CANADA

DEPARTMENT OF MINES AND RESOURCES

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W. B. TIMM, CHIEF

COMPARATIVE PULVERIZED FUEL BOILER TESTS ON BRITISH COLUMBIA AND ALBERTA COALS AND ON ONTARIO LIGNITE

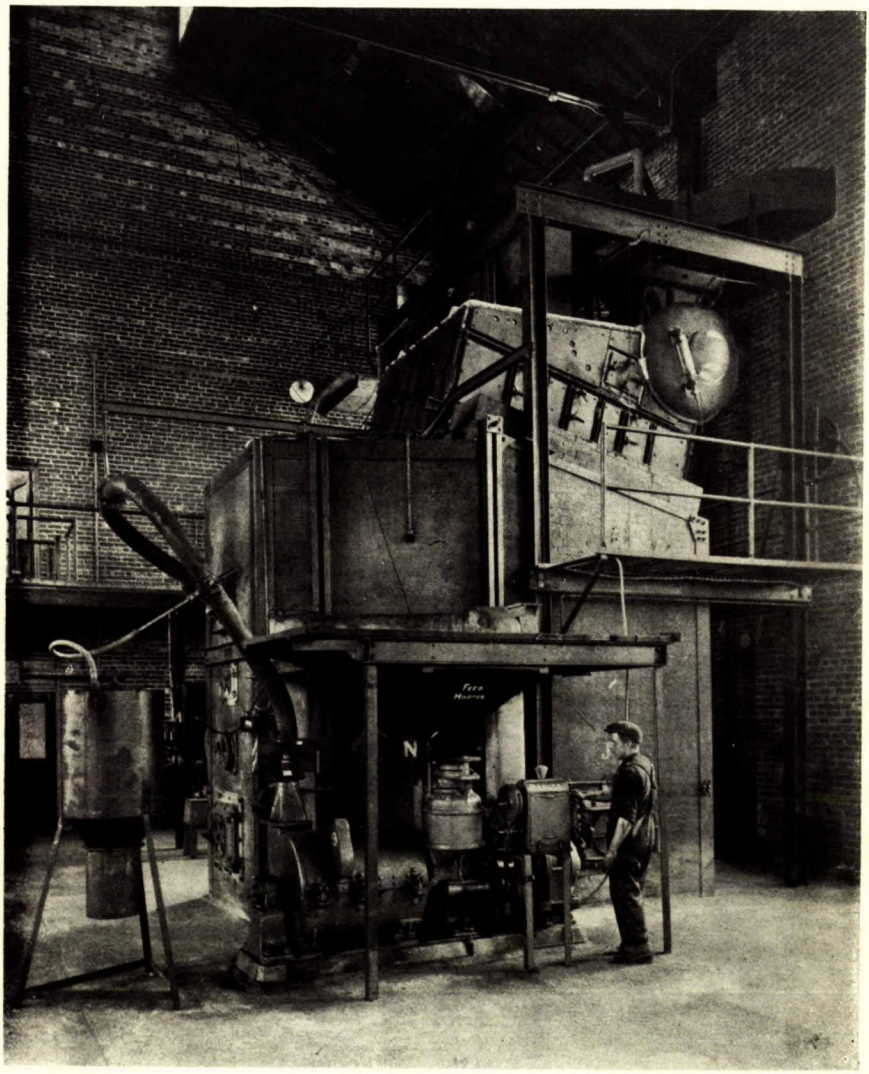
BY

C. E. Baltzer and E. S. Malloch

Price, 25 cents

No. 790

Frontispiece PLATE I



Side view of pulverizer, furnace, and boiler. Pulverized fuel sampling tubes and collector shown at left.

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Comparative Pulverized Fuel Boiler Tests on British Columbia and Alberta Coals and on Ontario Lignite

INTRODUCTION

The main objective of this investigation, which led to a series of boiler tests, was to obtain data regarding the burning of Canadian fuels in the pulverized state for steam raising. It was felt that this information would serve as a guide to operators of coal-fired boiler plants in Western and Central Canada who had adopted, or were contemplating the adoption of this method of coal firing, in the selection of a fuel best suited for their particular plant.

The investigation consisted of a series of comparative boiler tests made on some 28 different coal samples: 12 from British Columbia; 11 from Alberta; 4 from Northern Ontario; and 1 "operating" coal. The samples of coal from British Columbia were selected and shipped by the Government of that Province; the Scientific and Industrial Research Council of Alberta arranged for the selection, sampling, and shipment of the eleven samples of Alberta coal to Ottawa; and the Ontario Department of Mines sent four samples of Onakawana lignite from Northern Ontario. The selection of the "operating" coal which was a typical coking coal, ranking as a high-grade bituminous slack, of constant quality and readily obtained in Ottawa, was made by the authors.

The standard method of making boiler tests was adhered to except in minor details. Four tests were made on each of eleven samples, and three on one other sample from British Columbia; one on each sample from Alberta; one on each sample from Ontario, with the exception of one sample on which three tests were made, and three tests were made on the "operating" coal. Each test consisted of a 24-hour pre-heat period followed by an 8-hour test run.

In this report the results obtained when testing the "operating" coal were used as a basis of comparison; and those obtained from the tests of each coal sample are compared directly with those of the "operating" coal and thus indirectly a comparison is obtained with each other.

When studying the results of the tests it should be remembered that the endeavour was to make all the tests comparable and not to obtain the highest efficiencies; as to reach this end each sample would require different treatment and in so doing defeat the objective of the investigation which is a comparison.

The investigation was carried out at Ottawa and was part of the work of the Division of Fuels, Bureau of Mines, Department of Mines and Resources, by the staff of the Mechanical Engineering Section of the Division assisted by the following men.

Assistants—J. A. McDonald and J. R. Kirkconnell.

Observers—H. P. Hudson, J. W. Custeau, P. B. Seely, and W. H. Harper.

DESCRIPTION OF EQUIPMENT

General Description of Test Unit. The burning tests were made in a Babcock-Wilcox, marine type, water-tube boiler[1] with a total heating surface of 677 square feet, mounted over a solid refractory wall furnace with a volume of 710 cubic feet and having a horizontal, hollow air-cooled floor. The ratio of heating surface to furnace volume was therefore 0·954 : 1. The feed water, obtained from the city mains, was weighed as it was discharged into a steel tank, from which it was pumped to the boiler by either one or both of two independently operated, duplex reciprocating, steam-driven pumps which were operated at a working pressure of about 110 pounds gauge. Draught was obtained by means of a 30-inch steel plate, induced-draught fan, chain-driven by a 7½ h.p. electric motor at 1,750 r.p.m. The fan exhausted the products of combustion from the boiler outlet, delivering them through a steel plate breeching to a brick chimney, 27 by 27 inches and 40 feet high, above the breeching entrance. Draught control was obtained by regulating the main damper in the boiler outlet, and when needed, by regulating the auxiliary damper in the by-pass flue, which is so arranged as to prevent the flue gases from passing through the fan when it is not in operation. A steam jet was also fixed in the chimney to provide additional draught when cleaning the furnace or boiler heating surfaces and for emergency use in the event of electric power failure. The fuel, which was weighed out in 100-pound lots as it was fed to the pulverizer, was supplied in the pulverized state to the furnace on the direct-fired unit system. The fuel was prepared and mixed with primary air in an "Aero", size B, high-speed paddle type mill, driven by a 25 h.p. electric motor, and rated at 1,000 pounds per hour at 1,750 r.p.m. The air-floated coal was transmitted through a 5-inch fuel duct to a simple stream-line burner set downward in the front wall of the furnace at an angle of 60 degrees to the vertical. The secondary air needed to complete combustion was supplied through air ports in the front and side walls of the furnace. The test unit was also equipped with a full complement of measuring, indicating, and recording instruments, and special test apparatus for obtaining all the necessary weights, temperatures, pressures, and data needed for comprehensive test work of this kind. (*See* Figures 1 and 2.) Summarized particulars and dimensions regarding the equipment are given in the Appendix, page 52.

Limitations of Equipment. The pulverizer had a capacity greatly in excess of that required for the normal plant load when using average coals of bituminous rank, in order to provide sufficient pulverizing capacity to handle low-rank fuels at reasonably high plant loads. When using coals, such as the majority of those described, at combustion rates within the scope of practical operation for this plant, the rate of grinding was therefore only a fraction of the rated capacity of the pulverizer, and the power consumption per ton of fuel pulverized was much higher than would have obtained had the machine been operated at all times at rated capacity. The "no load power rate" of the pulverizer for all practical purposes was a constant and, therefore, that proportion of the power consumption chargeable to this factor becomes larger as the rate of grinding decreases

[1] For description of this boiler *see* Rept. No. 331, Mines Branch, Dept. of Mines (1915).

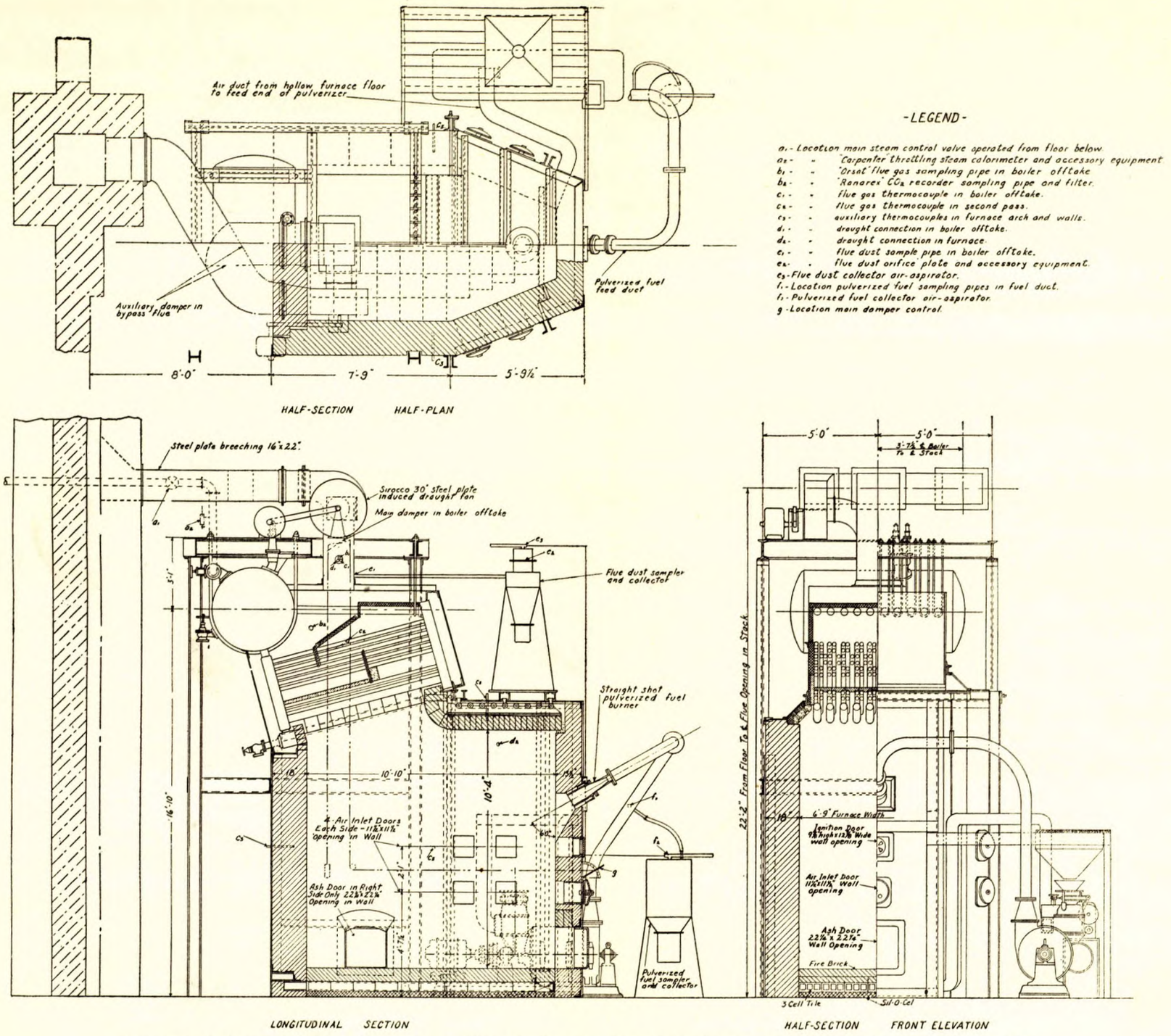
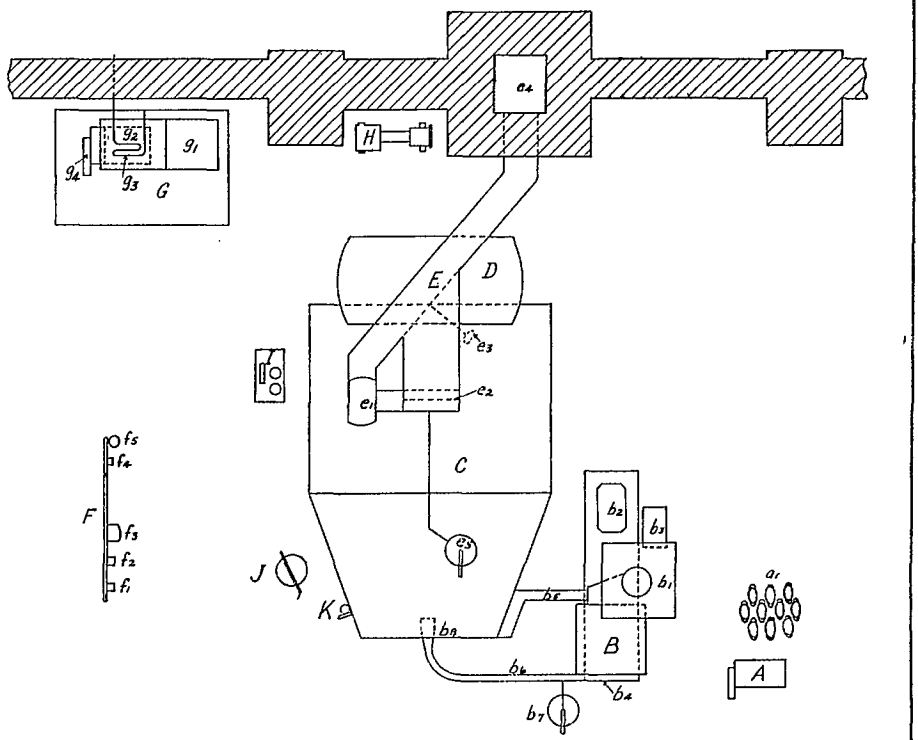


FIGURE 1. Half plan, half front elevation and sections showing pulverizer unit applied to marine type, water-tube boiler and solid, refractory wall furnace with hollow, air-cooled floor. Location of points is shown by legend.



A-Coal weigh scales, a_1-weighed and sampled test coal in bags ready for use.
B-Aero, size B, high speed, paddle type pulverizer rated at 1000 lb. per hour. b_1-raw coal hopper over pulverizer. b_2-pulverizer driving motor b_3-Reeves variable speed control, regulating speed of coal feed mechanism on pulverizer. b_4-Pulverizer fan. b_5-Air duct from hollow furnace floor to feed end of pulverizer. b_6-Pulverized fuel feed duct. b_7-Pulverized fuel sampler and collector b_8-Straight shot pulverized fuel burner entering front wall of furnace at an approximate angle of 60° to the vertical.
C-Solid refractory wall furnace with hollow air-cooled floor. Volume 710 cubic feet.
D-Babcock-Wilcox, marine type, water tube, 3 pass, single cross-drum boiler. Heating surface 677 square feet.
E-Steel plate breeching 16 by 22 inches. e_1-Sirocco 30 inch steel plate induced draught fan. e_2-Main damper in boiler offtake. e_3-Auxiliary damper in bypass flue. e_4-27 by 27 inch square flue brick chimney 40 feet high above the breeching entrance. e_5-Flue dust sampler and collector.
F-Instrument panel. f_1-Integrating kilowatt-hour meter measuring power taken by pulverizer. f_2-Indicating watt-hour meter indicating load fluctuations on the pulverizer. f_3-Ronarex indicating-recording CO_2 meter. f_4-Brown 6 point indicating pyrometer giving flue gas and furnace wall temperatures. f_5-Interval alarm time clock.
G-Water weighing & control platform. g_1-Wrought iron water receiving and supply tank, capacity 1800 lb. g_2-Wrought iron water weigh tank capacity 500 lb., g_3-Steam heated pipe coil immersed in tank g_2. g_4-Water weigh scales.
H-Two duplex steam-driven feed water pumps.
I-Flue gas sampling, collecting & analyzing apparatus.
J-Hauck oil torch used for initial light off purposes
K-Ellison water gauge for furnace draught and B&W. Bourdon pressure gauge for boiler pressure.
L-Numerous thermometers, U & inclined water gauges, etc, not indicated, for obtaining temperatures, pressures, etc.

FIGURE 2. General arrangement of pulverizer, furnace, boiler, and accessory test equipment.

and when computed on a ton basis forms a large part of the total. Moreover, owing to the pulverizer being over-size, the primary air furnished with the fuel through the fuel duct and burner to the furnace was excessive at combustion rates within the range of practical working conditions, precluding the efficient use of the pulverizer air controls, which to some extent control the fineness and character of grind needed for the highest combustion results with the different fuels.

The furnace volume was excessive in comparison with larger commercial units, owing to limitations imposed in the design of such a small unit, and the heat release per unit volume was consequently low at normal plant loads and cannot be compared directly with commercial practice in larger units. Further, the boiler itself was not the most efficient for this type of setting, and limitations in test arrangements precluded operating at the highest efficiency obtainable. High efficiencies are not, however, essential for these tests to be of value, inasmuch as the fuels themselves were under test rather than the equipment. All tests were conducted with the same equipment in identically the same manner and therefore are comparable one with another, special emphasis being placed on the characteristics of the fuels and their behaviour in the furnace.

TEST METHODS AND PROCEDURE

The burning tests and the computation of the results were made mainly in accordance with the procedure recommended and outlined fully by the American Society of Mechanical Engineers in its "Power Test Code for Stationary Steam Generating Units". Variations from code requirements, however, were made when it seemed both feasible and desirable to develop more detailed information concerning certain phases of the work or problems peculiar to this specific investigation. Each test was made in the same equipment in precisely the same manner, with the same care and attention to detail, so that the results would be comparable and as accurate and reliable as possible. Throughout the investigation baffles and packings were renewed when necessary and the setting and furnace were maintained in good condition as far as strength and freedom from air leaks were concerned.

As the boiler furnace was new, a number of short preliminary runs were not reported but were made merely to adjust the equipment. The unit was then "standardized" on one coal, referred to as the "operating coal", at three rates designated as low, medium, and high rates of coal feed, respectively. The operating coal was a typical coking coal ranking as a high-grade bituminous slack, and was well suited for use in the pulverized state. It was arbitrarily chosen for standardization and preheating use because of its constant quality and ready availability in the Ottawa market. After adjusting the test unit to the best advantage for overall working, combustion, and general conditions of control with the operating coal at the medium rate of feed, the main series of tests was begun.

At the outset the following plan was decided upon in regard to the British Columbia coals:—

(a) Three tests, one at each rate of coal feed, should be made on each of the twelve coals sent in for test.

(b) The setting should be preheated on the same (operating) coal at the same (medium) rate of coal feed for approximately the same length of time (24 hours) before starting any one test.

(c) Change-over from the operating to the test coal should be made without interrupting operation, immediately following the 24-hour preheat period, and at least 1 to 2 hours before start of test. During this time at least 400 pounds of the test coal was to be burned at the predetermined rate of feed set for the ensuing test, the equipment was to be checked over and made ready for test, and stabilized combustion conditions were to be secured before starting the test.

(d) Each trial should be made with the same care and attention to detail and under as nearly identical operating conditions as possible. The boiler pressure, rate of coal feed, and percentages of carbon dioxide and carbon monoxide in the flue gases were selected as the main controlling factors.

The series of tests on British Columbia coals was extended to include a repeat test at the medium rate of feed on eleven of the twelve coals (there was not sufficient of the twelfth coal left) for comparing their light-off and preheat characteristics. These eleven trials were made in exactly the same way except that the test coal was used for initial light-off and preheating.

The same procedure was followed in the tests on the Alberta coal, except that only one test was made on each coal at one rate of feed (medium). As sufficient of these coals was available, the test coal was used for initial lighting-off and preheating instead of the operating coal.

The tests on the Ontario lignite were made the same way as in the British Columbia trials, the operating coal being used for the initial light-off and preheat, except for the test at the highest rate of feed, a short one of four hours' duration, following another immediately, so that initial preheat had already been provided.

General Test Procedure. All tests were conducted in the following manner: 24 hours before start of the actual trial, the test unit was put into service, lighting-off with operating coal. After the preliminary period, changes were made in the feed arrangements, and operation was continued without interruption at the desired rate of coal feed for the ensuing test for a so-called "change-over period" of from 1 to 2 hours, during which time a set quantity (400 to 600 pounds) of the sampled test coal was burned; the boiler heating-surfaces and furnace floor were thoroughly cleaned; boiler pressure, draught, coal and water feed, and general combustion conditions were stabilized; and the unit in general checked over and made ready for test. At the end of the "change-over period" the trial was started without interrupting operation and continued for an 8-hour period, during which time all coal and water fed to the boiler were carefully measured, and general observations and readings were made and noted each 15 minutes of the trial.

Starting and Stopping. Immediately before the start of the test a note was made of boiler pressure, coal and water-feed rates, smoke, flame, and general furnace conditions, draught, damper and pulverizer control

settings, etc. After necessary adjustments and when conditions in general were satisfactory, the tests were started without interrupting operation just when the last of the coal in the raw coal hopper emptied and came to a set levelling mark over the feed mechanism of the pulverizer. At the same time the boiler pressure and water levels in both the feed tank and boiler were at predetermined levels. A weighed quantity of coal was immediately dumped into the feed hopper; the flame and furnace temperatures were taken by means of a radiation pyrometer, through several secondary air-ports; observation was made of the character and approximate quantity of fused refuse remaining on the furnace floor; and the initial temperature, pressure, and draught readings, etc., were noted. The test then proceeded for an 8-hour period.

During the test double-checked records were made of all coal and water fed to the pulverizer and boiler, and coal and water levels were brought to starting condition at the end of each hour. Starting conditions in respect to boiler pressure, coal and water feed rates, etc., were maintained as uniform as possible so that little or no adjustment was necessary at the close.

The tests were closed with conditions similar to those at the start, final observations were made and the unit was shut down. As soon as possible after the close of test, observation was made of the character and quantity of refuse collected at the base of the chimney, in the flue dust sampler, the boiler passes, and on the furnace floor.

Coal Handling, Sampling, and Analysis. The quantity of raw coal needed for each test was taken from storage the day before the trial. As it was withdrawn from the bin it was passed through a gyratory crusher to reduce the lumps to 1 inch and under. It was then screened through a 1-inch square-mesh screen, the coal not passing being recrushed and re-screened, so as to ensure no piece being over 1 inch in diameter, which might interfere with the feeding mechanism of the pulverizer. The screened coal was then mixed to ensure even distribution of the coarse pieces throughout the coal mass, and for ease in handling was bagged in suitable canvas containers holding 100 pounds net. During the last operation a small scoopful (2 to 3 pounds) was taken from the bottom, middle, and top of each bag and set aside as a representative sample, which was sent directly to the chemical laboratory for determination of screen, proximate and ultimate analyses, calorific value, apparent gravity, and ash fusibility, etc., all of which were made in accordance with standardized procedure. The handling was so arranged that the coal, from the time of being bagged until used for test, was protected from contamination and loss or gain of moisture, by being covered with heavy tarpaulins.

The weight of each bag of the sampled test coal was carefully checked and noted as it was dumped into the raw coal hopper set over the feeder of the pulverizer and sufficient coal was delivered to this hopper at one time to supply the pulverizer for one-half hour at the rate of coal feed chosen. By this means a careful check was obtained on the rate of feed, which was kept constant for each test.

A small sample of the pulverized fuel passing from the pulverizer to the burner was withdrawn from the fuel duct each hour of the test by means of adjustable sampling tubes and cyclone collection apparatus.

The two sampling tubes were placed in a straight vertical section of the fuel duct at right angles to each other, with the intake ends pointed against the coal-air stream in the fuel duct, so that the sampling was done in a horizontal plane. The operation of sampling consisted in traversing the fuel duct at a slow and uniform rate for 1, 2, or 3 minutes, dependent on the rate of coal feed, with each tube at alternate hours. The setting of the air-aspirated collecting apparatus ensured that the sample was drawn from the fuel duct at a rate corresponding with the flow in the duct. This apparatus included a closed container for storage of the hourly samples until the end of test. The hourly samples fell into a common and removable chamber attached to the collector, where they were bulked into one composite sample. This was withdrawn at the end of the test, carefully weighed, intimately mixed by rolling on a glazed oilcloth sheet, riffled into sealed containers, and finally delivered to the chemical laboratory for determination of moisture and for screen analysis.

Refuse Collection, Sampling, and Analysis. As was anticipated the true quantity of refuse produced from each test could not be recovered as difficulty arose in cleaning the furnace and setting, and a large quantity was lost as "fly ash".

The refuse collected on the furnace bottom, and that trapped in the boiler passes, flue dust sampler, and base of chimney was removed and weighed in a dry state as soon as possible after the close of each test. The hot refuse on the furnace floor was sliced, hoed, and scraped out through the clean-out door in the rear, right side wall into metal containers which were immediately covered to prevent further burning of the entrapped carbon. With some of the coals the removal was very difficult, owing to the molten condition of the refuse and its tendency to adhere to the floor in a solid sheet. An appreciable quantity of the ash also fused on the rear and side walls of the furnace in the form of a glassy sheet-like deposit, which could not be removed without injury to the brickwork. This was more pronounced at higher rates of combustion and introduced another problem into its collection, in that some of the deposit chargeable to other tests fell or flowed from the walls and became mixed with the refuse on the furnace floor. Generally, however, the colour or this part of the heavily fused refuse differed from that on the furnace floor and so could be removed and corrected for after the main body of refuse had cooled. The refuse lodging on the heating surfaces and baffles of the boiler in the second and third passes was removed by means of a brush and a long-handled shovel and placed in a covered container, and that trapped at the base of the chimney was also scraped and brushed into a container through the clean-out door.

In order to reduce the ash that was unaccounted for and to obtain some idea of the quantity and nature of the refuse passing out of the setting, an endeavour was made to collect a definite proportion of the flue dust by means of the air-aspirated cyclone dust-sampler shown in Figures 1 and 2, pages 2 and 3. Unfortunately, the construction and erection of this apparatus was delayed so that it was only available for the last nine tests with the British Columbia coals. It was used, however, for all subsequent tests. The collector was connected to a vertical section of the boiler offtake, as shown in Figure 1, page 2, by a 2-inch iron pipe, the intake of which was turned downward against the stream so that the sampling was done

in a horizontal plane with the sampling pipe in one fixed place, and was continuous throughout the trial. An air-jet on the outlet of the collector produced a suction so regulated that the velocity of the flue gas with its entrained dust entering the sampling pipe was about the same as the velocity of the gas in the offtake. Inside the collector, most of the dust was separated from the gases by cyclonic action and fell into a removable container at the bottom of the apparatus, while the finer dust remaining was filtered out before the gases passed to waste. After each test the filter was thoroughly cleaned and the loose dust so obtained was added to that trapped in the container below.

The whole of the refuse obtained from all four sources, viz., furnace bottom, boiler passes, flue dust sampler, and base of chimney, was sent to the chemical laboratory for determination of combustible matter.

Feed-water. The water was obtained directly from the city mains and being of extremely low hardness gave no trouble in the boiler. The water fed to the boiler was weighed by means of a rectangular iron weigh-tank of 500 pounds capacity, fitted with a quick action dumping valve, and placed on platform scales set over a larger rectangular wrought-iron feed- or suction-tank of 1,800 pounds capacity. Either one, or both, of two duplex reciprocating steam-driven pumps drew the water from the feed tank and passed it to the boiler throughout the test at as uniform a rate as possible consistent with manual control. The scales were balanced at every filling of the weigh tank and a record was kept of the weight of each tank dumped into the feed tank. The amount of water in the feed tank and boiler could be determined at any moment by means of fixed gauges attached to the side of the tank and gauge glass, respectively, and calibrated to read directly in pounds of water. Due precautions were taken to avoid either loss or make up of water in both the feed-water system and the boiler. The boiler and water columns in both gauge glasses were blown down sometime before the start of each test. In addition the blow-down pipe of the boiler, the tank drains, and all water drip pipes were connected to an open sump so that any leakage could be noted and corrected.

As the feed water was drawn directly from the city water mains it was at a comparatively low temperature, during the winter months as low as 35° F. In order to temper this water before feeding it to the boiler a small live-steam heating-coil was suspended in the weigh tank, and the temperature was taken at regular intervals by means of a calibrated mercury thermometer.

Flue Gases. The flue gases were sampled continuously and analyses were made at 20-minute intervals with an Orsat apparatus.

The gas samples were withdrawn from the boiler offtake, through a $\frac{5}{8}$-inch diameter, open ended, Pyrex glass tube fixed in the offtake at the point marked b_1 on Figure 1, page 2, about one foot below the main damper. The point of average gas composition for various rates of combustion and damper settings in the cross-section of the offtake was found by preliminary exploration and the open end of the sampling tube was fixed in this position. A $\frac{1}{2}$-inch wrought-iron pipe-line connected the outlet of the sampling tube with the aspirating and sample collection equipment.

Inasmuch as considerable quantities of fly-ash and dust were entrained in the flue gases, means were provided whereby the sampling line could be blown out with compressed air before the start of each test. The samples of gas for analysis were taken from the gas stream and collected over water saturated with gas by the liquid displacement method, using two pairs of 1-gallon aspirator bottles. These bottles were operated alternately, one pair for each 20-minute period, and had a relatively large suction head between them so as to minimize any error due to a change in rate of collection during the sampling period. A Hays' modified Orsat apparatus set up alongside the aspirator bottles was used to analyse the gases for CO_2, O_2, and CO; the N_2 was obtained by difference, and these analyses were used in the calculations for heat losses.

A Ranarex CO_2-meter, indicating and recording, was also used as a control medium. This instrument quickly indicated any sudden changes in furnace conditions and also provided a check on the Orsat determination for CO_2.

The temperature of the flue gas was determined by a base metal thermocouple placed in the boiler offtake at the point marked C_1, Figure 1, page 2, so that it gave the average temperature of the gases passing through. The couple was connected by compensating leads to a multiple-point switch and Brown indicating-pyrometer.

Miscellaneous Observations. Readings of temperatures, pressures, draughts, etc., were made every 15 minutes of each trial, the chief of which are noted below.

The draughts in the offtake and furnace were taken at the points marked d_1 and d_2 on Figure 1, page 2, and were obtained with Ellison inclined tube water gauges.

The quality of the steam was obtained by means of a Carpenter steam calorimeter of the throttling type, equipped with calibrated mercury thermometer and mercury U-tube pressure gauge. This instrument was placed on a vertical section of the steam main at the point marked a_2 on Figure 1, page 2.

The steam pressure in the boiler drum was determined by a Dewrance built pressure gauge of the Bourdon type, which was calibrated before and after each group of tests.

The flame temperatures at various points within the furnace were taken at the beginning, midway, and at the end of each trial, and were determined by means of a Pyro-radiation pyrometer sighted through the secondary air-ports in the front and side walls of the furnace.

All temperatures, with the exception of flue gas and flame temperatures, were measured with calibrated mercury thermometers protected from radiation where necessary by suitable screens. These temperature readings included those of the feed water, the preheated air to the pulverizer, the air-coal stream leaving the pulverizer, the average air in the boiler room, the secondary air, and the air outside the boiler room. The temperature of the coal fed to the pulverizer was assumed to be the same as the average temperature of the air in the boiler room.

The humidity of the air used for combustion was determined by a sling psychrometer each hour of the trial at a point very close to the thermometer measuring the temperature of the secondary air.

The barometric pressure was obtained each hour of the trial from a precision barometer and the average value of these hourly readings was used in the calculation of results.

The power used by the pulverizer was measured by an integrating kilowatt-hour meter, which was checked roughly by an indicating wattmeter that also indicated fluctuations in the pulverizer load.

Observations were also made of smoke, flame, and general combustion conditions, changes in damper and control settings, etc., throughout each trial.

Test Data and Computation of Results. The tests were conducted and the results computed mainly in accordance with the American Society of Mechanical Engineers' test code for stationary steam boilers. All data taken during the trials were recorded on log forms drawn up especially for these tests, and the results worked out from the data observed were recorded on a report form. Data obtained from the Chemical Laboratories, such as screen, proximate and ultimate analyses, determinations of calorific value, the ash fusibility of the fuel as well as the combustible content of the refuse, were submitted by the chemist in charge.

