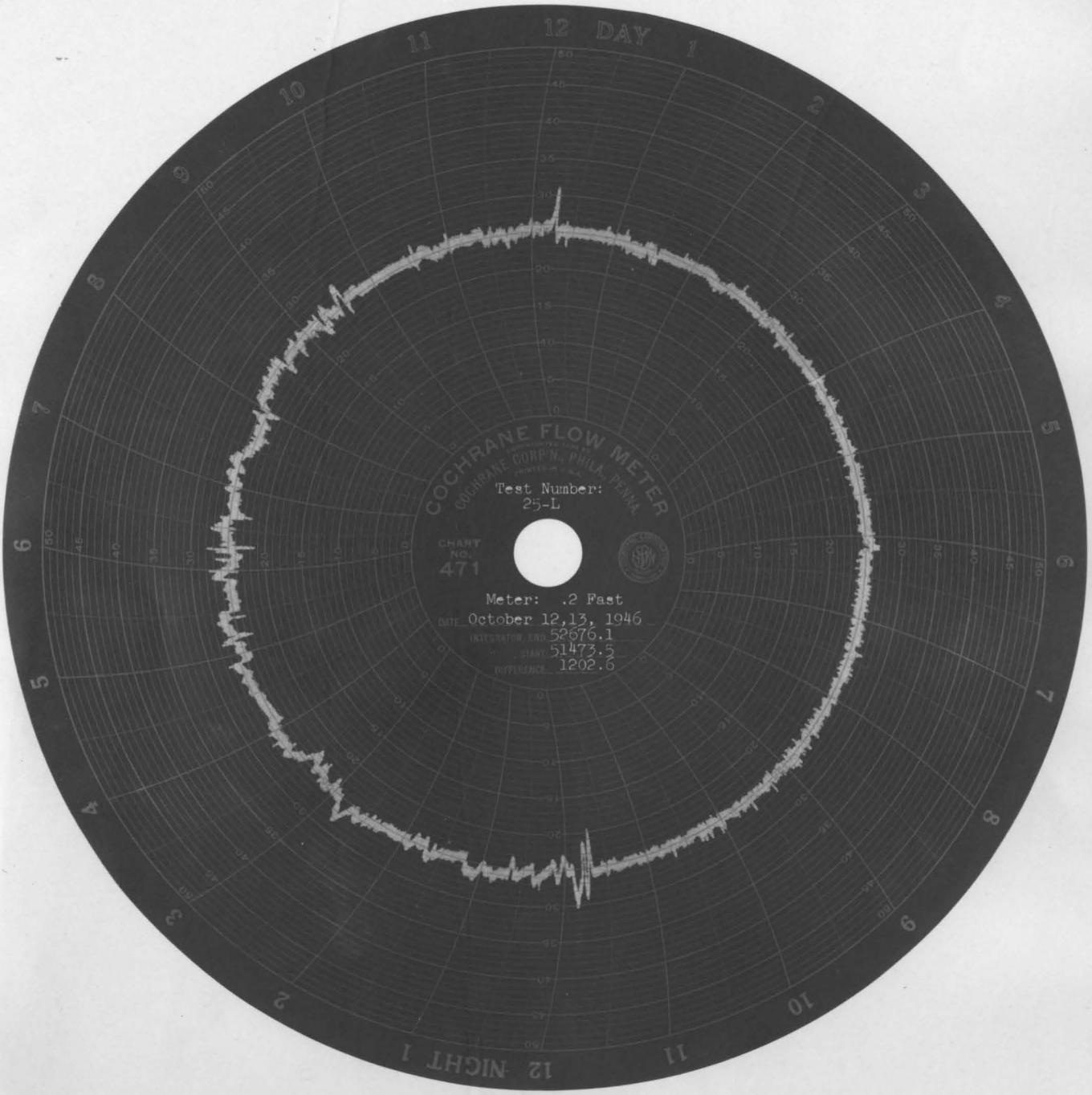
FLOW METER CHARTS

(Units are 1000 pounds of steam per hour)

