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DEPARTMENT OF THE INTERIOR

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CHARLES D. WALCOTT, DIRECTOR

PRELIMINARY REPORT

ON THE

OPERATIONS OF THE FUEL-TESTING PLANT OF THE UNITED STATES GEOLOGICAL SURVEY AT ST. LOUIS, MO., 1905

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INTRODUCTION.

By J. A. HOLMES.

ORGANIZATION.

The authority for continuing at St. Louis, Mo., the investigation of the fuel values and possibilities of the coals and lignites of the United States, inaugurated at the Louisiana Purchase Exposition in 1904, is contained in the act of Congress making appropriation for the sundry civil expenses of the Government for the fiscal year ending June 30, 1906. This act carried an item of $202,000 "for the analyzing and testing of the coals, lignites, and other fuel substances of the United States in order to determine their fuel values, and so forth, under the supervision of the Director of the United States Geological Survey."

This appropriation became available within a few days subsequent to the passage of the bill (March 3, 1905) and the investigations were resumed May 1, following. The appropriation covers the period from May 1, 1905, to July 1, 1906, but the present preliminary report covers the period from May 1 to December 31, 1905. During this period the work has been carefully conducted and the methods of procedure improved, as compared with those used during the Exposition period, but the scope of the work has, as heretofore, been largely limited to a series of comparative tests, made as nearly as possible under similar conditions, of the samples of bituminous coal and lignite collected from the different coal fields of the United States.

LOCATION AND BUILDINGS.

The plant in which these investigations are carried on has remained at its original location in Forest Park, in the city of St. Louis, Mo., the grounds formerly occupied by the Exposition.

The preliminary installation of the plant included a chemical laboratory, a boiler and engine house, a storage and washery building, two buildings for briquetting purposes, a drying plant, and three full-size beehive coke ovens, all of which, with the exception of the building containing the chemical laboratory, were, as previously reported, furnished at the expense of the United States Government. The chemical laboratory, during the Exposition period, was installed in a building occupied during the Exposition as a metal pavilion, but now utilized for cement-testing investigations. To the group of fuel-testing buildings have been added two others left from the Exposition—one a foundry building, 100 by 125 feet, for coking investigations, into which the chemical laboratory has been transferred; the other a building now used for offices which was formerly the State building of South Dakota. The foundry building was supplied by the Exposition company without charge; the office building, a 12-room house about 150 yards from the boiler plant, was leased from private parties, and a small monthly rental is paid.

The facilities at the plant for the storage of coal received for testing purposes have been largely increased. In the original washery building there were four 35-ton and two 17-ton bins. To these have been added five 35-ton bins on the northwest side of the washery building, immediately over the railway track; four 25-ton bins on the northwest side of the boiler room, and three 50-ton auxiliary bins on the ground adjacent to the coke ovens. Two 5-ton bins have been added on the gas-producer platform. These have brought the storage capacity from 175 tons in 1904 up to 610 tons in 1905.

EQUIPMENT.

The major part of the equipment of the plant during the current year has remained much as it was during 1904, though a number of additions have been made. In the list given below, the equipment mentioned in the reports for 1904 [a] is included for the convenience of those who may not have access to those reports; the articles which have been subsequently added are marked with an *. The new equipment is described more fully in the accompanying papers relative to the work of each division. The following list contains the more important items for all the divisions:

Two Heine water-tube boilers, 210 horsepower each, contributed by the Heine Safety Boiler Company, of New York and St. Louis.

One Allis Corliss engine, contributed by the Allis-Chalmers Company, of New York and Chicago. The Corliss engine was belt-connected to a Bullock electric generator contributed by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio.

One Frost fire-tube boiler of 100 horsepower and a 50-horsepower slide-valve engine, both contributed by the Frost Engine Company, of Galesburg, Ill.

Two Taylor gas producers (one 7-foot producer and one 8-foot producer with inside diameter reduced to 7 feet by fire brick), with complete outfit for scrubbing and purifying gas, supplied by R. D. Wood & Co., of Philadelphia. These producers are installed to operate alternately with one tar extractor and one engine.

One Westinghouse gas engine of 235 brake horsepower, supplied by the Westinghouse Machine Company, of Pittsburg, and operated by the gas made in the Taylor producers.

One Westinghouse electric generator, belt-connected to the gas engine, supplied by the Westinghouse Electric and Manufacturing Company, of Pittsburg.

Seven motors of different horsepower, required for the operation of the different portions of the plant, supplied by the Westinghouse Electric and Manufacturing Company.

One Bartlett direct-heat rotating drier for driving out the moisture from washed coals and lignites whose moisture contents were too high to permit successful briquetting, contributed by the C. O. Bartlett & Snow Company, of Cleveland, Ohio.

One briquetting plant supplied by William Johnson & Sons, of Leeds, England.

A washing plant equipped with two Luhrig jigs,* constructed at the plant, and a modified Stewart jig, supplied by the Link Belt Machinery Company, of Chicago.

A battery of three full-size beehive coke ovens, constructed of red brick and lined with fire brick, contributed by the Laclede Fire Brick Manufacturing Company, of St. Louis.

One 7-ton larry * for use in charging the coke oven, contributed by the Frick Coke Company, of Pittsburg.

One Climax gasoline gas machine,* about 1,000 candlepower, supplied by the Federal Gas Company, of St. Louis, for use in the chemical laboratory (this being rendered necessary by the cutting off of the city gas supply from these grounds after the Exposition closed).

One McClave rocking grate.*

One forced-draft outfit,* consisting of a blower and a direct-connected steam engine, supplied by the B. F. Sturtevant Company.

The foregoing list includes all that might properly be considered testing machinery, but the following additional incidental equipment and material were contributed by the firms mentioned:

One Williams crusher, by the Williams patent Crusher and Pulverizer Company, of St. Louis.

A complete outfit of belt-conveying apparatus, contributed and installed by the Robins Conveying Belt Company, of New York.

A 30-inch Jeffrey conveying belt * for delivery of coal to the gas producer direct from the car or from the ground bins.

Scales, by Fairbanks, Morse & Co., of New York and Chicago.

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[a] Bull. U. S. Geol. Survey No. 261, 1905, p. 12; Prof. Paper U. S. Geol. Survey No. 48, 1906, p. 25.

Smoke-preventing device, automatic steam jet, by H. H. Hughes, of St. Louis.

Thermometers and pressure gages, by the Hohmann & Maurer Manufacturing Company, of Rochester, N. Y.

One Crosby recording steam gage.*

Draft gages, by the Appliance Manufacturing Company, of Chicago.

One Bristol recording draft gage.*

Feed-water heater and pump, by the Stillwell-Bierce Smith-Vaile Company, of Cincinnati.

Le Chatelier pyrometers, by Charles Engelhard, of New York.

One Wann optical pyrometer.

Engine indicators and attachments, by the Ashcroft Manufacturing Company, of New York, and the Crosby Steam Gage and Valve Company, of Chicago.

Metallic piston packing, by the Steel Mill Packing Company, of Detroit.

Burroughs adding machine, by the American Arithmometer Company, of St. Louis.

Oil filter, by the Famous Filter Company, of St. Louis.

Gas meters, by the Pittsburg Meter Company, of Pittsburg.

Dumping car and bucket conveyors, by the Austin Manufacturing Company, of Chicago.

Centrifugal pump, by Henion & Hubbell, of Chicago.

Calculating machine, by the Keuffel & Esser Company, of New York.

Power crusher and automatic sampler for preparing samples for the chemical laboratory, by the F. W. Braun Company, of Los Angeles, Cal.

The plans for the buildings and their arrangement were prepared by the Roberts & Shaefer Company, engineers, of Chicago.

The boiler room was thoroughly equipped with standardized apparatus for weighing coal and water, for determining the force of the draft, for ascertaining the temperatures in the different parts of the furnace, and for analyzing the flue gases. The gas producer and gas engines were also provided with apparatus for ascertaining temperatures, for collecting samples of the gas as produced, and for determining the horsepower developed in the gas engine. The electrical horsepower developed by both the steam engine and the gas engine was ascertained by twenty-minute readings of voltmeters and ammeters, and the electrical horsepower developed per pound of fuel consumed by the two different methods was thus accurately determined and recorded.