FUELS TESTED AND THEIR RESULTS

BRITISH COLUMBIA COALS

The twelve samples of coal tested were selected and shipped under the direction of the Provincial Government of British Columbia in co-operation with the colliery operators, who supplied the coal gratuitously, and with the Canadian National and Canadian Pacific Railway companies who transported ten carloads of coal free of charge to Ottawa. Shipments were made from the following collieries: Pleasant Valley, Tulameen, South Wellington, Reserve, Coalmont, Middlesboro, Comox, Cassidy, Telkwa, Michel, and Corbin; the coals being representative of the Princeton, Nanaimo, Nicola, Comox, Telkwa, and Crowsnest Pass coal fields of British Columbia. The samples were shipped at monthly intervals, starting immediately after the British Columbia Coal Conference, and were received in Ottawa 10 to 14 days later. Immediately on receipt the samples were unloaded into individual bins in a covered coal storage shed. A large representative sample was taken from the total quantity received into storage at the time of unloading, on which proximate and ultimate analyses, calorific value determinations, ash fusion temperatures, etc., were made. Further analyses, calorific value determinations, etc., were made of a representative sample taken from the quantity used for each test. These analyses will be found in the general tabulation covering the details of the individual tests made on each fuel. (*See* Table XXXIII, in pocket.) Additional information respecting treatment of the fuels during the test will be found on page 6.

In all, forty-seven tests were made on twelve British Columbia coals; four tests being made on each of eleven coals and three on the remaining one. For purposes of standardization and comparison, three tests were made on the operating coal, results of which are included in Tables XXXIII and XXXIV. In general, the tests were made in three groups or periods. The preliminary results of the first group of trials were reported to the British Columbia Provincial Government, and through the Government to the coal operators concerned, and on completion of the test program individual final reports on each coal were prepared and forwarded to the same interested operators. These reports were superseded by a summary of the principal results made public in Mines Branch Memorandum Series No. 56.[1]

Table I lists the twelve British Columbia coals that were tested in comparison with the operating coal—a typical coking coal ranking as a high-grade bituminous slack, well suited for use in the pulverized state, and, moreover, a non-competing Eastern coal chosen for standardization and general use because of its constant quality. Table I gives also the coal areas from which the samples originated, the dates when they were shipped and received in storage, the quantities received, designation of fuel as shipped, approximate sizes as received, the treatment of samples before test, and finally the number of tests from each bulk shipment. Table II lists the fuels in the same order as in Table I and gives the proximate and ultimate analyses and other relative information regarding the respective fuels as they were received in Ottawa.

[1] Summary of Tests on British Columbia Coals when used as Pulverized Fuel; and Notes on Pulverized Fuel Fired Steam Generators *vs.* Other Types; Mines Branch, Dept. of Mines, Mem. Ser. No. 56 (August, 1932).

TABLE I

British Columbia Series: List of Fuels Tested

Sample Mark and Shipment No.	Origin of Sample	Date Shipped	Date Received in Storage	Quantity Received, Short Tons	Rank or Grade	Designation of Fuel	Approximate Size as Received								Treatment before Test	Number of Tests made and Reported
							Diameter of largest lumps	Per cent on 2 inch	Per cent on 1 inch through 2 inch	Per cent on ¾ inch through 1 inch	Per cent on ½ inch through ¾ inch	Per cent on ¼ inch through ½ inch	Per cent through ¼ inch			
A1= 2-29	Six carlot samples of so-called "Operating Coal"; three "standardizing" tests made on two samples underlined. Non-competing eastern coal chosen for standardization and general use.	Oct. 19/29	Oct. 29/29	42·8	Bituminous high grade	¾" slack, steam coal	Slack coal all under ¾-inch size as received								††	For general use
A2= 7-30		Jan. 11/30	Jan. 23/30	42·8	"	"									††	1
A3=12-30		Mar. 3/30	Mar. 15/30	42·5	"	"	Approximately								††	For general use
A4=16-30		May 8/30	May 21/30	31·7	"	"									††	2
A5=18-30		May 26/30	June 10/30	41·0	"	"									††	For general use.
A6=21-30		July 17/30	July 30/30	47·4	"	"									††	"
B = 5-29.....	Princeton area	Nov. 12/29	Nov. 29/29	20·0	"Lignitic", sub-bit.	Lump coal	Mostly lump coal 3" to 4" dia., with considerable proportion of fines.								—	4
C = 4-29.....	"	"	"	23·8	"	Mine run	6"	30	20			50			—	4
D = 8-30.....	"	Jan. 11/30	Feb. 3/30	41·5	Bituminous	Mine run, steam coal	4"	30	20		20		30		—	4
E = 6-29.....	Nicola area	Dec. 10/29	Dec. 26/29	32·2	"	Lump coal	6"	60	20	.....		20			—	4
F =10-30.....	Nanaimo area	Feb. 8/30	Feb. 24/30	17·2	"	Washed slack	½"	....	.....	.....	.....	10	90		††	4
G = 9-30.....	"	"	"	18·5	"	"	1"	....	.....	.....	.....	10	90		††	4
H =17-30.....	"	April 28/30	May 13/30	46·5	"	Washed slack, coking coal	1"	....	10			90			—	4
I =19-30.....	Comox area	May 23/30	June 10/30	43·5	"	Washed pea coal	½"	....	.....	.....	.....	10	90		††	4
J =13-30.....	Telkwa area	Mar. 10/30	Mar. 24/30	30·0	"	Lump coal	18"	80	20						††	4
K = 3-31.....	Crowsnest Pass area	April 11/31	April 28/31	14·4	"	Birdseye, ¼ slack	½"	....	.....	.....	.....	4	96		††	4
L = 2-31.....	"	"	"	14·3	"	Washed steam, slack coal	1½"	....	2	10	15	40	33		—	4
M =20-30.....	"	June 18/30	June 27/30	30·2	"	Mine run....	1½"	....	30		30		40		—	3

Required quantity—(gross sample for test)—drawn from storage bin, passed through gyratory crusher, then passed over a 1-inch square mesh screen. Coal not passing rocrushed and rescreened, all passing mixed and sampled while bagging in 100-pound lots. Bagged coal delivered to boiler room floor for test. Sample—(quantity for analysis)—treated by approved methods and sent to Chemical Laboratories for screen, proximate and ultimate analyses; calorific value, apparent gravity and ash fusibility determinations, etc.

* Arranged in the same order in which the respective fuels are tabulated in Table XXXIII (in pocket).

† These numbers were assigned to the coal samples as they were received in storage and have been retained throughout this report for convenient reference. They have no other significance.

†† Coal sampled and bagged as drawn from bin, needed neither crushing nor screening.

TABLE II

British Columbia Series: Proximate and Ultimate Analyses, etc., of a Representative Sample of the Total Bulk Shipment of Each Fuel, Taken at Time of Unloading into Bins in Covered Storage Shed

Sample Mark and Shipment No.	Moisture Condition of Sample	Proximate Analysis				Ultimate Analysis						Calorific Value B.T.U./lb. gross	Fuel Ratio F.C./V.M.	Carbon hydrogen ratio	Coking Properties	Ash Fusibility		
		Moisture	Ash	Volatile Matter	Fixed Carbon	Carbon	Hydrogen	Ash	Sulphur	Nitrogen	Oxygen					Initial Temperature °F.	Softening Temperature °F.	Fluid Temperature °F.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent							
Six carlot samples of so-called "Standard" Operating Coal*																		
A_1= 2-29	As received..	3·1	8·4	32·6	55·9	76·8	5·4	8·4	1·1	1·6	6·7	13,570	.....	14·3				
	Air-dried....	1·2	8·6	33·3	56·9	78·3	5·2	8·6	1·1	1·7	5·1	13,830	1·70	14·9	Good....	2,565	2,639	2,697
	Dry.....	.....	8·7	33·7	57·6	79·3	5·2	8·7	1·1	1·7	4·0	14,000	.....	15·3				
A_2= 7-30	As received..	4·0	8·6	30·4	57·0	75·4	5·3	8·6	1·2	1·7	7·8	13,450	.....	14·1				
	Air-dried....	1·3	8·8	31·2	58·7	77·5	5·2	8·8	1·3	1·7	5·5	13,830	1·90	15·0	Good....	2,497	2,575	2,680
	Dry.....	.....	8·9	31·7	59·4	78·6	5·1	8·9	1·3	1·7	4·4	14,010	.....	15·4				
A_3=12-30	As received..	4·7	8·1	31·1	56·1	75·2	5·4	8·1	1·1	1·6	8·6	13,350	.....	13·9				
	Air dried....	1·2	8·4	32·2	58·2	78·0	5·2	8·4	1·2	1·6	5·6	13,850	1·80	15·0	Good....	2,467	2,548	2,624
	Dry.....	.....	8·5	32·6	58·9	78·9	5·1	8·5	1·2	1·7	4·6	14,020	.....	15·4				
A_4=16-30	As received..	4·9	8·3	31·0	55·8	74·5	5·4	8·3	1·1	1·6	9·1	13,260	.....	13·7				
	Air-dried....	1·3	8·6	32·1	58·0	77·3	5·2	8·6	1·2	1·7	6·0	13,770	1·80	14·9	Good....	2,449	2,593	2,593+
	Dry.....	.....	8·7	32·6	58·7	78·3	5·1	8·7	1·2	1·7	5·0	13,940	.....	15·3				
A_5=18-30	As received..	3·0	7·9	31·0	58·1	76·1	5·4	7·9	1·2	1·3	8·1	13,640	.....	14·2				
	Air-dried....	1·2	8·1	31·6	59·1	77·5	5·3	8·1	1·2	1·3	6·6	13,890	1·85	14·8	Good....	2,450	2,607	2,607+
	Dry.....	.....	8·2	31·9	59·9	78·5	5·2	8·2	1·2	1·3	5·6	14,060	.....	15·2				
A_6=21-30	As received..	3·0	8·4	32·1	56·5	76·2	5·2	8·4	1·3	1·5	7·4	13,600	.....	14·8				
	Air-dried....	1·7	8·5	32·6	57·2	77·3	5·1	8·5	1·3	1·5	6·3	13,780	1·75	15·3	Good....	2,499	2,610	2,610+
	Dry.....	.....	8·7	33·1	58·2	78·6	5·0	8·7	1·3	1·5	4·9	14,010	.....	15·9				
B = 5-29	As received..	24·2	13·3	26·0	36·5	47·2	5·9	13·3	0·7	1·3	31·6	8,160	.....	8·0				
	Air-dried....	19·8	14·0	27·6	38·6	49·9	5·6	14·0	0·7	1·4	28·4	8,630	1·40	9·0	Non-coking	1,996	2,093	2,261
	Dry.....	.....	17·5	34·4	48·1	62·3	4·2	17·5	0·9	1·7	13·4	10,770	.....	14·9				
C = 4-29	As received..	21·1	8·6	28·9	41·4	54·2	5·9	8·6	0·3	1·6	29·4	9,380	.....	9·1	Non-coking..			
	Air-dried....	17·8	8·9	30·1	43·2	56·5	5·7	8·9	0·4	1·6	26·9	9,770	1·45	9·9		1,994	2,118	2,198
	Dry.....	.....	10·9	36·6	52·5	68·7	4·5	10·9	0·5	2·0	13·4	11,890	.....	15·2				
D = 8-30	As received..	7·7	13·0	34·0	45·3	63·7	5·2	13·0	0·4	1·3	16·4	11,190	.....	12·3				
	Air-dried....	4·1	13·5	35·3	47·1	66·2	5·0	13·5	0·4	1·3	13·6	11,630	1·35	13·3	Poor....	2,082	2,239	2,462
	Dry.....	.....	14·1	36·8	49·1	69·0	4·7	14·1	0·4	1·4	10·4	12,130	.....	14·7				

TABLE II—*Concluded*

Sample Mark and Shipment No.	Moisture Condition of Sample	Proximate Analysis				Ultimate Analysis						Calorific Value B.T.U./lb. gross	Fuel Ratio F.C./V.M.	Carbon hydrogen ratio	Coking Properties	Ash Fusibility		
		Moisture	Ash	Volatile Matter	Fixed Carbon	Carbon	Hydrogen	Ash	Sulphur	Nitrogen	Oxygen					Initial Temperature °F.	Softening Temperature °F.	Fluid Temperature °F.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent							
E = 6-29	As received	9·5	10·8	36·0	43·7	63·8	5·7	10·8	0·6	1·7	17·4	11,420	.....	11·2	Poor	2,475	2,588	2,588+
	Air-dried	7·4	11·1	36·8	44·7	65·3	5·5	11·1	0·6	1·7	15·8	11,670	1·20	11·8				
	Dry	.....	11·9	39·8	48·3	70·5	5·2	11·9	0·6	1·9	9·9	12,600	.....	13·8				
F = 10-30	As received	7·7	17·4	33·8	41·1	61·7	5·0	17·4	0·9	1·3	13·7	11,080	.....	12·4	Fair	2,070	2,145	2,320
	Air-dried	1·6	18·5	36·1	43·8	65·8	4·6	18·5	1·0	1·3	8·8	11,810	1·20	14·3				
	Dry	.....	18·8	36·7	44·5	66·9	4·5	18·8	1·0	1·4	7·4	12,010	.....	14·9				
G = 9-30	As received	6·7	13·8	35·8	43·7	65·6	5·4	13·8	0·8	1·3	13·1	11,740	.....	12·1	Fair	2,045	2,223	2,241
	Air-dried	1·7	14·5	37·7	46·1	69·2	5·1	14·5	0·8	1·4	9·0	12,380	1·20	13·5				
	Dry	.....	14·7	38·4	46·9	70·4	5·0	14·7	0·9	1·4	7·6	12,590	.....	14·1				
H = 17-30	As received	4·9	12·3	36·3	46·5	69·2	5·5	12·3	0·5	1·5	11·0	12,340	.....	12·6	Fair	2,267	2,307	2,340
	Air-dried	1·8	12·7	37·5	48·0	71·5	5·3	12·7	0·6	1·5	8·4	12,740	1·30	13·4				
	Dry	.....	12·9	38·2	48·9	72·8	5·2	12·9	0·6	1·6	6·9	12,970	.....	14·0				
I = 19-30	As received	5·3	14·2	29·5	51·0	67·8	5·3	14·2	1·4	0·9	10·4	12,180	.....	12·9	Good	2,434	2,459	2,502
	Air-dried	1·4	14·7	30·7	53·2	70·7	5·0	14·7	1·5	0·9	7·2	12,680	1·75	14·1				
	Dry	.....	15·0	31·1	53·9	71·6	4·9	15·0	1·5	1·0	6·0	12,860	.....	14·6				
J = 13-30	As received	5·4	12·4	29·9	52·3	70·2	5·0	12·4	1·1	0·9	10·4	12,440	.....	13·9	Good	2,148	2,170	2,278
	Air-dried	1·1	13·0	31·2	54·7	73·3	4·8	13·0	1·1	0·9	6·9	13,000	1·75	15·4				
	Dry	.....	13·1	31·6	55·3	74·2	4·7	13·1	1·1	0·9	6·0	13,140	.....	15·8				
K = 3-31	As received	5·0	16·8	21·4	56·8	68·5	4·4	16·8	0·2	1·0	9·1	11,665	.....	15·7	Poor	2,600	2,700+	2,700+
	Air-dried	1·8	17·4	22·1	58·7	70·7	4·1	17·4	0·3	1·0	6·5	12,051	2·65	17·2				
	Dry	.....	17·7	22·5	59·8	72·0	4·0	17·7	0·3	1·0	5·0	12,270	.....	18·0				
L = 2-31	As received	4·5	12·8	23·0	59·7	72·4	4·5	12·8	0·3	1·0	9·0	12,640	.....	16·0	Poor	2,375	2,485	2,645
	Air-dried	1·5	13·3	23·7	61·5	74·6	4·3	13·3	0·3	1·0	6·5	13,030	2·60	17·3				
	Dry	.....	13·4	24·1	62·5	75·8	4·2	13·4	0·3	1·1	5·2	13,230	.....	18·0				
M = 20-30	As received	1·9	6·1	27·9	64·1	80·5	5·1	6·1	0·7	1·3	6·3	14,260	.....	15·7	Good	1,962	2,032	2,347
	Air-dried	0·8	6·2	28·2	64·8	81·4	5·1	6·2	0·6	1·3	5·4	14,430	2·30	16·1				
	Dry	.....	6·2	28·4	65·4	82·1	5·0	6·2	0·7	1·3	4·7	14,540	.....	16·4				

* This fuel was used for light-off, preheating, and standardizing. (*See* page 4). The analyses give an idea of the constant properties of this coal.

ALBERTA AND ONTARIO COALS

The Alberta tests were made on representative samples supplied by colliery operators, the Research Council of Alberta arranging for their selection, sampling, and shipment to Ottawa. The Canadian National Railway and the Canadian Pacific Railway transported eleven carloads of Alberta coal to Ottawa free of charge from the following collieries: Bighorn Saunders, Hillcrest, International Luscar, McGillivray Creek, Mountain Park (two samples), Cadomin, West Canadian, Brazeau, and Canmore. These samples were representative of the coals in the Saunders Creek, Crowsnest Pass, Mountain Park, Nordegg, and Cascade coal areas, and were shipped at intervals during the autumn of 1931. The burning tests were made during February and March, 1932, after which reports were prepared for each of the coals tested and were forwarded to the respective colliery operators concerned; and, later, a full set of reports was furnished to the Research Council of Alberta.

During the series of tests on Alberta coals and Ontario lignite, seventeen trials were made on twelve different fuels. The three tests, each at different rates of combustion, made on the operating coal during the British Columbia series were used for comparison. One test at a constant rate of combustion (medium rate of coal feed) was made on each of eleven Alberta coals, and six tests were made on four samples of Ontario lignite. Final reports on each fuel were prepared and forwarded to the interested coal operators, as well as to the Provincial Government agencies concerned.

The Ontario lignite tests were made on carlot samples supplied and shipped to Ottawa by the Ontario Government from the Onakawana lignite deposits at Blacksmith Rapids in Northern Ontario and were representative of the lower seam in the original (old) Shaft No. 1 and of the lower seam in the (new) shaft W, more centrally placed in the deposit. The first five tests were made on lignite from the (old) Shaft No. 1, and the sixth and final burning test was made on lignite from the (new) shaft W. A final report was prepared after these tests, and copies were sent to the Ontario Department of Mines and The Ontario Research Foundation.

The samples from Alberta and Ontario were immediately unloaded into individual bins in a covered coal-storage shed. A large representative sample was taken at the time of unloading into storage, and on this screen, proximate, and ultimate analyses, calorific value determinations, ash fusion temperatures, etc., were made. The results of further analyses, determinations of calorific value, etc., of a representative sample taken from the quantity used for each burning test, will be found in Table XXXIV, in pocket.

Table III lists the various Alberta coals and Ontario lignite that were tested in comparison with the same operating coal as was used with the British Columbia coals. It gives also the coal areas from which each sample originated, the dates it was shipped and received in storage, the quantity received, designation of the fuel as shipped, approximate size as received, the treatment of the sample before test, and finally the number of tests made. Table IV lists the fuels in the same order as in Table III and gives the proximate and ultimate analyses and other relative information regarding the respective fuels as they were received in Ottawa.

TABLE III

Alberta-Ontario Series: List of Fuels Tested*

Sample Mark and Shipment No.†	Origin of Sample	Date Shipped	Date Received in Storage	Quantity received, short tons	Rank or Grade	Designation of Fuel	Approximate Size as Received	Treatment before Test	Number of Tests made and Reported
A1= 2-29	Non-competing Eastern Coal Chosen for Standardization and General Use.	Oct. 19/29	Oct. 29/29	42·8	Bituminous, high grade	¾" slack steam coal	Slack Coal all under ¾-inch size as received	††	For general use
A2= 7-30		Jan. 11/30	Jan. 23/30	42·8	"	"		††	1
A3=12-30		Mar. 3/30	Mar. 15/30	42·5	"	"	Screen Analysis	††	For general use
A4=16-30		May 8/30	May 21/30	31·7	"	"		††	2
A5=18-30		May 26/30	June 10/30	41·0	"	"		††	For general use
A6=21-30		July 17/30	July 30/30	47·4	"	"		††	"

Six carlot samples of so-called "Operating Coal"; three "standardizing" tests made on two samples underlined

Sample Mark and Shipment No.†	Per cent on 3-inch screen	Per cent on 2-inch screen	Per cent on 1½-inch screen	Per cent on 1-inch screen	Per cent on ¾-inch screen	Per cent on ½-inch screen	Per cent on ¼-inch screen	Per cent on ⅛-inch screen	Per cent through ⅛-inch screen
N =28-30	....	....	....	....	9·7	20·5	34·4	19·4	16·0
O =29-31	....	1·3	6·0	6·6	9·3	9·9	26·2	14·5	26·2
P =18-31	....	....	0·6	2·1	4·0	3·8	13·4	17·2	58·9
Q =26-31	....	3·2	2·8	3·8	5·7	5·4	15·2	16·5	47·4
R =23-31	....	....	2·3	4·7	9·0	8·5	20·0	17·0	38·5
S =20-31	2·2	1·6	4·6	4·0	6·9	7·3	19·2	19·3	34·9
T =24-31	4·8	6·2	5·0	3·9	....	8·9	20·7	15·7	34·8
U =21-31	....	0·9	0·9	0·9	....	5·5	20·5	20·5	50·8
V =22-31	....	....	0·7	3·6	11·1	12·5	32·8	17·5	21·8
W =25-31	....	1·4	2·3	2·3	3·4	4·3	13·7	16·8	55·8
X =28-31	....	....	....	0·8	3·0	6·7	7·4	21·6	60·5
Y1=11-30	60 per cent lumps up to 12" dia. 40 per cent slack.								
Y2=14-30	50 per cent lumps up to 6" dia. 50 per cent slack.								
Y3=15-30	50 per cent lumps up to 6" dia. 50 per cent slack.								
Z =10-31	20·2	8·8	8·0	7·4	7·4	5·9	12·5	9·4	20·4

Sample Mark and Shipment No.†	Treatment before Test	Number of Tests made and Reported
N =28-30	††	1
O =29-31	—	1
P =18-31	—	1
Q =26-31	—	1
R =23-31	—	1
S =20-31	—	1
T =24-31	—	1
U =21-31	—	1
V =22-31	—	1
W =25-31	—	1
X =28-31	††	1
Y1=11-30	—	3
Y2=14-30	—	1
Y3=15-30	—	1
Z =10-31	—	1

Required quantity (gross sample for test) drawn from bin, passed through gyratory crusher, then passed over a 1-inch square mesh screen. Coal not passing recrushed and rescreened, all passing mixed and sampled while bagging in 100-pound lots. Bagged coal delivered to boiler room floor for test. Sample (quantity for analysis) treated by approved methods and sent to Chemical Laboratories for screen, proximate and ultimate analyses, calorific value, apparent gravity and ash fusibility determinations, etc.

* Arranged in the same order in which the respective fuels are tabulated in Table XXXIV (in pocket).
† These numbers were assigned to the coal samples as they were received in storage.
†† Coal sampled and bagged as drawn from bin, needed neither crushing nor screening.

TABLE IV

Proximate and Ultimate Analyses, etc., of a Representative Sample of the Total Bulk Shipment of Each Fuel, Taken at Time of Unloading into Bins in Covered Storage Shed

Sample Mark and Shipment No.	Moisture Condition of Sample	Proximate Analysis				Ultimate Analysis						Calorific Value B.T.U. per lb. gross	Fuel ratio F.C./V.M.	Carbon-hydrogen Ratio	Coking Properties	Ash Fusibility		
		Moisture	Ash	Volatile Matter	Fixed Carbon	Carbon	Hydrogen	Ash	Sulphur	Nitrogen	Oxygen					Initial Temperature °F.	Softening Temperature °F.	Fluid Temperature °F.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent							
Six oariot samples of so-called "Standard" Operating Coal*																		
A_1= 2-29	As received	3·1	8·4	32·6	55·9	76·8	5·4	8·4	1·1	1·6	6·7	13,570	.....	14·3	Good...	2,565	2,639	2,697
	Air-dried	1·2	8·6	33·3	56·9	78·3	5·2	8·6	1·1	1·7	5·1	13,830	1·70	14·9				
	Dry	.....	8·7	33·7	57·6	79·3	5·2	8·7	1·1	1·7	4·0	14,000	.....	15·3				
A_2= 7-30	As received	4·0	8·6	30·4	57·0	75·4	5·3	8·6	1·2	1·7	7·8	13,450	.....	14·1	Good...	2,497	2,575	2,680
	Air-dried	1·3	8·8	31·2	58·7	77·5	5·2	8·8	1·3	1·7	5·5	13,830	1·90	15·0				
	Dry	.....	8·9	31·7	59·4	78·6	5·1	8·9	1·3	1·7	4·4	14,010	.....	15·4				
A_3=12-30	As received	4·7	8·1	31·1	56·1	75·2	5·4	8·1	1·1	1·6	8·6	13,350	.....	13·9	Good...	2,467	2,548	2,624
	Air-dried	1·2	8·4	32·2	58·2	78·0	5·2	8·4	1·2	1·6	5·6	13,850	1·80	15·0				
	Dry	.....	8·5	32·6	58·9	78·9	5·1	8·5	1·2	1·7	4·6	14,020	.....	15·4				
A_4=16-30	As received	4·9	8·3	31·0	55·8	74·5	5·4	8·3	1·1	1·6	9·1	13,260	.....	13·7	Good...	2,449	2,593	2,593+
	Air-dried	1·3	8·6	32·1	58·0	77·3	5·2	8·6	1·2	1·7	6·0	13,770	1·80	14·9				
	Dry	.....	8·7	32·6	58·7	78·3	5·1	8·7	1·2	1·7	5·0	13,940	.....	15·3				
A_5=18-30	As received	3·0	7·9	31·0	58·1	76·1	5·4	7·9	1·2	1·3	8·1	13,640	.....	14·2	Good...	2,450	2,607	2,607+
	Air-dried	1·2	8·1	31·6	59·1	77·5	5·3	8·1	1·2	1·3	6·6	13,890	1·85	14·8				
	Dry	.....	8·2	31·9	59·9	78·5	5·2	8·2	1·2	1·3	5·6	14,060	.....	15·2				
A_6=21-30	As received	3·0	8·4	32·1	56·5	76·2	5·2	8·4	1·3	1·5	7·4	13,600	.....	14·8	Good...	2,499	2,610	2,610+
	Air-dried	1·7	8·5	32·6	57·2	77·3	5·1	8·5	1·3	1·5	6·3	13,780	1·75	15·3				
	Dry	.....	8·7	33·1	58·2	78·6	5·0	8·7	1·3	1·5	4·9	14,010	.....	15·9				
N =28-30	As received	9·8	9·0	31·9	49·3	64·5	5·3	9·0	0·3	0·9	20·0	11,150	.....	12·3	Non-coking	2,050	2,210	2,310
	Air-dried	8·0	9·1	32·6	50·3	65·8	5·1	9·1	0·4	0·9	18·7	11,370	1·55	12·7				
	Dry	.....	9·9	35·4	54·7	71·5	4·6	9·9	0·4	1·0	12·6	12,360	.....	15·4				
O =29-31	As received	1·2	16·1	28·5	54·2	71·6	4·5	16·1	0·9	1·1	5·8	12,580	.....	15·8	Fair....	2,490	2,635	2,700+
	Air-dried	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1·90	.....				
	Dry	.....	16·3	28·8	54·9	72·5	4·4	16·3	0·9	1·1	4·8	12,740	.....	16·3				
P =18-31	As received	1·3	13·1	24·4	61·2	73·9	4·3	13·1	0·6	1·1	7·0	12,870	.....	17·2	Fair....	2,700+	2,700+	2,700+
	Air-dried	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2·50	.....				
	Dry	.....	13·3	24·7	62·0	74·9	4·2	13·3	0·6	1·1	5·9	13,040	.....	17·7				
Q =26-31	As received	1·9	14·2	20·1	63·8	75·1	4·3	14·2	0·3	1·1	5·0	13,120	.....	17·4	Good...	2,500	2,600	2,700+
	Air-dried	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3·20	.....				
	Dry	.....	14·5	20·5	65·0	76·5	4·2	14·5	0·3	1·1	3·4	13,360	.....	18·3				

TABLE IV—*Concluded*

Sample Mark and Shipment No.	Moisture Condition of Sample	Proximate Analysis				Ultimate Analysis						Calorific Value B.T.U. per lh. gross	Fuel Ratio F.C. / V.M.	Carbon-hydrogen Ratio	Coking Properties	Ash Fusibility		
		Moisture	Ash	Volatile Matter	Fixed Carbon	Carbon	Hydrogen	Ash	Sulphur	Nitrogen	Oxygen					Initial Temperature °F.	Softening Temperature °F.	Fluid Temperature °F.
		per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent							
R =23-31	As received	1·7	13·3	23·9	61·1	73·5	4·4	13·3	0·5	1·2	7·1	12,800		16·7				
	Air-dried												2·55		Poor...	2,700+	2,700+	2,700+
	Dry		13·5	24·3	62·2	74·8	4·3	13·5	0·5	1·2	5·7	13,010		17·5				
S =20-31	As received	6·6	11·0	26·5	55·9	72·2	5·1	11·0	0·3	1·1	10·3	12,770		14·2				
	Air-dried	1·1	11·7	28·1	59·1	76·4	4·7	11·7	0·3	1·2	5·7	13,530	2·10	16·2	Good...	2,250	2,380	2,510
	Dry		11·8	28·4	59·8	77·3	4·6	11·8	0·4	1·2	4·7	13,680		16·7				
T =24-31	As received	1·1	12·1	25·8	61·0	76·4	4·6	12·1	0·3	1·1	5·5	13,500		16·7				
	Air-dried												2·35		Good...	2,290	2,460	2,590
	Dry		12·2	26·1	61·7	77·3	4·5	12·2	0·3	1·1	4·6	13,650		17·1				
U =21-31	As received	1·9	13·3	28·6	56·2	74·0	4·8	13·3	0·6	1·2	6·1	13,190		15·4				
	Air-dried												1·95		Good...	2,225	2,420	2,680
	Dry		13·6	29·2	57·2	75·4	4·7	13·6	0·6	1·2	4·5	13,440		16·1				
V =22-31	As received	1·3	10·9	23·5	64·3	77·8	4·7	10·9	0·4	1·2	5·0	13,510		16·6				
	Air-dried												2·75		Good...	2,700+	2,700+	2,700+
	Dry		11·0	23·8	65·2	78·8	4·6	11·0	0·5	1·2	3·9	13,690		17·2				
W =25-31	As received	2·1	12·3	15·2	70·4	78·0	4·2	12·3	0·5	1·2	3·8	13,440		18·5				
	Air-dried	0·6	12·5	15·5	71·4	79·1	4·1	12·5	0·5	1·2	2·6	13,640	4·60	19·2	Fair....	2,700+	2,700+	2,700+
	Dry		12·6	15·5	71·9	79·6	4·1	12·6	0·5	1·2	2·0	13,730		19·5				
X =28-31	As received	2·7	11·4	13·9	72·0	77·1	4·1	11·4	0·7	1·6	5·1	13,240		18·8				
	Air-dried	0·6	11·7	14·2	73·5	78·7	4·0	11·7	0·7	1·6	3·3	13,520	5·20	19·9	Poor...	2,360	2,440	2,700+
	Dry		11·7	14·3	74·0	79·3	3·9	11·7	0·7	1·7	2·7	13,610		20·3				
Y_1=11-30	As received	51·8	6·9	19·6	21·7	29·9	7·8	6·9	1·0	0·3	54·1	5,020		3·9				
	Air-dried	18·3	11·7	33·2	36·8	50·8	5·4	11·7	1·7	0·5	29·9	8,510	1·10	9·4	Non-coking	1,951	1,976	1,985
	Dry		14·3	40·7	45·0	62·1	4·1	14·3	2·1	0·7	16·7	10,410		15·2				
Y_2=14-30	As received	33·7	11·5	25·9	28·9	39·7	6·4	11·5	1·1	0·5	40·8	6,610		6·3				
	Air-dried	18·2	14·2	32·0	35·6	49·0	5·2	14·2	1·3	0·6	29·7	8,160	1·10	9·4	Non-coking	1,934	2,005	2,066
	Dry		17·4	39·1	43·5	59·9	3·9	17·4	1·6	0·7	16·5	9,970		15·4				
Y_3=15-30	As received	25·9	16·9	27·7	29·5	41·5	5·5	16·9	1·3	0·5	34·3	6,750		7·5				
	Air-dried	17·3	18·9	30·9	32·9	46·3	4·9	18·9	1·4	0·6	27·9	7,540	1·05	9·5	Non-coking	1,925	1,999	2,061
	Dry		22·9	37·3	39·8	56·0	3·5	22·9	1·7	0·7	15·2	9,110		15·8				
Z =10-31	As received	36·3	7·0	27·1	29·6	40·2	6·8	7·0	0·8	0·4	44·8	6,630		5·9				
	Air-dried	25·2	8·3	31·8	34·7	47·2	6·0	8·3	0·9	0·5	37·1	7,790	1·10	7·9	Non-coking	2,030	2,210	2,235
	Dry		11·1	42·5	46·4	63·2	4·2	11·1	1·2	0·6	19·7	10,420		14·8				

* This fuel was used for light-off and preheating for tests made with Ontario lignite and for general use and standardizing. (*See* page 4.) The analyses give an idea of the constant properties of this coal.