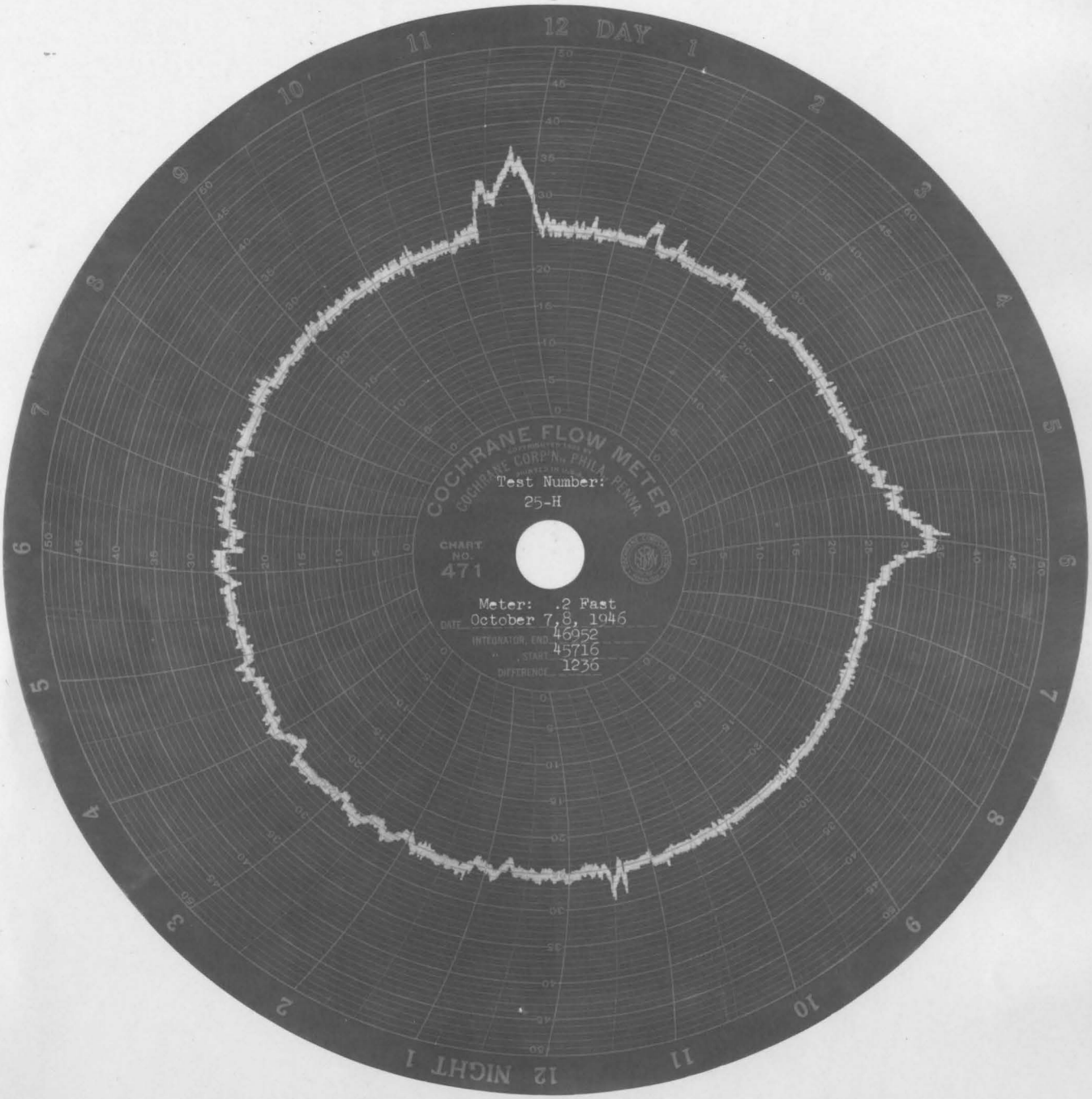

12 DAY 1
12 NIGHT 1
COCHRANE FLOW METER
COCHRANE CORP'N, PHILA., PENNA.
Test Number:
20-L
CHART NO.
471
Meter: .1 Slow
DATE October 30,31, 1946
INTEGRATOR, END 74513.7
START 73556.1
DIFFERENCE 957.6

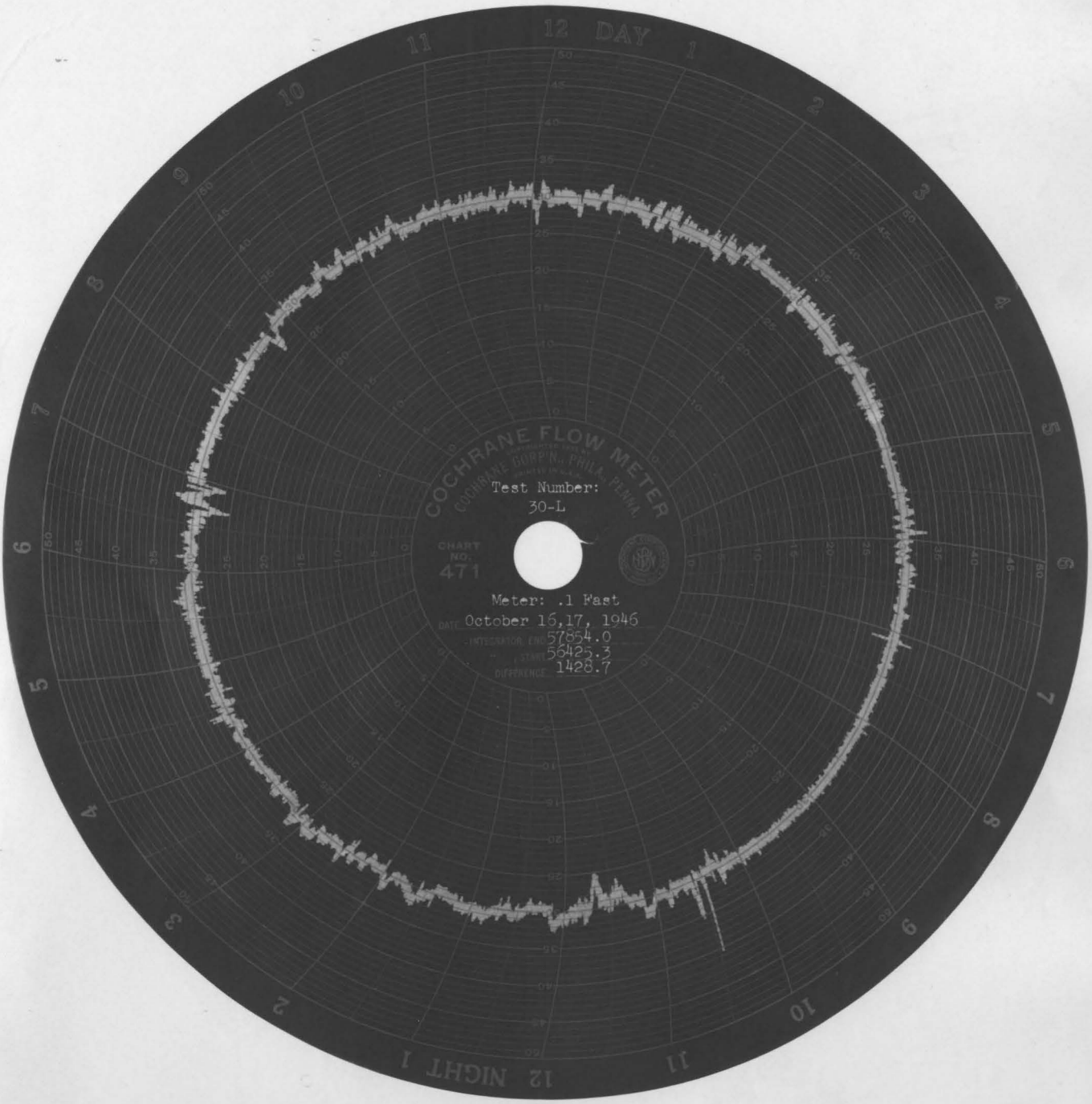

12 DAY 1
2
3
4
5
6
7
8
9
10
11
12 NIGHT 1
2
3
4
5
6
7
8
9
10
11
COCHRANE FLOW METER
COCHRANE CORP'N, PHILA., PENNA.
Test Number:
20-M
CHART NO. 471
Meter; .1 Fast
DATE November 9,10, 1946
INTEGRATOR, END 85305.0
START 84346.1
DIFFERENCE 958.9