The chemical laboratory was equipped with every necessary apparatus and chemical material for making proximate and ultimate analyses and for determining the calorific value of the coal. This value was obtained by a Mahler bomb calorimeter, the observations being made in a room especially set aside for this purpose. To this equipment was added during 1905 one Abbe ball mill for pulverizing; a 48-inch square steel-top table for quartering samples; one large drying oven for air-drying samples, and two moisture ovens for determining moisture at 105° C. (these ovens especially designed by Prof. N. W. Lord); an additional bomb and two Galaz thermometers for the Mahler bomb calorimeter equipment, and for general use in the laboratory two Troemner balances, one torsion balance, and a Climax gas machine (referred to above).

The railroad companies entering St. Louis or having coal resources along their lines have cooperated most heartily with the officers in charge of this work.

PERSONNEL.

Many of the experts who were in charge of the investigations during 1904 have been continued in charge of the tests now being conducted. A number of additional assistants however, have been necessary in order that more rapid and efficient progress might be made with the work. In addition to the skill and services of the experts regularly employed, the operations of the plant have been aided by the hearty cooperation and ready and helpful advice of leading engineers resident in many parts of the country. A general committee, appointed by the Director of the Geological Survey, on the investigation of coal and other fuels is composed of Messrs. C. W. Hayes, J. A. Holmes, E. W. Parker, and M. R. Campbell.

The names of the experts and assistants employed in connection with the several divisions of the testing work are presented in subjoined reports covering these tests. The following is a list of those in charge of the several divisions and the assistants having special assignments:

J. A. Holmes, fuel expert in charge.

N. W. Lord (University of Ohio, Columbus), in charge of chemical work.

L. P. Breckenridge (University of Illinois, Urbana), engineer in charge of steaming tests.

R. H. Fernald (Washington University, St. Louis), engineer in charge of producer-gas tests.

C. T. Malcomson, mechanical engineer, in charge of general work at the plant.

A. W. Belden, in charge of coking tests.

W. T. Ray, assistant engineer, in charge of steaming tests.

John D. Wick, in charge of washing tests.

John A. Laird, assistant engineer, operating gas producers.

J. P. Quam, engineer, in charge of gas engine.

E. E. Somermeier, chemist, in charge of laboratory.

F. M. Stanton, head chemist.

Joseph Underwood, electrician.

The collection of the samples of coal has been under the supervision of Mr. E. W. Parker, of the Geological Survey. The work of collecting the samples has been done mainly and most efficiently by Messrs. J. S. Burrows, chief inspector; and J. W. Groves and W. J. Von Borries, inspectors. The methods followed in the collection and shipment of these samples are fully described elsewhere (pp. 17–18).

NATURE AND RESULTS OF THE INVESTIGATIONS.

The principal branches of the work carried on include (1) taking samples of coal of various mines by inspectors employed by the Geological Survey for this purpose; (2) making proximate and ultimate chemical analyses of these samples; (3) washing tests, to determine the possibility of improving the quality of the coal shipped by carloads from mines inspected; (4) coking tests, to determine the possibility of making coke or of improving the coking practice with a view to betterment in the quality of the coke made from these coals; (5) gas-producer tests, to determine the efficiency with which each coal can be used in this manner for power production; (6) steaming tests, to determine the fuel value of such coal in the ordinary steam boilers; (7) and briquetting tests, to determine the extent to which the fines or slack coals can be economically made into briquettes.

The results of these investigations will be discussed more at length in the later and more complete report. For the purposes of this preliminary report the following brief statement will suffice:

The carefully made analyses of these representative coals and lignites are giving to the engineers of the country data of great value, not only because this work is done with care, but also because the complete history of every such sample is indicated and the record is authentic and reliable. Up to December 31, 1905, more than 1,600 such chemical analyses have been made, involving more than 7,000 chemical determinations.

The following tests have also been made:

In the gas producer and gas engine, 85 tests, each extending over two or three days, of coals, lignites, and peats from 18 States.

In the steam boilers, 283 tests, each of from nine to eleven hours' duration, of 170 different coals from 18 States.

In the coke ovens, 110 tests, each of forty-eight to seventy-two hours' duration, of 95 coals from 16 States. Of these coals a large portion have heretofore been considered as noncoking coals.

In the washery plant it has been shown how the quality of 43 coals from 13 States and several samples of coke breeze could be improved by washing, at a nominal cost of from 3 to 10 cents per ton.

In the briquetting plant a number of new possible binding materials for coke briquettes have been investigated, and a few of these have proved sufficiently satisfactory to warrant further investigation as to their more extended use, at a probable cost considerably less than that of coal-tar pitch, which is ordinarily used for briquetting operations. A number of lignites, representing both the extreme Northwest and Southwest, have been briquetted under high pressure without the use of binding materials, and it has been shown that the cost of briquetting such materials should not exceed 50 cents per ton. Furthermore, it has been shown that in the use of certain briquetted coals for railroad and domestic purposes the increase in the efficiency of the coals used in the briquetted form is more than sufficient to cover the cost of the briquetting operations.

The producer-gas investigations have shown the suitability of bituminous coals, lignites, and peats for power purposes in the gas producer and the gas engine. While there remain difficulties in the way of the general introduction of this new source of power, yet the results of these investigations have already contributed in an important degree toward the overcoming of these difficulties and are serving as a basis of plans for new power developments in many parts of the country. Already 14 or more different companies are reported to be making producers for power purposes and others are endeavoring to perfect new designs. It may be added that at two of our great steel plants blast-furnace gas engines have been introduced for power purposes, and a dozen companies are now either manufacturing or working on plans for the manufacture of gas engines.

The advances made in simplifying and handling the gas-producer equipment at the St. Louis plant have so increased its efficiency that the average bituminous coals recently tested have yielded in it 2.6 times the amount of power they have given under steam boilers of equivalent capacity (210 horsepower), and in several cases this difference in favor of the gas power has been considerably greater—as high as three to one.

The development of the steam boiler and engine has required more than two hundred years, for the reason that along its path there was but little record of accurate data to serve as a basis of invention. It is confidently hoped that the information now being secured and assembled by the Survey will be the means of stimulating more rapid improvements and higher efficiencies in the use of fuels along several lines, and particularly of demonstrating the great practical possibilities of power developed with the gas producer and engine.

In connection with the large beds of lignite found in many of the Western States, the present investigations have been and will continue to be of much value in showing how these lignites may be used to advantage for power purposes, either in their natural condition, in gas producers and gas engines, or briquetted and then used under ordinary boilers, in gas producers, or in ordinary domestic stoves and furnaces.

These investigations, in addition to demonstrating how many of the so-called noncoking coals of the United States may be coked by exercising increased care either in the construction or in the operation of the ovens, have also shown how the quality of certain of these cokes may be improved by adding pitch or other hydrocarbons to the coal before being charged into the oven.

A not unimportant result of this work is educational, through (1) the awakening of the coal producers of the country to a more careful study of their coals and of possible methods of improvement in quality by washing, etc., and (2) the recognition by manufacturers and other coal consumers of the need of using their fuels more efficiently, and of purchasing them on a basis which indicates their true heating value, rather than on some general and indefinite trade name or classification, or at the "lowest price."

During the remainder of the present fiscal year (to June 30, 1906) the work of the fuel-testing plant will be largely confined to comparative tests of the fuel efficiencies of coals and lignites collected from different coal fields. But if provision is made for continuing the investigations beyond this period, there are a number of important fuel problems that await investigation and that should be investigated by the Government, not only because of their importance but because of the further fact that the solution of these problems has

to do with the supplies of power, heat, and light and with metallurgical industries in every part of the country.

Some of the more important of these fuel problems are outlined in the following paragraphs:

SOME PROBLEMS NEEDING INVESTIGATION IN THE UTILIZATION OF AMERICAN FUELS.[a]

FUELS FOR GENERAL AND METALLURGICAL PURPOSES.

(1) The investigation of coal dust and coal gas in relation to fires and explosives in coal mines and elsewhere.

(2) An investigation of the nature and extent of the deterioration or other changes of different coals when mined and stored under different conditions, as affecting (*a*) their efficiencies when used in boilers or gas producers or when used for domestic purposes; (*b*) their value for coking; (*c*) their liability to spontaneous combustion.