DETAILED RESULTS

The detailed data and results of the forty-seven tests on British Columbia coals are shown for comparison in Table XXXIII. Seventy-eight items of information are tabulated for each test; the tests for each coal are arranged progressively in the order of increasing rates of combustion; and finally the coals themselves, exclusive of the operating coal, are arranged roughly in the order of increasing calorific value. The tabulated information given in Table XXXIII, which forms the actual basis of this part of the report, presents the results in detail much better than can be done by any written description.

The detailed results of the twenty tests on Alberta coal and Ontario lignite are shown in Table XXXIV. The tests for the operating coal are arranged in the order of combustion rates; and the fuels themselves, exclusive of the operating coal which is listed first and the Ontario lignite which is listed last, are arranged in the order of increasing calorific value.

The distinguishing numbers of the coal samples have been retained throughout this report simply for convenient reference.

SALIENT RESULTS SUMMARIZED

All seventy-eight items of information tabulated in Tables XXXIII and XXXIV (in pocket) will be self-explanatory to fuel engineers, conversant with the standardized test methods and procedure, but non-technical readers, interested from a marketing standpoint only, probably appreciate a summary of the more salient results whereby they obtain a general idea of the relative merits of the various coals tested. The more important items for three different tests (one each at low, medium, and high rates of combustion respectively) on each British Columbia coal are, therefore, summarized in Table V, and those for the eleven Alberta coals and the four Ontario lignites in Table VI.

The first item in these tables gives the duration of the respective trials of each coal. The second, third, fourth, and fifth items summarize the chemical properties of the coals tested in respect to moisture and ash content, gross heating value, and ash fusion temperature, which roughly indicates the point at which the ash and refuse begins to soften. The sixth and seventh items give the quantity of the fuel fired per hour and per unit of steam production. The eighth item gives the quantity of heat liberated in the furnace per unit of combustion space and is an indication of the heat load handled by the furnace. The next five items give the fineness of pulverization, the power used to pulverize one ton of fuel, and the rate of grinding based on the rated capacity of the pulverizer. The remaining six items give an idea of the combustion and steam-producing properties of the fuels tested.

The above items are arranged so as to permit of ready comparison between the three tests on each British Columbia fuel. Comparisons between tests on different fuels, however, are apt to be misleading without a full understanding of the many variable factors involved, and should only be made between tests having similar rates of combustion or coal feed.

PRINCIPAL RESULTS OF BRITISH COLUMBIA COALS AVERAGED

Table VII gives the average values of the principal results for all tests on each British Columbia fuel. The coals range in rank from lignitic to high-grade bituminous and are arranged in the order of increasing (as fired) calorific value, which brings them roughly in line in respect to their rank as indicated by the Specific Volatile Index, as well as in respect to certain of their chemical and physical characteristics. Moreover, as the average efficiencies and overall combustion conditions hold uniform for all the fuels, it was to be expected that the fuel fired per unit of evaporation, the equivalent evaporation per unit of fuel fired, the heat liberated per unit of furnace volume, and the rated boiler capacity developed, all grade themselves, more or less, directly with calorific value. The main features brought out by the data given in Table VII are more fully discussed in pages 27 to 38.

MISCELLANEOUS RESULTS

Although numerous observations were made during each test relative to: light-off characteristics of the fuel, smoke, flame, and general combustion conditions; changes in damper and control settings; character, disposition, and quantities of refuse produced, etc., such general data are difficult to tabulate in such a way as to give a clear-cut comparison of the different fuels. To reproduce the voluminous notes taken would merely confuse the issue, and such information is dealt with only in a very general way; its usefulness depends so much on the personal element involved in both taking and interpretation.

In general the light-off characteristics of all the fuels were good, no difficulty being experienced in regard to their ignition even in a cold setting. As would be expected the higher volatile fuels ignited more quickly than the lower. Once alight, the fuels burned with a short cloudy but steady flame, which gradually lengthened and cleared in colour as the heat became greater. Steam was quickly raised with all the fuels, so that full steam pressure was obtained in a few minutes. Invariably some dark smoke was noticeable at the chimney top during the light-off period when a rich fuel mixture was fed to the burner. After stabilized combustion conditions were obtained, however, the smoke became practically negligible, except at times of irregular coal feed when occasional puffs of dark smoke were noticed, until rectified by the proper control adjustments. At no time (except during the initial light-off) could the smoke of any of the fuels be said to be objectionable. Generally speaking, however, the fuels of higher rank produced the hotter and clearer flame. At all rates of combustion, more particularly medium and high, the flame practically filled the furnace, in which it followed a U-shaped path in a lazy turbulent sweep, just clearing the floor and side and rear walls without actually impinging on them. Irregular rates of coal feed had the effect of producing slight pulsations in the flame, which also lightened or darkened in colour as the fuel mixture became leaner or richer.

Overall combustion and control conditions were surprisingly uniform for such an extended series of tests on such a variety of fuels. Momentary irregularity in the coal feed caused by wet or unevenly graded (not intimately mixed in the various sizes) coal was the main reason for variation in combustion conditions and necessitated the majority of the alterations in damper and control settings during the tests. The refuse obtained from the several fuels varied so widely in nature, colour, quantity, and disposition in the furnace and setting, that no general statement can be made. The reader is therefore referred to the data given under the heading of "Refuse, Ash, and Carbon" in Tables XXXIII and XXXIV (in the pocket). Some fuels of low ash fusibility produced a refuse easily handled and removed even when hot, whereas others with higher fusion temperature produced a refuse extremely difficult to deal with either when hot or cold. Non- or poorly-coking coals of low ash fusibility gave less trouble than heavily coking coals of the same or even higher fusion temperature, and coals of lignitic rank and of extremely high ash fusibility gave the least trouble.

TABLE V

British Columbia Series: Summarized Results for Three Tests at Different Rates of Combustion on Each of Thirteen Coals*

No. †	Item	Approx. Combustion or Feed Rate of Coal, lb./hr.	Operating Coal Mark and Number	British Columbia Coal Mark and Number											
			A_2 & A_4 7 & 16–30	B 5–29	C 4–29	D 8–30	E 6–29	F 10–30	G 9–30	H 17–30	I 19–30	J 13–30	K 3–31	L 2–31	M 20–30
3	Duration of trial in hours.....	200	8·08	8·05	8·10	8·05	7·93	7·93	8·10	7·92	7·98	7·98	7·98	8·00	7·98
		400	8·13	7·83	8·57	7·88	7·93	8·03	7·98	7·97	7·97	7·98	8·00	8·02	7·98
		600	8·00	8·00	8·04	8·04	8·04	8·02	8·00	8·05	8·00	8·05	8·17	8·00	8·00
5a	Moisture in fuel as fired...per cent	200	3·7	23·5	20·0	14·9	9·4	5·4	4·5	3·6	3·7	4·1	4·1	4·1	2·2
		400	3·3	23·5	20·3	8·2	8·8	6·4	5·5	3·8	3·9	5·0	4·2	3·8	2·0
		600	1·8	22·9	19·7	7·9	9·3	5·3	3·9	3·0	3·9	3·2	4·9	3·9	1·7
5b	Ash in fuel as fired.....per cent	200	9·5	12·7	8·7	10·7	12·0	17·9	13·8	12·0	14·8	12·6	16·8	12·6	7·4
		400	8·7	13·6	9·3	11·6	12·0	16·3	14·0	12·2	14·3	12·8	16·7	13·1	5·9
		600	8·3	13·3	9·5	10·3	11·3	17·2	13·5	11·6	14·6	12·8	16·9	12·7	7·7
7a	Calorific value of fuel as fired, gross value.....B.T.U/lb.	200	13,240	8,320	9,570	10,490	11,270	11,240	12,000	12,510	12,210	12,610	11,910	12,600	13,940
		400	13,470	8,080	9,270	11,250	11,360	11,380	11,900	12,440	12,290	12,470	11,770	12,610	14,280
		600	13,700	8,110	9,360	11,450	11,230	11,330	12,140	12,630	12,250	12,820	11,680	12,540	13,950
11b	Fusion-point of ash.....°F.	200	2593	2093	2145	2239	2588	2145	2223	2307	2459	2170	2700+	2590	2050
		400	2575	2093	2118	2239	2588	2145	2223	2307	2459	2170	2700+	2590	2032
		600	2593	2093	2118	2239	2588	2145	2223	2307	2459	2170	2700+	2590	2032
14b	Weight of fuel fired per hour....lb.	200	197	198	197	198	201	201	196	201	199	199	200	200	200
		400	392	408	419	405	403	397	399	400	400	400	400	399	400
		600	598	598	595	596	595	597	599	595	598	595	588	600	548
14d	Weight of fuel fired per 1,000 lb. of equivalent evaporation....lb.	200	109·1	169·2	141·6	127·7	131·4	125·2	115·8	109·4	115·6	111·4	114·8	109·8	98·0
		400	112·6	186·2	162·3	135·5	137·0	133·0	121·8	118·8	121·7	117·9	120·6	114·4	103·8
		600	115·1	187·3	159·0	131·6	133·7	133·2	125·6	121·8	124·1	117·8	125·2	117·1	105·7
15	Heat liberated per cubic foot of furnace-volume per hour.B.T.U.	200	3,674	2,320	2,655	2,925	3,191	3,182	3,313	3,542	3,422	3,534	3,355	3,549	3,927
		400	7,437	4,643	5,471	6,417	6,448	6,363	6,687	7,008	6,924	7,025	6,631	7,086	8,045
		600	11,539	6,831	7,844	9,612	9,411	9,527	10,242	10,584	10,318	10,744	9,673	10,597	10,767
16a, b, and c	Pulverized fuel, quantity retained on 50-mesh sieve.per cent	200	1·9	3·9	6·7	1·4	1·6	1·1	1·6	0·8	2·2	2·0	0·4	0·5	1·0
		400	3·1	9·9	11·4	4·6	3·4	1·5	2·1	1·6	2·2	1·8	0·4	0·7	1·2
		600	2·8	13·0	13·1	4·8	5·2	1·9	3·4	2·4	3·2	2·8	1·0	0·9	1·0

16e and f	Pulverized fuel, quantity passing 100-mesh sieve.....per cent	200	86·5	76·6	66·2	86·8	84·9	94·1	88·6	90·5	82·9	91·2	97·8	94·8	93·5
		400	83·9	64·6	58·2	73·3	77·0	87·5	84·6	87·7	84·1	89·2	98·0	94·0	93·7
		600	86·6	60·9	60·0	76·3	79·6	86·6	82·5	85·7	84·2	84·4	93·1	93·7	92·8
16f	Pulverized fuel, quantity passing 200-mesh sieve.....per cent	200	67·9	57·2	43·2	62·6	61·6	78·6	68·8	72·5	62·7	68·5	89·9	80·1	77·6
		400	60·3	52·6	36·2	48·9	49·6	66·7	63·2	69·0	63·9	71·6	88·3	79·6	79·2
		600	69·5	41·9	40·4	53·0	54·3	67·9	61·6	67·1	65·0	66·1	78·7	80·9	78·6
20c	Power used per "net" ton of fuel pulverized.....kw. hr.	200	57·8	77·0	67·9	68·0	82·1	73·5	65·3	58·8	62·9	55·4	79·9	62·7	57·9
		400	36·2	43·5	39·6	37·7	38·5	44·2	42·8	39·0	40·3	42·9	62·4	51·7	38·1
		600	30·9	32·7	33·4	33·3	32·3	34·2	31·7	31·5	30·8	32·4	48·7	46·1	31·6
20e	Rate of grinding, per cent of rated capacity of pulverizer.....per cent	200	19·7	19·8	19·7	19·8	20·1	20·1	19·6	20·1	19·9	19·9	20·0	20·0	20·0
		400	39·2	40·8	41·9	40·5	40·3	39·7	39·9	40·0	40·0	40·0	40·0	39·9	40·0
		600	59·8	59·8	59·5	59·6	59·5	59·7	59·9	59·5	59·8	59·5	58·8	60·0	54·8
48d	Equivalent evaporation per pound of fuel as fired.....lb.	200	9·17	5·91	7·06	7·83	7·61	7·99	8·63	9·14	8·65	8·98	8·71	9·11	10·20
		400	8·88	5·37	6·16	7·38	7·30	7·59	8·21	8·42	8·22	8·48	8·29	8·74	9·63
		600	8·69	5·34	6·29	7·60	7·48	7·51	7·96	8·21	8·06	8·49	7·99	8·54	9·46
52b	Flame temperature in furnace, midway of trial.....°F.	200	.....	.....	1910	.....	.....	.....	.....	2080	2050	.....	1970	1950	2080
		400	.....	.....	.....	.....	.....	.....	.....	2280	2270	.....	2330	2350	2390
		600	.....	2130	2180	2400	2280	2340	2420	2340	2400	2390	2500	2520	2510
56	Ratio, air supplied to air used for combustion.....	200	1·13	1·52	1·39	1·22	1·18	1·27	1·11	1·21	1·23	1·52	1·28	1·50	1·16
		400	1·23	1·53	1·46	1·27	1·28	1·22	1·27	1·24	1·28	1·18	1·11	1·09	1·17
		600	1·18	1·36	1·42	1·34	1·37	1·27	1·40	1·24	1·21	1·21	1·20	1·08	1·16
58a	Carbon dioxide in flue gases.....per cent	200	15·7	11·8	13·2	15·1	15·4	14·1	16·0	14·7	14·5	11·7	14·3	12·0	15·6
		400	14·4	11·9	12·7	14·2	14·0	14·5	14·1	14·2	13·8	14·9	16·2	16·5	14·6
		600	15·1	13·3	13·0	13·6	13·0	14·2	12·6	14·4	14·3	14·7	15·0	16·3	15·1
64	Percentage of rated boiler capacity developed.....per cent	200	77	50	59	66	65	69	73	79	74	77	75	78	87
		400	149	94	111	128	126	129	140	144	140	145	142	149	165
		600	223	137	160	194	191	192	204	209	206	216	201	219	222
65a	Efficiency of boiler and furnace based on gross calorific value of fuel as fired.....per cent	200	67·2	68·9	71·6	72·4	65·5	69·0	69·8	70·9	68·7	69·1	71·0	70·1	71·0
		400	64·0	64·5	64·5	63·7	62·3	64·7	66·9	65·7	64·9	66·0	68·3	67·3	65·4
		600	61·6	63·9	65·2	64·4	64·6	64·3	63·6	63·1	63·8	64·3	66·4	66·1	65·8

* See Table XXXIII (in pocket) for detailed data and results.
† These numbers correspond to similar item numbers in the main tabulation given in Table XXXIII (in pocket).

TABLE VI

Alberta-Ontario Series: Summarized Results for Tests Made on Various Coals at Comparable Rates of Combustion, and on Ontario Lignite*

No.†	Item	Approx. Combustion or Feed Rate of Coal, lb/hr.	Operating Coal Mark and Number, A_2= 7-30	Alberta Coal Sample Mark and Shipment Number											Ontario Lignite Mark and Number				
															Lower Seam Old Shaft				New Shaft
				N= 28-30	O= 29-31	P= 18-31	Q= 26-31	R= 23-31	S= 20-31	T= 24-31	U= 21-31	V= 22-31	W= 25-31	X= 28-31	As received, Y_1= 11-30	Air-dried, Y_1= 11-30	Mechanically dried		Air-dried, Z= 10-31
																	Y_2= 14-30	Y_3= 15-30	
3	Duration of trial in hours	Constant rate of 400 pounds per hour for the coal fuels and 600 pounds per hour for the Ontario Lignite.	8·13	8·02	7·97	7·97	8·00	8·00	8·00	8·03	8·00	8·00	7·98	8·00	8·03	8·08	8·07	8·10	8·02
5*a*	Moisture in fuel as fired.....per cent		3·3	8·2	1·4	1·9	2·0	2·1	3·0	2·0	2·4	1·4	1·9	1·4	46·7	35·2	35·5	26·7	31·5
5*b*	Ash in fuel, as fired.....per cent		8·7	9·0	17·2	14·4	16·0	13·4	12·3	12·7	11·6	11·8	12·7	10·9	7·4	9·1	7·1	9·9	7·7
7*a*	Calorific value of fuel, as fired gross value.....B.T.U./lb.		13,470	11,310	12,330	12,660	12,780	12,810	13,080	13,110	13,230	13,330	13,370	13,580	5,280	6,510	6,640	7,330	7,010
11*b*	Fusion-point of ash.....°F.		2575	2250	2700+	2700+	2700+	2700+	2350	2590	2450	2700+	2700+	2275	1976	1976	2005	1999	2060
14*b*	Weight of fuel fired per hour.....lb.		392	399	402	400	398	398	398	397	398	400	399	398	594	591	589	590	596
14*d*	Weight of fuel fired per 1,000 lb. of equivalent evaporation.....lb.		112·6	125·0	114·8	115·2	115·1	112·0	105·3	104·4	106·0	105·8	105·0	104·9	316·5	244·5	238·1	225·2	218·3
15	Heat liberated per cubic foot of furnace volume per hour.....B.T.U.		7,437	6,356	6,981	7,132	7,164	7,181	7,332	7,331	7,416	7,510	7,514	7,612	4,417	5,419	5,508	6,091	5,884
16*a*, *b*, and *c*	Pulverized fuel, quantity retained on 50-mesh sieve.....per cent		3·1	4·4	1·6	1·0	0·8	0·9	0·7	0·3	1·3	0·8	1·1	0·8	9·0	16·2	18·8	21·1	12·5
16*e* and *f*	Pulverized fuel, quantity passing 100-mesh sieve.....per cent		83·9	75·9	91·4	93·1	94·6	93·0	94·5	96·9	84·0	96·2	93·5	96·0	76·4	67·8	63·6	59·0	74·1
16*f*	Pulverized fuel, quantity passing 200-mesh sieve.....per cent		60·3	53·7	77·8	79·4	82·1	78·3	81·0	87·6	81·1	87·0	79·8	85·3	62·7	55·8	49·6	45·2	63·1
20*c*	Power used per "net" ton of fuel pulverized.....kw. hr.		36·2	42·6	45·8	45·6	42·1	46·7	44·7	47·4	45·9	43·1	52·0	45·0	57·3	40·0	40·6	35·3	50·9
20*e*	Rate of grinding, per cent of rated capacity of pulverizer.....per cent		39·2	39·9	40·2	40·0	39·8	39·8	39·8	39·7	39·8	40·0	39·9	39·8	59·4	59·1	58·9	59·0	59·6
48*d*	Equivalent evaporation per lb. of fuel, as fired.....lb.		8·88	8·00	8·71	8·68	8·69	8·93	9·50	9·58	9·43	9·45	9·52	9·53	3·16	4·09	4·20	4·44	4·58
52*b*	Flame temperature in furnace, midway of trial.....°F.		—	2310	2380	2430	2420	2490	2370	2470	2400	2450	2520	2450	1610	1980	.....	2075	2040
56	Ratio, air supplied to air used for combustion.....		1·23	1·14	1·07	1·01	1·01	1·05	1·07	1·04	1·03	1·08	1·06	.....	1·16	1·42	1·13	1·07	1·15
58*a*	Carbon dioxide in flue gases.....per cent		14·4	16·3	16·8	17·7	17·0	17·3	16·8	17·3	17·5	17·0	17·1	17·2	14·8	12·8	16·3	17·3	16·2
64	Percentage of rated boiler capacity developed.....per cent		149	137	150	148	148	152	162	163	161	162	163	162	80	104	106	112	117
65*a*	Efficiency of boiler and furnace based on gross calorific value of fuel, as fired.....per cent		64·0	68·6	68·6	66·5	66·0	67·7	70·5	70·9	69·2	68·8	69·1	68·1	58·1	61·0	61·4	58·8	63·4

*See Table XXXIV (in pocket) for detailed data and results.
†These numbers correspond to similar item numbers in the main tabulation given in Table XXXIV (in pocket).

TABLE VII

British Columbia Series: Average Values of the Principal Results for all Tests on Each of Thirteen Coals

Item No.*	7a	5a	5b	5c	5d	See footnote ‡		11b	14b	14d	48d	15	16a b c	16e f	16f	20c	20e	52a	52b	52c	58a	56	64	73	74a	74b	74c	75	76	77	78
Fuel Mark and No.*	Calorific Value Fuel as Fired, Gross	Proximate Analysis Fuel as Fired				Specific Volatile Index		Fusion Point of Ash	Fuel Fired per		Equivalent Evaporation per lb. Fuel as Fired	Heat Liberated per cu. ft. Furnace Volume per Hour	Screen Analysis of Pulverized Fuel as Delivered to Burner			Pulverizer		Flame Temperatures in Furnace			CO_2 in Flue Gas	Excess Air	Rated Boiler Capacity Developed	Heat Balance—Heat in Coal as Fired							
									Hour	1,000 lb. equivalent evaporation						Power per Net Ton Fuel Pulverized	Rate of Grind, per cent of Rated Capacity	Start of Trial	Mid Trial	End of Trial				Absorbed by Water in Boiler	Lost						
		Moisture	Ash	Volatile Matter	Fixed Carbon	Number	Rank						On 50 Mesh	Through 100 Mesh	Through 200 Mesh										Steam						
																									From Moisture in Coal	From Hydrogen in Dry Coal	Entering with Air	Heat in Dry Flue Gas	Unburned CO	Carbon in Refuse	Radiation Errors and Unaccounted for
	B.T.U./lb.	per cent	per cent	per cent	per cent			°F.	lb.	lb.	lb.	B.T.U.	per cent	per cent	per cent	kw. hr.	per cent	°F.	°F.	°F.	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
B=5-29	8,162	23·0	13·0	26·9	36·5	106·7	Black lignite (ortho lignitous)	2,093	401	183·4	5·47	4,592	9·8	65·6	47·0	49·1	40·1	2,223	2,115	2,050	12·9	42	93	65·0	3·5	4·5	0·2	12·5	0·0	2·2	12·1
C=4-29	9,405	19·9	9·2	30·6	40·3	116·4	" "	2,128	402	155·4	6·46	5,313	11·3	64·8	38·3	46·1	40·2	2,280	2,077	2,091	13·6	37	110	66·6	2·7	4·4	0·2	12·5	0·0	1·3	12·3
D=8-30	11,118	9·8	11·2	32·5	46·5	134·6	Sub-bituminous (meta lignitous)	2,237	400	132·2	7·57	6,323	3·4	79·1	54·7	45·3	40·0	2,297	2,325	2,261	14·4	27	129	66·2	1·1	4·5	0·2	12·4	0·0	1·1	14·5
F=10-30	11,305	5·9	17·0	34·7	42·4	148·6	" "	2,180	399	132·0	7·60	6,351	1·8	88·0	68·8	48·6	39·9	2,318	2,339	2,274	14·7	22	129	65·3	0·7	4·4	0·2	12·5	0·0	1·4	15·5
E=6-29	11,310	9·1	11·7	34·9	44·3	140·0	" "	2,003	399	133·5	7·50	6,353	3·6	79·5	54·4	49·4	39·9	2,243	2,300	2,266	13·8	32	128	64·3	1·0	4·8	0·3	13·6	0·0	0·7	15·3
K=3-31	11,773	4·5	16·8	22·5	56·2	161·1	Bituminous (para-bituminous)	2,700+	397	121·1	8·27	6,563	0·6	96·0	85·0	60·1	39·7	2,360	2,300	2,298	15·5	18	139	68·1	0·5	3·7	0·1	12·0	0·0	2·3	13·3
G=9-30	11,985	4·0	14·1	36·3	45·0	150·4	Sub-bituminous (meta lignitous)	2,237	398	123·2	8·13	6,704	2·2	86·0	65·9	46·8	39·8	2,283	2,405	2,320	14·3	20	137	66·1	0·5	4·8	0·3	13·3	0·0	0·8	14·2
I=19-30	12,208	3·8	14·6	30·1	51·5	159·5	" "	2,462	400	121·3	8·25	6,910	2·1	85·1	65·2	44·8	40·0	2,298	2,285	2,283	14·3	23	140	65·3	0·4	4·5	0·3	12·3	0·0	1·6	15·6
H=17-30	12,528	3·5	12·0	36·3	48·2	152·6	" "	2,311	399	117·8	8·51	7,040	1·4	88·0	70·8	44·6	39·9	2,323	2,273	2,320	14·6	22	143	65·9	0·4	4·7	0·3	12·4	0·0	0·7	15·6
L=2-31	12,603	3·9	12·7	22·8	60·8	107·5	Bituminous (para-bituminous)	2,500	400	113·5	8·82	7,091	0·8	96·2	79·5	51·1	40·0	2,383	2,305	2,325	15·0	22	150	67·9	0·4	3·8	0·1	13·1	0·0	2·5	12·2
J=13-30	12,690	3·5	12·9	30·6	53·0	163·5	" "	2,182	398	115·0	8·71	7,133	1·9	89·7	71·6	46·0	39·8	2,385	2,370	2,313	14·3	26	147	66·6	0·4	4·2	0·2	13·0	0·0	2·0	13·6
A_2 and A_4=7 and 16-30	13,470	2·9	8·8	31·4	56·9	160·2	" "	2,587	396	112·3	8·91	7,550	2·6	85·7	65·9	41·2	39·6	2,260	.....	2,278	15·1	18	150	64·3	0·3	4·3	0·3	12·7	0·0	1·2	16·9
M=20-30	14,057	2·0	7·0	27·4	63·6	176·5	Bituminous (ortho bituminous)	2,038	383	102·5	9·76	7,580	1·1	93·3	78·5	42·5	38·3	2,307	2,327	2,227	15·1	16	158	67·4	0·2	4·0	0·2	12·2	0·0	2·2	13·8

*These numbers correspond to similar item numbers in the main tabulation given in Table XXXIII.
†The fuels are listed in the order of increasing calorific value.
‡"Classification of Coals Using Specific Volatile Index" by Burrough, Swartzman and Strong, Mines Branch Publication No. 725-2.

DISCUSSION OF RESULTS

General Discussion. The tests were comprehensive in character rather than "industrial," their primary function being to compare the behaviour of the various fuels when burned in the pulverized state and to determine their usefulness for steam raising. Two main objectives were, therefore, borne in mind: (1) to determine in each case the amount of steam generated per unit of fuel fired under conditions as nearly uniform as possible; and (2) to form an opinion as to the behaviour of the fuel, the amount of attention and labour required for its efficient use, and its general suitability for steam raising as evidenced by freedom from trouble arising from the formation of clinker and slag, difficulties in the removal of refuse, formation of smoke, etc. Special effort was made to obtain data relative to the amenability to pulverization and the power required therefor, the behaviour and disposition of the ash; the steam-producing capability of each fuel when tested in the same equipment under uniform conditions.

In considering the equipment in which these tests were made the following should be noted:

(1) In order that peat and low-grade lignites could be handled at normal boiler ratings the mill in which the fuels were pulverized had a capacity greatly in excess of that required for any coal ranking above the lignitic class. Unfortunately, this introduced some undesirable features into the tests made with the higher ranking fuels, but as the equipment was intended for all ranks and grades of fuels the makers who designed it advocated an oversize mill.

(2) The furnace had a volume excessive for the size of boiler in comparison with present practice in larger commercial units. This was due to limitations in designing such a small unit to operate with all ranks and grades of fuel, and resulted in very low rates of heat release per unit of furnace volume at boiler ratings below normal. The majority of the tests were, therefore, made at normal ratings or above, in order to give heat releases more comparable with commercial practice.

(3) The efficiency of the boiler and setting was somewhat lower than would have obtained with a larger unit; even so, limitations in test arrangements precluded operating at the highest efficiency obtainable. High efficiencies, therefore, were not to be expected, nor are they considered necessary for these trials to be of value, inasmuch as the fuels themselves were under test rather than the equipment.

Tables Nos. XXXIII and XXXIV (in pocket) described on page 19 of this report, give the detailed data and the results of the tests. This information could be presented in a variety of tabular and graphical forms but a lengthy discussion would be tedious to the lay reader and serve no purpose from the standpoint of the expert. Tables XXXIII and XXXIV are, therefore, left to speak for themselves and only a few of the more important points of general interest are discussed. A study of the information given in these tables shows that certain of the coals are so much better than others in some respects that it is possible to tabulate them in apparent order of merit. To do so, however, calls for the exercise of great caution.

COMPARISON OF THE FUELS TESTED

Twelve of the more important items of information given in Tables XXXIII and XXXIV (in pocket) have been selected and are given in Tables VIII to XXXII inclusive, each of which, with the exception of the last, deals with one coal in comparison with the so-called "standard" or operating coal. In interpreting these tables, care and discretion must be used, for although in some particulars the results given for a number of the test coals are not so favourable as those for the operating coal, it should be borne in mind that no plant can be operated with the same ease, economic result, and efficiency when burning various grades of fuel; each plant should be designed for the use of one particular class of coal.

The results are arranged in the following tables to permit of comparison in the case of the British Columbia coals between three tests each made at different rates of combustion on the coal under discussion and tests made at the same combustion rates on the operating coal. The first three items give the moisture, ash, and gross heat value of the coal used for each test. The fourth item gives the ash-fusion temperature which roughly indicates the point at which the ash and refuse begin to soften. The fifth and sixth items give the quantity of fuel fired per unit of time and per unit of steam production. The next three items give some idea of the suitability of the fuel for pulverization, of its amenability thereto, and the power required. The last three items give an idea of its combustion and steam-producing properties. The item numbers given in these tables correspond to those given in Tables Nos. XXXIII and XXXIV (in pocket).

TABLE VIII

British Columbia Series: Summary Comparison of Results of Tests on "Operating" Coal A

No.	Item	Coal Name	Operating Coal, A=7 and 16-30		
	Name	Test No. P.F.	33-34	3-4	39-40
		Rate of feed	Low	Medium	High
5*a*	Moisture in fuel as fired.....per cent		3·7	3·3	1·8
5*b*	Ash in fuel as fired.....per cent		9·5	8·7	8·3
7*a*	Calorific value—fuel as fired, gross value....B.T.U./lb.		13,240	13,470	13,700
11*b*	Ash-fusion temperature or softening point.....°F.		2593	2575	2593
14*b*	Weight of fuel fired per hour.....lb.		197	392	598
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1
16*f*	Quantity of pulverized fuel passing No. 200 sieve, per cent		67·9	60·3	69·5
20*c*	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9
20*e*	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8
58*a*	CO_2 content of flue gases.....per cent		15·7	14·4	15·1
48*d*	Equivalent evaporation per pound of fuel as fired....lb.		9·17	8·88	8·69
64	Percentage of rated boiler-capacity developed..per cent		77	149	223

Summary. Coal A was a typical coking coal ranking as high-grade bituminous, well suited for use in the pulverized state. The moisture and ash contents (items 5a and 5b respectively) of this coal are low, while the calorific values (item 7a) are high. The ash-fusion temperatures (item 11b) of the coal are high, a decided advantage for no trouble should be experienced through the slagging of the ash in most boiler settings. The power used in pulverizing (item 20c) is higher at low rates of coal feed (item 14b) and varies with the rate of pulverization (item 20e); whereas the fineness of pulverization (item 16f) is roughly about the same at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed. The economic output (item 14d or item 48d) is slightly higher at the lower rates of coal feed, and the percentage of the rated capacity developed (item 64) varies almost directly with the rate of feed.

TABLE IX

British Columbia Series: Summary Comparison, "Test" Coal B with "Operating" Coal A

No.	Item / Name	Coal Name.... / Test No. P.F. Rate of feed...	Operating Coal, A=7 and 16-30			Test Coal, B=5-29		
			33-34 Low	3-4 Medium	39-40 High	23-24 Low	9-10 Medium	43-44 High
5a	Moisture in fuel as fired....per cent		3·7	3·3	1·8	23·5	23·5	22·9
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	12·7	13·6	13·3
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	8,320	8,080	8,110
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2093	2093	2093
14b	Weight of fuel fired per hour.....lb.		197	392	598	198	408	598
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	169·2	186·2	187·3
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	57·2	52·6	41·9
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	77·0	43·5	32·7
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	19·8	40·8	59·8
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	11·8	11·9	13·3
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	5·91	5·37	5·34
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	50	94	137

Summary. Coal B, referred as to the "test coal," ranks as a free-burning "lignitic" sub-bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is very high; the ash content (item 5b) averages 4·4 per cent higher than that of the operating coal; and the calorific value (item 7a) is very much lower, being roughly only 61 per cent of that of the operating coal. The comparatively low ash-fusion temperature of the test coal (item 11b) is not in

its favour; it may cause slagging trouble in some boiler settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item 20e) and is considerably higher for the test coal than for the operating coal, whereas the fineness of pulverization (item 16f) is somewhat lower for the test coal at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were much lower for the test coal than for the operating coal, averaging roughly 38 per cent less. This indicates that about $1\frac{5}{8}$ tons[1] of test coal was burned to give the same output of steam as 1 ton of operating coal; this agrees closely with the relation between the calorific values of the two coals, showing that the boiler steamed at about equal efficiency with both fuels.