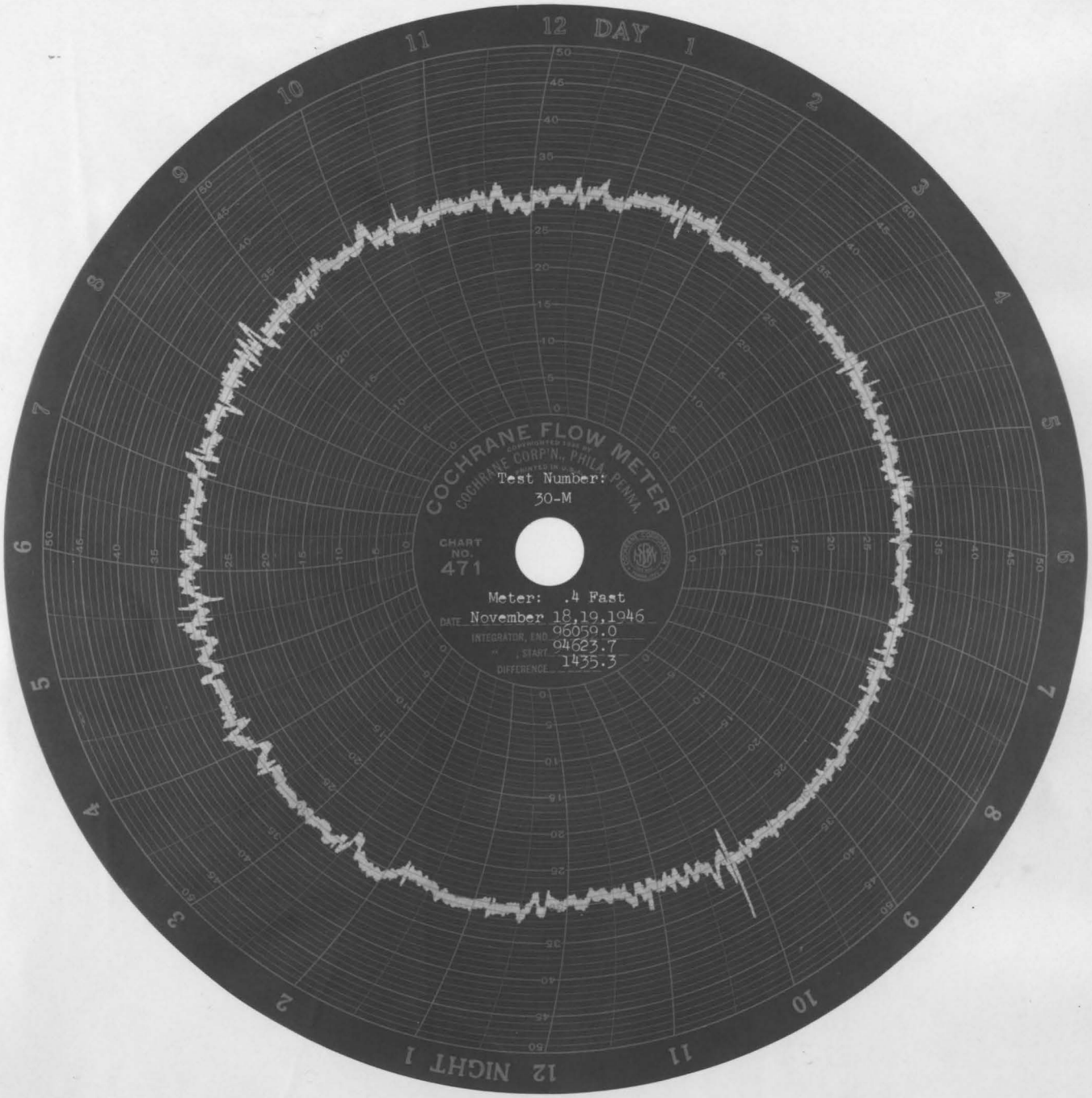

12 DAY 1
11 2
10 3
9 4
8 5
7 6
6 7
5 8
4 9
3 10
2 11
1 12 NIGHT
COCHRANE FLOW METER
COCHRANE CORP'N., PHILA., PENNA.
Test Number:
20-H
CHART NO. 471
Meter: .1 Fast
DATE November 6,7, 1946
INTEGRATOR, END 82310.1
" START 81350.1
DIFFERENCE 960.0

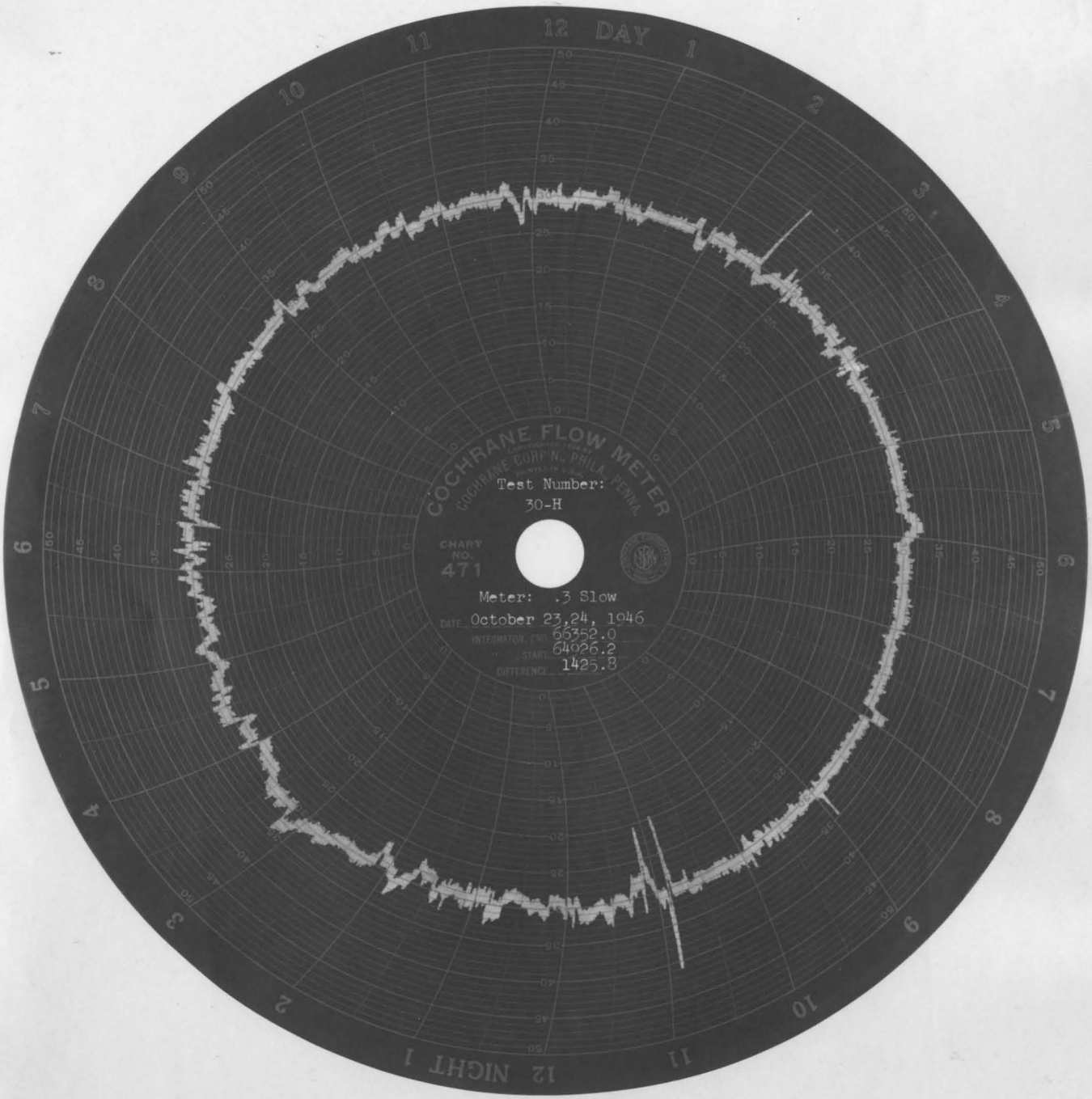

12 DAY 1
2
3
4
5
6
7
8
9
10
11
12 NIGHT 1
COCHRANE FLOW METER
COCHRANE CORP'N, PHILA., PENNA.
Test Number:
25-L
CHART NO. 471
Meter: .2 Fast
DATE October 12,13, 1946
INTEGRATOR, END 52676.1
START 51473.5
DIFFERENCE 1202.6