(3) The development of quicker and cheaper methods of testing coals, lignites, and other fuels, based on a knowledge of their chemical and physical characteristics.

(4) The establishment of an equitable basis for the sale and purchase of coal and other fuels, embodying a statement of their heat units and chemical and physical properties.

(5) The determination of the chemical and physical properties and fuel values of coals, lignites, and peats from such fields as have not yet been fully examined, or from new deposits that are being or may be opened up; also of the comparative values for fuel and power purposes of different coals, lignites, peats, and other substances.

(6) The development of briquetting and other methods for utilizing most efficiently slack or fine coals.

(7) The development of washing and other methods of improving the quality of low-grade coals for different uses.

(8) An investigation of the advantages of sizing coals for different uses, under different conditions, as compared with the use of run-of-mine coal.

(9) Investigations of coals in their relation to metallurgical work; of conditions under which the so-called noncoking coals can be made into coke by mixing different coals, by mixing other materials with the coals, or by other methods; of the relative value of cokes made in different ovens and under different conditions; of the most economical methods of making and using gases for metallurgical purposes.

(10) An investigation of the extent to which valuable by-products can be manufactured from the different American coals.

FUELS FOR BOILER PURPOSES.

A study of conditions under which different coals may be most economically burned under steam boilers, including the laws of combustion and smoke prevention:

(1) By variation of furnace conditions, as to grates, baffling, draft, rate of combustion, temperature, etc.

(2) By variations in character of the coal, as to sizes, etc., rate and regularity of firing, condition of the coal, etc.

(3) The effect of distribution and composition of ash in different coals, as to their economical burning.

(4) Reduction in the ash by washing the coal and other methods of lessening or avoiding the slagging of the ash on grate bars.

FUELS USED IN GAS PRODUCERS.

(1) The conditions under which different bituminous coals, lignites, and peats may be most efficiently used in gas producers.

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[a] Reproduced largely from Senate Doc. 214, 59th Congress, 1st sess., 1906.

(2) The separation of the tar and other by-products from the gases made in the producer and the commercial recovery of these by-products, or the fixing of the tar and other hydrocarbons as available gases for power purposes.

(3) The use of slack coals in the gas producer and the value of the sizing of lump coals for producer purposes.

(4) Utilization of blast-furnace gases and gases from coke ovens for power purposes.

DETAILED REPORTS OF TESTS.

Reports in detail of the results of the various tests described are printed on pages 53–233. It will be noted that the form and order in which the various test tables are arranged differ from those used in the reports on the fuel tests made during 1904.[a] In the present report the test records are grouped together under the respective coal samples and the samples are presented by States in alphabetical order. That this method of publication is an improvement will be apparent.

ANALYSES OF ALASKA COAL.

By way of cooperation with the Alaska division of the United States Geological Survey the laboratory of the fuel-testing plant at St. Louis analyzed 34 coals, samples of which were collected in the Bering and Matanuska River coal fields by Mr. G. C. Martin, one of the assistant geologists of the Survey. These analyses are to be found on pages 230–231 of this report.

INVESTIGATION OF PEAT.

Arrangements are being made for an examination of the nature and fuel value of peat from a number of localities in the different States. Prior to the writing of this report peat from but one locality (Massachusetts) has been tested through the producer and gas engine. The results of this test are given on page 134. The peat was collected, cut into small fragments, pressed into crude bricks approximately 3 by 6 by 1½ inches in size, and the moisture reduced, by air drying, from 85 to 45 or 50 per cent. In this form the peat was fed into the producer at the rate of 600 to 750 pounds per hour. The results of the test were eminently satisfactory. The peat burned freely, evenly, and completely. The gas had a fuel efficiency of 166 British thermal units per cubic foot of gas, as compared with 142 to 159 British thermal units per cubic foot of gas made from bituminous coal. The engine was run continuously during this test under full load. This same peat, cut into small fragments, but in a loose and wet condition (containing 80 to 85 per cent of moisture), did not burn satisfactorily in the producer, and attempts to dry this loose peat in the Bartlett direct-heat rotating dryer were unsatisfactory, owing in part, probably, to lack of time for readjusting the equipment to suit the unusual conditions imposed on it in handling the peat.

Shipments of peat from a number of other localities will be tested during 1906 and efforts will be made to develop better facilities for handling the unbriquetted material.

LITERATURE RELATING TO PEAT AND ITS UTILIZATION.

The following list will be found to include a number of articles of interest on the character and extent of peat deposits and the methods through which they are utilized in different countries. In a subsequent and more elaborate report on this subject the list of articles will doubtless be enlarged and descriptive notes will be added.

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[a] Bull. U. S. Geol. Survey No. 261, 1905; Prof. Paper U. S. Geol. Survey No. 48, 1906.

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Peat, its use and value for fuel: First Rept. Ontario Bureau of Mines, p. 175.

Shaler, N. S., On peat and swamp soils: Twelfth Ann. Rept. U. S. Geol. Survey, pt. 1, p. 311.

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FIELD WORK.

By EDWARD W. PARKER and J. SHOBER BURROWS.

INTRODUCTION.

The collection of samples of coal for testing purposes for the year 1905 was begun by Mr. Burrows, under the direction of Mr. Parker, during the latter part of April. The early work consisted of shipping several samples of coal from Illinois, arrangements for which had been made during the Exposition period, but which could not be carried out until the work was resumed under the new appropriation.

Later, Messrs. John W. Groves and William J. Von Borries were employed as inspectors, and shipped most of the samples. Mr. Marius R. Campbell, of the United States Geological Survey, cooperated with the fuel-testing plant to the extent of shipping several samples of coal and lignite from points in the Western States, this work being done in connection with his geologic field work.

About May 1 an application form "to have coal tested at the United States Geological Survey coal-testing plant at St. Louis, Mo.," was sent to each operator of a shipping colliery in the United States. A descriptive circular accompanying this form set forth the conditions under which coal might be furnished for testing purposes, as follows:

1. The coal must be furnished to the testing plant free of cost to the Government.
2. The coal must be loaded under the supervision of one of the inspectors employed for that purpose, who shall be at the same time allowed to visit the working places in the mine to secure samples for analysis.
3. When it is possible to do so, the coal should be loaded in box cars and shipped under seal Lignites must always be shipped in this way.
4. Where the market requires screened coal, this grade will be accepted for tests. The selection of coal is always to be under the direct control of the representative of the testing plant
5. Where one of the problems involved is the better utilization of slack coal, a carload of slack may be accepted for testing purposes.
6. As soon as possible after the tests are completed, a brief statement of the results will be furnished to parties supplying the coal, for their information, but this must not be made public until the results are published by the Geological Survey.
7. Everyone interested in any particular test or in the general operation of the plant is invited to be present at any time, but the official record of the tests will not be given out except as indicated in the preceding paragraph.

The committee in charge of the work, recognizing the probability of receiving applications from two or more operators working the same seam of coal in the same locality, reserved the right to accept but one such application, in order that unprofitable duplication of results might be avoided.

The largest number of applications were received from Illinois, probably owing to the proximity of that field to St. Louis and the consequent low freight rates. Indiana, Ohio, West Virginia, and Tennessee follow Illinois in the number of applications, while Pennsylvania, Maryland, Virginia, Kentucky, and Alabama are well represented in the tests of coals from the Appalachian field, and Iowa, Missouri, Kansas, Arkansas, and Indian Territory in the tests of coals from the western interior fields. Applications for tests have also been received from North Dakota, Wyoming, Colorado, New Mexico, Utah, Washington, Oregon, North Carolina, and Georgia, and arrangements for meeting these requests have been made.

INSPECTION PROCEDURE.

In collecting the samples to be shipped to the plant, an inspector visits the mine and carefully examines the coal throughout its extent. He sees that the coal loaded for testing purposes fairly represents the average product of the mine; that when screened coal is to be sent, the size selected is available to the consumer and adapted to the purpose for which it is to be tested. Therefore, his first duty is to examine the screens and observe the method generally employed in separating the slate and other impurities from the coal while it is being loaded in the railroad car. He then enters the mine and notes carefully the character of the bed, the method of mining, and the amount of care taken by the miners to separate the shale partings and sulphur balls from the coal while loading it into mine cars. While the sample is being loaded into the railroad car the inspector stands inside and permits the slate pickers to discard only such material as is thrown off in the usual practice and as is consistent with the customary speed of loading. The material thrown out is afterwards examined by the inspector to determine why it is considered detrimental to the fuel value of the coal. When large amounts of slate, bone, iron pyrites, etc., have been discarded, the entire amount of refuse is weighed and noted in the inspector's report. Should the weight of this refuse exceed 2 per cent of the total weight of the sample of coal, the refuse is carefully sampled and analyzed. By this means an approximate idea of the reduction of ash and sulphur, due to hand picking, can be ascertained.