TABLE X

British Columbia Series: Summary Comparison, "Test" Coal C with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16–30			Test Coal, C=4–29		
	Name	Test No. P.F.	33–34	3–4	39–40	77–78	5–6	41–42
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired....per cent		3·7	3·3	1·8	20·0	20·3	19·7
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	8·7	9·3	9·5
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	9,570	9,270	9,360
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2145	2118	2118
14b	Weight of fuel fired per hour.....lb.		197	392	598	197	419	595
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	141·6	162·3	159·0
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	43·2	36·2	40·4
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	67·9	39·6	33·4
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	19·7	41·9	59·5
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	13·2	12·7	13·0
48d	Equivalent evaporation per pound of fuel, as fired..... lb.		9·17	8·88	8·69	7·06	6·16	6·29
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	59	111	160

Summary. Coal C, referred to as the "test coal," ranks as a free-burning lignitic sub-bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is very high; the ash content (item 5b) averages about the same as for the operating coal; the calorific value (item 7a) is very much lower, being roughly

[1] Throughout these tables the short ton of 2,000 pounds is used.

only 70 per cent of that of the operating coal. The comparative low ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at the low rate of coal feed (item 14b), it varies with the rate of pulverization (item 20e) and is somewhat higher for the test coal; whereas the fineness of pulverization (item 16f) is much lower for the test coal at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were considerably lower for the test coal than for the operating coal, averaging roughly 27 per cent less. This indicates that about $1\frac{3}{5}$ tons of test coal was burned to give the same output of steam as 1 ton of operating coal; this agrees fairly closely with the relation between the calorific values of the two coals, showing that the boiler steamed at about equal efficiency with both fuels.

TABLE XI

British Columbia Series: Summary Comparison, "Test" Coal D with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16-30			Test Coal, D=8-30		
	Name	Test No. P.F.	33-34	3-4	39-40	27-28	11-12	45-46
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	14·9	8·2	7·9
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	10·7	11·6	10·3
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	10,490	11,250	11,450
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2239	2239	2239
14b	Weight of fuel fired per hour.....lb.		197	392	598	198	405	596
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	127·7	135·5	131·6
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	62·6	48·9	53·0
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	68·0	37·7	33·3
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	19·8	40·5	59·6
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	15·1	14·2	13·6
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	7·83	7·38	7·60
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	66	128	194

Summary. Coal D, referred to as the "test coal", ranks as a low-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is comparatively high; the ash content (item 5b) averages 2·0 per cent higher than that of

the operating coal; the calorific value (item 7a) is much lower, being roughly 82 per cent of that of the operating coal. The comparatively low, ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item 20e) and is somewhat higher for the test coal; whereas the fineness of pulverization (item 16f) is somewhat lower for the test coal at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is fairly uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were somewhat lower for the test coal, averaging roughly 15 per cent less. This indicates that about 2,340 pounds of test coal was burned to give the same output of steam as 1 ton of operating coal; and agrees fairly closely with the relation between the calorific values of the two coals, showing that the boiler steamed at about equal efficiency with both fuels.

TABLE XII

British Columbia Series: Summary Comparison, "Test" Coal E with "Operating" Coal A

No.	Item / Name	Coal Name....	Operating Coal, A=7 and 16-30			Test Coal, E=6-29		
		Test No. P.F.	33-34	3-4	39-40	25-26	7-8	53-54
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	9·4	8·8	9·3
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	12·0	12·0	11·3
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	11,270	11,360	11,230
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2588	2588	2588
14b	Weight of fuel fired per hour.....lb.		197	392	598	201	403	595
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	131·4	137·0	133·7
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	61·6	49·6	54·3
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	82·1	38·5	32·3
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	20·1	40·3	59·5
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	15·4	14·0	13·0
48d	Equivalent evaporation per pound of fuel, as fired.....lb.		9·17	8·88	8·69	7·61	7·30	7·48
64	Percentage of rated boiler-capacity developed.....per cent		77	140	223	65	126	191

Summary. Coal E, referred to as the "test coal," ranks as a low-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is high; the ash content (item 5b) averages 3·0 per cent higher than that of the operating coal;

the calorific value (item 7a) is much lower, being roughly 84 per cent of that for the operating coal. The comparatively high ash-fusion temperature of the test coal (item 11b) is in its favour; it may help to obviate slagging trouble in the boiler setting. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item 20e) and averages somewhat higher for the test coal; whereas the fineness of pulverization (item 16f) is somewhat lower for the test coal at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is fairly uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were somewhat lower for the test coal, averaging roughly 16 per cent less. This indicates that about 2,390 pounds of test coal was burned to give the same output of steam as one ton of operating coal; and agrees fairly closely with the relation between the calorific values of the two coals, showing that the boiler steamed at about equal efficiency with both fuels.

TABLE XIII

British Columbia Series: Summary Comparison, "Test" Coal F with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16-30			Test Coal, F=10-30		
	Name	Test No. P.F.	33-34	3-4	39-40	29-30	13-14	47-48
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	5·4	6·4	5·3
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	17·9	16·3	17·2
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	11,240	11,380	11,330
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2145	2145	2145
14b	Weight of fuel fired per hour.....lb.		197	392	598	201	397	597
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	125·2	133·0	133·2
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	78·6	66·7	67·9
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	73·5	44·2	34·2
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	20·1	39·7	59·7
58a	CO_2 content of flue gases.....per cent		15·7	14·4	15·1	14·1	14·5	14·2
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	7·99	7·59	7·51
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	69	129	192

Summary. Coal F, referred to as the "test coal," ranks as a low-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) and its ash content (item 5b) are about double the corresponding values of the operating coal; the

calorific value (item 7a) is much lower, being roughly 84 per cent of that of the operating coal. The comparatively low ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item 20e) and is much higher for the test coal. The fineness of pulverization (item 16f) averages somewhat higher for the test coal. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were somewhat lower for the test coal, averaging roughly 14 per cent less. This indicates that about 2,320 pounds of test coal was burned to give the same output of steam as one ton of operating coal, which in turn agrees fairly closely with the relation between the calorific values of the two coals, showing that the boiler steamed at about equal efficiency with both fuels.

TABLE XIV

British Columbia Series: Summary Comparison, "Test" Coal G with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16-30			Test Coal, G=9-30		
	Name	Test No. P.F..	33-34	3-4	39-40	31-32	15-16	49-50
		Rate of feed....	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	4·5	5·5	3·9
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	13·8	14·0	13·5
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	12,000	11,900	12,140
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2223	2223	2223
14b	Weight of fuel fired per hour.....lb.		197	392	598	196	399	599
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	115·8	121·8	125·6
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	68·8	63·2	61·6
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	65·3	42·8	31·7
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	19·6	39·9	59·9
58a	CO_2 content of flue gases.....per cent		15·7	14·4	15·1	16·0	14·1	12·6
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	8·63	8·21	7·96
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	73	140	204

Summary. Coal D, referred to as the "test coal," ranks as a low-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is fairly low; the ash content (item 5b) averages 5·0 per cent higher than that of the operating coal; the calorific value (item 7a) is much lower, being roughly 89 per cent

of that of the operating coal. The comparatively low ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item 20e) and is somewhat higher for the test coal; whereas the fineness of pulverization (item 16f) of the test coal averages about the same as that of the operating coal. The CO_2 content of the flue gases (item 58a) is fairly uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were somewhat lower for the test coal, averaging roughly 7 per cent less. This indicates that about 2,160 pounds of test coal was burned to give the same output of steam as one ton of operating coal.

TABLE XV

British Columbia Series: Summary Comparison, "Test" Coal H with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16-30			Test Coal, H=17-30		
	Name	Test No. P.F.	33-34	3-4	39-40	67-68	65-66	55-56
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	3·6	3·8	3·0
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	12·0	12·2	11·6
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	12,510	12,440	12,630
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2307	2307	2307
14b	Weight of fuel fired per hour.....lb.		197	392	598	201	400	595
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	109·4	118·8	121·8
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	72·5	69·0	67·1
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	58·8	39·0	31·5
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	20·1	40·0	59·5
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	14·7	14·2	14·4
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	9·14	8·42	8·21
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	79	144	209

Summary. Coal H, referred to as the "test coal," ranks as a medium-grade bituminous coal, whereas the operating coal, for which comparative figures are given in the above table, is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is low; the ash content (item 5b) averages 3·1 per cent higher than that of the operating coal; the calorific value (item 7a) is lower, being roughly 93 per cent of that of the operating coal. The fairly low ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler

settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item 20e) and is slightly higher for the test coal. The fineness of pulverization (item 16f) averages somewhat higher for the test coal. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were slightly lower for the test coal, averaging roughly 4 per cent less. This indicates that about 2,080 pounds of test coal was burned to give the same output of steam as one ton of operating coal.

TABLE XVI

British Columbia Series: Summary Comparison, "Test" Coal I with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16-30			Test Coal, I=19-30		
	Name	Test No. P.F.	33-34	3-4	39-40	71-72	63-64	57-58
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	3·7	3·9	3·9
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	14·8	14·3	14·6
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	12,210	12,290	12,250
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2459	2459	2459
14b	Weight of fuel fired per hour.....lb.		197	392	598	199	400	598
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	115·6	121·7	124·1
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	62·7	63·9	65·0
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	62·9	40·3	30·8
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	19·9	40·0	59·8
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	14·5	13·8	14·3
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	8·65	8·22	8·06
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	74	140	206

Summary. Coal I, referred to as the "test coal," ranks as a low-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is low; the ash content (item 5b) averages 5·8 per cent higher than for the operating coal; the calorific value (item 7a) is lower, being roughly 91 per cent of that for the operating coal. The fairly high ash-fusion temperature of the test coal (item 11b) is in its favour; it may help to obviate slagging trouble in the furnace. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b);

it varies with the rate of pulverization (item 20e) and averages slightly higher for the test coal; whereas the fineness of pulverization (item 16f) averages slightly lower for the test coal. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were slightly lower for the test coal, averaging roughly 7 per cent less. This indicates that about 2,150 pounds of test coal was burned to give the same output of steam as one ton of operating coal; this agrees fairly closely with the relation between the calorific values of the two coals showing that the boiler steamed at about equal efficiency with both fuels.

TABLE XVII

British Columbia Series: Summary Comparison, "Test" Coal J with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16-30			Test Coal, J=13-30		
	Name	Test No. P.F.	33-34	3-4	39-40	19-20	17-18	51-52
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	4·1	5·0	3·2
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	12·6	12·8	12·8
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	12,610	12,470	12,820
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2170	2170	2170
14b	Weight of fuel fired per hour.....lb.		197	392	598	199	400	595
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	111·4	117·9	117·8
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	68·5	71·6	66·1
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	55·4	42·9	32·4
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	19·9	40·0	59·5
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	11·7	14·9	14·7
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	8·98	8·48	8·49
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	77	145	216

Summary. Coal J, referred to as the "test coal," ranks as a medium-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is low; the ash content (item 5b) averages 3·9 per cent higher than for the operating coal; the calorific value (item 7a) is lower, being roughly 94 per cent of that of the operating coal. The comparatively low ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal

feed (item 14b); it varies with the rate of pulverization (item 20e) and averages a little higher for the test coal. The fineness of pulverization (item 16f) also averages a little higher for the test coal. The CO_2 content of the flue gases (item 58a) is fairly uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were slightly lower for the test coal, averaging roughly 3 per cent less. This indicates that about 2,060 pounds of test coal was burned to give the same output of steam as one ton of operating coal.

TABLE XVIII

British Columbia Series: Summary Comparison, "Test" Coal K with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16–30			Test Coal, K=3–31		
	Name	Test No. P.F.	33–34	3–4	39–40	109–110	105–106	113–114
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	4·1	4·2	4·9
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	16·8	16·7	16·9
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	11,910	11,770	11,680
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2700+	2700+	2700+
14b	Weight of fuel fired per hour.....lb.		197	392	598	200	400	588
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	114·8	120·6	125·2
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	89·9	88·3	78·7
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	79·9	62·4	48·7
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	20·0	40·0	58·8
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	14·3	16·2	15·0
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	8·71	8·29	7·99
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	75	142	201

Summary. Coal K, referred to as the "test coal," ranks as a low-grade bituminous coal, whereas the operating coal, for which comparative figures are given in the above table, is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is fairly low; the ash content (item 5b) averages 8·0 per cent higher than that of the operating coal; the calorific value (item 7a) is much lower, being roughly 88 per cent of that of the operating coal. The high ash-fusion temperature of the test coal (item 11b) is decidedly advantageous and will tend to obviate slagging troubles in the boiler setting. The three different rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item

20e) and is much higher for the test coal, whereas the fineness of pulverization (item 16f) is noticeably higher for the test coal at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is fairly uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were somewhat lower for the test coal, being roughly 7 per cent less. This indicates that about 2,140 pounds of test coal was burned to give the same output of steam as one ton of operating coal.

TABLE XIX

British Columbia Series: Summary Comparison, "Test" Coal L with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A= 7 and 16-30			Test Coal, L=2-31		
	Name	Test No. P.F.	33-34	3-4	39-40	107-108	103-104	111-112
		Rate of feed...	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	4·1	3·8	3·9
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	12·6	13·1	12·7
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,240	13,470	13,700	12,600	12,610	12,540
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2590	2490	2490
14b	Weight of fuel fired per hour.....lb.		197	392	598	200	399	600
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	109·8	114·4	117·1
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	80·1	79·6	80·9
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	62·7	51·7	46·1
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	20·0	39·9	60·0
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	12·0	16·5	16·3
48d	Equivalent evaporation per pound of fuel as fired.....lb.		9·17	8·88	8·69	9·11	8·74	8·54
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	78	149	219

Summary. Coal L, referred to as the "test coal," ranks as a medium-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is fairly low; the ash content (item 5b) averages 4·0 per cent higher than that of the operating coal; the calorific value (item 7a) is lower, being roughly 93 per cent of that of the operating coal. The comparatively high ash-fusion temperature of the test coal (item 11b) is in its favour as it may help to obviate slagging trouble in the boiler setting. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals. The power used in pulverization (item 20c) for both fuels is higher at low rates of coal feed (item 14b); it varies with the rate of pulverization (item 20e)

and is much higher for the test coal; whereas the fineness of pulverization (item 16f) is noticeably higher for the test coal at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is fairly uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were almost identical for both fuels, being only 1 to 2 per cent lower for the test coal. This indicates that about 2,030 pounds of test coal was burned to give the same output of steam as one ton of operating coal.

TABLE XX

British Columbia Series: Summary Comparison, "Test" Coal M with "Operating" Coal A

No.	Item	Coal Name.....	Operating Coal, A=7 and 16-30			Test Coal, M=20-30		
	Name	Test No. P.F...	33-34	3-4	39-40	75-76	61-62	59-60
		Rate of feed....	Low	Medium	High	Low	Medium	High
5a	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	2·2	2·0	1·7
5b	Ash in fuel as fired.....per cent		9·5	8·7	8·3	7·4	5·9	7·7
7a	Calorific value—fuel as fired, gross value,.....B.T.U./lb.		13,240	13,470	13,700	13,940	14,280	13,950
11b	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	2050	2032	2032
14b	Weight of fuel fired per hour.....lb.		197	392	598	200	400	548
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	98·0	103·8	105·7
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	77·6	79·2	78·6
20c	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	57·9	38·1	31·6
20e	Rate of grinding, per cent of rated capacity.....per cent		19·7	39·2	59·8	20·0	40·0	54·8
58a	CO_2 content of flue gases....per cent		15·7	14·4	15·1	15·6	14·6	15·1
48d	Equivalent evaporation per pound of fuel, as fired.....lb.		9·17	8·88	8·69	10·20	9·63	9·46
64	Percentage of rated boiler-capacity developed.....per cent		77	149	223	87	165	222

Summary. Coal M, referred to as the "test coal," ranks as a high-grade bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is very low; the ash content (item 5b) averages 1·8 per cent lower than that of the operating coal; the calorific value (item 7a) is higher, being roughly 104 per cent of that of the operating coal. The very low ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler settings. The three rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for the two coals except at the high rate of feed. The power used in pulverization (item 20c) for both fuels is higher at the low rates of coal feed (item 14b), it varies with the rate of pulverization (item 20e) and is slightly higher for the test coal.

The fineness of pulverization (item 16f) is considerably higher for the test coal at all rates of feed and pulverization. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace at the three rates of coal feed for both fuels. The economic and developed outputs were higher for the test coal, averaging roughly 10 per cent more. This indicates that about 1,830 pounds of test coal was burned to give the same output of steam as one ton of operating coal.

TABLE XXI

Alberta-Ontario Series: Summary Comparison, "Test" Coal N with "Operating" Coal A

No.	Item		Operating Coal, A=7 and 16-30	Test Coal, N= 28-30
		Coal Name....		
		Test No.....	P.F. 3-4	P.F. 119
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired	per cent	3·3	8·2
5*b*	Ash in fuel as fired	per cent	8·7	9·0
7*a*	Calorific value—fuel as fired, gross value	B.T.U./lb.	13,470	11,310
11*b*	Ash-fusion temperature or softening point	°F.	2575	2250
14*b*	Weight of fuel fired per hour	lb.	392	399
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation	lb.	112·6	125·0
16*f*	Quantity of pulverized fuel passing No. 200 sieve	per cent	60·3	53·7
20*c*	Power used per ton of fuel pulverized	kw. hr.	36·2	42·6
20*e*	Rate of grinding, per cent of rated capacity	per cent	39·2	39·9
58*a*	CO_2 content of flue gases	per cent	14·4	16·3
48*d*	Equivalent evaporation per pound of fuel as fired	lb.	8·88	8·00
64	Percentage of rated boiler-capacity developed	per cent	149	137

Summary. Coal N, referred to as the "test coal," ranks as a sub-bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is high in comparison with the operating coal; the ash contents (item 5b) approximate closely; the calorific value (item 7a) is considerably lower, being roughly 84 per cent of that of the operating coal. The comparatively low ash-fusion temperature of the test coal (item 11b) is not in its favour; it may cause slagging trouble in some boiler settings. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, more power is required to pulverize the test coal, and the fineness of pulverization (item 16f) is less for the test coal. The CO_2 content of the flue gases (item 58a) was 1·9 per cent higher for the test coal, showing very satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is somewhat lower for the test coal and indicates that about 2,220 pounds of the test coal was burned to give the same output of steam as one ton of the operating coal.

TABLE XXII

Alberta-Ontario Series: Summary Comparison, "Test" Coal O with "Operating" Coal A

No.	Item		Operating Coal, A=7 and 16-30	Test Coal, O= 29-31
	Name	Coal Name....		
		Test No.....	P.F. 3-4	P.F. 121
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	1·4
5*b*	Ash in fuel as fired.....per cent		8·7	17·2
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	12,330
11*b*	Ash-fusion temperature or softening point.....°F..		2575	2700+
14*b*	Weight of fuel fired per hour.....lb.		392	402
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	114·8
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	77·8
20*c*	Power used per ton of fuel pulverized.....kw.-hr.		36·2	45·8
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	40·2
58*a*	CO_2 content of flue gases.....per cent		14·4	16·8
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	8·71
64	Percentage of rated boiler-capacity developed.....per cent		149	150

Summary. Coal O, referred to as the "test coal," ranks as a typical bituminous coal, as does the operating coal for which comparative figures are given in the above table. The total moisture content of the test coal (item 5a) is very low in comparison with the operating coal; the ash content (item 5b) is very much higher, the calorific value (item 7a) is somewhat lower being roughly 92 per cent of that of the operating coal. The high ash-fusion temperature of the test coal (item 11b) is decidedly in its favour as this prevented slagging troubles in the furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, much more power (item 20c) is required to pulverize the test coal but the fineness of pulverization (item 16f) is greater. The CO_2 content of the flue gases (item 58a) is 2·4 per cent higher for the test coal showing very satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is a little less for the test coal and indicates that about 2,040 pounds of the test coal was burned to give the same output of steam as one ton of the operating coal.

TABLE XXIII

Alberta-Ontario Series: Summary Comparison, "Test" Coal P with "Operating" Coal A

No.	Item	Name	Operating Coal, A=7 and 16-30	Test Coal, P= 18-31
		Coal Name....		
		Test No.....	P.F. 3-4	P.F. 126
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	1·9
5*b*	Ash in fuel as fired.....per cent		8·7	14·4
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb..		13,470	12,660
11*b*	Ash-fusion temperature or softening point.....°F.		2575	2700+
14*b*	Weight of fuel fired per hour.....lb.		392	400
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	115·2
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	79·4
20*c*	Power used per ton of fuel pulverized.....kw. hr.		36·2	45·6
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	40·0
58*a*	CO_2 content of flue gases.....per cent		14·4	17·7
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	8·68
64	Percentage of rated boiler-capacity developed.....per cent		149	148

Summary. Coal P, referred to as the "test coal," ranks as a typical bituminous coal, as does the operating coal for which comparative figures are given in the above table. The total moisture content of the test coal (item 5a) is low in comparison with the operating coal; the ash content (item 5b) is much higher, the calorific value (item 7a) is lower, being roughly 94 per cent of that of the operating coal. The high ash-fusion temperature of the test coal (item 11b) is decidedly in its favour as it prevented slagging troubles in the furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, much more power (item 20c) is required to pulverize the test coal but the fineness of pulverization (item 16f) is greater. The CO_2 content of the flue gases (item 58a) is 3·3 per cent higher for the test coal, showing satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is a little less for the test coal and indicates that about 2,040 pounds of the test coal would be burned to give the same output of steam as one ton of the operating coal.

TABLE XXIV

Alberta-Ontario Series: Summary Comparison, "Test" Coal Q with "Operating" Coal A

No.	Item		Operating Coal, A=7 and 16-30	Test Coal, Q= 26-31
	Name	Coal Name....		
		Test No.....	P.F. 3-4	P.F. 125
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	2·0
5*b*	Ash in fuel as fired.....per cent		8·7	16·0
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	12,780
11*b*	Ash-fusion temperature or softening point.....°F.		2575	2700+
14*b*	Weight of fuel fired per hour.....lb.		392	398
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	115·1
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	82·1
20*c*	Power used per ton of fuel pulverized.....kw. hr.		36·2	42·1
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	39·8
58*a*	CO_2 content of flue gases.....per cent		14·4	17·0
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	8·69
64	Percentage of rated boiler-capacity developed.....per cent		149	148

Summary. Coal Q, referred to as the "test coal," ranks as a semi-bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is 1·3 per cent lower than for the operating coal; the ash content (item 5b) is very much higher whereas the calorific value (item 7a) is somewhat lower being roughly 95 per cent. The high ash-fusion temperature of the test coal (item 11b) is an important factor for owing to it no excessive slagging occurred in the furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, more power (item 20c) is required to pulverize the test coal but the fineness of pulverization (item 16f) is greater. The CO_2 content of the flue gases (item 58a) is 2·6 per cent higher for the test coal showing very satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is a little less for the test coal and indicates that about 2,040 pounds of the test coal was burned to give the same output of steam as one ton of the operating coal.

TABLE XXV

Alberta-Ontario Series: Summary Comparison, "Test" Coal R with "Operating" Coal A

No.	Item	Coal Name....	Operating Coal, A=7 and 16-30	Test Coal, R= 23-31
	Name	Test No.....	P.F. 3-4	P.F. 124
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	2·1
5*b*	Ash in fuel as fired.....per cent		8·7	13·4
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	12,810
11*b*	Ash-fusion temperature or softening point.....°F.		2575	2700+
14*b*	Weight of fuel fired per hour.....lb.		392	398
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	112·0
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	78·3
20*c*	Power used per ton of fuel pulverized.....kw. hr.		36·2	46·7
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	39·8
58*a*	CO_2 content of flue gases.....per cent		14·4	17·3
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	8·93
64	Percentage of rated boiler-capacity developed.....per cent		149	152

Summary. Coal R, referred to as the "test coal," ranks as a typical bituminous coal as does the operating coal for which comparative figures are given in the above table. The total moisture content of the test coal (item 5a) is 1·2 per cent lower than that of the operating coal; the ash content (item 5b) is much higher, whereas the calorific value (item 7a) is somewhat lower, being roughly 95 per cent. The high ash-fusion temperature of the test coal (item 11b) is decidedly in its favour as it prevented slagging troubles in the furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, much more power (item 20c) is required to pulverize the test coal, but the fineness of pulverization (item 16f) is greater. The CO_2 content of the flue gases (item 58a) is 2·9 per cent higher for the test coal, showing very satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is a little higher for the test coal, and indicates that about 1,990 pounds of the test coal was burned to give the same output of steam as one ton of the operating coal.

TABLE XXVI

Alberta-Ontario Series: Summary Comparison, "Test" Coal S with "Operating" Coal A

No.	Item		Operating Coal, A=7 and 16-30	Test Coal, S= 20-31
	Name	Coal Name....		
		Test No.....	P.F. 3-4	P.F. 122
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	3·0
5*b*	Ash in fuel as fired.....per cent		8·7	12·3
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	13,080
11*b*	Ash-fusion temperature or softening point.....°F.		2575	2350
14*b*	Weight of fuel fired per hour.....lb.		392	398
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	105·3
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	81·0
20*c*	Power used per ton of fuel pulverized.....kw. hr.		36·2	44·7
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	39·8
58*a*	CO_2 content of flue gases.....per cent		14·4	16·8
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	9·50
64	Percentage of rated boiler-capacity developed.....per cent		149	162

Summary. Coal S, referred to as the "test coal," ranks as a typical bituminous coal, as does the operating coal for which comparative figures are given in the above table. The total moisture content of the test coal (item 5a) very closely approximates the value given for the operating coal; the ash content (item 5b) is much higher, whereas the calorific value (item 7a) is a little lower, being roughly 97 per cent. The ash-fusion temperature of the test coal (item 11b) is of a medium order and is lower than that of the operating coal, indicating that there may be more clinker and slagging trouble in the furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals more power (item 20c) is required to pulverize the test coal, but the fineness of pulverization (item 16f) is greater. The CO_2 content of the flue gases (item 58a) is 2·4 per cent higher for the test coal showing very satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is somewhat higher for the test coal and indicates that about 1,870 pounds of the test coal was burned to give the same output of steam as one ton of the operating coal.

TABLE XXVII

Alberta-Ontario Series: Summary Comparison, "Test" Coal T with "Operating" Coal A

No.	Item	Name	Operating Coal, A=7 and 16-30	Test Coal, T=24-31
		Coal Name....		
		Test No.....	P.F. 3-4	P.F. 128
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired	per cent	3·3	2·0
5*b*	Ash in fuel as fired	per cent	8·7	12·7
7*a*	Calorific value—fuel as fired, gross value	B.T.U./lb.	13,470	13,110
11*b*	Ash-fusion temperature or softening point	°F.	2575	2590
14*b*	Weight of fuel fired per hour	lb.	392	397
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation	lb.	112·6	104·4
16*f*	Quantity of pulverized fuel passing No. 200 sieve	per cent	60·3	87·6
20*c*	Power used per ton of fuel pulverized	kw. hr.	36·2	47·4
20*e*	Rate of grinding, per cent of rated capacity	per cent	39·2	39·7
58*a*	CO_2 content of flue gases	per cent	14·4	17·3
48*d*	Equivalent evaporation per pound of fuel as fired	lb.	8·88	9·58
64	Percentage of rated boiler-capacity developed	per cent	149	163

Summary. Coal T, referred to as the "test coal," ranks as a typical bituminous coal as does the operating coal for which comparative figures are given in the above table. The total moisture content of the test coal (item 5a) is 1·3 per cent lower than for the operating coal; the ash content (item 5b) is much higher, and the calorific value (item 7a) a little lower being roughly 97 per cent. In spite of the comparatively high ash-fusion temperature of the test coal (item 11b), which should preclude slagging, the ash fused badly and was difficult to remove from the furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, much more power (item 20c) is required to pulverize the test coal, but the fineness of pulverization (item 16f) is much greater. The CO_2 content of the flue gases (item 58a) is 2·9 per cent higher for the test coal showing satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is somewhat higher for the test coal and indicates that about 1,850 pounds of the test coal would be burned to give the same output of steam as one ton of operating coal.

TABLE XXVIII

Alberta-Ontario Series: Summary Comparison, "Test" Coal U with "Operating" Coal A

No.	Item		Operating Coal, A=7 and 16-30	Test Coal, U= 21-31
	Name	Coal Name....		
		Test No.....	P.F. 3-4	P.F. 123
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	2·4
5*b*	Ash in fuel as fired.....per cent		8·7	11·6
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	13,230
11*b*	Ash-fusion temperature or softening point.....°F.		2575	2450
14*b*	Weight of fuel fired per hour.....lb.		392	393
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	106·0
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	81·1
20*c*	Power used per ton of fuel pulverized.....kw. hr.		36·2	45·0
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	39·8
58*a*	CO_2 content of flue gases.....per cent		14·4	17·5
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	9·43
64	Percentage of rated boiler-capacity developed.....per cent		149	161

Summary. Coal U, referred to as the "test coal," ranks as a typical bituminous coal as does the operating coal for which comparative figures are given in the above table. The total moisture content of the test coal (item 5a) is within 1 per cent of the value given for the operating coal; the ash content (item 5b) is much higher, whereas the calorific value (item 7a) is a little lower, being roughly 98 per cent. The ash-fusion temperature of the test coal (item 11b) is moderately high, but not sufficiently so to obviate slagging trouble in this furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, more power (item 20c) is required to pulverize the test coal, but the fineness of pulverization (item 16f) is greater. The CO_2 content of the flue gases (item 58a) is 3·1 per cent higher for the test coal, showing very satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is somewhat higher for the test coal and indicates that about 1,880 pounds of the test coal was burned to give the same output of steam as one ton of the operating coal.

TABLE XXIX

Alberta-Ontario Series: Summary Comparison, "Test" Coal V with "Operating" Coal A

No.	Item		Operating Coal, A=7 and 16-30	Test Coal, V=22-31
	Name	Coal Name....		
		Test No.....	P.F. 3-4	P.F. 120
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	1·4
5*b*	Ash in fuel as fired.....per cent		8·7	11·8
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	13,330
11*b*	Ash-fusion temperature or softening point.....°F.		2575	2700+
14*b*	Weight of fuel fired per hour.....lb.		392	400
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	105·8
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	87·0
20*c*	Power used per ton of fuel pulverized.....kw. hr.		36·2	43·1
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	40·0
58*a*	CO_2 content of flue gases.....per cent		14·4	17·0
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	9·45
64	Percentage of rated boiler-capacity developed.....per cent		149	162

Summary. Coal V, referred to as the "test coal," ranks as a typical bituminous coal as does the operating coal for which comparative figures are given in the above table. The total moisture content of the test coal (item 5a) is very low in comparison with the operating coal; the ash content (item 5b) is much higher, whereas the calorific value (item 7a) is only a little lower, being roughly 99 per cent. The high ash-fusion temperature of the test coal (item 11b) is decidedly in its favour as it ensures freedom from slagging in the furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, more power (item 20c) is required to pulverize the test coal but the fineness of pulverization (item 16f) is much greater for the test coal. The CO_2 content of the flue gases (item 58a) is 2·6 per cent higher for the test coal showing very satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is somewhat higher for the test coal and indicates that about 1,880 pounds of the test coal was burned to give the same output of steam as one ton of the operating coal.

TABLE XXX

Alberta-Ontario Series: Summary Comparison, "Test" Coal W with "Operating" Coal A

No.	Item	Name	Operating Coal, A=7 and 16-30	Test Coal, W=25-31
		Coal Name....		
		Test No.....	P.F. 3-4	P.F. 127
		Rate of feed...	Medium	Medium
5*a*	Moisture in fuel as fired.....per cent		3·3	1·9
5*b*	Ash in fuel as fired.....per cent		8·7	12·7
7*a*	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	13,370
11*b*	Ash-fusion temperature or softening point.....°F.		2575	2700+
14*b*	Weight of fuel fired per hour.....lb.		392	399
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	105·0
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	79·8
20*c*	Power used per ton of fuel pulverized.....kw. hr.		36·2	52·0
20*e*	Rate of grinding, per cent of rated capacity.....per cent		39·2	39·9
58*a*	CO_2 content of flue gases.....per cent		14·4	17·1
48*d*	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	9·52
64	Percentage of rated boiler-capacity developed.....per cent		149	163

Summary. Coal W, referred to as the "test coal," ranks as a semi-bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is low in comparison with the operating coal; the ash content (item 5b) is much higher and the calorific value (item 7a) is only a little lower being roughly 99 per cent. The high ash-fusion temperature of the test coal (item 11b) is decidedly in its favour as it prevented excessive slagging in this furnace. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, much more power (item 20c) is required to pulverize the test coal, but the fineness of pulverization (item 16f) is greater. The CO_2 content of the flue gases (item 58a) is 2·7 per cent higher for the test coal showing satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is somewhat higher for the test coal and indicates that about 1,870 pounds of the test coal would be burned to give the same output of steam as one ton of the operating coal.