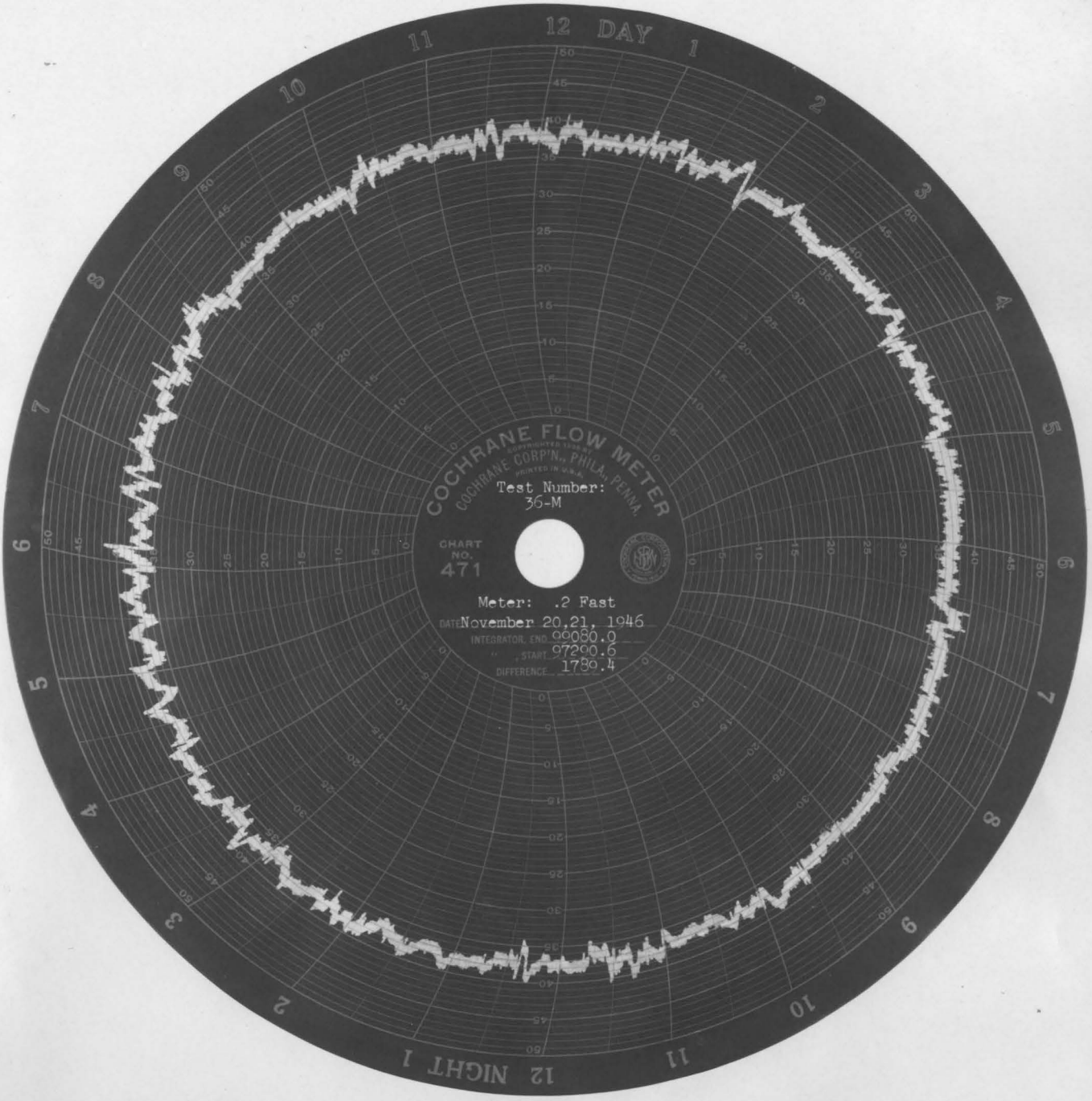

COCHRANE FLOW METER
Test Number:
25-M
CHART NO. 471
Meter: .3 Fast
October 19,20, 1946
51472.7
60280.8
1191.9
12 DAY
12 NIGHT