MINE SAMPLES.

Two or more samples for chemical analysis are taken by the inspector from working places in the mine. These analyses give the experts at the plant a definite idea of the quality of the coal before the practical tests are begun. They are also useful in showing the composition of the coal in its native condition; especially is this true of the moisture content. The object of the inspector is to secure a sample that will, as nearly as possible, represent run-of-mine coal.

The analytical results from mine samples taken during the Exposition period (August to December, 1904) showed that some modification of the method then used was desirable. These changes have been made with the idea of determining more accurately the amount of moisture in the coal in its native condition and of eliminating as far as possible the personal element, which figures so largely in all sampling where everything is left to the judgment of the sampler.

Mine sampling as it is done at present by the inspectors of the fuel-testing plant consists of first making a careful study of the coal throughout the mine and observing what parts of the bed are discarded by the miner. Two or more places where the coal is of average development are then selected. These places are usually at widely separated points in the part of the mine from which most of the coal is being shipped. The face is then cleared of burned powder, loose coal, and dirt for 5 feet or so, and insecure pieces of the roof are taken down to prevent their falling into the sample. The sampler then spreads a rubber blanket on the floor of the mine close up to the face of the coal and makes a perpendicular cut from floor to roof, including everything in the sample but the parts of the bed discarded by the miner. He cuts sufficient coal to make not less than 5 pounds per foot in height—that is, a sample weighing not less than 30 pounds would be cut from a 6-foot seam of coal. When shale or other partings are to be included in the sample, great care is exercised in cutting them the full width and depth of the groove in order to preserve the proper proportion of coal and extraneous matter. When the required amount of coal is obtained a detailed record is made of the section of the bed from top to bottom, every perceptible parting and variation in the section being noted. The parts of the bed not included in the sample are clearly shown in this record, and from these notes the value of the sample may be judged.

The cuttings are at once weighed and then sifted through a screen with a half-inch mesh. The remaining lumps are broken up in a portable grinding machine, and this process of screening and breaking is continued until the entire sample will pass through the screen,

The sample is then mixed by two men who stand opposite each other. Grasping the corners of the rectangular blanket, they roll the sample diagonally by raising one corner of the blanket at a time. This mixes the sample very thoroughly, and when the larger pieces are observed to be evenly distributed throughout the mass the sample is divided into four equal quarters. Two opposite quarters are discarded and the remainder mixed as before. If the sample is still too bulky to be conveniently handled, it is again mixed and quartered.

The remaining material is spread into a circular mass about 2 inches deep on the blanket, and a small trowel is used to fill a sample can with alternate sections of the sample taken from the circumference to the center of the mass around the entire circle. The can is closed and hermetically sealed with electrical insulating tape, and the weight is noted. This weight shows accurately what proportion of the original sample is sent to the laboratory.

The entire process of sampling is carried on as rapidly as possible at the place in the mine where the sample is cut. The maximum time for cutting and preparing a large sample is about one hour. Although it is known that rapid changes take place in the moisture content of some coals, it is reasonable to assume that where the sampling is quickly done in the atmosphere to which the native coal is exposed there is probably only a slight gain or loss of moisture while the sample is being broken up and quartered.

In an effort to establish some definite relation between these moisture changes and the atmospheric conditions, temperature, humidity, and dew-point determinations are made at the beginning and completion of the preparation of the sample. Similar readings are taken in the chemical laboratory. When sufficient data have been collected, it is possible that this subject will be more thoroughly understood.

DESIGNATION OF SAMPLES.

The samples or cars of coal when they are shipped are marked with the name of the State and numbered consecutively in the order of shipment. When two or three cars or lots constituting different grades of coal, such as lump, nut, etc., are shipped from the same mine, each lot is designated by a letter. For example, Illinois No. 1 A may be lump, Illinois No. 1 B nut, and Illinois No. 1 C slack, etc. These State numbers begin for 1905 where those in use during the previous work left off.

SAMPLES RECEIVED AND TESTED.

The following is a complete list of the car samples received during the period from May 1, 1905, to January 1, 1906, with details of ownership, location, character of sample, etc.:

Samples of coal

Name of sample.	Operator.	Mine.	Location.	Railroad.
California No. 1	San Francisco and San Joaquin Coal Co.	Tesla	Tesla, Alameda County, Cal.	Alameda and San Joaquin.
Illinois No. 6	Clover Leaf Coal Co.	Coffeen	Coffeen, Montgomery County, Ill.	Toledo, St. Louis and Western.
Illinois No. 7 A	Lumaghi Coal Co.	No. 2	Near Collinsville, Madison County, Ill.	Vandalia
Illinois No. 7 B	do	do	do	do
Illinois No. 7 C	do	do	do	do
Illinois No. 7 D	do	do	do	do
Illinois No. 8	Dering Coal Co	Paisley	Paisley, Montgomery County, Ill	Big Four
Illinois No. 9 A	Mount Olive and Staunton Coal Co.	No. 2	Near Staunton, Macoupin County, Ill.	Litchfield and Madison.
Illinois No. 9 B	do	do	do	do
Illinois No. 10	Dering Coal Co	West Frankfort	West Frankfort, Franklin County, Ill.	Chicago and Eastern Illinois.
Illinois No. 11 A	St. Louis and Big Muddy Coal Co.	Daws shaft	Near Carterville, Williamson County, Ill.	Illinois Central
Illinois No. 11 B	do	do	do	do
Illinois No. 11 C	do	do	do	do
Illinois No. 11 D	do	do	do	do
Illinois No. 12	Western Coal and Mining Co.	Bush No. 1	Bush, Williamson County, Ill.	St. Louis, Iron Mountain and Southern.
Illinois No. 13	The Benton Coal Co.	Benton	Benton, Franklin County, Ill.	Chicago and Eastern Illinois.
Illinois No. 14	Capital Coal Co	No. 2	East side of Springfield, Sangamon County, Ill.	Illinois Central
Illinois No. 15	Pettinger & Davis.	South	Centralia, Marion County, Ill.	do
Illinois No. 16	Big Muddy Coal and Iron Co.	No. 7	Herrin, Williamson County, Ill.	do
Illinois No. 18	La Salle County Carbon Coal Co.	La Salle shaft	La Salle, La Salle County, Ill.	do
Illinois No. 19 A	Zeigler Coal Co	Zeigler	Zeigler, Franklin County, Ill.	do

received and tested.