TABLE XXXI

Alberta-Ontario Series: Summary Comparison, "Test" Coal X with "Operating" Coal A

No.	Item		Operating Coal, A=7 and 16-30	Test Coal, X=28-31
	Name	Coal Name....		
		Test No.....	P.F. 3-4	P.F. 129
		Rate of feed...	Medium	Medium
5a	Moisture in fuel as fired.....per cent		3·3	1·4
5b	Ash in fuel as fired.....per cent		8·7	10·9
7a	Calorific value—fuel as fired, gross value.....B.T.U./lb.		13,470	13,580
11b	Ash-fusion temperature or softening point.....°F.		2575	2275
14b	Weight of fuel fired per hour.....lb.		392	398
14d	Weight of fuel fired per 1,000 pounds of equivalent evaporation...lb.		112·6	104·9
16f	Quantity of pulverized fuel passing No. 200 sieve.....per cent		60·3	85·3
20c	Power used per ton of fuel pulverized.....kw. hr.		36·2	45·0
20e	Rate of grinding, per cent of rated capacity.....per cent		39·2	39·8
58a	CO_2 content of flue gases.....per cent		14·4	17·2
48d	Equivalent evaporation per pound of fuel as fired.....lb.		8·88	9·53
64	Percentage of rated boiler-capacity developed.....per cent		149	162

Summary. Coal X, referred to as the "test coal," ranks as a semi-bituminous coal, whereas the operating coal for which comparative figures are given in the above table is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is 1·9 per cent lower than for the operating coal; the ash content (item 5b) is 2·2 per cent higher and the calorific value (item 7a) is a little higher being roughly 101 per cent. The low ash-fusion temperature of the test coal (item 11b) is not in its favour as it may cause slagging in some boiler settings. Although the rates of coal feed (item 14b) and pulverization (item 20e) are almost identical for both coals, more power (item 20c) is required to pulverize the test coal but the fineness of pulverization (item 16f) is considerably greater. The CO_2 content of the flue gases (item 58a) is 2·8 per cent higher for the test coal showing satisfactory combustion in this furnace. The output of steam per unit quantity of fuel fired (item 48d) is somewhat higher for the test coal and indicates that about 1,860 pounds of the test coal would be burned to give the same output of steam as one ton of the operating coal.

TABLE XXXII

Alberta-Ontario Series: Summary Comparison, "Test" Coals Y_1, Y_2, Y_3 and Z with "Operating" Coal A

No.	Item / Name	Coal Name	Operating Coal, A=7 and 16-30			Ontario Lignite, Lower Seam, Old Shaft				New Shaft, Air-dried Z=10-31
						Y_1=11-30		Mechanically-dried		
						As Received	Air-dried	Y_2= 14-30	Y_3= 15-30	
		Test No. P.F	33-34	3-4	39-40	73-74	69-70	35-36	37-38	130
		Rate of feed	Low	Medium	High	High	High	High	High	High
5*a*	Moisture in fuel as fired.....per cent		3·7	3·3	1·8	46·7	35·2	35·5	26·7	31·5
5*b*	Ash in fuel as fired.....per cent		9·5	8·7	8·3	7·4	9·1	7·1	9·9	7·7
7*a*	Calorific value—fuel as fired, gross value.B.T.U./lb.		13,240	13,470	13,700	5,280	6,510	6,640	7,330	7,010
11*b*	Ash-fusion temperature or softening point.....°F.		2593	2575	2593	1976	1976	2005	1999	2060
14*b*	Weight of fuel fired per hour.....lb.		197	392	598	594	591	589	590	596
14*d*	Weight of fuel fired per 1,000 pounds of equivalent evaporation.....lb.		109·1	112·6	115·1	316·5	244·5	238·1	225·2	218·3
16*f*	Quantity of pulverized fuel passing No. 200 sieve.....per cent		67·9	60·3	69·5	62·7	55·8	49·6	45·2	63·1
20*c*	Power used per ton of fuel pulverized.....kw. hr.		57·8	36·2	30·9	57·3	40·0	40·6	35·3	50·9
20*e*	Rate of grinding, per cent of rated capacity..per cent		19·7	39·2	59·8	59·4	59·1	58·9	59·0	59·6
58*a*	CO_2 content of flue gases.....per cent		15·7	14·4	15·1	14·8	12·8	16·3	17·3	16·2
48*d*	Equivalent evaporation per pound of fuel, as fired.....lb.		9·17	8·88	8·69	3·16	4·09	4·20	4·44	4·58
64	Percentage of rated boiler-capacity developed.....per cent		77	146	223	80	104	106	112	117

Summary. The Ontario "test coal" ranks as a lignite, whereas the operating coal, for which comparative figures are given in the above table, is a typical coking bituminous coal. The total moisture content of the test coal (item 5a) is very high; the ash-content (item 5b) averages about the same as for the operating coal, the calorific value (item 7a) is very much lower being roughly only 50 per cent. The comparatively low, ash-fusion temperature of the test coal (item 11b) is not in its favour as it may cause slagging in some boiler settings. The tests were made at about equal rates of coal feed (item 14b) and pulverization (item 20e), corresponding closely to trial No. P.F. 39-40 on the operating coal. At a comparable rate of pulverization (item 20e) the power consumption (item 20c) is higher for the test coal, whereas the fineness of pulverization (item 16f) is somewhat lower for the test coal at a comparable rate of feed and pulverization. The CO_2 content of the flue gases (item 58a) is uniform and indicates satisfactory combustion in the furnace for all tests on both fuels. The economic and developed outputs were very much lower for the test coal averaging roughly 55 per cent less. This indicates that slightly less than $2\frac{1}{4}$ tons of test coal was burned to give the same output of steam as one ton of operating coal.

In general, the Ontario lignite can be burned in the pulverized state, for it is amenable to pulverization, and in the pulverized form it can be burned fairly efficiently. Much more power will, however, be required to pulverize it and much less steam will be generated per unit quantity of fuel fired than from a good grade of steam coal such as that represented by the operating coal.

APPENDIX

SUMMARIZED GENERAL INFORMATION, DESCRIPTION AND PRINCIPAL DIMENSIONS OF BOILER, FURNACE, AND ACCESSORIES

General Information

(a) Number of tests reported on: 70.

(b) Date of tests: January 1930 to March 1932.

(c) Location of plant: Ottawa, Canada.

(d) Make and type of boiler: Babcock-Wilcox, Marine type, water-tube.

(e) Make and type of fuel-burning equipment: Foster-Wheeler, Aero, size B, high-speed paddle-type pulverizer, coal feeder and straight-shot burner installed in 1929. Furnace construction: No. 1 firebrick solid refractory wall, Detrick arch, and hollow air-cooled floor.

(f) Method of producing draught: Induced and chimney.

(g) Fuels used: 12 samples of various coals from 11 collieries in 6 coal areas of British Columbia; 11 samples of various coals from 5 areas in Alberta; 4 samples of 3 shipments from Ontario; and one so-called "standard" or operating coal.

(h) Tests conducted by: Staff of Mechanical Engineering Section, Fuel Research Laboratories, Department of Mines and Resources.

(i) Object of tests: To determine and compare the physical and chemical properties, and general burning qualities of various Canadian coals and lignite, when burned in the pulverized state for the generation of steam.

(j) Test conditions: Tests of 8 hours duration under steady load at uniform rates of coal feed for each test. Steam generated at 110 ± 5 pounds gauge pressure and exhausted direct to atmosphere.

(k) Method of measuring feed water and coal consumption: By weighing on standard platform-scales.

(l) Method of sampling and analysing fuel and refuse: Standard A.S.T.M., A.S.M.E., U.S. Bureau of Mines, and Fuel Research Laboratory methods.

(m) Method of sampling and analysing flue gases: Samples mechanically aspirated through open-ended hard-glass tube and iron piping into glass sampling apparatus, analysed in "Hays" modified Orsat apparatus, Ranarex CO_2 meter indicating and recording, used as check on above and for combustion control.

(n) Method of measuring temperatures: Thermometers and pyrometers.

(o) Method of measuring draught and pressures: U tube and inclined water gauges, and Bourdon pressure gauge.

(p) Method of measuring power taken by pulverizer: By integrating kilowatt-hour meter, which was roughly checked during trials by means of an indicating watt-meter that indicated load fluctuations on pulverizer.

(q) Steam tables on which calculations are based: Marks and Davis.

Descriptions, Dimensions, etc.

(1) (a) Boiler.

Babcock-Wilcox marine type, water tube, 3 pass, cross drum.

Number of tubes high, 1 large and 8 small, total	9
Number of tubes wide, and rows of each, 10 large (1), 20 (6) and 18 (2) small. Total number of tubes, 10 large and 156 small	166
Length of tubes	7 ft.
Diameter of tubes, inches, 3 15/16 for large tubes and 1 13/16 for small tubes.	
Number of steam and water drums (single cross drum)	1
Overall length and diameter of steam, and water drum	8 and 3·5 ft.
Heating surface tubes	633 sq. ft.
Heating surface drum, etc	44 sq. ft.
Total heating surface of boiler	677 sq. ft.
Capacity of water space	57 cu. ft.
Capacity of steam space	48 cu. ft.
Weight of boiler empty, including mountings	15 tons (approx.)
Weight of hot water	1¼ tons (approx.)
Total weight boiler and water	16¼ tons (approx.)
Pressure, designed and working	200 and 110 lb./sq. in. gauge.
Baffles and passes, vertical and inclined baffles	3 passes
Smoke outlet, size, and location, rectangular top centre	16 x 22 inches.
Casings: wrought iron plates, fitted with fire refractory material and provided with outer air casings.	

(b) Furnace:

Solid refractory wall with hollow air-cooled floor and Detrick arch, designed and built for pulverized fuel.

Maximum inside width of furnace	6 ft. 8½ in.
Maximum inside length of furnace	10 ft. 9 in.
Average inside height of furnace under tubes	11 ft. 4 in.
Average inside height of furnace under arch	10 ft. 5½ in.
Total furnace volume (below tubes)	710 cu. ft.
Furnace volume per sq. ft. of heating surface	1·05 cu. ft.
Maximum length of flame travel in furnace (burner to tubes)	24 ft.
Maximum length of gas travel through boiler	15 ft.
Number, type, and location of burners: one straight-shot oval mouth in front furnace wall at 60 degrees to vertical.	
Area of burner mouth	34 sq. in.
Diameter and length of fuel duct, pulverizer to burner	5 in., 15 ft. 4 in.
Number of secondary air ports	10 installed, 4 blocked off
Number and size of ignition and observation doors	One, 9 by 12 in.
Number and size of clean-out doors	Two, 21 by 21 in.

(c) Accessories:

(1) *Pulverizer:* Foster-Wheeler "Aero," size B, high-speed, paddle-type mill.

Motive power: 25 h.p. Canadian General Electric Company, 3-phase, 550-volt induction motor, direct connected.

Speed designed and working	1750, 1840 r.p.m.
Rated capacity	1000 lb. coal/hr.

Number and location of primary air ports: Two, discharge end of mill.

Number and location of carrier air ports: One, feed end of mill—heated air from hollow furnace floor used when necessary for wet coal.

Feed arrangements: Gravity feed from small overhead hopper having capacity of 500 pounds on to and over table and magnetic separator feed mechanism, speed and feed controlled by Reeves variable drive and sliding sleeve arrangement.

(2) *Draught Equipment:—*

Fan: Sirocco 30-inch steel plate induced-draught fan, motive power, 7½ h.p., 3-phase, 550-volt electric motor, chain driven at 1,750 r.p.m.

Chimney: 27 by 27 inch square flue, brick chimney, 40 feet high above breeching entrance.

Boiler flue: 16 by 22-inch rectangular 3/16-inch steel plate breeching and by-pass flue, with one main and one auxiliary damper.

(3) *Feed-water Equipment:—*

Water supply: From city water mains.

Water weighing apparatus: One 24 by 24 by 30-inch wrought-iron rectangular weigh tank, capacity 500 pounds, mounted on standard platform scales and discharging weighed and heated feed-water through suitable quick-acting gate valve to one 24 by 48 by 54-inch wrought-iron receiving and pump-supply tank, capacity 1,800 pounds.

Water heater: Steam-heated pipe coil immersed, and weight compensated for in weigh tank.

Pumps: Two duplex-type, steam-driven boiler feed-water pumps.

(4) *Auxiliary Test Apparatus:—*

Integrating kilowatt-hour meter and indicating watt-hour meter for measuring power-consumption and load-fluctuations on pulverizer.

Ranarex CO_2 indicating and recording meter for combustion and operating control and checking hand analysis of flue gases.

Hays modified orsat apparatus and glass sampling equipment for hand analysing flue-gas at regular intervals during test.

Interval alarm time clock for indicating time of regular observations while boiler unit is under test.

Brown 6-point indicating pyrometer for obtaining flue gas, boiler pass, and furnace-wall temperatures.

Hauck large size oil torch for initial light-off of furnace.

Two cyclone-type pulverized-fuel and flue-dust samplers and collectors.

Pyro radiation type pyrometer for obtaining flame temperatures in furnace.

Thermometers, U and inclined water gauges, pressure gauges, etc., for obtaining all necessary and desirable temperatures and pressures.

TABLE XXXIII

DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES—FUEL RESEARCH LABORATORIES, OTTAWA, CANADA

Detailed Data and Results of Fifty Pulverized Fuel Fired Boiler Trials Made on Various British Columbia Coals

Fuel Number	Operating Coal A=No. 7 and 16-30			B.C. Coal B=No. 5-29				B.C. Coal C=No. 4-29			
Item — Column Number	1	2	3	4	5	6	7	8	9	10	11
Combustion Rate—Lb. Coal/Hour	200	400	600	200	400	400*	600	200	400	400*	600
1. Trial number	P.F. 33–34	P.F. 3–4	P.F. 39–40	P.F. 23–24	P.F. 9–10	P.F. 83–84	P.F. 43–44	P.F. 77–78	P.F. 5–6	P.F. 85–86	P.F. 41–42
2. Date conducted	5/6/30	11/2/30	19/6/30	7/5/30	27/2/30	29/1/31	27/6/30	13/1/31	14/2/30	3/2/31	24/6/30
3. Duration of trial in hours	8·08	8·13	8·00	8·05	7·83	8·00	8·00	8·10	8·57	8·02	8·04
RAW FUEL AS DELIVERED TO PULVERIZER FEED HOPPER											
4. Screen analysis—											
(a) Retained on ¾" square mesh screen, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
(b) Passing ¾", retained on ½" square mesh screen, %	1·1	1·1	0·8	6·1	2·9	7·5	6·0	5·1	6·4	6·2	7·7
(c) Passing ½", retained on ¼" square mesh screen, %	26·7	19·0	15·9	40·8	40·9	36·5	37·1	40·9	45·9	35·6	40·4
(d) Passing ¼", retained on ⅛" square mesh screen, %	25·5	25·6	24·6	27·2	23·0	22·9	24·9	26·1	21·7	23·1	25·0
(e) Passing ⅛" square mesh screen, %	46·7	54·3	58·7	25·9	33·2	33·1	32·0	27·9	26·0	35·1	26·9
5. Proximate analysis—											
(a) Moisture, %	3·7	3·3	1·8	23·5	23·5	22·0	22·9	20·0	20·3	19·5	19·7
(b) Ash, %	9·5	8·7	8·3	12·7	13·6	14·8	13·3	8·7	9·3	9·4	9·5
(c) Volatile matter, %	31·1	31·2	31·9	26·3	25·7	28·6	27·0	32·1	28·6	32·2	29·3
(d) Fixed carbon (by difference), %	55·7	56·8	58·0	37·5	37·2	34·6	36·8	39·2	41·8	38·9	41·5
6. Ultimate analysis—											
(a) Carbon, %	74·5	75·9	77·2	48·2	47·5	47·7	48·2	54·9	54·3	54·8	54·6
(b) Hydrogen, %	5·3	5·3	5·2	5·9	5·8	5·7	5·8	5·9	5·8	5·8	5·8
(c) Ash, %	9·5	8·7	8·3	12·7	13·6	14·8	13·3	8·7	9·3	9·4	9·4
(d) Sulphur, %	1·1	1·1	1·2	0·7	0·8	0·7	0·7	0·3	0·4	0·3	0·4
(e) Nitrogen, %	1·6	1·7	1·7	1·3	1·3	1·3	1·3	1·6	1·6	1·6	1·6
(f) Oxygen (by difference), %	8·0	7·3	6·4	31·2	31·0	29·8	30·7	28·6	28·6	28·1	28·2
7. Calorific value—											
(a) As fired, gross value, B.T.U./lb.	13240	13470	13700	8320	8080	8140	8110	9570	9270	9420	9360
(b) As fired, net value, B.T.U./lb.	12737	12967	13206	7760	7529	7599	7559	9010	8719	8869	8809
(c) Dry, gross value, B.T.U./lb.	13749	13930	13951	10876	10562	10436	10519	11963	11630	11702	11656
8. Fuel ratio, fixed carbon/volatile matter	1·80	1·80	1·80	1·40	1·45	1·20	1·35	1·20	1·45	1·20	1·40
9. Carbon-hydrogen ratio	14·1	14·4	14·7	8·2	8·2	8·4	8·4	9·4	9·3	9·5	9·4
10. Coking properties	Good	Good	Good				Non-coking				
11. Ash fusibility—											
(a) Initial deformation temperature, °F.	2449	2497	2449	1996	1996	1996	1996	2045	1994	2070	1994
(b) Softening point or fusion temperature, °F.	2593	2575	2593	2093	2093	2093	2093	2145	2118	2133	2118
(c) Fluid temperature or melting point, °F.	2593+	2680	2593+	2261	2261	2261	2261	2380	2198	2420	2198
12. Apparent specific gravity	1·26	1·26	1·26	1·31	1·31	1·32	1·31	1·27	1·27	1·28	1·27
13. Weight per cubic foot, lb.	48·8	48·8	48·4	48·0	48·0	49·9	48·0	48·4	47·0	49·1	47·0
14. Weight fired—											
(a) Total for trial, lb.	1591	3192	4784	1593	3194	3193	4785	1593	3595	3194	4784
(b) Per hour, lb.	197	392	598	198	408	399	598	197	419	398	595
(c) Per cubic foot furnace volume per hour, lb.	0·277	0·552	0·842	0·279	0·574	0·562	0·842	0·277	0·590	0·561	0·838
(d) Per 1,000 pounds of equivalent evaporation, lb.	109·1	112·6	115·1	169·2	186·2	190·8	187·3	141·6	162·3	158·5	159·0
(e) Total dry for trial, lb.	1532	3087	4698	1219	2443	2491	3689	1274	2865	2571	3842
(f) Dry per hour, lb.	190	380	587	151	312	311	461	157	334	321	478
(g) Dry per cubic foot furnace volume per hour, lb.	0·268	0·536	0·827	0·213	0·439	0·438	0·649	0·221	0·470	0·452	0·673
15. Heat liberated per cubic foot furnace volume per hour, B.T.U.	3674	7437	11539	2320	4643	4574	6831	2655	5471	5281	7844
PULVERIZED FUEL AS DELIVERED TO BURNER											
16. Screen analysis—											
(a) Retained on No. 16 sieve, %	0·2	0·0	0·2	0·2	0·1	0·1	0·2	0·2	0·0	0·2	0·2
(b) Retained on No. 30 sieve, passing No. 16 sieve, %	0·3	0·4	0·2	0·3	1·6	1·1	1·1	0·3	0·6	0·7	1·0
(c) Retained on No. 50 sieve, passing No. 30 sieve, %	1·4	2·7	2·4	3·4	8·2	11·1	11·7	6·2	10·8	12·9	11·9
(d) Retained on No. 100 sieve, passing No. 50 sieve, %	11·6	13·0	10·6	19·5	25·5	27·3	26·1	27·1	30·4	11·4	26·9
(e) Retained on No. 200 sieve, passing No. 100 sieve, %	18·6	23·6	17·1	19·4	12·0	21·8	19·0	23·0	22·0	41·3	19·6
(f) Passing No. 200 sieve, %	67·9	60·3	69·5	57·2	52·6	38·6	41·9	43·2	36·2	33·5	40·4
17. Moisture in pulverized fuel, %	2·0	1·3	1·7	18·6	20·3	19·6	20·6	12·0	17·4	16·8	17·1
18. Temperature—											
(a) Preheated air at entrance to pulverizer, °F.	124	......	115	115	......	95	115	241	......	96	115
(b) Fuel and air in fuel duct pulverizer end, °F.	117	104	102	98	84	88	96	97	87	91	99
19. Pressure in fuel duct pulverizer end, In W.G.	0·3	0·6	0·3	0·4	0·4	0·2	0·4	0·1	0·5	0·2	0·4
20. Pulverizer—											
(a) Total power used during trial, kw. hr.	46·0	57·7	74·0	61·3	69·5	68·8	78·2	54·1	71·1	69·2	80·0
(b) Power used per hour, kw. hr.	5·69	7·10	9·25	7·61	8·88	8·60	9·78	6·68	8·30	8·63	9·96
(c) Power used per hour, "net" ton of fuel pulverized, kw. hr.	57·8	36·2	30·9	77·0	43·5	43·1	32·7	67·9	39·6	43·3	33·4
(d) No load power rate, kw.	4·04	3·85	3·73	3·85	3·85	3·99	3·73	3·60	3·85	3·99	3·73
(e) Rate of grinding, per cent of rated capacity, %	19·7	39·2	59·8	19·8	40·8	39·9	59·8	19·7	41·9	39·8	59·5
REFUSE, ASH AND CARBON**											
21. Dry refuse from furnace bottom—											
(a) Total weight removed**, lb.	55	205	100	60	173	255	325	52	95	91	180
(b) Ash content**, %	99·2	95·7	90·6	98·5	95·6	87·4	82·1	97·8	97·9	90·7	85·3
(c) Ash content**, lb.	55	196	91	59	165	223	267	51	93	83	154
(d) Combustible content**, %	0·8	4·3	9·4	1·5	4·4	12·6	17·9	2·2	2·1	9·3	14·7
(e) Combustible content**, lb.	0	9	9	1	8	32	58	1	2	8	26
22. Dry refuse from boiler passes—											
(a) Total weight removed**, lb.	10	4	9	9	8	54	6	13	3	26	4
(b) Ash content**, %	85·6	85·4	91·6	92·3	96·1	96·8	97·7	84·5	94·0	97·8	91·2
(c) Ash content**, lb.	9	3	8	8	8	52	6	11	3	25	4
(d) Combustible content**, %	14·4	14·6	8·4	7·7	3·9	3·2	2·3	15·5	6·0	2·2	8·8
(e) Combustible content**, lb.	1	1	1	1	0	2	0	2	0	1	0
23. Dry refuse from dust collector—											
(a) Total weight removed**, lb.	......	......	......	......	......	......	......	......	......	......	......
(b) Ash content**, %	......	......	......	......	......	......	......	......	......	......	......
(c) Ash content**, lb.	......	......	......	......	......	......	......	......	......	......	......
(d) Combustible content**, %	......	......	......	......	......	......	......	......	......	......	......
(e) Combustible content**, lb.	......	......	......	......	......	......	......	......	......	......	......
24. Dry refuse from base of chimney—											
(a) Total weight removed**, lb.	6	3	16	4	4	10	13	6	2	8	13
(b) Ash content**, %	85·1	73·0	77·2	83·4	93·9	94·8	95·5	82·2	85·8	95·4	96·3
(c) Ash content**, lb.	5	2	12	3	4	9	12	5	2	8	13
(d) Combustible content**, %	14·9	27·0	22·8	16·6	6·1	5·2	4·5	17·8	14·2	4·6	3·7
(e) Combustible content**, lb.	1	1	4	1	0	1	1	1	0	0	0
25. Total weight of ash in fuel fired (calculated), lb.	151	278	397	202	434	473	636	139	334	300	454
26. Total ash accounted for**, lb.	69	200	111	70	177	284	285	67	98	116	171
27. Total ash unaccounted for**, lb.	82	78	286	132	257	189	351	72	236	184	283
28. Distribution of ash as a percentage of ash in fuel fired—											
(a) From furnace bottom**, %	36·4	70·5	22·9	29·2	38·0	47·1	42·0	36·7	27·8	27·7	33·9
(b) From boiler passes**, %	6·0	1·1	2·0	4·0	1·8	11·0	0·9	7·9	0·9	8·3	0·9
(c) From dust collector**, %	......	......	......	......	......	......	......	......	......	......	......
(d) From base of chimney**, %	3·3	0·7	3·0	1·5	0·9	1·9	1·9	3·6	0·6	2·7	2·9
(e) Unaccounted for**, %	54·3	27·7	72·1	65·3	59·3	40·0	55·2	51·8	70·7	61·3	62·3
29. Total refuse accounted for**, lb.	71	212	125	73	185	319	344	71	100	125	197
30. Combustible in unaccounted for refuse (assumed)**, %	14·7	20·8	15·6	12·2	5·0	4·2	3·4	16·7	10·1	3·4	6·3
31. Combustible in unaccounted for refuse (assumed)**, lb.	14	20	53	18	14	8	12	14	27	6	19
32. Total refuse unaccounted for**, lb.	96	98	339	150	271	197	363	86	263	190	302
33. Calculated total refuse**, lb.	167	310	464	223	456	516	707	157	363	315	499
34. Total weight of carbon fired, lb.	1185	2423	3693	768	1517	1523	2306	875	1952	1750	2612
35. Calculated total unburned carbon**, lb.	16	31	68	21	22	43	71	18	29	15	45
36. Total weight of carbon consumed, lb.	1169	2392	3625	747	1495	1480	2235	857	1923	1735	2567
37. Carbon consumed per pound of fuel fired, lb.	0·735	0·750	0·758	0·469	0·468	0·464	0·467	0·538	0·535	0·543	0·537
FEED WATER AND STEAM											
38. Average temperature of feed water in feed tank, °F.	133	112	111	150	125	132	120	143	128	129	100
39. Water fed to boiler—											
(a) Total for trial, lb.	13150	25116	36544	8622	15327	14990	22642	10200	19894	18010	26142
(b) Per hour, lb.	1627	3089	4568	1071	1957	1874	2830	1259	2321	2246	3252
(c) Per pound of fuel as fired, lb.	8·27	7·87	7·64	5·41	4·80	4·69	4·73	6·40	5·53	5·64	5·46
40. Average barometric pressure, In Hg.	29·82	30·19	29·70	29·73	30·12	29·69	29·27	29·57	29·88	29·89	29·48
41. Average boiler steam pressure by gauge, lb./sq. in.	112·3	109·9	109·3	109·0	108·5	107·8	107·1	107·6	107·9	107·2	106·4
42. Average calorimeter steam pressure by gauge, In Hg.	2·7	......	1·9	2·1	2·4	2·2	1·8	2·0	......	2·4	1·8
43. Average calorimeter steam temperature, °F.	271	......	282	272	272	283	282	276	......	284	284
44. Moisture content of steam, %	1·5	1·5	0·8	1·4	1·3	0·7	0·8	1·1	1·5	0·7	0·6
45. Factor of correction for quality of steam	0·988	0·988	0·994	0·989	0·990	0·994	0·994	0·991	0·988	0·994	0·995
46. Water evaporated corrected for quality of steam—											
(a) Total for trial, lb.	12992	24815	36325	8527	15174	14900	22506	10108	19655	17902	26011
(b) Per hour, lb.	1608	3052	4541	1059	1938	1863	2813	1248	2293	2232	3235
(c) Per pound of fuel as fired, lb.	8·17	7·77	7·59	5·35	4·75	4·67	4·70	6·35	5·47	5·60	5·44
47. Factor of evaporation	1·123	1·144	1·145	1·105	1·130	1·123	1·135	1·112	1·127	1·126	1·156
48. Equivalent evaporation—											
(a) Total for trial, lb.	14590	28338	41592	9422	17147	16733	25544	11240	22151	20158	30069
(b) Per hour, lb.	1806	3486	5199	1170	2190	2092	3193	1388	2585	2513	3740
(c) Per square foot heating surface per hour, lb.	2·67	5·15	7·68	1·73	3·23	3·09	4·72	2·05	3·82	3·71	5·52
(d) Per pound of fuel as fired, lb.	9·17	8·88	8·69	5·91	5·37	5·24	5·34	7·06	6·16	6·31	6·29
(e) Per pound of dry fuel fired, lb.	9·52	9·18	8·85	7·73	7·02	6·72	6·92	8·82	7·73	7·84	7·83
MISCELLANEOUS TEMPERATURES AND PRESSURES											
49. Average air temperature—											
(a) Outside boiler room, °F.	86	14	78	69	28	19	72	24	11	20	79
(b) Inside boiler room, °F.	88	79	81	75	84	74	78	77	80	76	82
50. Air humidity—											
(a) Relative of boiler room at pulverizer, %	45	47	63	41	24	35	67	32	37	32	68
(b) Water vapour per pound of air, lb.	·01314	·01013	·01454	·00770	·00612	·00636	·01398	·00645	·00825	·00623	·01625
51. Average flue gas temperature in 2nd pass of boiler, °F.	717	......	1169	762	......	788	913	619	......	858	977
52. Flame temperature in furnace—											
(a) Start of test, °F.	2300	......	2220	2250	......	2120	2300	2410	......	2180	2250
(b) Midway of test, °F.	......	......	......	......	......	2100	2130	1910	......	2140	2180
(c) End of test, °F.	2110	2325	2400	1860	2050	2130	2160	1900	2175	2140	2150
53. Average draught—											
(a) In furnace, In W.G.	0·020	0·024	0·136	......	0·059	0·003	0·087	......	0·028	0·026	0·109
(b) In boiler outlet, In W.G.	......	0·142	0·511	......	0·120	......	0·195	......	0·104	0·038	0·302
AIR AND PRODUCTS OF COMBUSTION											
54. Air supplied per pound of fuel as fired, lb.	11·4	12·7	12·3	9·6	9·5	7·9	8·5	9·9	10·2	8·6	10·1
55. Air theoretically required per pound of fuel as fired, lb.	10·1	10·3	10·4	6·3	6·2	6·2	6·3	7·1	7·0	7·1	7·1
56. Excess air, %	13	23	18	52	53	27	36	39	46	21	42
57. Average temperature of flue gases at boiler outlet, °F.	456	699	769	434	615	494	595	421	618	557	647
58. Volumetric analysis of dry flue gases at boiler outlet—											
(a) CO_2, %	15·7	14·4	15·1	11·8	11·9	14·4	13·3	13·2	12·7	15·4	13·0
(b) O_2, %	3·8	5·1	4·3	8·7	8·4	5·2	6·5	6·9	7·2	4·2	6·6
(c) CO, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
(d) N_2 (by difference), %	80·5	80·5	80·6	79·5	79·7	80·4	80·2	79·9	80·1	80·4	80·4
59. Steam—											
(a) From moisture in coal per pound of fuel as fired, lb.	0·037	0·033	0·018	0·235	0·235	0·220	0·229	0·200	0·203	0·195	0·197
(b) From H_2 in dry coal per pound of fuel as fired, lb.	0·440	0·444	0·450	0·296	0·287	0·293	0·293	0·331	0·319	0·327	0·325
(c) From moisture in air per pound of fuel as fired, lb.	0·150	0·129	0·178	0·074	0·058	0·050	0·119	0·064	0·084	0·054	0·164
60. Dry flue gases—											
(a) Per pound of carbon, lb.	16·3	17·4	16·9	21·6	21·2	17·7	19·0	19·2	19·6	16·6	19·5
(b) Per pound of fuel as fired, lb.	12·0	13·2	12·8	10·1	9·9	8·2	8·9	10·3	10·6	9·0	10·5
CAPACITIES AND EFFICIENCIES											
61. Rated boiler horse-power, h.p.	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7
62. Rated capacity per hour equivalent evaporation, lb.	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336
63. Boiler horse-power developed, h.p.	52·3	101·0	150·7	33·9	63·5	60·6	92·6	40·2	74·9	72·8	108·4
64. Percentage of rated capacity developed, %	77	149	223	50	94	90	137	59	111	108	160
65. Efficiency of boiler and furnace—											
(a) Based on gross calorific value fuel as fired, %	67·2	64·0	61·6	68·9	64·5	62·5	63·9	71·6	64·5	65·0	65·2
(b) Based on net calorific value fuel as fired, %	69·9	66·5	64·8	73·9	69·2	66·9	68·6	76·0	68·6	69·0	69·3
HEAT BALANCE IN B.T.U. AND PER CENT											
66. Heat absorbed by the boiler, B.T.U.	8899	8617	8433	5735	5211	5085	5182	6851	5978	6123	6104
67. Loss due to steam—											
(a) From moisture in fuel, B.T.U.	45	44	25	285	303	273	294	241	263	247	257
(b) By burning H_2 in dry fuel, B.T.U.	532	592	614	359	370	364	376	398	413	415	424
(c) From moisture entering with air, B.T.U.	26	38	58	12	14	10	29	10	21	12	44
68. Loss due to heat carried away in dry flue gases, B.T.U.	1060	1964	2114	870	1262	827	1104	867	1369	1039	1424
69. Loss due to unburned carbon monoxide, B.T.U.	0	0	0	0	0	0	0	0	0	0	0
70. Loss due to carbon in refuse and flue dust, B.T.U.	147	139	208	192	101	197	217	165	120	69	137
71. Loss due to radiation errors and unaccounted for, B.T.U.	2531	2076	2248	867	819	1385	908	1038	1106	1515	970
72. Total calorific value of 1 pound of fuel as fired, gross value, B.T.U.	13240	13470	13700	8320	8080	8140	8110	9570	9270	9420	9360
73. Heat absorbed by the boiler (thermal efficiency), %	67·2	64·0	61·6	68·9	64·5	62·5	63·9	71·6	64·5	65·0	65·2
74. Loss due to steam—											
(a) From moisture in fuel, %	0·4	0·3	0·2	3·4	3·7	3·3	3·6	2·5	2·8	2·6	2·7
(b) By burning H_2 in dry fuel, %	4·0	4·4	4·5	4·3	4·6	4·5	4·6	4·2	4·5	4·4	4·5
(c) From moisture entering with air, %	0·2	0·3	0·4	0·2	0·2	0·1	0·4	0·1	0·2	0·1	0·5
75. Loss due to heat carried away in dry flue gases, %	8·0	14·6	15·4	10·5	15·6	10·2	13·6	9·1	14·8	11·0	15·2
76. Loss due to unburned carbon monoxide, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
77. Loss due to carbon in refuse and flue dust, %	1·1	1·0	1·5	2·3	1·3	2·4	2·7	1·7	1·3	0·8	1·5
78. Loss due to radiation errors and unaccounted for, %	19·1	15·4	16·4	10·4	10·1	17·0	11·2	10·8	11·9	16·1	10·4