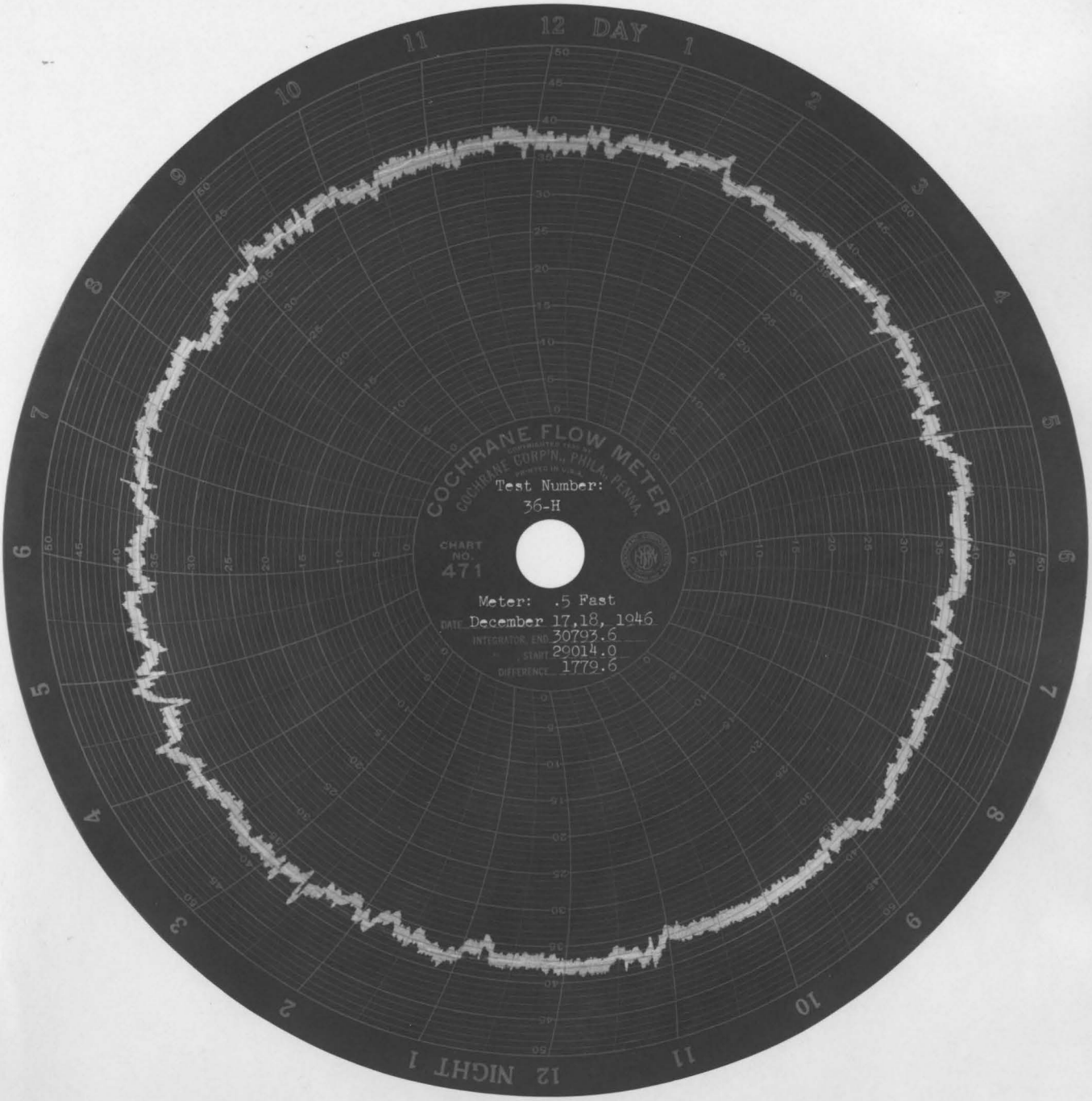

12 DAY 1
12 NIGHT 1
COCHRANE FLOW METER
COCHRANE CORP'N, PHILA. PENNA.
Test Number:
25-H
CHART NO. 471
Meter: .2 Fast
DATE October 7,8, 1946
INTEGRATOR, END 46952
" START 45716
DIFFERENCE 1236

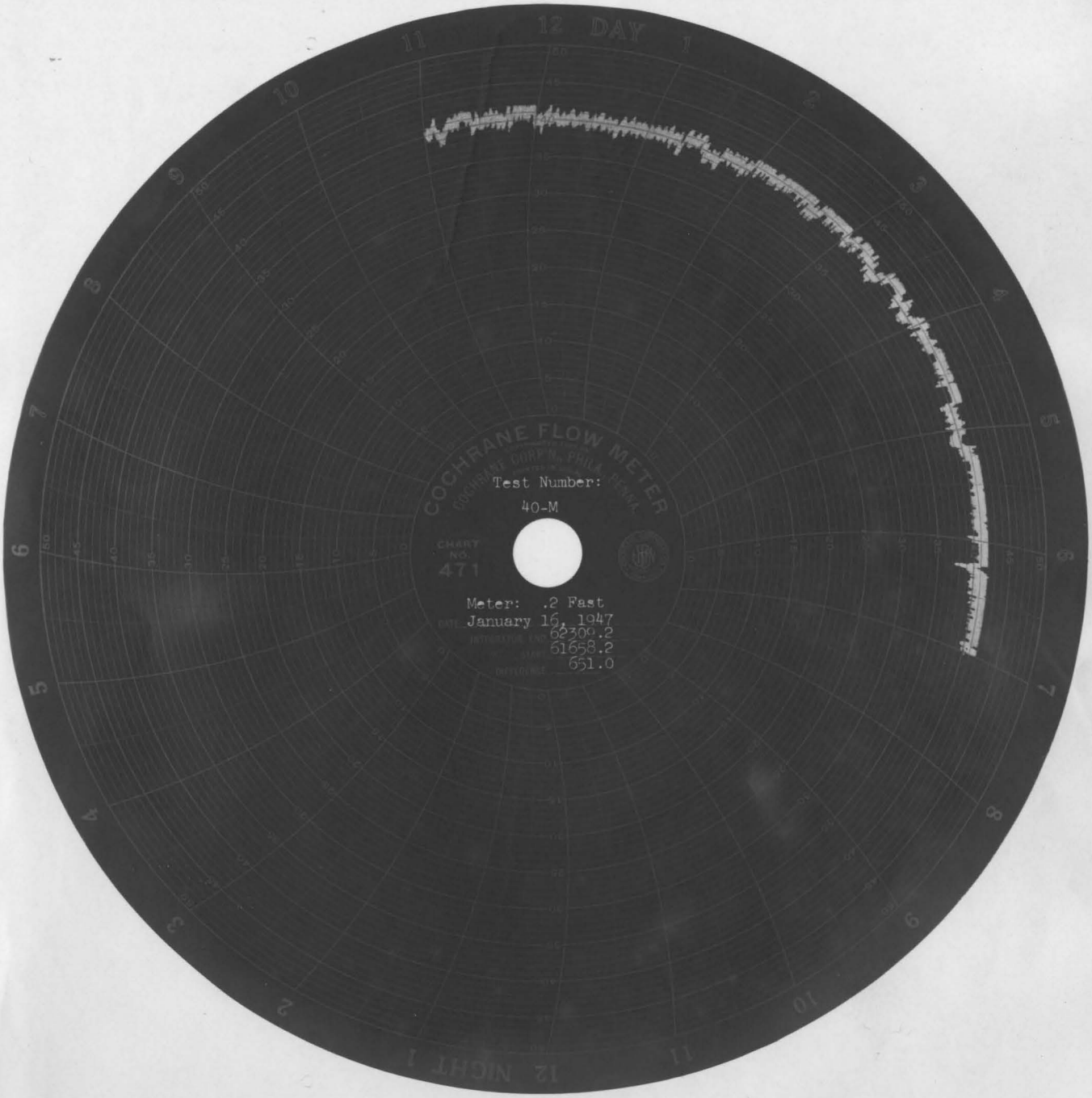

12 DAY
12 NIGHT
COCHRANE FLOW METER
COCHRANE CORPN., PHILA., PENNA.
Test Number:
30-L
CHART NO. 471
Meter: .1 Fast
DATE October 16,17, 1946
INTEGRATOR END 57854.0
START 56425.3
DIFFERENCE 1428.7


12 DAY
12 NIGHT
COCHRANE FLOW METER
COCHRANE CORP'N., PHILA., PENNA.
Test Number:
30-M
CHART NO. 471
Meter: .4 Fast
DATE November 18,19,1946
INTEGRATOR, END 96059.0
" , START 94623.7
DIFFERENCE 1435.3


12 DAY 1
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12 NIGHT 1
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10
11
COCHRANE FLOW METER
COCHRANE CORP'N, PHILA, PENNA.
Test Number:
30-H
CHART NO. 471
Meter: .3 Slow
DATE October 23,24, 1946
INTEGRATOR, END 66352.0
START 64926.2
DIFFERENCE 1425.8