Inspector.	Kind of coal.	Name of bed.	Tests.
E. W. Parker.....	Lignite; run of mine.....	(?)	Producer-gas, p. 53.
J. W. Groves.....	Bituminous; run of mine...	No. 5.....	Steaming, p. 55. Producer-gas, p. 56. Washing, p. 57.
.....do.....	Bituminous; slack, through 1-inch mesh screen.	(?)	Producer-gas, p. 59.
J. S. Burrows.....	Bituminous; nut, over 1-inch mesh screen.	(?)	Producer-gas, p. 59.
.....do.....	Bituminous; slack.....	(?)	Steaming, p. 58. Producer-gas, p. 59. Washing, p. 60.
J. W. Groves.....	Bituminous; run of mine...	(?)	Steaming, p. 58. Washing, p. 60. Coking, p. 60.
Shipped by operator..	Bituminous; nut.....	(?)	Steaming, p. 61. Producer-gas, p. 62.
J. S. Burrows.....	Bituminous; run of mine...	(?)	Steaming, p. 63. Washing, p. 66.
.....do.....	Bituminous; lump.....	(?)	Steaming, p. 63. Producer-gas, p. 65.
Shipped by operator .	Bituminous; slack.....	(?)	Steaming, p. 67. Producer-gas, p. 68. Washing, p. 69.
J. S. Burrows.....	Bituminous; one-half screenings, one-half egg coal.	Big Muddy.....	Steaming, p. 70. Producer-gas, p. 72.
.....do.....	Bituminous; one-half run of mine, one-half lump coal.	.....do.....	Steaming, p. 70.
.....do.....	Bituminous; one-half No. 4 washed coal, one-half No. 5 washed coal.	.....do.....	Steaming, p. 70. Producer-gas, p. 72.
.....do.....	Bituminous; No. 3 washed coal.	.....do.....	Producer-gas, p. 72. Coking, p. 74.
J. W. Groves.....	Bituminous; run of mine...	No. 6.....	Steaming, p. 75. Washing, p. 76.
.....do.....	Bituminous; egg, through 6-inch screen and over 1½-inch screen.	No. 6.....	Steaming, p. 77. Producer-gas, p. 78. Washing, p. 79. Coking, p. 79.
.....do.....	Bituminous; lump, over 1½-inch bar screens.	No. 5.....	Steaming, p. 80. Producer-gas, p. 81. Washing, p. 82.
J. S. Burrows.....	Bituminous; lump, over 6-inch screens.	No. 6.....	Steaming, p. 83. Producer-gas, p. 84. Washing, p. 85.
.....do.....	Bituminous; mixture of lump and egg, made by passing run of mine coal over 3-inch mesh.	No. 7.....	Steaming, p. 86. Producer-gas, p. 86. Washing, p. 87. Coking, p. 88.
.....do.....	Bituminous; lump over 6-inch mesh screens.	No. 2.....	Steaming, p. 89. Producer-gas, p. 90. Washing, p. 91.
J. W. Groves	Bituminous; "¾-inch coal," over ¾-inch perforated shaking screens.	Big Muddy.....	Steaming, p. 92. Coking, p. 94.

Samples of coal

Name of sample.	Operator.	Mine.	Location.	Railroad.
Illinois No. 19 B	Zeigler Coal Co	Zeigler	Zeigler, Franklin County, Ill.	Illinois Central
Indiana No. 3	J. Woolley Coal Co.	No. 3	Near Boonville, Warrick County, Ind.	Southern
Indiana No. 4	Consolidated Indiana Coal Co.	No. 29	Star City, Sullivan County, Ind.	Evansville and Terre Haute.
Indiana No. 5	do	No. 33	Hymera, Sullivan County, Ind.	do
Indiana No. 6	do	No. 34	do	do
Indiana No. 7 A	S. W. Little Coal Co.	Little's	Little's, Pike County, Ind	do
Indiana No. 7 B	do	do	do	do
Indiana No. 8	Deep Vein Coal Co.	Deep Vein	2 miles west of Terre Haute, Vigo County, Ind.	Vandalia
Indiana No. 9 A	Fauvre Coal Co	Red Bird	Macksville, Vigo County, Ind.	do
Indiana No. 9 B	do	do	do	do
Indiana No. 10	Park County Coal Co.		Near Rosedale, Park County, Ind.	do
Indiana No. 11	Island Coal Co	No. 4	Dugger, Sullivan County, Ind.	do
Kansas No. 5	Southwestern Development Co.	No. 11	West Mineral, Kans.	Missouri, Kansas and Texas.
Kentucky No. 1 B	Straight Creek Coal and Coke Co.	No. 2	Straight Creek, Bell County, Ky.	Louisville and Nashville.
Kentucky No. 1 C	do	do	do	do
Kentucky No. 5	Interstate Investment Co.	Gilliam's Rockhouse prospect.	Big Black Mountain, 15 miles from Louisville and Nashville Railroad.	Nearest Louisville and Nashville.
Kentucky No. 6	Justus Collins	Millers Creek country bank.	5 miles southeast of Paintsville, Johnson County, Ky.	7 miles from Chesapeake and Ohio.
Kentucky No. 7	Central Coal and Iron Co.	Central	Central City, Muhlenburg County, Ky.	Illinois Central
Maryland No. 1	Piedmont and Georges Creek Coal Co	Washington No. 3	2 miles north of Westernport, Garrett County, Md.	Cumberland and Pennsylvania.
Massachusetts No. 1			Halifax, Plymouth County, Mass.	
North Dakota No. 1 B.	Consolidated Coal Co.	Lehigh	Lehigh, Stark County, N. Dak.	Northern Pacific.

received and tested—Continued.

Inspector.	Kind of coal.	Name of bed.	Tests.
J. W. Groves	Bituminous; "3-inch coal," over 1½-inch perforated shaking screens.	Big Muddy	Steaming, p. 92. Producer-gas, p. 93. Coking, p. 94.
do	Bituminous; nut and slack mixed.	No. 5	Steaming, p. 95. Producer-gas, p. 96. Washing, p. 96. Coking, p. 97.
J. S. Burrows	Bituminous; screenings, through 1¼-inch bar screens.	(?)	Steaming, p. 98. Washing, p. 99. Coking, p. 99.
do	Bituminous; run of mine	(?)	Steaming, p. 100. Producer-gas, p 101. Coking, p. 102.
do	do	(?)	Steaming, p. 103. Producer-gas, p. 104. Washing, p. 105. Coking, p. 105.
W. J. Von Borries	Bituminous; lump over 1⅝-inch screen.	No. 5	Steaming, p. 106. Producer-gas, p. 107. Washing, p. 108. Coking, p. 108.
do	Bituminous; screenings through 1⅝-inch screen.	do	Steaming, p. 106.
J. W. Groves	Bituminous; lump, over 1¼-inch bar screen.	(?)	Steaming, p. 109. Producer-gas, p. 110. Washing, p. 111.
W. J. Von Borries	Bituminous; lump, over 1¼-inch screen.	No. 7	Steaming, p. 112. Producer-gas, p. 113. Coking, p. 114.
do	Bituminous; run of mine	do	Steaming, p. 112. Washing, p. 114. Coking, p. 114.
J. W. Groves	Bituminous; lump, over 1¼-inch bar screen.	No. 6	Steaming, p. 115. Washing, p. 116.
do	Bituminous; lump, over 1½-inch and 3-inch screens.	No. 4	Steaming, p. 117. Producer-gas, p. 118. Coking, p. 119.
M. R. Campbell	Bituminous; over ⅝-inch screens.	(?)	Producer-gas, p. 120.
J. W. Groves	Bituminous; one-half 3-inch and 1-inch coal, one-half ¾-inch coal.	Straight Creek	Producer-gas, p. 122. Coking, p. 123.
do	Bituminous; 1¼-inch slack coal.	do	Steaming, p. 121. Coking, p. 123.
J. S. Burrows	Bituminous; run of mine	High Splint	Steaming, p. 124. Producer-gas, p. 124. Coking, p. 125.
W. J. Von Borries	do	No. 1	Steaming, p. 126. Producer-gas, p. 127. Coking, p. 128.
J. W. Groves	Bituminous; standard lump, over 1½-inch bar screen.	No. 9	Steaming, p. 129. Producer-gas, p. 130. Coking, p. 131.
do	Bituminous; run of mine	(?)	Steaming, p. 132. Washing, p. 133. Coking, p. 133.
J. S. Burrows	Peat briquettes		Producer-gas, p. 134.
M. R. Campbell	Brown lignite	No name	Producer-gas, p. 136.