Fuel Number	B.C. Coal D=No. 8-30				B.C. Coal E=No. 6-29				B.C. Coal F=No. 10-30				B.C. Coal G=No. 9-30				B.C. Coal H=17-30			
Item — Column Number	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Combustion Rate—Lb. Coal/Hour	200	400	400*	600	200	400	400*	600	200	400	400*	600	200	400	400*	600	200	400	400*	600
1. Trial number	P.F. 27–28	P.F. 11–12	P.F. 89–90	P.F. 45–46	P.F. 25–26	P.F. 7–8	P.F. 91–92	P.F. 53–54	P.F. 29–30	P.F. 13–14	P.F. 87–88	P.F. 47–48	P.F. 31–32	P.F. 15–16	P.F. 93–94	P.F. 49–50	P.F. 67–68	P.F. 65–66	P.F. 97–98	P.F. 55–56
2. Date conducted	20/5/30	5/3/30	12/2/31	3/7/30	15/5/30	20/2/30	19/2/31	18/7/30	23/5/30	25/3/30	6/2/31	8/7/30	28/5/30	28/3/30	24/2/31	11/7/30	29/8/30	26/8/30	5/3/30	22/7/30
3. Duration of trial in hours	8·05	7·88	8·02	8·04	7·93	7·93	8·05	8·04	7·93	8·03	8·02	8·02	8·10	7·98	8·00	8·00	7·92	7·97	8·02	8·05
RAW FUEL AS DELIVERED TO PULVERIZER FEED HOPPER																				
4. Screen analysis—																				
(a) Retained on ¾" square mesh screen, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
(b) Passing ¾", retained on ½" square mesh screen, %	2·1	2·0	5·9	2·3	3·6	4·7	3·4	3·6	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	4·5	4·5	4·7	2·6
(c) Passing ½", retained on ¼" square mesh screen, %	35·4	30·6	32·8	30·3	24·5	36·2	28·7	26·5	0·4	0·3	0·5	0·4	0·9	0·4	0·8	0·8	31·8	32·2	26·9	31·6
(d) Passing ¼", retained on ⅛" square mesh screen, %	24·6	24·0	23·4	25·0	24·4	22·9	21·3	20·7	28·1	19·3	26·3	24·5	33·3	37·7	35·1	30·3	25·1	25·4	22·3	25·7
(e) Passing ⅛" square mesh screen, %	37·9	43·4	37·9	42·4	47·0	36·2	46·6	49·2	71·5	80·4	73·2	75·1	65·8	61·9	64·1	68·9	38·6	37·9	46·1	40·1
5. Proximate analysis—																				
(a) Moisture, %	14·9	8·2	8·2	7·9	9·4	8·8	8·7	9·3	5·4	6·4	6·3	5·3	4·5	5·5	4·6	3·9	3·6	3·8	3·5	3·0
(b) Ash, %	10·7	11·6	12·2	10·3	12·0	12·0	11·4	11·3	17·9	16·3	16·6	17·2	13·8	14·0	15·2	13·5	12·0	12·2	12·0	11·6
(c) Volatile matter, %	31·0	32·8	32·5	33·6	34·7	35·4	34·6	34·8	34·7	34·8	34·3	34·9	36·3	36·4	35·3	37·1	36·2	36·4	35·9	36·8
(d) Fixed carbon (by difference), %	43·4	47·4	47·1	48·2	43·9	43·8	45·3	44·6	42·0	42·5	42·8	42·6	45·4	44·1	44·9	45·5	48·2	47·6	48·6	48·6
6. Ultimate analysis—																				
(a) Carbon, %	59·8	64·5	63·9	65·7	62·8	63·4	64·0	63·5	63·3	63·8	63·5	63·9	67·5	66·5	66·2	68·2	70·6	70·3	70·7	71·4
(b) Hydrogen, %	5·7	5·3	5·3	5·4	5·6	5·6	5·6	5·7	4·8	5·0	4·9	4·9	5·3	5·4	5·2	5·3	5·5	5·5	5·5	5·4
(c) Ash, %	10·7	11·6	12·2	10·3	12·0	12·0	11·4	11·3	17·9	16·3	16·6	17·2	13·8	14·0	15·2	13·5	12·0	12·2	12·0	11·6
(d) Sulphur, %	0·4	0·4	0·4	0·4	0·7	0·6	0·6	0·6	0·9	0·9	1·0	0·9	0·8	0·8	0·9	0·8	0·5	0·5	0·5	0·6
(e) Nitrogen, %	1·2	1·3	1·3	1·3	1·7	1·7	1·7	1·7	1·3	1·3	1·3	1·3	1·4	1·3	1·3	1·4	1·5	1·5	1·5	1·6
(f) Oxygen (by difference), %	22·2	16·9	16·9	16·9	17·2	16·7	16·7	17·2	11·8	12·7	12·7	11·8	11·2	12·0	11·2	10·8	9·9	10·0	9·8	9·4
7. Calorific value—																				
(a) As fired, gross value, B.T.U./lb.	10490	11250	112 0	11450	11270	11360	11380	11230	11240	11380	11270	11330	12000	11900	11700	12140	12510	12440	12530	12630
(b) As fired, net value, B.T.U./lb.	9949	10747	10777	10937	10738	10828	10848	10689	10784	10905	10805	10865	11497	11387	11206	11637	11988	11918	12008	12117
(c) Dry, gross value, B.T.U./lb.	12327	12255	12288	12432	12439	12456	12464	12381	11882	12159	12028	11964	12565	12593	12264	12633	12977	12931	12984	13021
8. Fuel ratio, fixed carbon/volatile matter	1·40	1·45	1·45	1·45	1·25	1·25	1·30	1·30	1·20	1·20	1·25	1·20	1·25	1·20	1·25	1·20	1·35	1·30	1·35	1·30
9. Carbon-hydrogen ratio	10·4	12·2	12·2	12·3	11·2	11·3	11·4	11·2	13·1	12·8	12·8	13·1	12·7	12·4	12·7	12·9	12·9	12·9	13·0	13·1
10. Coking properties				Agglomerate											Fair					
11. Ash fusibility—																				
(a) Initial deformation temperature, °F.	2082	2082	2075	2082	2475	2475	2500	2475	2070	2070	2150	2070	2045	2045	2170	2045	2267	2267	2165	2267
(b) Softening point or fusion temperature, °F.	2239	2239	2230	2239	2588	2588	2650	2588	2145	2145	2282	2145	2223	2223	2280	2223	2307	2307	2325	2307
(c) Fluid temperature or melting point, °F.	2462	2462	2445	2462	2588+	2588+	2700	2588+	2320	2320	2415	2320	2241	2241	2390	2241	2340	2340	2465	2340
12. Apparent specific gravity	1·30	1·30	1·32	1·30	1·28	1·28	1·30	1·28	1·33	1·33	1·33	1·32	1·29	1·29	1·31	1·30	1·27	1·27	1·27	1·27
13. Weight per cubic foot, lb.	51·3	51·3	51·5	51·3	50·9	53·6	53·2	53·6	46·1	46·1	45·8	46·0	45·1	45·1	46·7	46·1	50·0	48·0	53·7	50·0
14. Weight fired—																				
(a) Total for trial, lb.	1592	3195	3196	4788	1591	3193	3194	4786	1591	3189	3196	4784	1590	3188	3195	4788	1593	3190	3194	4787
(b) Per hour, lb.	198	405	399	596	201	403	397	595	201	397	399	597	196	399	399	599	201	400	398	595
(c) Per cubic foot furnace volume per hour, lb.	0·279	0·570	0·562	0·839	0·283	0·568	0·559	0·838	0·283	0·559	0·562	0·841	0·276	0·562	0·562	0·844	0·283	0·563	0·561	0·838
(d) Per 1,000 pounds of equivalent evaporation, lb.	127·7	135·5	134·2	131·6	131·4	137·0	131·8	133·7	125·2	133·0	136·6	133·2	115·8	121·8	129·7	125·6	109·4	118·8	121·1	121·8
(e) Total dry for trial, lb.	1355	2933	2934	4410	1441	2912	2916	4341	1505	2985	2995	4530	1518	3013	3048	4601	1536	3069	3082	4643
(f) Dry per hour, lb.	168	372	366	549	182	367	362	540	190	372	373	565	187	378	381	575	194	385	384	577
(g) Dry per cubic foot furnace volume per hour, lb.	0·237	0·524	0·515	0·773	0·256	0·517	0·510	0·761	0·268	0·524	0·525	0·796	0·263	0·532	0·537	0·810	0·273	0·542	0·541	0·813
15. Heat liberated per cubic foot furnace volume per hour, B.T.U.	2925	6417	6339	9612	3191	6448	6363	9411	3182	6363	6333	9527	3313	6687	6575	10242	3542	7008	7024	10584
PULVERIZED FUEL AS DELIVERED TO BURNER																				
16. Screen analysis—																				
(a) Retained on No. 16 sieve, %	0·1	0·4	0·1	0·2	0·1	0·0	0·2	0·0	0·2	0·2	0·1	0·1	0·3	0·5	0·1	0·1	0·1	0·1	0·1	0·0
(b) Retained on No. 30 sieve, passing No. 16 sieve, %	0·2	0·2	0·1	0·4	0·1	0·4	0·2	0·6	0·2	0·4	0·2	0·2	0·5	0·5	0·1	0·2	0·1	0·2	0·1	0·3
(c) Retained on No. 50 sieve, passing No. 30 sieve, %	1·1	4·0	2·5	4·2	1·4	3·0	3·9	4·6	0·7	0·9	2·3	1·6	0·8	1·1	1·5	3·1	0·6	1·3	0·7	2·1
(d) Retained on No. 100 sieve, passing No. 50 sieve, %	11·8	22·1	17·3	18·9	13·5	19·6	19·2	15·2	4·8	11·0	13·5	11·5	9·8	13·3	9·9	14·1	8·7	10·7	7·4	11·9
(e) Retained on No. 200 sieve, passing No. 100 sieve, %	24·2	24·4	25·8	23·3	23·3	27·4	24·5	25·3	15·5	20·8	21·9	18·7	19·8	21·4	18·4	20·9	18·0	18·7	17·3	18·6
(f) Passing No. 200 sieve, %	62·6	48·9	54·2	53·0	61·6	49·6	52·0	54·3	78·6	66·7	62·0	67·9	68·8	63·2	70·0	61·6	72·5	69·0	74·4	67·1
17. Moisture in pulverized fuel, %	5·3	5·4	5·4	5·6	5·8	6·4	5·7	7·0	2·3	2·4	3·4	3·0	2·3	2·4	1·6	3·0	1·9	2·2	1·9	2·2
18. Temperature—																				
(a) Preheated air at entrance to pulverizer, °F.	138	......	345	119	115	......	312	117	123	383	195	123	135	207	305	122	126	114	123	111
(b) Fuel and air in fuel duct pulverizer end, °F.	108	90	120	100	113	94	114	107	127	104	106	103	111	101	124	109	119	115	125	114
19. Pressure in fuel duct pulverizer end, In W.G.	0·2	0·5	0·2	0·4	0·2	0·5	0·2	0·3	0·3	0·8	0·2	0·4	0·2	0·8	0·3	0·4	0·1	0·2	0·3	0·8
20. Pulverizer—																				
(a) Total power used during trial, kw. hr.	54·1	60·3	67·1	79·8	65·3	61·4	70·9	77·2	58·5	70·5	68·0	81·9	51·9	68·2	75·9	76·0	46·8	62·2	78·5	75·3
(b) Power used per hour, kw. hr.	6·72	7·65	8·37	9·93	8·23	7·75	8·81	9·61	7·38	8·78	8·48	10·22	6·41	8·55	9·50	9·50	5·91	7·80	9·79	9·35
(c) Power used per hour, "net" ton of fuel pulverized, kw. hr.	68·0	37·7	42·0	33·3	82·1	38·5	44·4	32·3	73·5	44·2	42·6	34·2	65·3	42·8	47·5	31·7	58·8	39·0	49·2	31·5
(d) No load power rate, kw.	3·85	3·85	3·74	3·73	3·85	3·85	3·85	4·02	3·82	3·85	4·13	4·02	3·98	3·85	3·78	4·02	3·71	3·80	3·89	4·23
(e) Rate of grinding, per cent of rated capacity, %	19·8	40·5	39·9	59·6	20·1	40·3	39·7	59·5	20·1	39·7	39·9	59·7	19·6	39·9	39·9	59·9	20·1	40·0	39·8	59·5
REFUSE, ASH AND CARBON**																				
21. Dry refuse from furnace bottom—																				
(a) Total weight removed**, lb.	110	170	153	140	60	127	140	81	110	166	42	109	80	243	......	30	70	55	134	15
(b) Ash content**, %	99·4	98·8	97·1	98·5	99·5	99·9	99·3	99·3	98·3	99·5	95·0	95·0	99·0	99·8	......	95·0	99·1	97·5	99·0	98·1
(c) Ash content**, lb.	109	168	149	138	60	127	139	80	108	165	40	104	79	243	......	29	69	54	133	15
(d) Combustible content**, %	0·6	1·2	2·9	1·5	0·5	0·1	0·7	0·7	1·7	0·5	5·0	5·0	1·0	0·2	......	5·0	0·9	2·5	1·0	1·9
(e) Combustible content**, lb.	1	2	4	2	0	0	1	1	2	1	2	5	1	0	......	1	1	1	1	0
22. Dry refuse from boiler passes—																				
(a) Total weight removed**, lb.	16	14	33	9	15	12	29	8	12	6	51	12	8	9	41	6	11	11	7	9
(b) Ash content**, %	91·2	92·4	91·7	93·7	93·7	94·8	95·0	96·6	95·3	95·0	95·4	96·0	92·8	95·1	97·2	95·9	91·5	95·5	96·9	96·1
(c) Ash content**, lb.	15	13	30	8	14	11	28	8	11	6	49	12	7	9	40	6	10	11	7	9
(d) Combustible content**, %	8·5	7·6	8·3	6·3	6·3	5·2	5·0	3·4	4·7	5·0	4·6	4·0	7·2	4·9	2·8	4·1	8·5	4·5	3·1	3·9
(e) Combustible content**, lb.	1	1	3	1	1	1	1	0	1	0	2	0	1	0	1	0	1	0	0	0
23. Dry refuse from dust collector—																				
(a) Total weight removed**, lb.	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
(b) Ash content**, %	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
(c) Ash content**, lb.	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
(d) Combustible content**, %	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
(e) Combustible content**, lb.	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
24. Dry refuse from base of chimney—																				
(a) Total weight removed**, lb.	6	4	11	19	3	9	12	14	3	5	16	28	6	4	13	20	6	10	10	18
(b) Ash content**, %	85·9	81·7	87·1	90·0	92·0	82·8	91·2	93·2	87·9	81·6	93·9	94·7	85·7	83·3	95·3	95·8	87·3	89·1	91·6	94·8
(c) Ash content**, lb.	5	3	10	17	3	8	11	13	3	4	15	27	5	3	12	19	5	9	9	17
(d) Combustible content**, %	14·1	18·3	12·9	10·0	8·0	17·2	8·8	6·8	12·1	18·4	6·1	5·3	14·3	16·7	4·7	4·2	12·7	10·6	8·4	5·2
(e) Combustible content**, lb.	1	1	1	2	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
25. Total weight of ash in fuel fired (calculated), lb.	170	371	390	493	191	383	364	541	285	520	531	823	219	446	486	646	191	389	383	555
26. Total ash accounted for**, lb.	129	184	189	163	77	146	178	101	122	175	104	143	91	255	52	54	84	74	149	41
27. Total ash unaccounted for**, lb.	41	187	201	330	114	237	186	440	163	345	427	680	128	191	434	592	107	315	234	514
28. Distribution of ash as a percentage of ash in fuel fired—																				
(a) From furnace bottom**, %	64·1	45·3	38·2	28·0	31·4	33·2	38·2	14·8	37·9	31·7	7·5	12·6	36·1	54·5	......	4·5	36·1	13·9	34·7	2·7
(b) From boiler passes**, %	8·8	3·5	7·7	1·6	7·3	2·9	7·7	1·5	3·9	1·2	9·2	1·5	3·2	2·0	8·2	0·9	5·2	2·8	1·8	1·6
(c) From dust collector**, %	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
(d) From base of chimney**, %	2·9	0·8	2·6	3·4	1·6	2·1	3·0	2·4	1·1	0·8	2·8	3·3	2·3	0·7	2·5	2·9	2·6	2·3	2·3	3·1
(e) Unaccounted for**, %	24·2	50·4	51·5	67·0	59·7	61·8	51·1	81·3	57·1	66·3	80·5	82·6	58·4	42·8	89·3	91·7	56·1	81·0	61·2	92·6
29. Total refuse accounted for**, lb.	132	188	197	168	78	148	181	103	125	177	109	149	94	256	54	56	87	76	151	42
30. Combustible in unaccounted for refuse (assumed)**, %	11·5	13·0	10·6	8·2	7·2	11·2	6·9	5·1	8·4	11·7	5·4	4·7	10·9	10·8	3·8	4·2	10·6	7·6	5·8	4·6
31. Combustible in unaccounted for refuse (assumed)**, lb.	5	28	24	28	9	30	14	24	15	46	24	34	16	23	17	26	13	26	14	25
32. Total refuse unaccounted for**, lb.	46	215	225	342	123	267	200	464	178	391	451	714	144	214	451	618	120	341	248	539
33. Calculated total refuse**, lb.	178	403	422	510	201	415	381	567	303	568	560	863	238	470	505	674	207	417	399	581
34. Total weight of carbon fired, lb.	952	2061	2042	3146	999	2024	2044	3030	1007	2035	2029	3057	1073	2120	2115	3265	1125	2243	2258	3418
35. Calculated total unburned carbon**, lb.	8	32	32	33	10	32	17	26	18	48	29	40	19	24	19	28	16	28	16	26
36. Total weight of carbon consumed, lb.	944	2029	2010	3113	989	1992	2027	3013	989	1987	2000	3017	1054	2096	2096	3237	1109	2215	2242	3392
37. Carbon consumed per pound of fuel fired, lb.	0·593	0·635	0·629	0·650	0·622	0·624	0·635	0·630	0·622	0·623	0·626	0·631	0·663	0·657	0·656	0·676	0·696	0·694	0·702	0·709
FEED WATER AND STEAM																				
38. Average temperature of feed water in feed tank, °F.	143	108	123	114	141	121	121	120	138	110	124	122	127	114	118	115	138	128	114	119
39. Water fed to boiler—																				
(a) Total for trial, lb.	11342	20796	21130	32042	11022	20774	21490	31720	11560	21370	20800	31860	12160	23203	21810	33600	13120	23970	23240	34800
(b) Per hour, lb.	1409	2638	2635	3985	1390	2620	2670	3945	1458	2660	2594	3973	1501	2908	2726	4200	1657	3008	2898	4323
(c) Per pound of fuel as fired, lb.	7·12	6·51	6·61	6·69	6·93	6·51	6·73	6·61	7·27	6·70	6·51	6·66	7·65	7·28	6·83	7·02	8·24	7·51	7·28	7·27
40. Average barometric pressure, In Hg.	29·84	29·49	29·89	30·04	29·58	29·83	30·04	29·74	29·80	29·51	30·05	29·83	29·68	29·63	29·89	29·57	29·72	29·97	29·65	29·66
41. Average boiler steam pressure by gauge, lb./sq. in.	108·5	108·3	108·6	107·4	106·8	108·9	108·4	109·3	108·0	110·8	109·0	108·8	109·9	109·8	107·2	108·2	107·9	108·8	108·4	107·5
42. Average calorimeter steam pressure by gauge, In Hg.	2·1	2·3	2·2	1·8	2·2	......	2·2	1·9	2·1	1·9	2·4	1·9	2·1	......	2·1	1·9	1·9	2·0	2·1	1·9
43. Average calorimeter steam temperature, °F.	270	268	284	282	265	......	284	283	264	......	284	283	266	......	283	282	281	283	284	282
44. Moisture content of steam, %	1·5	1·5	0·7	0·8	1·7	1·5	0·7	0·8	1·8	1·5	0·7	0·8	1·7	1·5	0·8	0·8	0·8	0·8	0·7	0·8
45. Factor of correction for quality of steam	0·988	0·988	0·994	0·994	0·986	0·988	0·994	0·994	0·985	0·988	0·994	0·994	0·985	0·988	0·994	0·994	0·994	0·994	0·994	0·994
46. Water evaporated corrected for quality of steam—																				
(a) Total for trial, lb.	11206	20546	21003	31850	10868	20525	21361	31530	11387	21114	20675	31669	11978	22925	21679	33398	13041	23826	23101	34591
(b) Per hour, lb.	1392	2607	2619	3961	1370	2588	2654	3922	1436	2629	2578	3949	1479	2873	2710	4175	1647	2989	2880	4297
(c) Per pound of fuel as fired, lb.	7·04	6·43	6·57	6·65	6·83	6·43	6·69	6·59	7·16	6·62	6·47	6·62	7·53	7·19	6·79	6·98	8·19	7·47	7·23	7·23
47. Factor of evaporation	1·113	1·148	1·133	1·142	1·114	1·135	1·135	1·136	1·117	1·146	1·132	1·134	1·129	1·142	1·137	1·141	1·117	1·127	1·142	1·136
48. Equivalent evaporation—																				
(a) Total for trial, lb.	12472	23587	23796	36373	12107	23296	24245	35818	12719	24197	23404	35913	13729	26180	24649	38107	14567	26852	26381	39295
(b) Per hour, lb.	1549	2993	2967	4524	1527	2938	3012	4455	1604	3013	2918	4478	1695	3281	3081	4763	1839	3369	3289	4881
(c) Per square foot heating surface per hour, lb.	2·29	4·42	4·38	6·68	2·26	4·34	4·45	6·58	2·37	4·45	4·31	6·61	2·50	4·85	4·55	7·04	2·72	4·98	4·86	7·21
(d) Per pound of fuel as fired, lb.	7·83	7·38	7·45	7·60	7·61	7·30	7·59	7·48	7·99	7·59	7·32	7·51	8·63	8·21	7·71	7·96	9·14	8·42	8·26	8·21
(e) Per pound of dry fuel fired, lb.	9·20	8·04	8·11	8·25	8·40	8·00	8·31	8·25	8·45	8·11	7·81	7·93	9·04	8·69	8·09	8·28	9·48	8·75	8·56	8·46
MISCELLANEOUS TEMPERATURES AND PRESSURES																				
49. Average air temperature—																				
(a) Outside boiler room, °F.	55	36	28	66	49	47	30	82	83	33	14	76	56	35	31	68	76	77	38	74
(b) Inside boiler room, °F.	74	81	76	74	70	85	75	85	86	82	74	81	75	81	74	76	81	80	77	78
50. Air humidity—																				
(a) Relative of boiler room at pulverizer, %	48	32	28	51	55	39	35	56	47	33	31	62	54	29	31	66	63	62	32	70
(b) Water vapour per pound of air, lb.	·00871	·00742	·00545	·00926	·00868	·01027	·00657	·01475	·01283	·00788	·00563	·01431	·01014	·00669	·00563	·01285	·01454	·01380	·00645	·01460
51. Average flue gas temperature in 2nd pass of boiler, °F.	800	......	911	1028	759	......	906	1078	772	......	993	1067	691	......	943	1060	653	884	1020	1099
52. Flame temperature in furnace—																				
(a) Start of test, °F.	2370	......	2220	2300	2380	......	2030	2320	2360	2250	2300	2360	2340	2200	2250	2340	2300	2290	2370	2330
(b) Midway of test, °F.	......	......	2250	2400	......	......	2320	2280	......	......	2320	2340	......	......	2390	2420	2080	2280	2390	2340
(c) End of test, °F.	2100	2325	2270	2350	2050	2325	2340	2350	2040	2375	2350	2330	2070	2400	2390	2420	2090	2300	2430	2460
53. Average draught—																				
(a) In furnace, In W.G.	0·022	0·021	0·053	0·125	0·015	0·025	0·097	0·084	0·037	0·054	0·025	0·101	0·023	0·065	0·092	0·135	0·032	0·096	0·098	0·080
(b) In boiler outlet, In W.G.	......	0·111	0·102	0·374	......	0·230	0·163	0·383	......	0·110	0·058	0·351	......	0·152	0·155	0·456	......	0·202	0·173	0·394
AIR AND PRODUCTS OF COMBUSTION																				
54. Air supplied per pound of fuel as fired, lb.	9·6	10·8	10·5	11·6	9·9	10·9	12·3	11·8	10·7	10·5	9·5	10·8	10·1	11·4	11·2	12·9	11·6	11·9	11·4	12·0
55. Air theoretically required per pound of fuel as fired, lb.	7·9	8·5	8·5	8·7	8·4	8·5	8·6	8·6	8·5	8·6	8·5	8·6	9·1	9·0	9·0	9·2	9·6	9·6	9·6	9·7
56. Excess air, %	22	27	24	34	18	28	43	37	27	22	12	27	11	27	24	40	21	24	19	24
57. Average temperature of flue gases at boiler outlet, °F.	440	617	606	707	438	670	630	742	463	624	671	734	439	622	666	758	388	579	699	764
58. Volumetric analysis of dry flue gases at boiler outlet—																				
(a) CO_2, %	15·1	14·2	14·6	13·6	15·4	14·0	12·6	13·0	14·1	14·5	16·1	14·2	16·0	14·1	14·4	12·6	14·7	14·2	15·0	14·4
(b) O_2, %	4·6	5·4	4·8	6·0	4·1	5·6	6·9	6·9	5·6	4·8	2·9	5·4	3·3	5·3	4·8	7·9	4·7	5·2	4·4	5·3
(c) CO, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
(d) N_2 (by difference), %	80·3	80·4	80·6	80·4	80·5	80·4	80·5	80·1	80·3	80·7	81·0	80·4	80·7	80·6	80·8	79·5	80·6	80·6	80·6	80·3
59. Steam—																				
(a) From moisture in coal per pound of fuel as fired, lb.	0·149	0·082	0·082	0·079	0·094	0·088	0·087	0·093	0·054	0·064	0·063	0·053	0·045	0·055	0·046	0·039	0·036	0·038	0·035	0·030
(b) From H_2 in dry coal per pound of fuel as fired, lb.	0·364	0·395	0·395	0·407	0·410	0·416	0·417	0·420	0·378	0·386	0·378	0·388	0·432	0·431	0·422	0·438	0·459	0·457	0·460	0·456
(c) From moisture in air per pound of fuel as fired, lb.	0·084	0·080	0·057	0·108	0·092	0·112	0·081	0·174	0·138	0·083	0·053	0·155	0·102	0·076	0·063	0·166	0·169	0·164	0·074	0·175
60. Dry flue gases—																				
(a) Per pound of carbon, lb.	16·9	17·9	17·4	18·6	16·6	17·8	20·0	19·5	18·0	17·5	15·9	17·9	16·0	18·0	17·6	20·1	17·3	17·9	17·0	17·7
(b) Per pound of fuel as fired, lb.	10·0	11·4	10·9	12·1	10·3	11·3	12·7	12·3	11·2	10·9	10·0	11·3	10·6	11·8	11·5	13·6	12·0	12·4	11·9	12·5
CAPACITIES AND EFFICIENCIES																				
61. Rated boiler horse-power, h.p.	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7
62. Rated capacity per hour equivalent evaporation, lb.	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336
63. Boiler horse-power developed, h.p.	44·9	86·8	86·0	131·1	44·3	85·2	87·3	129·1	46·5	87·3	84·6	129·8	49·1	95·1	89·3	138·1	53·3	97·7	95·3	141·5
64. Percentage of rated capacity developed, %	66	128	127	194	65	126	129	191	69	129	125	192	73	140	132	204	79	144	141	209
65. Efficiency of boiler and furnace—																				
(a) Based on gross calorific value fuel as fired, %	72·4	63·7	64·1	64·4	65·5	62·3	64·7	64·6	69·0	64·7	63·0	64·3	69·8	66·9	63·9	63·6	70·9	65·7	64·0	63·1
(b) Based on net calorific value fuel as fired, %	76·4	66·6	67·1	67·4	68·8	65·4	67·9	67·9	71·9	67·5	65·7	67·1	72·8	70·0	66·8	66·4	74·0	68·6	66·8	65·8
HEAT BALANCE IN B.T.U. AND PER CENT																				
66. Heat absorbed by the boiler, B.T.U.	7598	7162	7229	7375	7385	7084	7365	7259	7753	7365	7103	7288	8375	7967	7482	7724	8869	8171	8016	7967
67. Loss due to steam—																				
(a) From moisture in fuel, B.T.U.	181	106	106	106	115	116	113	125	66	83	83	71	55	71	61	53	43	48	47	41
(b) By burning H_2 in dry fuel, B.T.U.	442	510	510	546	500	546	544	566	459	499	501	523	524	558	584	597	544	583	614	622
(c) From moisture entering with air, B.T.U.	14	20	14	32	16	31	21	54	24	21	15	48	17	19	18	53	24	38	22	56
68. Loss due to heat carried away in dry flue gases, B.T.U.	878	1466	1386	1838	910	1587	1692	1939	1013	1418	1433	1771	926	1532	1634	2226	884	1485	1776	2058
69. Loss due to unburned carbon monoxide, B.T.U.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70. Loss due to carbon in refuse and flue dust, B.T.U.	73	146	146	101	92	147	78	12	165	220	132	122	174	110	87	15	147	128	73	9
71. Loss due to radiation errors and unaccounted for, B.T.U.	1306	1840	1889	1452	2252	1849	1567	1275	1760	1774	2003	1507	1929	1643	1834	1472	1999	1987	1982	1877
72. Total calorific value of 1 pound of fuel as fired, gross value, B.T.U.	10490	11250	11280	11450	11270	11360	11380	11230	11240	11380	11270	11330	12000	11900	11700	12140	12510	12440	12530	12630
73. Heat absorbed by the boiler (thermal efficiency), %	72·4	63·7	64·1	64·4	65·5	62·3	64·7	64·6	69·0	64·7	63·0	64·3	69·8	66·9	63·9	63·6	70·9	65·7	64·0	63·1
74. Loss due to steam—																				
(a) From moisture in fuel, %	1·7	0·9	0·9	0·9	1·0	1·0	1·0	1·1	0·6	0·7	0·7	0·6	0·5	0·6	0·5	0·4	0·3	0·4	0·4	0·3
(b) By burning H_2 in dry fuel, %	4·2	4·5	4·5	4·8	4·4	4·8	4·8	5·1	4·1	4·4	4·5	4·6	4·4	4·7	5·0	4·9	4·3	4·7	4·9	4·9
(c) From moisture entering with air, %	0·1	0·2	0·1	0·3	0·2	0·3	0·2	0·5	0·2	0·2	0·1	0·4	0·1	0·2	0·2	0·5	0·2	0·3	0·2	0·4
75. Loss due to heat carried away in dry flue gases, %	8·4	13·0	12·3	16·0	8·1	14·0	14·8	17·3	9·0	12·5	12·7	15·7	7·7	12·9	14·0	18·4	7·1	11·9	14·1	16·3
76. Loss due to unburned carbon monoxide, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
77. Loss due to carbon in refuse and flue dust, %	0·7	1·3	1·3	0·9	0·8	1·3	0·7	0·1	1·5	1·9	1·2	1·1	1·5	0·9	0·7	0·1	1·2	1·0	0·6	0·1
78. Loss due to radiation errors and unaccounted for, %	12·5	16·4	16·8	12·7	20·0	16·3	13·8	11·3	15·6	15·6	17·8	13·3	16·0	13·8	15·7	12·1	16·0	16·0	15·8	14·9