12 DAY 1
2
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6
7
8
9
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11
12 NIGHT 1
COCHRANE FLOW METER
COCHRANE CORP'N., PHILA., PENNA.
Test Number:
36-M
CHART NO. 471
Meter: .2 Fast
DATE November 20,21, 1946
INTEGRATOR, END 99080.0
" , START 97300.6
DIFFERENCE 1780.4


12 DAY 1
2 3 4 5 6 7 8 9 10 11
12 NIGHT 1
2 3 4 5 6 7 8 9 10 11
COCHRANE FLOW METER
COCHRANE CORP'N, PHILA., PENNA.
Test Number:
36-H
CHART NO. 471
Meter: .5 Fast
DATE December 17,18, 1946
INTEGRATOR, END 30793.6
, START 29014.0
DIFFERENCE 1779.6


12 DAY 1
11 10 9 8 7 6 5 4 3 2
COCHRANE FLOW METER
Test Number:
40-M
CHART NO. 471
Meter: .2 Fast
January 16, 1947
62300.2
61658.2
651.0
12 NIGHT 1
11 10 9 8 7 6 5 4 3 2

LIST OF ABBREVIATIONS USED

A.B.M.A.	American Boiler Manufacturer's Association
A.S.M.E.	American Society of Mechanical Engineers
A.S.T.M.	American Society for Testing Materials
avg	average
bar	barometer
Btu	British thermal units
BWG	Birmingham Wire Gauge
C	degrees Centigrade
cfm	cubic feet per minute
cor	correction
corr	corrected
deg	degrees
eff	efficiency
F	degrees Fahrenheit
Fah	Fahrenheit
ft and '	foot or feet
in. and "	inch or inches
kilo-Btu	thousand British thermal units
mfg	manufacturer
mm	millimeters
M.O.	Methyl Orange
No.	Number
ppm	parts per million
press	pressure

psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gage
sq ft	square feet
temp	temperature
vs	versus

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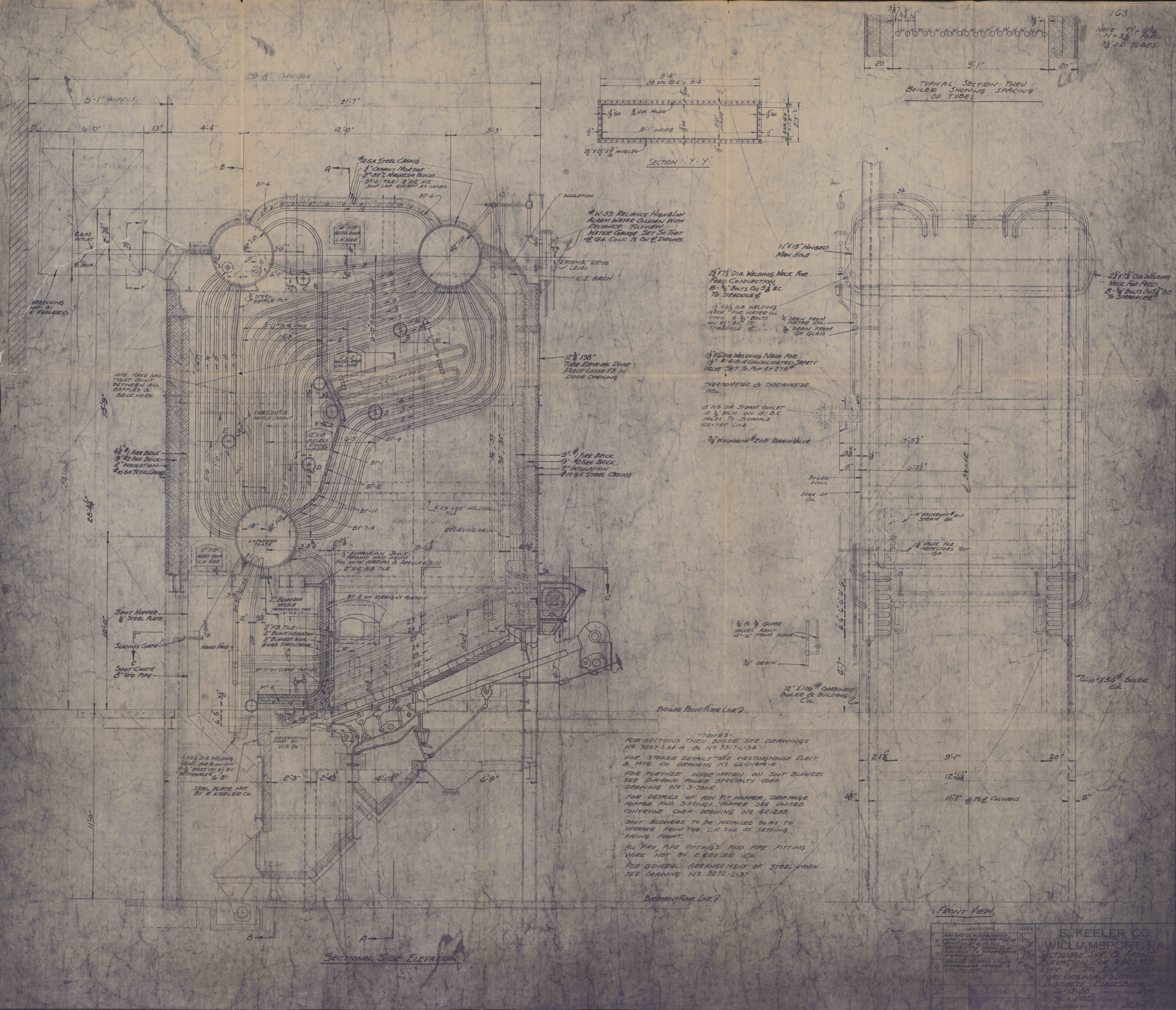
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NOTES

FOR SECTIONS THRU BOILER SEE DRAWINGS Nº 3257-L-34-A & Nº 3317-L-34

FOR STOKER DETAILS SEE WESTINGHOUSE ELECT. & MFG. CO. DRAWING Nº 66-D-419-A

FOR FURTHER INFORMATION ON SOOT BLOWERS SEE DIAMOND POWER SPECIALTY CORP. DRAWING Nº 3-7905.

FOR DETAILS OF ASH PIT HOPPER, DRIPPAGE HOPPER AND SITTINGS HOPPER SEE UNITED CONVEYOR CORP. DRAWING Nº 4C-283

SOOT BLOWERS TO BE INSTALLED SO AS TO OPERATE FROM THE L.H. SIDE OF SETTING FACING FRONT.

ALL PIPE, PIPE FITTINGS AND PIPE FITTING WORK NOT BY E. KEELER CO.