Samples of coal

Name of sample.	Operator.	Mine.	Location.	Railroad.
North Dakota No. 2 B.	Furnished by engineers of United States Reclamation Service.	Cedar Coulee.....	4 miles southeast of Williston, Williams County, N. Dak.	.....
North Dakota No. 3.	Washburn Lignite Coal Co.	Wilton.....	1 mile east of Wilton, McLean County, N. Dak.	Minneapolis, St. Paul and Sault Ste. Marie.
Ohio No. 1.....	Superior Coal Co..	No. 10.....	9 miles southeast of Wellston, Jackson County, Ohio.	Baltimore and Ohio.
Ohio No. 2.....	.....do.....	.....do.....	.....do.....	.....do.....
Ohio No. 3.....	Ohio Mining and Manufacturing Co.	Gosline & Barbour.	Shawnee, Perry County, Ohio.	Zanesville and Western.
Ohio No. 4.....	United States Coal Co.	Crow Hollow.....	Bradley, Jefferson County, Ohio.	Baltimore and Ohio.
Ohio No. 5.....	The Glens Run Coal Co.	Rush Run No. 1...	Rush Run, Jefferson County, Ohio.	Pennsylvania....
Ohio No. 6.....	Neff Coal Mining Co.	No 1.....	Neffs, Belmont County, Ohio.	Baltimore and Ohio.
Ohio No. 7.....	Forsythe Coal Co.	Forsythe.....	Danford, Guernsey County, Ohio.	.....do.....
Ohio No. 8.....	Upson Coal and Mining Co.	Dixie.....	Dixie, Perry County, Ohio.	.....do.....
Ohio No. 9 A.....	Gallia Mining Co..	Clarion	Clarion, Vinton County, Ohio.	Hocking Valley.
Ohio No. 9 B.....	.....do.....	.....do.....	.....do.....	.....do.....
Pennsylvania No. 4.	Jamison Coal and Coke Co.	Jamison No. 2....	4 miles north of Greensburg, Westmoreland County Pa.	Pennsylvania....
Pennsylvania No. 5.	James W. Ellsworth & Co.	No. 1 and No. 2...	Ellsworth, Washington County, Pa.	.....do.....
Pennsylvania No. 6.	Hustead-Seamens Coal and Coke Co.	Hustead-Seamens	East Millsboro, Westmoreland County, Pa.	.....do.....
Pennsylvania No. 7.	Old Colony Coal and Coke Co.	Ligonier.....	3 miles north of Ligonier, Westmoreland County, Pa.	Ligonier Valley...
Pennsylvania No. 8.	Pennsylvania Coal and Coke Co.	No. 3.....	Ehrenfeld, Cambria County, Pa.	Pennsylvania.....
Pennsylvania No. 9.	Reading Iron Co..	Kimmelton.....	Kimmelton, Somerset County, Pa.	Baltimore and Ohio.

received and tested—Continued.

Inspector.	Kind of coal.	Name of bed.	Tests.
.....	Brown lignite; run of mine..	No name.....	Producer-gas, p. 137.
M. R. Campbell.....	Brown lignite; lump.....	.....do.....	Steaming, p. 138. Producer-gas, p. 139.
J. W. Groves.....	Bituminous; run of mine from No. 4 bed.	No. 4.....	Steaming p. 140. Washing, p. 141. Coking, p. 142.
.....do.....	Bituminous; run of mine from No. 5 bed.	No. 5.....	Steaming, p. 143. Washing, p. 144. Coking, p. 144.
.....do.....	Bituminous; run of mine...	No. 6.....	Steaming, p. 145. Producer-gas, p. 146. Washing, p. 147. Coking, p. 147.
.....do.....	Bituminous; ¾-inch coal over ¾-inch bar screens.	No. 8.....	Steaming, p. 148. Producer-gas, p. 149. Washing, p. 150. Coking, p. 150.
.....do.....	Bituminous; "¾-inch coal," over ¾-inch bar screen.	Pittsburg, or No. 8.	Steaming, p. 151. Producer-gas, p. 152. Coking, p. 153.
W. J. Von Borries....	Bituminous; run of mine...	No. 8.....	Steaming, p. 154. Producer-gas, p. 155. Washing, p. 156. Coking, p. 156.
J. W. Groves	Bituminous; lump, over 1¼-inch bar screen.	No. 7.....	Steaming, p. 157. Producer-gas, p. 158. Washing, p. 159. Coking, p. 159.
.....do.....	Bituminous; run of mine...	No. 6 Hocking....	Steaming, p. 160. Producer-gas, p. 161. Washing, p. 162. Coking, p. 162.
.....do.....	Bituminous; lump, over 1¼-inch screen.	No. 4.....	Steaming, p. 163. Producer-gas, p. 165. Coking, p. 166.
.....do.....	Bituminous; nut and slack.	.....do.....	Steaming, p. 163. Washing, p. 165. Coking, p. 166.
.....do.....	Bituminous; lump, over 1¼-inch bar screen.	Pittsburg.....	Steaming, p. 167 Producer-gas, p 168.
W. J. Von Borries....	Bituminous; "¾-inch coal," over ¾-inch bar screen.	.....do.....	Steaming, p. 169. Producer-gas, p. 170. Washing, p. 171. Coking, p. 171.
J. W. Groves.....	Bituminous; run of mine...	.....do.....	Steaming, p. 172. Producer-gas, p. 173. Washing, p. 174. Coking, p. 175.
J. S. Burrows.....	.....do.....	Pittsburg, or Connellsville.	Steaming, p. 176. Producer-gas, p. 177. Washing, p. 178. Coking, p. 178.
.....do.....	.....do.....	Lower Kittanning.	Steaming, p. 179. Producer-gas, p. 180. Coking, p. 181.
W. J. Von Borries....	.....do.....	.....do.....	Washing, p. 182. Coking, p. 183.

Samples of coal

Name of sample.	Operator.	Mine.	Location.	Railroad.
Pennsylvania No.10	Pittsburg-Buffalo Coal Co.	Bertha	Bruce, Allegheny County, Pa.	Baltimore and Ohio.
Virginia No. 1	Interstate Investment Co.	H. C. Morris prospect.	Crab Orchard, Lee County, Va.	About 7 miles from Louisville and Nashville.
Virginia No. 2	Interstate Investment Co.	Big opening on Wilson farm.	Near Crab Orchard, Lee County, Va.	About 7 miles from Louisville and Nashville.
Virginia No. 3	Virginia Iron, Coal and Coke Co.	Coburn	Toms Creek, Wise County, Va.	Norfolk and Western.
Virginia No. 4	Darby Coal and Coke Co.	Darby	Darby, Lee County, Va.	Louisville and Nashville.
West Virginia No. 4.	Elkins Coal Co	No. 2	Bretz, Preston County, W. Va.	Morgantown and Kingwood.
West Virginia No. 13.	Loup Creek Colliery Co.	Page No. 2	Page, Fayette County, W. Va.	Deepwater; Chesapeake and Ohio.
West Virginia No. 14.	do	Page No. 1	do	do
West Virginia No. 15.	Fairmont Coal Co.	Ocean	3 miles east of Clarksburg, Harrison County, W. Va.	Baltimore and Ohio.
West Virginia No. 16A.	do	Monongah No. 6	Monongah, Marion County, W. Va.	do
West Virginia No. 16B.	do	do	do	do
West Virginia No. 17.	Elkins Coal Co	Country bank	2½ miles above Bretz, Preston County, W. Va.	Morgantown and Kingwood.
West Virginia No. 18.	Glen Alum Fuel Co.	Glen Alum	Glen Alum, Mingo County, W. Va.	Norfolk and Western.
West Virginia No. 19.	White Oak Coal Co.	McDonald	McDonald, Fayette County, W. Va.	Chesapeake and Ohio.
West Virginia No. 20.	Stevens Coal Co.	Keystone	Acme, Kanawha County, W. Va.	do
West Virginia No. 21.	Winifrede Coal Co.	Gas	Winifrede, Kanawha County, W. Va.	do
Wyoming No. 2B	Cambria Fuel Co.	Antelope, Nos. 1 and 2, and Jumbo.	Cambria, Weston County, Wyo.	Burlington and Missouri River.
Wyoming No. 3	Stilwell Coal Co.		Sec. 27, T. 54 N., R. 61 W., at Aladdin, Crook County, Wyo.	Wyoming and Missouri River; Chicago and Northwestern.
Brazil, No. 1		Sao Jeronymo	Rio Grande do Sul, Brazil.	

received and tested—Continued.