Fuel Number	B.C. Coal I=No. 19-30				B.C. Coal J=No. 13-30				B.C. Coal K=No. 3-31				B.C. Coal L=No. 2-31				B.C. Coal M=No. 20-30		
Item — Column Number	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Combustion Rate—Lb. Coal/Hour	200	400	400*	600	200	400	400*	600	200	400	400*	600	200	400	400*	600	200	400	600
1. Trial number	P.F. 71–72	P.F. 63–64	P.F. 95–96	P.F. 57–58	P.F. 19–20	P.F. 17–18	P.F. 101–102	P.F. 51–52	P.F. 109–110	P.F. 105–106	P.F. 117–118	P.F. 113–114	P.F. 107–108	P.F. 103–104	P.F. 115–116	P.F. 111–112	P.F. 75–76	P.F. 61–62	P.F. 59–60
2. Date conducted	11/9/30	21/8/30	27/2/31	25/7/30	24/4/30	3/4/30	8/1/32	15/7/30	26/1/32	15/1/32	9/2/32	2/2/32	19/1/32	12/1/32	5/2/32	29/1/32	8/1/31	1/8/30	28/7/30
3. Duration of trial in hours	7·98	7·97	7·95	8·00	7·98	7·98	8·03	8·05	7·98	8·00	8·02	8·17	8·00	8·02	8·00	8·00	7·98	7·98	8·00
RAW FUEL AS DELIVERED TO PULVERIZER FEED HOPPER																			
4. Screen analysis—																			
(a) Retained on ¾" square mesh screen, %	0·0	0·0	0·0	0·0	0·0	0·0	6·5	0·0	0·0	0·0	0·0	0·0	8·7	11·0	7·4	7·7	0·0	0·0	0·9
(b) Passing ¾", retained on ½" square mesh screen, %	0·0	0·0	0·0	0·0	2·7	0·2	23·3	3·7	0·4	0·3	0·3	0·4	11·9	14·7	12·5	11·0	1·7	1·3	1·5
(c) Passing ½", retained on ¼" square mesh screen, %	18·9	17·7	20·6	18·6	20·8	7·3	37·2	24·1	4·8	4·2	4·3	3·5	42·0	41·7	44·1	43·2	21·6	15·8	21·4
(d) Passing ¼", retained on ⅛" square mesh screen, %	30·5	30·8	30·8	32·7	26·8	35·6	13·0	20·0	27·3	27·2	26·5	23·4	18·7	16·3	18·0	19·8	21·2	18·5	20·2
(e) Passing ⅛" square mesh screen, %	50·6	51·5	48·6	48·7	49·7	56·9	20·0	52·2	67·5	68·3	68·9	72·7	18·7	16·3	18·0	18·3	55·5	64·4	56·8
5. Proximate analysis—																			
(a) Moisture, %	3·7	3·9	3·6	3·9	4·1	5·0	1·7	3·2	4·1	4·2	4·7	4·9	4·1	3·8	3·7	3·9	2·2	2·0	1·7
(b) Ash, %	14·8	14·3	14·6	14·6	12·6	12·8	13·2	12·8	16·8	16·7	16·7	16·9	12·6	13·1	12·3	12·7	7·4	5·9	7·7
(c) Volatile matter, %	30·4	30·6	29·5	29·7	30·5	30·6	30·8	30·6	22·7	22·6	22·3	22·2	22·6	22·1	22·9	22·8	27·0	27·3	28·0
(d) Fixed carbon (by difference), %	51·1	51·2	52·3	51·8	52·8	51·6	54·3	53·4	56·4	56·5	56·3	56·0	60·7	61·0	61·1	60·6	63·4	64·8	62·6
6. Ultimate analysis—																			
(a) Carbon, %	68·6	68·7	68·9	68·6	70·9	70·2	72·6	71·7	69·1	69·1	68·7	68·3	72·9	72·8	73·6	73·0	79·1	80·6	79·3
(b) Hydrogen, %	5·1	5·2	5·1	5·2	5·0	5·0	4·8	4·9	4·2	4·3	4·3	4·3	4·5	4·4	4·5	4·5	5·1	5·2	5·1
(c) Ash, %	14·8	14·3	14·6	14·6	12·6	12·8	13·2	12·8	16·8	16·7	16·7	16·9	12·6	13·1	12·3	12·7	7·4	5·9	7·7
(d) Sulphur, %	1·5	1·6	1·5	1·5	1·2	1·2	1·1	1·1	0·3	0·3	0·3	0·3	0·2	0·3	0·2	0·2	0·6	0·6	0·6
(e) Nitrogen, %	0·9	0·9	0·9	0·9	0·9	0·8	0·9	0·9	1·1	1·1	1·0	1·0	1·0	1·0	1·0	1·1	1·3	1·3	1·3
(f) Oxygen (by difference), %	9·1	9·3	9·0	9·2	9·4	10·0	7·4	8·6	8·5	8·5	9·0	9·2	8·8	8·4	8·4	8·5	6·5	6·4	6·0
7. Calorific value—																			
(a) As fired, gross value, B.T.U./lb.	12210	12290	12320	12250	12610	12470	12860	12820	11910	11770	11730	11680	12600	12610	12660	12540	13940	14280	13950
(b) As fired, net value, B.T.U./lb.	11726	11796	11836	11756	12135	11995	12404	12355	11511	11362	11322	11272	12173	12192	12233	12113	13456	13786	13466
(c) Dry, gross value, B.T.U./lb.	12679	12789	12780	12747	13149	13126	13082	13244	12419	12286	12308	12282	13139	13108	13146	13049	14254	14571	14191
8. Fuel ratio, fixed carbon/volatile matter	1·70	1·70	1·80	1·75	1·75	1·70	1·75	1·75	2·50	2·50	2·55	2·50	2·70	2·75	2·65	2·65	2·35	2·35	2·25
9. Carbon-hydrogen ratio	13·4	13·3	13·5	13·3	14·3	14·1	15·1	14·7	16·3	16·2	16·0	15·9	16·1	16·3	16·3	16·3	15·6	15·7	15·7
10. Coking properties	Good	Good	Good	Good	Fair	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Good
11. Ash fusibility—																			
(a) Initial deformation temperature, °F.	2434	2434	2420	2434	2148	2148	2180	2148	2545	2570	2700+	2610	2450	2390	2315	2400	1980	1962	1962
(b) Softening point or fusion temperature, °F.	2459	2459	2470	2459	2170	2170	2220	2170	2700+	2700+	2700+	2700+	2590	2490	2430	2490	2050	2032	2032
(c) Fluid temperature or melting point, °F.	2502	2502	2590	2502	2278	2278	2330	2278	2700+	2700+	2700+	2700+	2700+	2700+	2540	2610	2350	2347	2347
12. Apparent specific gravity	1·30	1·30	1·30	1·30	1·26	1·26	1·29	1·26	1·37	1·38	1·38	1·37	1·38	1·24	1·37	1·36	1·25	1·24	1·26
13. Weight per cubic foot, lb.	47·9	48·4	49·7	47·3	53·1	53·1	45·3	53·1	57·3	57·0	55·2	55·8	50·5	45·3	50·3	51·0	50·6	53·1	53·1
14. Weight fired—																			
(a) Total for trial, lb.	1591	3190	3194	4787	1592	3189	3200	4787	1597	3196	3199	4800	1599	3198	3198	4799	1593	3189	4387
(b) Per hour, lb.	199	400	402	598	199	400	399	595	200	400	399	588	200	399	400	600	200	400	548
(c) Per cubic foot furnace volume per hour, lb.	0·280	0·563	0·566	0·842	0·280	0·563	0·562	0·838	0·282	0·563	0·562	0·828	0·282	0·562	0·563	0·845	0·282	0·563	0·772
(d) Per 1,000 pounds of equivalent evaporation, lb.	115·6	121·7	123·9	124·1	111·4	117·9	112·7	117·8	114·8	120·6	123·8	125·2	109·8	114·4	112·7	117·1	98·0	103·8	105·7
(e) Total dry for trial, lb.	1532	3066	3079	4600	1527	3030	3146	4634	1532	3062	3049	4565	1533	3076	3080	4612	1558	3125	4312
(f) Dry per hour, lb.	192	385	387	575	191	380	392	576	192	383	380	559	192	384	385	577	195	392	539
(g) Dry per cubic foot furnace volume per hour, lb.	0·270	0·542	0·545	0·810	0·269	0·535	0·552	0·811	0·270	0·539	0·535	0·787	0·270	0·541	0·542	0·813	0·275	0·552	0·759
15. Heat liberated per cubic foot furnace volume per hour, B.T.U.	3422	6924	6976	10318	3534	7025	7227	10744	3355	6631	6592	9673	3549	7086	7132	10597	3927	8045	10767
PULVERIZED FUEL AS DELIVERED TO BURNER																			
16. Screen analysis—																			
(a) Retained on No. 16 sieve, %	0·1	0·1	0·1	0·0	0·5	0·4	0·1	0·1	0·1	0·0	0·1	0·0	0·1	0·2	0·1	0·1	0·1	0·5	0·3
(b) Retained on No. 30 sieve, passing No. 16 sieve, %	0·3	0·2	0·1	0·2	0·5	0·4	0·1	0·2	0·1	0·1	0·0	0·1	0·1	0·1	0·1	0·1	0·2	0·5	0·1
(c) Retained on No. 50 sieve, passing No. 30 sieve, %	1·8	1·9	0·7	3·0	1·0	1·0	0·8	2·5	0·2	0·3	0·6	0·9	0·3	0·4	0·9	0·7	0·7	0·2	0·6
(d) Retained on No. 100 sieve, passing No. 50 sieve, %	14·9	13·7	10·1	12·6	6·8	9·0	5·2	12·8	1·8	1·6	4·4	5·9	4·7	5·3	6·7	5·4	5·5	5·1	6·2
(e) Retained on No. 200 sieve, passing No. 100 sieve, %	20·2	20·2	20·0	19·2	22·7	17·6	13·6	18·3	7·9	9·7	12·0	14·4	14·7	14·4	14·7	12·8	15·9	14·5	14·2
(f) Passing No. 200 sieve, %	62·7	63·9	69·0	65·0	68·5	71·6	80·2	66·1	89·9	88·3	82·9	78·7	80·1	79·6	77·5	80·9	77·6	79·2	78·6
17. Moisture in pulverized fuel, %	1·5	1·8	1·4	2·2	1·3	1·5	0·9	1·4	1·7	1·7	1·9	2·1	1·1	1·5	1·3	1·1	1·0	0·9	1·5
18. Temperature—																			
(a) Preheated air at entrance to pulverizer, °F.	126	112	324	124	314	221	164	119	351	333	316	316	336	168	302	328	240	122	121
(b) Fuel and air in fuel duct pulverizer end, °F.	115	108	131	107	116	103	146	113	137	148	118	121	123	126	118	133	113	121	120
19. Pressure in fuel duct pulverizer end, In W.G.	0·1	0·2	0·4	0·5	0·3	0·6	0·2	0·5	0·2	0·3	0·3	0·4	0·1	0·3	0·3	0·3	0·1	0·3	0·5
20. Pulverizer—																			
(a) Total power used during trial, kw. hr.	50·0	64·3	71·9	73·7	44·1	68·4	85·5	77·6	63·8	99·7	78·7	116·9	50·1	82·7	69·9	110·7	46·1	60·8	69·4
(b) Power used per hour, kw. hr.	6·27	8·07	9·04	9·21	5·53	8·57	10·65	96·4	8·00	12·46	9·81	14·31	6·26	10·31	8·74	13·84	5·78	7·62	8·66
(c) Power used per hour, "net" ton of fuel pulverized, kw. hr.	62·9	40·3	45·0	30·8	55·4	42·9	53·4	32·4	79·9	62·4	49·2	48·7	62·7	51·7	43·7	46·1	57·9	38·1	31·6
(d) No load power rate, kw.	4·07	3·80	3·70	4·23	4·47	3·85	4·18	4·02	4·23	4·21	4·22	4·23	3·85	3·94	4·06	4·06	3·97	3·80	4·23
(e) Rate of grinding, per cent of rated capacity, %	19·9	40·0	40·2	59·8	19·9	40·0	39·9	59·5	20·0	40·0	39·9	58·8	20·0	39·9	40·0	60·0	20·0	40·0	54·8
REFUSE, ASH AND CARBON**																			
21. Dry refuse from furnace bottom—																			
(a) Total weight removed**, lb.	115	127	150	117	77	45	......	65	112	137	190	261	91	45	159	20	83	5	0
(b) Ash content**, %	99·3	98·6	98·6	77·5	98·2	99·1	......	93·7	97·2	99·6	99·9	95·2	96·1	98·2	99·7	77·8	98·5	91·4	......
(c) Ash content**, lb.	114	125	148	91	76	45	......	61	109	136	190	248	87	44	159	16	82	5	......
(d) Combustible content**, %	0·7	1·4	1·4	22·5	1·8	0·9	......	6·3	2·8	0·4	0·1	4·8	3·9	1·8	0·3	22·2	1·5	8·6	......
(e) Combustible content**, lb.	1	2	2	26	1	0	......	4	3	1	0	13	4	1	0	4	1	0	......
22. Dry refuse from boiler passes—																			
(a) Total weight removed**, lb.	8	13	39	19	9	11	29	9	18	22	41	17	19	14	18	15	18	10	9
(b) Ash content**, %	90·3	93·5	92·0	94·3	86·9	79·7	91·5	95·2	86·3	99·6	89·7	91·9	85·6	86·3	88·3	86·3	75·6	73·3	76·0
(c) Ash content**, lb.	7	12	36	18	8	9	27	9	16	22	37	16	16	12	16	13	14	7	7
(d) Combustible content**, %	9·7	6·5	8·0	5·7	13·1	20·3	8·5	4·8	13·7	0·4	10·3	8·1	14·4	13·7	11·7	13·7	24·4	26·7	24·0
(e) Combustible content**, lb.	1	1	3	1	1	2	2	0	2	0	4	1	3	2	2	2	4	3	2
23. Dry refuse from dust collector—																			
(a) Total weight removed**, lb.	......	......	......	......	......	......	81	......	105	219	143	340	37	94	88	140	......	......	......
(b) Ash content**, %	......	......	......	......	......	......	81·2	......	87·1	82·7	89·9	80·1	87·8	80·5	88·1	70·8	......	......	......
(c) Ash content**, lb.	......	......	......	......	......	......	66	......	91	181	129	272	32	76	78	99	......	......	......
(d) Combustible content**, %	......	......	......	......	......	......	18·8	......	12·9	17·3	10·1	19·9	12·2	19·5	11·9	29·2	......	......	......
(e) Combustible content**, lb.	......	......	......	......	......	......	15	......	14	38	14	68	5	18	10	41	......	......	......
24. Dry refuse from base of chimney—																			
(a) Total weight removed**, lb.	4	12	15	24	1	4	......	16	......	......	......	......	......	......	......	......	5	10	12
(b) Ash content**, %	84·7	85·2	86·0	89·6	73·4	75·8	......	79·3	......	......	......	......	......	......	......	......	74·8	65·3	66·0
(c) Ash content**, lb.	3	10	13	22	1	3	......	13	......	......	......	......	......	......	......	......	4	7	8
(d) Combustible content**, %	15·3	14·5	14·0	10·4	26·6	24·2	......	20·7	......	......	......	......	......	......	......	......	25·2	34·7	34·0
(e) Combustible content**, lb.	1	2	2	2	0	1	......	3	......	......	......	......	......	......	......	......	1	3	4
25. Total weight of ash in fuel fired (calculated), lb.	235	456	466	699	201	408	422	613	268	534	534	811	201	419	393	609	118	188	338
26. Total ash accounted for**, lb.	124	147	197	131	85	57	93	83	216	339	356	536	135	132	253	128	100	19	15
27. Total ash unaccounted for**, lb.	111	309	269	568	116	351	329	530	52	195	178	275	66	287	140	481	18	169	323
28. Distribution of ash as a percentage of ash in fuel fired—																			
(a) From furnace bottom**, %	48·5	27·4	31·8	13·0	37·8	11·0	......	10·0	40·7	25·5	35·6	30·6	43·3	10·5	40·5	2·6	69·5	2·7	0·0
(b) From boiler passes**, %	3·0	2·6	7·7	2·6	4·0	2·2	6·4	1·5	6·0	4·1	6·9	2·0	8·0	2·9	4·1	2·1	11·9	3·7	2·1
(c) From dust collector**, %	......	......	......	......	......	......	15·6	......	34·0	33·9	24·2	33·5	15·9	18·1	19·8	16·3	......	......	......
(d) From base of chimney**, %	1·3	2·2	2·8	3·1	0·5	0·7	......	2·1	......	......	......	......	......	......	......	......	3·4	3·7	2·4
(e) Unaccounted for**, %	47·2	67·8	57·7	81·3	57·7	86·1	78·0	86·4	19·3	36·5	33·3	33·9	32·8	68·5	35·6	79·0	15·2	89·9	95·5
29. Total refuse accounted for**, lb.	127	152	204	160	87	60	110	90	235	378	374	618	147	153	265	175	106	25	21
30. Combustible in unaccounted for refuse (assumed)**, %	12·5	10·5	11·0	8·1	19·9	22·3	14·2	12·8	13·3	8·9	10·2	14·0	13·3	16·6	11·8	21·5	24·8	30·7	29·0
31. Combustible in unaccounted for refuse (assumed)**, lb.	16	36	33	50	29	101	54	78	8	19	20	45	10	57	19	132	6	75	132
32. Total refuse unaccounted for**, lb.	127	345	302	618	145	452	383	608	60	214	198	320	76	344	159	613	24	244	455
33. Calculated total refuse**, lb.	254	497	506	778	232	512	493	698	295	592	572	938	223	497	424	788	130	269	476
34. Total weight of carbon fired, lb.	1091	2192	2201	3284	1129	2239	2323	3432	1104	2208	2198	3278	1166	2328	2354	3503	1260	2570	3479
35. Calculated total unburned carbon**, lb.	19	41	40	79	31	78	71	85	27	58	38	127	22	78	31	179	12	81	138
36. Total weight of carbon consumed, lb.	1072	2151	2161	3205	1098	2161	2252	3347	1077	2150	2160	3151	1144	2250	2323	3324	1248	2489	3341
37. Carbon consumed per pound of fuel fired, lb.	0·674	0·672	0·677	0·670	0·690	0·678	0·704	0·699	0·674	0·673	0·675	0·656	0·715	0·704	0·726	0·693	0·783	0·780	0·762
FEED WATER AND STEAM																			
38. Average temperature of feed water in feed tank, °F.	144	127	114	119	103	102	97	114	116	101	99	85	114	98	101	83	140	124	117
39. Water fed to boiler—																			
(a) Total for trial, lb.	12460	23380	22710	34120	12477	23726	24580	35790	12280	23030	22450	32900	12830	24220	24670	35060	14660	27320	36700
(b) Per hour, lb.	1561	2934	2857	4265	1564	2973	3061	4446	1539	2879	2799	4027	1604	3020	3084	4383	1837	3424	4588
(c) Per pound of fuel as fired, lb.	7·83	7·33	7·11	7·13	7·84	7·44	7·68	7·48	7·69	7·21	7·02	6·85	8·02	7·57	7·71	7·31	9·20	8·57	8·37
40. Average barometric pressure, In Hg.	29·76	30·13	29·96	29·86	29·46	29·60	30·00	29·95	29·97	29·67	30·36	29·85	30·13	29·99	29·87	29·65	29·98	29·85	29·74
41. Average boiler steam pressure by gauge, lb./sq. in.	108·4	107·0	107·6	108·5	109·8	110·4	107·5	109·4	105·4	105·4	105·2	105·5	104·7	104·8	104·6	105·8	107·7	107·9	107·4
42. Average calorimeter steam pressure by gauge, In Hg.	2·0	1·9	2·1	1·9	2·0	1·9	3·0	1·9	2·7	2·8	2·8	2·7	2·7	2·8	2·7	2·7	2·1	1·9	1·9
43. Average calorimeter steam temperature, °F.	281	282	283	283	281	......	288	283	284	287	286	287	285	288	286	287	282	282	282
44. Moisture content of steam, %	0·8	0·7	0·7	0·8	0·8	1·5	0·5	0·8	0·6	0·5	0·6	0·5	0·6	0·4	0·5	0·5	0·8	0·8	0·8
45. Factor of correction for quality of steam	0·994	0·994	0·994	0·994	0·994	0·988	0·996	0·994	0·995	0·996	0·995	0·996	0·995	0·997	0·996	0·996	0·994	0·994	0·994
46. Water evaporated corrected for quality of steam—																			
(a) Total for trial, lb.	12385	23240	22574	33915	12402	23441	24482	35575	12219	22938	22338	32768	12766	24147	24571	34920	14572	27156	36480
(b) Per hour, lb.	1552	2916	2839	4239	1554	2937	3048	4419	1531	2867	2785	4011	1596	3011	3071	4365	1826	3403	4560
(c) Per pound of fuel as fired, lb.	7·78	7·29	7·07	7·08	7·79	7·35	7·65	7·43	7·65	7·18	6·98	6·83	7·98	7·55	7·68	7·28	9·15	8·52	8·32
47. Factor of evaporation	1·111	1·128	1·142	1·137	1·153	1·154	1·159	1·142	1·139	1·155	1·157	1·171	1·141	1·158	1·155	1·173	1·115	1·131	1·138
48. Equivalent evaporation—																			
(a) Total for trial, lb.	13760	26215	25780	38561	14300	27051	28375	40627	13917	26493	25845	38371	14566	27962	28380	40961	16248	30713	41514
(b) Per hour, lb.	1724	3289	3243	4820	1792	3390	3534	5047	1744	3312	3223	4697	1821	3487	3548	5120	2036	3849	5189
(c) Per square foot heating surface per hour, lb.	2·55	4·86	4·79	7·12	2·65	5·01	5·22	7·45	2·58	4·89	4·76	6·94	2·69	5·15	5·24	7·56	3·01	5·69	7·66
(d) Per pound of fuel as fired, lb.	8·65	8·22	8·07	8·06	8·98	8·48	8·87	8·49	8·71	8·29	8·08	7·99	9·11	8·74	8·87	8·54	10·20	9·63	9·46
(e) Per pound of dry fuel fired, lb.	8·98	8·50	8·37	8·38	9·36	8·93	9·02	8·77	9·08	8·65	8·48	8·41	9·50	9·09	9·21	8·88	10·43	9·83	9·63
MISCELLANEOUS TEMPERATURES AND PRESSURES																			
49. Average air temperature—																			
(a) Outside boiler room, °F.	72	74	28	76	37	42	37	71	37	37	5	18	23	36	16	20	12	76	70
(b) Inside boiler room, °F.	76	77	76	81	73	83	83	77	77	85	74	72	76	81	74	76	72	81	77
50. Air humidity—																			
(a) Relative of boiler room at pulverizer, %	57	58	28	62	37	26	29	55	27	32	17	24	24	29	19	25	30	49	55
(b) Water vapour per pound of air, lb.	·01110	·01170	·00545	·01431	·00649	·00642	·00716	·01109	·00545	·00843	·00309	·00406	·00467	·00669	·00345	·00487	·00508	·01131	·01109
51. Average flue gas temperature in 2nd pass of boiler, °F.	744	885	978	1072	815	......	1034	1086	754	983	990	1075	806	981	1015	1163	712	993	1076
52. Flame temperature in furnace—																			
(a) Start of test, °F.	2310	2190	2390	2300	2530	2250	2360	2400	2300	2350	2440	2350	2300	2410	2400	2420	2300	2300	2320
(b) Midway of test, °F.	2050	2270	2420	2400	......	......	2350	2390	1970	2330	2400	2500	1950	2350	2400	2520	2080	2390	2510
(c) End of test, °F.	2000	2270	2440	2420	2060	2400	2340	2450	2030	2300	2410	2450	2000	2400	2400	2500	2080	2340	2410
53. Average draught—																			
(a) In furnace, In W.G.	0·033	0·064	0·094	0·079	0·009	0·074	0·081	0·071	0·027	0·044	0·025	0·129	0·009	0·039	0·067	0·131	0·020	0·066	0·074
(b) In boiler outlet, In W.G.	......	0·153	0·156	0·359	......	0·147	0·138	0·360	......	0·096	0·058	0·339	......	0·077	0·169	0·356	......	0·187	0·372
AIR AND PRODUCTS OF COMBUSTION																			
54. Air supplied per pound of fuel as fired, lb.	11·4	11·9	11·3	11·4	14·4	11·1	10·8	11·6	11·5	10·1	10·1	10·7	14·4	10·4	11·7	10·4	12·3	13·0	12·3
55. Air theoretically required per pound of fuel as fired, lb.	9·3	9·3	9·4	9·4	9·5	9·4	9·7	9·6	9·0	9·1	9·0	8·9	9·6	9·5	9·7	9·6	10·6	11·1	10·6
56. Excess air, %	23	28	20	21	52	18	11	21	28	11	12	20	50	9	21	8	16	17	16
57. Average temperature of flue gases at boiler outlet, °F.	451	561	665	739	482	647	675	761	469	630	606	729	509	626	649	816	451	651	736
58. Volumetric analysis of dry flue gases at boiler outlet—																			
(a) CO_2, %	14·5	13·8	14·7	14·3	11·7	14·9	16·0	14·7	14·3	16·2	16·4	15·0	12·0	16·5	15·2	16·3	15·6	14·6	15·1
(b) O_2, %	4·8	5·7	4·6	5·2	7·7	4·6	3·2	5·1	5·3	3·3	3·0	4·4	8·2	2·8	4·3	3·1	3·7	4·9	4·6
(c) CO, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
(d) N_2 (by difference), %	80·7	80·5	80·7	80·5	80·6	80·5	80·8	80·2	80·4	80·5	80·6	80·6	79·8	80·7	80·5	80·6	80·7	80·5	80·3
59. Steam—																			
(a) From moisture in coal per pound of fuel as fired, lb.	0·037	0·039	0·036	0·039	0·041	0·050	0·017	0·032	0·041	0·042	0·047	0·049	0·041	0·038	0·037	0·039	0·022	0·020	0·017
(b) From H_2 in dry coal per pound of fuel as fired, lb.	0·422	0·429	0·423	0·429	0·409	0·400	0·415	0·409	0·337	0·345	0·340	0·338	0·364	0·358	0·368	0·366	0·437	0·448	0·442
(c) From moisture in air per pound of fuel as fired, lb.	0·127	0·139	0·062	0·163	0·093	0·071	0·077	0·129	0·063	0·085	0·031	0·043	0·067	0·070	0·040	0·051	0·062	0·147	0·136
60. Dry flue gases—																			
(a) Per pound of carbon, lb.	17·5	18·4	17·3	17·8	21·5	17·1	16·0	17·3	17·8	15·8	15·6	17·0	21·0	15·5	16·8	15·7	16·4	17·4	16·9
(b) Per pound of fuel as fired, lb.	11·8	12·4	11·7	11·9	14·8	11·6	11·3	12·1	12·0	10·6	10·5	11·2	15·0	10·9	12·2	10·9	12·8	13·6	13·3
CAPACITIES AND EFFICIENCIES																			
61. Rated boiler horse-power, h.p.	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7
62. Rated capacity per hour equivalent evaporation, lb.	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336
63. Boiler horse-power developed, h.p.	50·0	95·3	94·0	139·7	51·9	98·3	102·4	146·3	50·6	96·0	93·4	136·1	52·8	101·1	102·8	148·4	59·0	111·6	150·4
64. Percentage of rated capacity developed, %	74	140	139	206	77	145	151	216	75	142	138	201	78	149	152	219	87	165	222
65. Efficiency of boiler and furnace—																			
(a) Based on gross calorific value fuel as fired, %	68·7	64·9	63·6	63·8	69·1	66·0	66·9	64·3	71·0	68·3	66·8	66·4	70·1	67·3	68·0	66·1	71·0	65·4	65·8
(b) Based on net calorific value fuel as fired, %	71·6	67·6	66·2	66·5	71·8	68·6	69·4	66·7	73·4	70·8	69·3	68·8	72·6	69·6	70·4	68·4	73·6	67·8	68·2
HEAT BALANCE IN B.T.U. AND PER CENT																			
66. Heat absorbed by the boiler, B.T.U.	8394	7977	7831	7821	8714	8229	8607	8239	8452	8045	7841	7753	8840	8481	8607	8287	9898	9345	9180
67. Loss due to steam—																			
(a) From moisture in fuel, B.T.U.	45	50	47	53	51	65	22	44	50	54	61	66	51	49	49	54	27	26	23
(b) By burning H_2 in dry fuel, B.T.U.	514	545	558	579	506	522	547	558	413	446	440	457	454	464	483	509	534	586	597
(c) From moisture entering with air, B.T.U.	22	32	17	50	18	19	21	41	12	22	8	13	14	18	11	18	11	39	42
68. Loss due to heat carried away in dry flue gases, B.T.U.	1062	1440	1654	1879	1453	1567	1606	1986	1129	1386	1341	1766	1559	1426	1684	1936	1164	1860	2104
69. Loss due to unburned carbon monoxide, B.T.U.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70. Loss due to carbon in refuse and flue dust, B.T.U.	174	188	183	241	284	357	324	46	247	265	173	386	201	356	142	545	110	371	459
71. Loss due to radiation errors and unaccounted for, B.T.U.	1999	2058	2030	1627	1584	1711	1733	1906	1607	1552	1866	1239	1481	1816	1684	1191	2196	2053	1545
72. Total calorific value of 1 pound of fuel as fired, gross value, B.T.U.	12210	12290	12320	12250	12610	12470	12860	12820	11910	11770	11730	11680	12600	12610	12660	12540	13940	14280	13950
73. Heat absorbed by the boiler (thermal efficiency), %	68·7	64·9	63·6	63·8	69·1	66·0	66·9	64·3	71·0	68·3	66·8	66·4	70·1	67·3	68·0	66·1	71·0	65·4	65·8
74. Loss due to steam—																			
(a) From moisture in fuel, %	0·4	0·4	0·4	0·4	0·4	0·5	0·2	0·3	0·4	0·5	0·5	0·6	0·4	0·4	0·4	0·4	0·2	0·2	0·2
(b) By burning H_2 in dry fuel, %	4·2	4·4	4·5	4·7	4·0	4·2	4·2	4·3	3·4	3·8	3·8	3·9	3·6	3·7	3·8	4·1	3·8	4·1	4·2
(c) From moisture entering with air, %	0·2	0·3	0·1	0·4	0·1	0·1	0·2	0·3	0·1	0·2	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·3	0·3
75. Loss due to heat carried away in dry flue gases, %	8·7	11·7	13·4	15·3	11·5	12·6	12·5	15·5	9·5	11·8	11·4	15·1	12·4	11·3	13·3	15·4	8·4	13·0	15·1
76. Loss due to unburned carbon monoxide, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
77. Loss due to carbon in refuse and flue dust, %	1·4	1·5	1·5	2·0	2·3	2·9	2·5	0·4	2·1	2·2	1·5	3·3	1·6	2·8	1·1	4·4	0·8	2·6	3·3
78. Loss due to radiation errors and unaccounted for, %	16·4	16·8	16·5	13·4	12·6	13·7	13·5	14·9	13·5	13·2	15·9	10·6	11·8	14·4	13·3	9·5	15·7	14·4	11·1

*The eleven trials so marked (*) were repeat tests made for the purpose of studying light-off and pre-heat characteristics of the coal under test and differed from the remaining trials in that test coal was used for light-off and pre-heat purposes instead of the so-called operating coal.

**Inasmuch as difficulty was experienced in collecting the true quantities of refuse chargeable to any one trial as noted under items 21, 22, 23 and 24, it was practically impossible to obtain true samples and consequently true analyses of these quantities. Therefore the values given for items so marked (**) under the heading "Refuse, Ash, and Carbon" may be more or less above or below the true value and should therefore be used with discretion.