FOR GENERAL ARRANGEMENT OF STEEL WORK SEE DRAWING Nº 3272-L-37

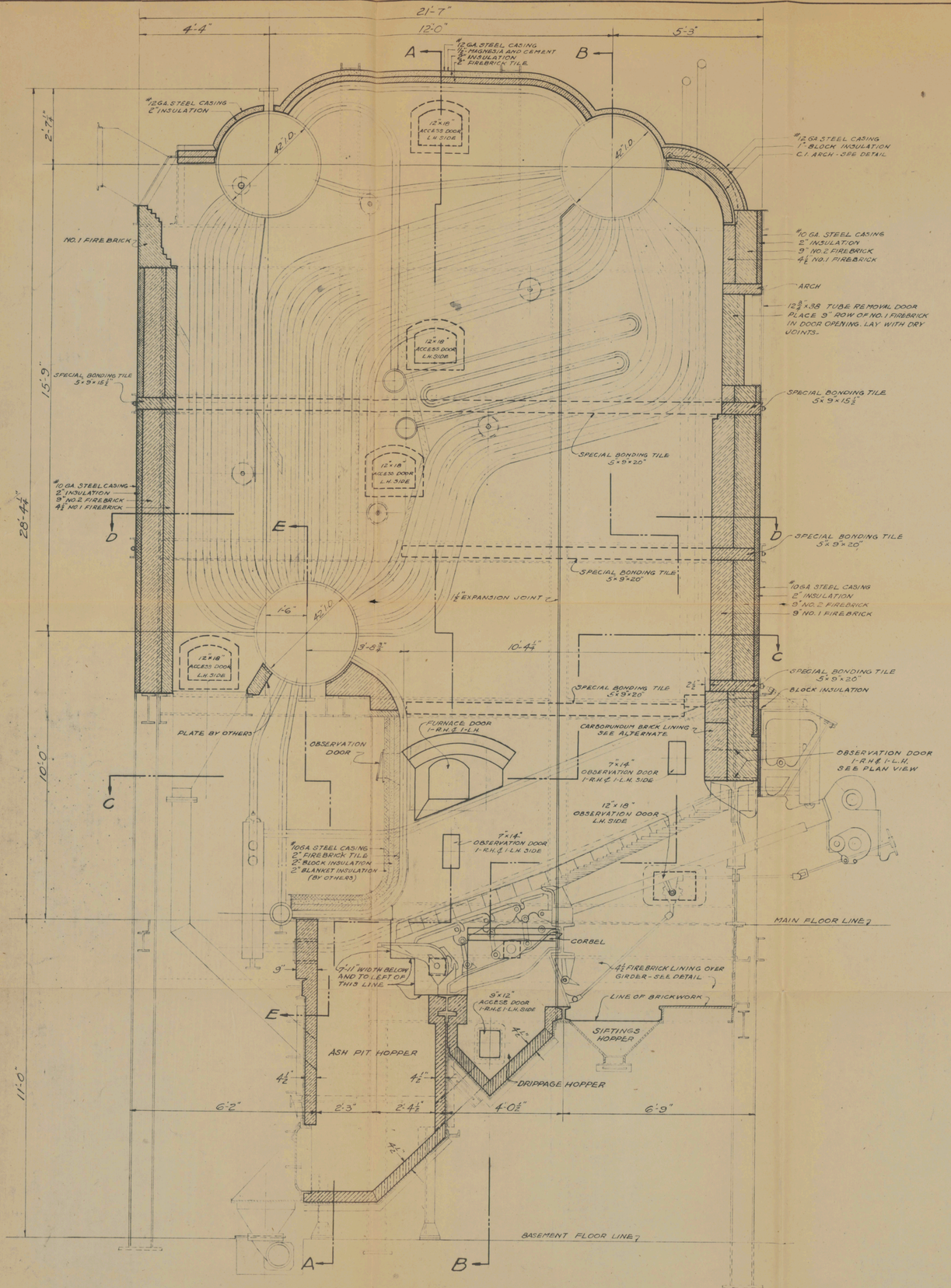
	REVISIONS	DATE
A	REVISED IN ACCORDANCE WITH LETTER DATED 7-6-38 FROM VALE & HILSON	7/20/38
B	REVISED TO SHOW DIMENSIONS TO SUPERHEATER STEAM OUTLET	10/6/38
C	REVISED TO SHOW LOWER SUPERHEATER HANGER IN NEW POSITION	6/4/40
D		
E		
F		

E. KEELER CO.
WILLIAMSPORT, PA.

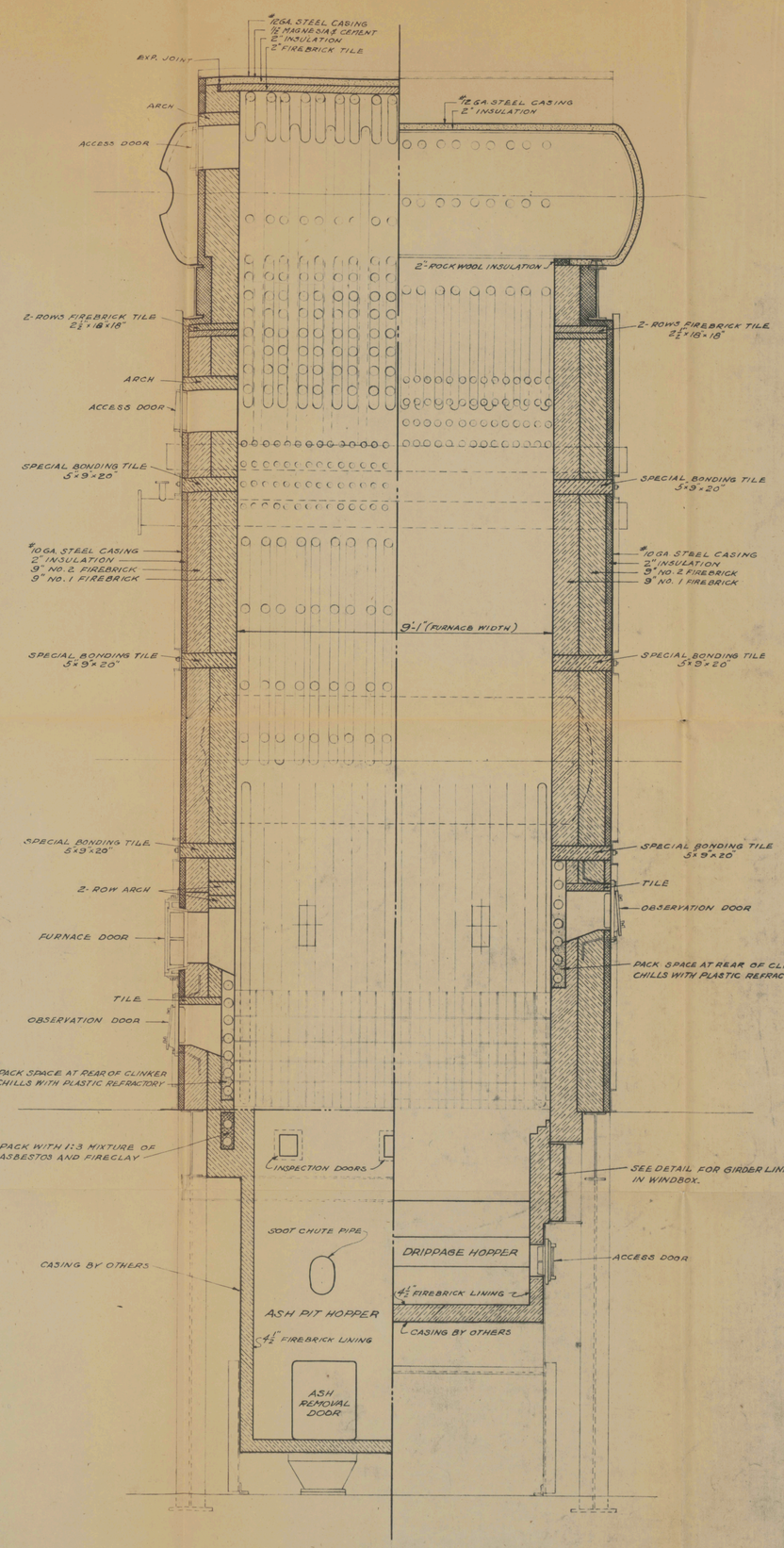
SECTIONAL SIDE & FRONT ELEVATION FOR 1500 H.P. TYPE "P" SPL. BUR. MATERIAL FOR VIRGINIA POLYTECHNIC INSTITUTE, BLACKSBURG, VA.