Inspector.	Kind of coal.	Name of bed.	Tests.
W. J. Von Borries....	Bituminous; "¾-inch coal".	Pittsburg.....	Steaming, p. 184. Producer-gas, p. 185. Coking, p. 186.
J. S. Burrows.....	Bituminous; run of mine...	Wilson.....	Steaming, p. 187. Producer-gas, p. 188. Coking, p. 189.
.....do	.....do	McConnell.....	Steaming, p. 190. Producer-gas, p. 192. Washing, p. 192. Coking, p. 193.
W. J. Von Borries....	Bituminous; lump, over 3½-inch bar screen.	Upper Banner....	Steaming, p. 194. Producer-gas, p. 195. Coking, p. 196.
J. W. Groves.....	Bituminous; lump, over 1¼-inch bar screen.	Darby.....	Steaming, p. 197. Producer-gas, p. 198. Coking, p. 199.
.....do.....	Bituminous; run of mine...	Freeport.....	Washing, p. 200. Coking, p. 200.
E. W. Parker.....	.....do.....	Ansted.....	Steaming, p. 201. Producer-gas, p. 202. Coking, p. 203.
.....do.....	.....do.....	Eagle.....	Steaming, p. 204. Producer-gas, p. 205. Coking, p. 206.
J. S. Burrows.....	.....do.....	Pittsburg.....	Steaming, p. 207. Coking, p. 208.
.....do.....	Bituminous; ¾-inch lump, over ¾-inch screen.	.....do.....	Producer-gas, p. 209. Coking, p. 210.
.....do.....	Bituminous; slack, through ¾-inch screen.	.....do.....	Washing, p. 209. Coking, p. 210.
J. W. Groves.....	Bituminous; run of mine...	Bakerstown.....	Steaming, p. 211. Washing, p. 212. Coking, p. 212.
.....do.....	.....do.....	Local Glen Alum .	Steaming, p. 213. Producer-gas, p. 214. Coking, p. 215.
.....do.....	.....do.....	Sewell.....	Steaming, p. 216. Coking, p. 217.
.....do.....	.....do.....	Keystone.....	Steaming, p. 218. Producer-gas, p. 220. Washing, p. 220. Coking, p. 221.
.....do.....	.....do.....	Winifrede.....	Steaming, p. 222. Washing, p. 224. Coking, p. 224.
M. R. Campbell.....	.....do.....	(?)	Steaming, p. 225. Producer-gas, p. 226.
.....do.....	Bituminous	(?)	Steaming, p. 227. Producer-gas, p. 228. Washing, p. 229. Coking, p. 229.
.....	Bituminous; run of mine...	.....	Steaming, p. 232. Producer-gas, p. 233.

SAMPLES COLLECTED AND EN ROUTE TO ST. LOUIS JANUARY 1, 1906.

The following samples were en route and in the yards of the fuel-testing plant January 1, 1906. The results of tests on these samples will appear in a later report:

Arkansas No. 1.—Slack coal for washing and coking tests furnished by Central Coal and Coke Company, of Kansas City, Mo., from mine No. 3, Huntington, Ark.

Arkansas No. 7.—Lump and slack coal for steaming, producer-gas, coking, and washing tests, furnished by Mammoth Vein Coal Company, of Midland, Ark., from Mammoth Vein mine, Midland, Ark.

Arkansas No. 8.—No. 4 coal for steaming and washing tests furnished by Consolidated Anthracite Coal Company, of Spadre, Ark., from No. 1 mine, Spadre, Ark.

Arkansas No. 9.—Slack coal for coking and washing tests furnished by Central Coal and Coke Company, of Kansas City, Mo., from mine No. 26, Bonanza, Ark.

Arkansas No. 10.—Lignite for producer-gas test furnished by Richmond Hibbard, of Camden, Ark., from mine L. O. U. No. 2, Lester Mill Company, Ark

Illinois No. 20.—Slack for steaming, coking, and washing tests furnished by the Mount Olive and Staunton Coal Company, of St. Louis, Mo., from mine No. 1, Staunton, Ill.

Indiana No. 12.—Run of mine coal for steaming, coking, and washing tests furnished by Patoka River Coal and Coke Company, of Huntington, Ind., from Hartwell mine, Hartwell, Ind.

Massachusetts No. 1.—Peat for producer-gas test furnished by C. L. Norton, Massachusetts Institute of Technology, Boston, Mass., from bog near Halifax, Mass.

Texas No. 3.—Lignite for producer-gas and briquetting tests furnished by J. J. Olsen & Son, of San Antonio, Tex., from Olsen mine, Olsen, Tex.

Texas No. 4.—Lignite for steaming, producer-gas, and briquetting tests furnished by Consumers Lignite Company, of Dallas, Tex., from mine No. 3, Hoyt, Tex.

WORK OF THE CHEMICAL LABORATORY.

By N. W. Lord.

INTRODUCTION.

The routine work of the laboratory and the general methods used in making the chemical and analytical tests on the samples of coal and other fuels tested at the fuel-testing plant, continue to be essentially the same as during the St. Louis Exposition and are described in the reports covering that period. [a]

NEW EQUIPMENT.

The temporary laboratory employed during the Exposition was very crowded and inconvenient owing to the limited space at the disposal of the fuel-testing plant for this work. Since that time the work has been done in a new laboratory fitted up in the foundry building left by the Exposition. This new laboratory is larger, more convenient, and better equipped in every way for the work, and materially facilitates accuracy and uniformity of results.

Under the head of "New equipment" may also be mentioned, for the analytical work, two additional analytical balances, an extra combustion furnace for ultimate work, an extra steel bomb for calorimeter work, and two calcium-chloride drying ovens of special design for the moisture determinations; for the sampling work, an especially designed drying oven, for facilitating the drying of the samples to a nearly air-dry condition, and a four-jar laboratory ball mill (manufactured by the Abbé Engineering Company), for final pulverization of the sample. These are mentioned more in detail under "Changes in methods."

During the Exposition city gas was used as a laboratory fuel. After the close of the Exposition this was not available and, as a consequence, gasoline gas is at present used in the laboratory. The machine used for supplying the gas is furnished by the Federal Gas Company, of St. Louis, Mo., and so far has proved satisfactory.

CHANGES IN METHODS.

In general the methods employed in the work have been only slightly changed from those in use during the Exposition. However, certain modifications have been introduced, following out lines developed in the experimental work of the laboratory. One of the most important of these is in regard to the preliminary or air drying of the samples. The earlier method of exposing the sample to the air of the laboratory proved unsatisfactory owing to the extremely varying moisture conditions resulting from the general character of the weather; the air drying loss in different samples of the same coal varied greatly, though it was, of course, accompanied by corresponding changes in the residual moisture of the coal and therefore did not materially affect the final statement of the analysis of the sample as received. In order to make determinations of the loosely held moisture more uniform and definite, a special drying oven has been designed and introduced into the laboratory; in this oven samples of several pounds weight can be dried in a gentle current of air raised from 10° to 20° above the temperature of the laboratory. In this way the coal is air dried in an

[a] Bull. U. S. Geol. Survey No. 261, 1905; Prof. Paper U. S. Geol. Survey No. 48, 1906.

atmosphere with a very low dew-point and not subject to large percentage variations, and the results obtained are considerably more concordant. Another advantage of this method is that it greatly shortens the time of air drying, so that the samples can be prepared in much less time than formerly. A detailed description of the apparatus will be presented in the complete report.

As it has been clearly demonstrated in the earlier work of the laboratory that there was a marked loss in moisture in many samples during the reduction of the air-dried sample and the weighing out for analysis, the system of sampling in this respect has been radically changed. The sample is ground in tight jars with quartz pebbles, in a ball mill. The ground sample is placed in wide-mouthed bottles and the sample for analysis mixed and weighed direct therefrom without pouring out and mixing, as was done in the earlier work. Direct comparison between samples reduced in this way and those ground on a bucking board or in an open mortar shows a distinct difference in the percentage of moisture, due to changes from the exposure during sampling.

PERSONNEL.

The personnel of the laboratory at present is as follows: Prof. E. E. Somermeier, in charge; Mr. F. M. Stanton, head chemist; Mr. G. A. Burrell first assistant ; Messrs. Karl M. Way and E. C. Waters, assistants.

WORK DONE IN THE LABORATORY.

From May up to January 1 the laboratory has received over 1,000 samples, representing coal from nineteen States and three Territories. The proximate analyses and sulphur determinations have been made on practically all of these, and the ultimate analyses, determinations of the heating value, and other special determinations have been made on such of the samples as have required the additional work.

In addition to the regular routine work on the coal samples, some tests on tars and some laboratory work on the washing of coal have been conducted, while a limited number of experimental lines of work have been followed up, in so far as the time at the disposal of the laboratory force has permitted.

Analytical results are presented in the detailed report on each sample (pp. 53–233).

WASHING TESTS.

By JOHN D. WICK.

INTRODUCTION.

As noted in the description of the washing tests made during 1904,[a] the lack of adequate storage facilities and the constant demand on the conveying and weighing apparatus for delivering coal to the boilers and producer greatly interfered with the washing tests and tended somewhat to vitiate the results.