TABLE XXXIV

DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES—FUEL RESEARCH LABORATORIES, OTTAWA, CANADA

Detailed Data and Results of Twenty Pulverized Fuel Fired Boiler Trials Made on Various Alberta Coals and Ontario Lignite

Item	Operating Coal			Alberta Coal											Ontario Lignite					
															Lower Seam—Old Shaft					New Shaft Air-dried
															As received		Air-dried	Mechanically dried		
Fuel Number	A_4= 16-30	A_2= 7-30	A_4= 16-30	N= 28-30	O= 29-31	P= 18-31	Q= 26-31	R= 23-31	S= 20-31	T= 24-31	U= 21-31	V= 22-31	W= 25-31	X= 28-31	Y_1= 11-30	Y_1= 11-30	Y_1= 11-30	Y_2= 14-30	Y_3= 15-30	Z= 10-31
Column Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Combustion Rate—Lb. Coal/hr.	200	400	600	400	400	400	400	400	400	400	400	400	400	400	600	800	600	600	600	600
1. Trial number	P.F. 33-34	P.F. 3-4	P.F. 39-40	P.F. 119	P.F. 121	P.F. 126	P.F. 125	P.F. 124	P.F. 122	P.F. 128	P.F. 123	P.F. 120	P.F. 127	P.F. 129	P.F. 73-74	P.F. 74A	P.F. 69-70	P.F. 35-36	P.F. 37-38	P.F. 130
2. Date conducted	5/6/30	11/2/30	19/6/30	16/2/32	23/2/32	11/3/32	8/3/32	4/3/32	26/2/32	18/3/32	1/3/32	19/2/32	15/3/32	22/3/32	18/9/30	18/9/30	4/9/30	10/6/30	13/6/30	30/3/32
3. Duration of trial in hours	8·08	8·13	8·00	8·02	7·97	7·97	8·00	8·00	8·00	8·03	8·00	8·00	7·98	8·00	8·03	4·07	8·08	8·07	8·10	8·02
RAW FUEL AS DELIVERED TO PULVERIZER FEED HOPPER																				
4. Screen analysis: (a) Retained on ⅜" sq. mesh screen, %	0·0	0·0	0·0	12·1	2·1	1·7	2·0	1·4	1·5	0·7	0·8	1·2	1·0	0·7	0·0	0·0	0·0	0·5	0·0	4·9
(b) Passing ⅜", retained on ¼" sq. mesh screen, %	1·1	1·1	0·8	19·5	7·5	6·2	6·6	6·1	5·3	4·5	3·1	6·0	2·9	4·9	1·6	1·6	2·2	4·7	5·7	8·9
(c) Passing ¼", retained on ⅛" sq. mesh screen, %	26·7	19·0	15·9	33·2	26·4	19·8	23·4	24·3	21·8	19·4	15·6	35·2	12·8	16·1	22·7	22·7	29·0	41·3	36·7	33·7
(d) Passing ⅛", retained on ⅛" sq. mesh screen, %	25·5	25·6	24·6	16·7	22·3	17·8	22·7	21·6	21·0	20·9	18·7	21·6	17·3	16·8	22·3	22·3	24·7	27·2	24·1	22·8
(e) Passing ⅛" sq. mesh screen, %	46·7	54·3	58·7	18·5	41·7	54·5	45·3	46·6	50·4	54·5	61·8	36·0	66·0	61·5	53·4	53·4	44·1	26·3	33·5	29·7
5. Proximate analysis: (a) Moisture, %	3·7	3·3	1·8	8·2	1·4	1·9	2·0	2·1	3·0	2·0	2·4	1·4	1·9	1·4	46·7	46·7	35·2	35·5	26·7	31·5
(b) Ash, %	9·5	8·7	8·3	9·0	17·2	14·4	16·0	13·4	12·3	12·7	11·6	11·8	12·7	10·9	7·4	7·4	9·1	7·1	9·9	7·7
(c) Volatile matter, %	31·1	31·2	31·9	32·1	27·4	24·1	19·5	23·6	26·9	24·8	28·5	22·2	15·1	14·1	22·2	22·2	27·0	27·6	30·8	29·4
(d) Fixed carbon—(by difference), %	55·7	56·8	58·0	50·7	54·0	59·6	62·5	60·9	57·8	60·5	57·5	64·6	70·3	73·6	23·7	23·7	28·7	29·8	32·6	31·4
6. Ultimate analysis: (a) Carbon, %	74·5	75·9	77·2	65·7	70·7	27·1	73·3	73·0	74·3	75·2	75·0	77·0	77·8	78·7	33·3	33·3	40·2	41·9	46·4	42·6
(b) Hydrogen, %	5·3	5·3	5·2	5·2	4·5	4·3	4·2	4·4	4·8	4·6	4·9	4·6	4·2	4·1	7·4	7·4	6·6	6·7	5·9	6·3
(c) Ash, %	9·5	8·7	8·3	9·0	17·2	14·4	16·0	13·4	12·3	12·7	11·6	11·8	12·7	10·9	7·4	7·4	9·1	7·1	9·9	7·7
(d) Sulphur, %	1·1	1·1	1·2	0·4	0·6	0·7	0·3	0·6	0·3	0·3	0·6	0·4	0·5	0·7	1·1	1·1	1·6	0·7	1·0	0·9
(e) Nitrogen, %	1·6	1·7	1·7	0·9	1·1	1·1	1·1	1·2	1·1	1·1	1·2	1·2	1·2	1·7	0·3	0·3	0·4	0·5	0·6	0·4
(f) Oxygen—(by difference), %	8·0	7·3	6·4	18·8	5·9	7·4	5·1	7·4	7·2	6·1	6·7	5·0	3·6	3·9	50·5	50·5	42·1	43·1	36·2	42·1
7. Calorific value: (a) As fired, gross value, B.T.U./lb.	13240	13470	13700	11310	12330	12660	12780	12810	13080	13110	13230	13330	13370	13580	5280	5280	6510	6640	7330	7010
(b) As fired, net value, B.T.U./lb.	12737	12967	13206	10816	11903	12252	12381	12392	12624	12673	12765	12893	12971	13191	4577	4577	5883	6004	6770	6412
(c) Dry, gross value, B.T.U./lb.	13749	13930	13951	12320	12505	12497	13041	13085	13485	13378	13555	13519	13629	13773	9906	9906	10046	10295	10000	10234
8. Fuel ratio, fixed carbon/volatile matter	1·80	1·80	1·80	1·60	1·95	2·45	3·20	2·60	2·15	2·45	2·00	2·90	4·65	5·20	1·10	1·10	1·05	1·10	1·05	1·05
9. Carbon-hydrogen ratio	14·1	14·4	14·7	12·7	15·7	16·9	17·3	16·6	15·5	16·3	15·2	16·6	18·6	19·5	4·5	4·5	6·1	6·3	7·9	6·8
10. Coking properties	Good	Good	Good	Non-coking	Good	Fair	Good	Good	Good	Good	Good	Good	Fair	Poor	Non-coking	Non-coking	Non-coking	Non-coking	Non-coking	Non-coking
11. Ash fusibility: (a) Initial deformation temperature, °F.	2449	2497	2449	2180	2700	2700+	2580	2700+	2200	2500	2330	2700	2700+	2125	1951	1951	1951	1934	1925	1900
(b) Softening point or fusion temperature, °F.	2593	2575	2593	2250	2700+	2700+	2700+	2700+	2350	2590	2450	2700+	2700+	2275	1976	1976	1976	2005	1999	2060
(c) Fluid temperature or melting point, °F.	2593+	2680	2593+	2350	2700+	2700+	2700+	2700+	2470	2680	2580	2700+	2700+	2445	1985	1985	1985	2066	2061	2270
12. Apparent specific gravity	1·26	1·26	1·26	1·34	1·33	1·29	1·32	1·32	1·26	1·31	1·31	1·22	1·28	1·35	1·18	1·18	1·18	1·17	1·17	1·18
13. Weight per cubic foot, lb.	48·8	48·8	48·4	51·7	55·5	56·0	54·5	55·3	49·5	55·2	51·2	53·3	55·5	59·5	40·5	40·5	38·0	36·5	35·8	36·0
14. Weight fired: (a) Total for trial, lb.	1591	3192	4784	3200	3200	3185	3184	3185	3185	3185	3184	3198	3184	3185	4773	3357	4777	4572	4776	4777
(b) Per hour, lb.	197	392	398	399	402	400	398	398	398	397	398	400	399	398	594	825	591	589	590	596
(c) Per cubic foot furnace volume per hour, lb.	0·277	0·552	0·842	0·562	0·566	0·563	0·561	0·561	0·561	0·559	0·561	0·563	0·562	0·561	0·837	1·162	0·832	0·830	0·831	0·839
(d) Per 1,000 pounds of equivalent evaporation, lb.	109·1	112·6	115·1	125·0	114·8	115·2	115·1	112·0	105·3	104·4	106·0	105·8	105·0	104·9	316·5	444·4	244·5	238·1	225·2	218·3
(e) Total dry for trial, lb.	1532	3087	4698	2938	3155	3124	3120	3118	3089	3121	3108	3153	3124	3140	2544	1789	3095	3065	3501	3272
(f) Dry per hour, lb.	190	380	587	366	396	392	390	390	386	389	389	394	391	393	317	440	383	380	432	408
(g) Dry per cubic foot furnace volume per hour, lb.	0·268	0·536	0·827	0·515	0·558	0·552	0·549	0·549	0·544	0·548	0·548	0·555	0·551	0·554	0·446	0·620	0·539	0·535	0·608	0·575
15. Heat liberated per cubic foot furnace volume per hour, B.T.U.	3674	7437	11539	6356	6981	7132	7164	7181	7332	7331	7416	7510	7514	7612	4417	6135	5419	5508	6091	5884
PULVERIZED FUEL AS DELIVERED TO BURNER																				
16. Screen analysis: (a) Retained on No. 16 sieve, %	0·2	0·0	0·2	0·1	0·1	0·0	0·0	0·1	0·1	0·0	0·1	0·1	0·0	0·2	0·0	0·0	1·3	0·3	0·4	1·0
(b) Retained on No. 30 sieve, passing No. 16 sieve, %	0·3	0·4	0·2	0·5	0·1	0·1	0·1	0·0	0·0	0·1	0·1	0·3	0·1	0·1	1·4	3·8	3·5	5·5	8·4	2·2
(c) Retained on No. 50 sieve, passing No. 30 sieve, %	1·4	2·7	2·4	3·8	1·4	0·9	0·7	0·8	0·6	0·2	1·1	0·4	1·0	0·5	7·6	10·0	11·4	13·0	12·3	9·3
(d) Retained on No. 100 sieve, passing No. 50 sieve, %	11·6	13·0	10·6	19·7	7·0	5·9	4·6	6·1	4·8	2·8	4·7	3·0	5·4	3·2	14·6	17·8	16·0	17·6	19·9	13·4
(e) Retained on No. 200 sieve, passing No. 100 sieve, %	18·6	23·6	17·1	22·2	13·6	13·7	12·5	14·7	13·5	9·3	12·9	9·2	13·7	10·7	13·7	14·0	12·0	14·0	13·8	11·0
(f) Passing No. 200 sieve, %	67·9	60·3	69·5	53·7	77·8	79·4	82·1	78·3	81·0	87·6	81·1	87·0	79·8	85·3	62·7	54·4	55·8	49·6	45·2	63·1
17. Moisture in pulverized fuel, %	2·0	1·3	1·7	5·6	0·6	0·7	0·9	1·1	0·5	1·1	0·9	1·2	0·6	1·4	41·7	45·4	32·9	32·0	23·0	24·2
18. Temperature: (a) Preheated air at entrance to pulverizer, °F.	124	....	115	284	307	320	297	310	349	327	340	323	316	307	285	177	109	122	115	294
(b) Fuel and air in fuel duct pulverizer end, °F.	117	104	102	105	130	128	119	128	125	126	132	128	132	121	109	110	91	95	98	90
19. Pressure in fuel duct pulverizer end, In W.G.	0·3	0·6	0·3	0·2	0·3	0·2	0·2	0·2	0·3	0·2	0·2	0·4	0·2	0·2	1·4	1·8	0·7	0·5	0·5	0·1
20. Pulverizer: (a) Total power used during trial, kw. hr.	46·0	57·7	74·0	68·1	73·2	72·6	67·1	74·3	71·2	75·5	71·6	68·9	82·8	71·7	136·8	93·3	95·5	96·4	84·4	121·5
(b) Power used per hour, kw. hr.	5·69	7·10	9·25	8·49	9·18	9·11	8·39	9·29	8·90	9·40	8·95	8·61	10·38	8·96	17·03	22·94	11·82	11·95	10·42	15·15
(c) Power used per hour, "Net" ton of fuel pulverized, kw. hr.	57·8	36·2	30·9	42·6	45·8	45·6	42·1	46·7	44·7	47·4	45·0	43·1	52·0	45·0	57·3	55·6	40·0	40·6	35·3	50·9
(d) No load power rate, kw.	4·04	3·85	3·73	4·22	3·99	4·26	4·26	4·04	3·99	4·27	3·99	4·17	4·27	4·37	4·55	4·55	3·71	3·73	3·73	4·30
(e) Rate of grinding, per cent of rated capacity, %	19·7	39·2	59·8	39·9	40·2	40·0	39·8	39·8	39·8	39·7	39·8	40·0	39·9	39·8	59·4	82·5	59·1	58·9	59·0	59·6
REFUSE, ASH AND CARBON**																				
21. Dry refuse from furnace bottom: (a) Total weight removed**, lb.	55	205	100	101	269	259	268	240	149	217	201	236	227	151	195	194	184	185	300	107
(b) Ash content**, %	99·2	95·7	90·6	99·4	99·8	97·0	96·6	98·1	99·6	99·7	97·3	99·4	99·4	82·2	56·3	45·9	91·0	78·1	70·9	40·3
(c) Ash content**, lb.	55	196	91	100	268	251	259	235	148	216	196	235	226	124	110	89	167	144	213	43
(d) Combustible content**, %	0·8	4·3	9·4	0·6	0·2	3·0	3·4	1·9	0·4	0·3	2·7	0·6	0·6	17·8	43·7	54·1	9·0	21·9	29·1	59·7
(e) Combustible content**, lb.	0	9	9	1	1	8	9	5	1	1	5	1	1	27	85	105	17	41	87	64
22. Dry refuse from boiler passes: (a) Total weight removed**, lb.	10	4	9	7	8	10	10	7	7	6	6	7	8	19	2	4	7	7	6	10
(b) Ash content**, %	85·6	85·4	91·6	91·8	91·6	81·5	72·2	88·4	89·9	83·3	90·3	82·5	91·0	58·7	91·0	93·8	97·0	95·4	94·2	89·5
(c) Ash content**, lb.	9	3	8	6	7	8	7	6	6	5	5	6	7	11	2	4	7	7	6	9
(d) Combustible content**, %	14·4	14·6	8·4	8·2	8·4	18·5	27·8	11·6	10·1	16·7	9·7	17·5	9·0	41·3	9·0	6·2	3·0	4·6	5·8	10·5
(e) Combustible content**, lb.	1	1	1	1	1	2	3	1	1	1	1	1	1	8	0	0	0	0	0	1
23. Dry refuse from dust collector: (a) Total weight removed**, lb.	....	....	....	86	108	214	241	141	223	120	102	108	150	171	....	....	....	....	....	53
(b) Ash content**, %	....	....	....	92·7	83·0	71·0	59·4	81·7	80·2	78·4	77·3	77·2	76·5	47·5	....	....	....	....	....	93·5
(c) Ash content**, lb.	....	....	....	80	90	152	143	115	179	94	79	83	115	81	....	....	....	....	....	50
(d) Combustible content**, %	....	....	....	7·3	17·0	29·0	40·6	18·3	19·8	21·6	22·7	22·8	23·5	52·5	....	....	....	....	....	6·5
(e) Combustible content**, lb.	....	....	....	6	18	62	98	26	44	26	23	25	35	90	....	....	....	....	....	3
24. Dry refuse from base of chimney: (a) Total weight removed**, lb.	6	3	16	....	....	....	....	....	....	....	....	....	....	....	2	4	4	4	3	....
(b) Ash content**, %	85·1	73·0	77·2	....	....	....	....	....	....	....	....	....	....	....	85·2	87·0	91·3	85·8	87·8	....
(c) Ash content**, lb.	5	2	12	....	....	....	....	....	....	....	....	....	....	....	2	3	4	3	3	....
(d) Combustible content**, %	14·9	27·0	22·8	....	....	....	....	....	....	....	....	....	....	....	14·8	13·0	8·7	14·2	12·2	....
(e) Combustible content**, lb.	1	1	4	....	....	....	....	....	....	....	....	....	....	....	0	1	0	1	0	....
25. Total weight of ash in fuel fired—(calculated), lb.	151	278	397	288	550	459	509	427	392	404	369	377	404	347	353	248	435	337	473	368
26. Total ash accounted for**, lb.	69	200	111	186	365	411	409	356	333	315	280	324	348	216	114	96	178	154	222	102
27. Total ash unaccounted for**, lb.	82	78	286	102	185	48	100	71	59	89	89	53	56	131	239	152	257	183	251	266
28. Distribution of ash as a percentage of ash in fuel fired:— (a) From furnace bottom**, %	36·4	70·5	22·9	34·7	48·7	54·7	50·9	55·0	37·8	53·5	53·1	62·3	55·9	35·7	31·2	35·9	38·4	42·7	45·0	11·7
(b) From boiler passes**, %	6·0	1·1	2·0	21·1	1·3	1·7	1·4	1·4	1·5	1·2	1·4	1·6	1·7	3·2	0·6	1·6	1·6	2·1	1·3	2·4
(c) From dust collector**, %	....	....	....	27·8	16·4	33·1	28·1	26·9	45·7	23·3	21·4	22·0	28·5	23·3	....	....	....	....	....	13·6
(d) From base of chimney**, %	3·3	0·7	3·0	....	....	....	....	....	....	....	....	....	....	....	1·2	1·2	0·9	0·9	0·6	....
(e) Unaccounted for**, %	54·3	27·7	72·1	35·4	33·6	10·5	19·6	16·7	15·0	22·0	24·1	14·1	13·9	37·8	67·6	61·3	59·1	54·3	53·1	72·3
29. Total refuse accounted for**, lb.	71	212	125	194	385	483	519	388	379	343	309	351	385	341	199	202	195	196	309	170
30. Combustible in unaccounted for refuse (assumed)**, %	14·7	20·8	15·6	7·8	12·7	23·8	34·2	15·0	15·0	19·2	16·2	20·2	16·3	46·9	11·9	9·6	5·8	9·4	9·0	8·5
31. Combustible in unaccounted for refuse (assumed)**, lb.	14	20	53	9	27	15	52	13	10	21	17	13	11	116	32	16	16	19	25	25
32. Total refuse unaccounted for**, lb.	96	98	339	111	212	63	152	84	69	110	106	66	67	247	271	168	273	202	276	291
33. Calculated total refuse**, lb.	167	310	464	305	597	546	671	472	448	453	415	417	452	588	470	370	468	398	585	461
34. Total weight of carbon fired, lb.	1185	2423	3693	2102	2262	2296	2334	2325	2366	2395	2388	2462	2477	2507	1589	1118	1920	1991	2216	2035
35. Calculated total unburned carbon**, lb.	16	31	68	17	47	87	162	45	56	49	46	40	48	241	117	122	33	61	112	93
36. Total weight of carbon consumed, lb.	1169	2392	3625	2085	2215	2209	2172	2280	2310	2346	2342	2422	2429	2266	1472	996	1887	1930	2104	1942
37. Carbon consumed per pound of fuel fired, lb.	0·735	0·750	0·758	0·652	0·692	0·694	0·682	0·716	0·725	0·737	0·736	0·757	0·763	0·711	0·308	0·297	0·395	0·406	0·441	0·407
FEED WATER AND STEAM																				
38. Average temperature of feed water, in feed tank, °F.	133	112	111	104	98	102	103	101	99	97	96	95	98	99	143	138	142	128	130	118
39. Water fed to boiler: (a) Total for trial, lb.	13150	25116	36544	22320	24190	24090	24130	24750	26270	26470	26010	26140	26330	26400	13640	6810	17660	17800	18970	19350
(b) Per hour, lb.	1627	3089	4568	2783	3035	3023	3016	3094	3284	3296	3251	3268	3299	3300	1699	1673	2186	2206	2342	2413
(c) Per pound of fuel as fired, lb.	8·27	7·87	7·64	6·98	7·56	7·56	7·58	7·77	8·25	8·31	8·17	8·17	8·27	8·29	2·86	2·03	3·70	3·75	3·97	4·05
40. Average barometric pressure, In Hg.	29·82	30·19	29·70	30·26	29·98	30·00	29·30	29·75	29·79	29·70	29·81	29·76	29·70	28·99	29·82	29·91	30·07	29·87	30·02	29·75
41. Average boiler steam pressure by gauge, lb./sq. in.	112·3	109·9	109·3	105·2	103·3	103·0	103·9	102·7	103·8	101·3	104·0	104·5	102·5	101·9	108·1	105·2	108·7	111·0	109·1	103·8
42. Average calorimeter steam pressure by gauge, In Hg.	2·7	....	1·9	2·7	2·7	2·6	2·6	2·6	2·7	2·4	2·7	2·7	2·5	2·5	2·0	2·0	2·0	2·0	1·9	2·6
43. Average calorimeter steam temperature, °F.	271	....	282	286	285	284	285	285	285	283	285	286	284	283	281	281	282	283	284	285
44. Moisture content of steam, %	1·5	1·5	0·8	0·5	0·6	0·6	0·6	0·5	0·6	0·6	0·6	0·5	0·6	0·6	0·9	0·8	0·8	0·8	0·7	0·6
45. Factor of correction for quality of steam	0·988	0·988	0·994	0·996	0·995	0·995	0·995	0·996	0·995	0·995	0·995	0·996	0·995	0·995	0·993	0·994	0·994	0·994	0·994	0·995
46. Water evaporated corrected for quality of steam:— (a) Total for trial, lb.	12992	24815	36325	22231	24069	23970	24009	24651	26139	26338	25880	26035	26198	26268	13545	6769	17554	17693	18856	19253
(b) Per hour, lb.	1608	3052	4541	2772	3020	3008	3001	3081	3267	3280	3235	3254	3283	3284	1687	1663	2173	2192	2328	2401
(c) Per pound of fuel as fired, lb.	8·17	7·77	7·59	6·95	7·52	7·53	7·54	7·74	8·21	8·27	8·13	8·14	8·23	8·25	2·84	2·02	3·67	3·72	3·95	4·03
47. Factor of evaporation	1·123	1·144	1·145	1·152	1·158	1·153	1·152	1·154	1·157	1·158	1·160	1·161	1·157	1·156	1·112	1·117	1·113	1·128	1·125	1·137
48. Equivalent evaporation: (a) Total for trial, lb.	14590	28338	41592	25610	27872	27637	27658	28447	30243	30499	30021	30227	30311	30366	15062	7561	19538	19958	21213	21891
(b) Per hour, lb.	1806	3486	5199	3193	3497	3468	3457	3556	3780	3798	3753	3778	3798	3796	1876	1858	2418	2473	2619	2730
(c) Per square foot heating surface per hour, lb.	2·67	5·15	7·68	4·72	5·17	5·12	5·11	5·25	5·58	5·61	5·54	5·58	5·61	5·61	2·77	2·74	3·57	3·65	3·87	4·03
(d) Per pound of fuel as fired, lb.	9·17	8·88	8·69	8·00	8·71	8·68	8·69	8·93	9·50	9·58	9·43	9·45	9·52	9·53	3·16	2·25	4·09	4·20	4·44	4·58
(e) Per pound of dry fuel fired, lb.	9·52	9·18	8·85	8·72	8·83	8·85	8·86	9·12	9·79	9·77	9·66	9·59	9·70	9·67	5·92	4·23	6·31	6·51	6·06	6·69
MISCELLANEOUS TEMPERATURES AND PRESSURES																				
49. Average air temperature: (a) Outside boiler room, °F.	86	14	78	20	5	18	28	33	32	20	43	22	9	27	61	57	61	73	81	45
(b) Inside boiler room, °F.	88	79	81	74	74	75	74	75	75	79	79	74	76	78	70	70	71	78	85	79
50. Air humidity: (a) Relative of boiler room at pulverizer, %	45	47	63	23	20	22	26	25	25	20	26	23	17	28	57	65	54	75	61	32
(b) Water vapour per pound of air, lb.	·01314	·01013	·01454	·00418	·00363	·00413	·00472	·00469	·00469	·00431	·00561	·00418	·00331	·00584	·00899	·01026	·00883	·01565	·01607	·00690
51. Average flue gas temperature in 2nd pass of boiler, °F.	717	....	1169	890	915	1016	953	1031	921	988	963	954	1024	964	747	806	839	832	841	894
52. Flame temperature in furnace: (a) Start of test, °F.	2300	....	2220	2310	2350	2400	2420	2480	2410	2490	2420	2490	2520	2500	2400	1360	2330	2400	2320	2080
(b) Midway of test, °F.	....	....	....	2310	2380	2430	2420	2490	2370	2470	2400	2450	2520	2450	1610	1570	1980	....	2075	2040
(c) End of test, °F.	2110	2325	2400	2300	2400	2500	2420	2530	2390	2470	2400	2470	2520	2480	1720	1690	1960	2050	2050	2050
53. Average draught: (a) In furnace, In W.G.	0·020	0·024	0·136	0·026	0·028	0·019	0·018	0·023	0·049	0·025	0·032	0·013	0·036	0·035	0·020	0·031	0·066	0·048	0·050	0·015
(b) In boiler outlet, In W.G.	....	0·142	0·511	0·044	0·056	0·050	0·066	0·069	0·095	0·081	0·071	0·059	0·110	0·080	....	0·049	0·119	0·063	0·072	0·044
AIR AND PRODUCTS OF COMBUSTION																				
54. Air supplied per pound of fuel as fired, lb.	11·4	12·7	12·3	9·8	10·1	9·6	9·8	10·1	10·6	10·4	10·3	11·0	10·9	10·1	5·0	4·8	7·4	6·0	6·2	6·1
55. Air theoretically required per pound of fuel as fired, lb.	10·1	10·3	10·4	8·6	9·4	9·5	9·7	9·6	9·9	10·0	10·0	10·2	10·3	10·3	4·3	4·3	5·2	5·3	5·8	5·3
56. Excess air, %	13	23	18	14	7	1	1	5	7	4	3	8	6	....	16	12	42	13	7	15
57. Average temperature of flue gases at boiler outlet, °F.	456	699	769	576	578	619	590	635	593	624	623	597	639	597	495	547	550	537	546	601
58. Volumetric analysis of dry flue gases at boiler outlet: (a) CO_2, %	15·7	14·4	15·1	16·3	16·8	17·7	17·0	17·3	16·8	17·3	17·5	17·0	17·1	17·2	14·8	14·8	12·8	16·3	17·3	16·2
(b) O_2, %	3·8	5·1	4·3	2·8	2·0	1·6	2·3	2·1	2·3	2·3	1·7	1·6	2·4	2·2	5·7	5·7	7·7	4·1	3·0	4·1
(c) CO, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
(By difference)—(d) N_2, %	80·5	80·5	80·6	80·9	81·2	80·7	80·7	80·6	80·9	80·4	80·8	81·4	80·5	80·6	79·5	79·5	79·5	79·6	79·7	79·7
59. Steam: (a) From moisture in coal per pound of fuel as fired, lb.	0·037	0·033	0·018	0·082	0·014	0·019	0·020	0·021	0·030	0·020	0·024	0·014	0·019	0·014	0·467	0·467	0·352	0·355	0·267	0·315
(b) From H_2 in dry coal per pound of fuel as fired, lb.	0·440	0·444	0·450	0·386	0·391	0·368	0·358	0·375	0·420	0·394	0·417	0·400	0·359	0·355	0·199	0·199	0·242	0·248	0·264	0·252
(c) From moisture in air per pound of fuel as fired, lb.	0·150	0·129	0·178	0·041	0·037	0·40	0·046	0·047	0·050	0·045	0·058	0·046	0·034	0·059	0·045	0·049	0·065	0·094	0·100	0·042
60. Dry flue gases: (a) Per pound of carbon, lb.	16·3	17·4	16·9	15·7	15·3	14·5	15·1	14·9	15·3	14·9	14·7	15·1	15·0	14·9	17·2	17·2	19·8	15·7	14·9	15·8
(b) Per pound of fuel as fired, lb.	12·0	13·2	12·8	10·2	10·6	10·1	10·3	10·7	11·1	11·0	10·8	11·4	11·4	10·6	5·3	5·3	7·8	6·4	6·6	6·4
CAPACITIES AND EFFICIENCIES																				
61. Rated boiler horse-power, H.P.	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7	67·7
62. Rated capacity per hour, equivalent evaporation, lb.	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336	2336
63. Boiler horse-power developed, H.P.	52·3	101·0	150·7	92·6	101·4	100·5	100·2	103·1	109·6	110·1	108·8	109·5	110·1	110·0	54·4	53·9	70·1	71·7	75·9	79·1
64. Percentage of rated capacity developed, %	77	149	223	137	150	148	148	152	162	163	161	162	163	162	80	80	104	106	112	117
65. Efficiency of boiler and furnace: (a) Based on gross calorific value fuel as fired, %	67·2	64·0	61·6	68·6	68·6	66·5	66·0	67·7	70·5	70·9	69·2	68·8	69·1	68·1	58·1	41·3	61·0	61·4	58·8	63·4
(b) Based on net calorific value fuel as fired, %	69·9	66·5	64·8	71·8	71·0	68·7	68·1	69·9	73·0	73·4	71·7	71·1	71·2	70·1	67·0	47·7	67·5	67·9	63·6	69·4
HEAT BALANCE IN B.T.U. AND PER CENT																				
66. Heat absorbed by the boiler, B.T.U.	8899	8617	8433	7763	8452	8423	8433	8666	9219	9296	9151	9170	9238	9248	3066	2183	3969	4076	4309	4444
67. Loss due to steam: (a) From moisture in fuel, B.T.U.	45	44	25	105	18	25	26	27	39	26	31	18	25	18	582	593	447	446	335	405
(b) By burning H_2 in dry fuel, B.T.U.	532	592	614	494	501	478	460	490	517	511	541	516	469	456	248	253	307	312	331	324
(c) From moisture entering with air, B.T.U.	26	38	58	10	9	10	11	12	12	12	15	11	9	14	9	11	15	20	22	10
68. Loss due to heat carried away in dry flue gases, B.T.U.	1060	1964	2114	1229	1282	1319	1276	1438	1380	1439	1410	1431	1540	1320	541	584	897	704	730	802
69. Loss due to unburned carbon monoxide, B.T.U.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70. Loss due to carbon in refuse and flue dust, B.T.U.	147	139	208	78	214	399	743	206	257	225	211	183	220	1105	358	531	101	187	342	284
71. Loss due to radiation errors and unaccounted for, B.T.U.	2531	2076	2248	1631	1854	2006	1831	1971	1656	1601	1871	2001	1869	1419	476	1125	774	895	1261	741
72. Total calorific value of 1 pound of fuel as fired, gross value, B.T.U.	13240	13470	13700	11310	12330	12660	12780	12810	13080	13110	13230	13330	13370	13580	5280	5280	6510	6640	7330	7010
73. Heat absorbed by the boiler—(Thermal efficiency), %	67·2	64·0	61·6	68·6	68·6	66·5	66·0	67·7	70·5	70·9	69·2	68·8	69·1	68·1	58·1	41·3	61·0	61·4	58·8	63·4
74. Loss due to steam: (a) From moisture in fuel, %	0·4	0·3	0·2	0·9	0·1	0·2	0·2	0·2	0·3	0·2	0·2	0·1	0·2	0·1	11·0	11·2	6·9	6·7	4·6	5·8
(b) By burning H_2 in dry fuel, %	4·0	4·4	4·5	4·4	4·1	3·8	3·6	3·8	3·9	3·9	4·1	3·9	3·5	3·4	4·7	4·8	4·7	4·7	4·5	4·6
(c) From moisture entering with air, %	0·2	0·3	0·4	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·2	0·2	0·3	0·3	0·1
75. Loss due to heat carried away in dry flue gases, %	8·0	14·6	15·4	10·9	10·4	10·4	10·0	11·2	10·5	11·0	10·7	10·7	11·5	9·7	10·3	11·1	13·8	10·6	9·9	11·4
76. Loss due to unburned carbon monoxide, %	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
77. Loss due to carbon in refuse and flue dust, %	1·1	1·0	1·5	0·7	1·7	3·2	5·8	1·6	2·0	1·7	1·6	1·4	1·6	8·1	6·8	10·1	1·5	2·8	4·7	4·1
78. Loss due to radiation errors and unaccounted for, %	19·1	15·4	16·4	14·4	15·0	15·2	14·3	15·4	12·7	12·2	14·1	15·0	14·0	10·5	9·0	21·3	11·9	13·5	17·2	10·6

**Inasmuch as difficulty was experienced in collecting the true quantities of refuse chargeable to any one trial as noted under Items 21, 22, 23 and 24, it was practically impossible to obtain true samples and consequently true analyses of these quantities. Therefore the values given for items so marked (**) under the heading "Refuse, Ash, and Carbon", may be more or less above or below the true value and should therefore be used with discretion.

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