6-13-38
½" = 1'-0"

321



SECTIONAL SIDE ELEVATION
SCALE: ½" = 1'-0"



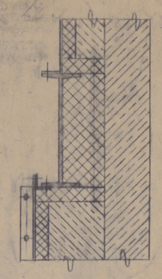
SECTION-AA SECTION-BB
SCALE: ½" = 1'-0"

BOILER BRICK SETTING WORK
FOR
POWER HOUSE ADDITION
AT THE
VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VA.

WILEY & WILSON
CONSULTING ENGINEERS
LYNCHBURG, VA. - RICHMOND, VA.

MADE BY A.L.A.	TRACED BY A.L.A.
REVISED	APPROVED BY
SCALE ON PLAN	COMM. NO. 3810
DATE OCT 15, 1938	DRAWING NO. B-1

Fig 25



TYPICAL SECTION THRU SIDE WALL AT BOILER SUPPORTING GIRDER

1½"x6" DIA. WELDING NECK - 4-⅞" BOLTS ON 4½" B.C. TO STRADDLE ℄ FOR WATER COL. CONN

2½"x7½" DIA. WELDING NECK 8-¾" BOLTS ON 5⅞" B.C. TO STRADDLE ℄ FOR AUX. STEAM CONN.

1½" DIA. PIPE TAP FOR CONTINUOUS BLOW DOWN

2"x⅜" BAR IRON AROUND ALL MANHOLE OPENINGS, WITH LUGS WELDED TO BARS ON 12" CENTRES FOR FASTENING WIRE MESH FOR BACKING UP 2" INSULATION

2=3" WELDING NECKS FOR SAFETY VALVES

3'-6" 2'-0" 8'-0" 3'-6"

11"x15" HINGED MANHOLE

ENLARGED VIEW AT "C"

2½"x7½" WELDING NECK FOR FEED CONN. 8-¾" BOLTS ON 5⅞" B.C. HOLES TO STRADDLE ℄

2½"x7½" WELDING NECK FOR FEED CONN. 8-¾" BOLTS ON 5⅞" B.C. HOLES TO STRADDLE ℄

11"x15" HINGED MANHOLE

12"x18" STEEL DOOR

½" ROCKWOOL INSULATION BETWEEN DRUM & BRICK WORK

2" YARWAY BLOW OFF VALVE FIG. # 3483-56

5'-0"

1'-7½"

EXPANSION JOINT BETWEEN TILE AND BACKING

HAND HOLE

FLOOR LINE

SEAL PLATE EXTENDED TO ANGLE COLUMN

BOILER ROOM FLOOR LINE

PACK WITH ASBESTOS AND FIRE CLAY (1:3) BETWEEN TUBES AND BRICK WORK

3'-0" 3'-0"

7'-11"

2'-0" 2'-0"

BASEMENT FLOOR LINE

SECTION B-B

NOTES:

FOR SECTIONAL SIDE & FRONT ELEVATIONS SEE DRAWING Nº 3254-L-34-A.

FOR PLAN SECTION THRU BOILER SEE DRAWING Nº 3117-L-34

FOR FUTHER DETAILS OF ASH HOPPER, DEIPPAGE HOPPERS AND SIFTINGS HOPPER SEE UNITED CONVEYOR CORP. DRAWING Nº 4C-288

#12 GA. STEEL CASING

½" CEMENT FINISH

2"-85% MAGNESIA BLOCKS

2½" FIRE BRICK

1½"x6" DIA. WELDING NECK FOR 1-1½" # 1425-A CONSOLIDATED SAFETY VALVE SET TO POP AT 215#

THERMOMETER & THERMOMETER WELL

8"x15" DIA. STEAM OUTLET 12-⅞" BOLTS ON 13" DIA B.C. HOLES TO STRADDLE ℄

¾" NAVIGETH #205 DRAIN VALVE

2'-0" 28 SPC @ 3¾" = 8'-9" 2'-0"

PLACE 1½" OF ASBESTOS & FIRECLAY (3:1) ALL AROUND SUPERHEATER HEADERS WHERE THEY PASS THRU BRICK WALL. MAKE GAS TIGHT

15"

6'-2½"

7'-5½"

5"x9"x20" HOLDING TILE

9"-#1 FIRE BRICK

9"-#2 FIRE BRICK

2" INSULATION

#10 GA. STEEL CASING

6'-7⅝"

17 SPC @ 8'-6"

9'-1"

Centers of Boilers

NOTE: PACK WITH ASBESTOS & FIRE CLAY (3:1) BACK OF ARMOR BLOCKS

9'-1"

10'-5"

SECTION A-A

	REVISIONS	DATE
A	REVISED IN ACCORDANCE WITH LETTER DATED 7-16-38 FROM WHITE & WILSON	7/20/38
B	NOTES INSULATION AT SUPERHEATER HEADERS	10/28/38
C		
D		
E		
F		

E. KEELER CO.
WILLIAMSPORT, PA.

SECTIONS THRU BOILER

1-500 H.P. TYPE 'P' SPL. BOILER
18 SECTIONS WIDE FOR
VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VA

DATE 6-14-38 DRAUGHTSMAN R.K.

SCALE ½" = 1'-0" CHECKED BY

USE DIMENSIONS ONLY JOB NO. 3257-L-34