IMPROVEMENT IN EQUIPMENT.

In order to eliminate these difficulties, important changes were made at the beginning of 1905 in the arrangement of the washery building. To the four 35-ton and two 17½-ton storage bins in use during 1904 were added five 35-ton bins, which increased the storage capacity of the washery building from 175 tons to 350 tons. The construction of three 50-ton auxiliary bins on the ground adjacent to the coke ovens further increased the capacity to 500 tons.

A 30-inch Jeffrey conveying belt was installed running from the car siding directly to the gas producer and boilers. This is used to deliver coal to the gas producer and boilers without crushing, or, in other words, in the same condition as when received from the mine. This conveyer has the additional advantage of relieving the main conveyer in the washery building of a large portion of work, leaving it available for use in connection with washing tests.

In rearranging the washing apparatus the Stewart modified jig in use during 1904 was retained, but the New Century jig was replaced by two Luhrig fine-coal jigs. The Stewart jig will wash coal composed of pieces crushed to 1½ inches in diameter, but the Luhrig jigs can be used only for coal one-half inch in diameter or less. With this equipment washing tests have been made with considerably better results than were obtained in 1904, and owing to the increased storage facilities larger samples of coal have been treated, affording a better opportunity for accurate adjustment of the jigs and for continuous runs approximating practical washing conditions. The water for washing tests is taken from the city mains and is reused by being pumped from the settling tank back to the jigs.

TESTS MADE.

Thirty-eight samples of coal from eight States, as enumerated below, were washed during the period from May 1, 1905, to January 1, 1906. The results of these washing tests will be found in the detailed report on each sample, presented on pages 53–233 of this report.

Illinois No. 6.—Run-of-mine coal from Coffeen mine, Clover Leaf Coal Company, Coffeen, Ill.; washed for steaming test.

Illinois No. 7.—Slack coal from No. 2 mine, Lumaghi Coal Company, Collinsville, Ill.; washed for steaming and coking tests.

Illinois No. 9.—Run-of-mine coal from No. 2 mine, Mount Olive and Staunton Coal Company, Staunton, Ill.

[a] Bull. U. S. Geol. Survey No. 261, 1905, p. 60.

Illinois No. 10.—Slack coal from West Frankfort mine, Dering Coal Company, West Frankfort, Ill. washed for steaming test.

Illinois No. 12.—Run-of-mine coal from Bush No. 1 mine, Western Coal and Mining Company, Bush, Ill.; washed for steaming test.

Illinois No. 13.—1½-inch and 6-inch egg coal from Benton mine, Benton Coal Company, Benton, Ill.; washed for steaming test.

Illinois No. 14.—Lump coal from No. 2 mine, Capital Coal Company, Springfield, Ill.; washed for steaming test.

Illinois No. 15.—Lump coal from South mine, Pettinger & Davis Company, Centralia, Ill.; washed for steaming test.

Illinois No. 16.—Lump and egg coal from No. 7 mine, Big Muddy Coal and Iron Company, Herrin, Ill.; washed for steaming and coking tests.

Illinois No. 18.—Lump coal from La Salle mine, La Salle County Carbon Coal Company, Lasalle, Ill.; washed for steaming test.

Indiana No. 3.—Nut and slack coal from No. 3 mine, J. Wooley Coal Company, Boonville, Ind.; washed for steaming and coking tests.

Indiana No. 4.—Screenings from No. 29 mine, Consolidated Indiana Coal Company, Star City, Ind.; washed for steaming and coking tests.

Indiana No. 6.—Run-of-mine coal from No. 34 mine, Consolidated Indiana Coal Company, Hymera, Ind.; washed for steaming and coking tests.

Indiana No. 7.—Lump and nut coal from Little's mine, S. W. Little Coal Company, Littles, Ind.; washed for steaming and coking tests.

Indiana No. 8.—Lump coal from Deep Vein mine, Deep Vein Coal Company, Terre Haute, Ind.; washed for steaming test.

Indiana No. 9.—Run-of-mine coal from Red Bird mine, Fauvre Coal Company, Macksville, Ind.; washed for steaming test.

Indiana No. 10.—Lump coal from No. 10 mine, Park County Coal Company, Rosedale, Ind.; washed for steaming tests.

Maryland No. 1.—Run-of-mine coal from Washington No. 3 mine, Piedmont and Georges Creek Coal Company, near Piedmont, W. Va.; washed for steaming and coking tests.

Ohio Nos. 1 and 2.—Run-of-mine coal from No. 10 mine, Superior Coal Company, near Wellston, Ohio; washed for steaming and coking tests.

Ohio No. 3.—Run-of-mine coal from Gosline & Barbour mine, Ohio Mining and Manufacturing Company, Shawnee, Ohio; washed for steaming and coking tests.

Ohio No. 4.—Three-fourths inch coal from Crow Hollow mine, United States Coal Company, Bradley, Ohio; washed for steaming and coking tests.

Ohio No. 6.—Run-of-mine coal from No. 1 mine, Neffs Coal Mining Company, Neffs, Ohio; washed for steaming and coking tests.

Ohio No. 7.—Lump coal from Forsythe mine, Forsythe Coal Company, Danford, Ohio; washed for steaming and coking tests.

Ohio No. 8.—Run-of-mine coal from Dixie mine, Upson Coal and Mining Company, Dixie, Ohio; washed for coking tests.

Ohio No. 9.—Screenings from Clarion mine, Gallia Mining Company, Clarion, Ohio; washed for steaming and coking tests.

Pennsylvania No. 5.—Three-fourths inch coal from No. 2 mine, James W. Ellsworth & Co., Ellsworth, Pa.; washed for steaming and coking tests.

Pennsylvania No. 6.—Run-of-mine coal from Hustead-Seamens mine, Hustead-Seamens Coal and Coke Company, East Millsboro, Pa.; washed for steaming and coking tests.

Pennsylvania No. 7.—Run-of-mine coal from Ligonier mine, Old Colony Coal and Coke Company near Ligonier, Pa.; washed for steaming and coking tests.

Pennsylvania No. 9.—Run-of-mine coal from Kimmelton mine, Reading Iron Company, Kimmelton, Pa.; washed for coking test.

Virginia No. 2.—Run-of-mine coal from McConnell mine, Interstate Investment Company, near Crab Orchard, Va.; washed for steaming and coking tests.

West Virginia No. 4.—Run-of-mine coal from No. 2 mine, Elkins Coal Company, Bretz, W. Va.; washed for coking test.

West Virginia No. 16.—Slack coal from Monongah No. 6 mine, Fairmont Coal Company, Monongah, W. Va.; washed for coking test.

West Virginia No. 17.—Run-of-mine coal from country bank, Elkins Coal Company, near Bretz, W. Va.; washed for steaming and coking tests.

West Virginia No. 20.—Run-of-mine coal from Keystone mine, Stevens Coal Company, Acme, W. Va.; washed for steaming and coking tests.

West Virginia No. 21.—Run-of-mine coal from Gas mine, Winifrede Coal Company, Winifrede, W. Va.; washed for steaming and coking tests.

Wyoming No. 3.—Run-of-mine coal from mine of Stilwell Coal Company, Aladdin, Wyo.; washed for steaming and coking tests.

STEAMING TESTS.

By L. P. BRECKENRIDGE.

EQUIPMENT.

The steaming tests under the Heine boilers have been continued under practically the same conditions as the 78 trials made during the period of the Louisiana Purchase Exposition. For convenience the principal proportions of the boiler settings are shown in the following table:

Leading proportions of the two Heine water-tube boilers used in the fuel-testing plant.

	Boiler No. 1.	Boiler No. 2.
Rated capacity of boiler.....horse power..	210	210
Water-heating surface.....square feet..	2,031	2,031
Superheating surface.....	None.	None.
Grate area.....square feet..	40.55	36.4
Air space through grate.....per cent..	45	35
Available stack draft.....inches of water..	.75	.75
Height of steel stacks.....feet..	115	115
Area of steel stacks.....square feet..	7.67	7.67
Number of 3¼-inch tubes on each boiler.....	116	116
Usual steam pressure carried.....pounds..	80	80

The two boilers used for these tests are exactly similar in construction and setting. Each is provided with its own stack and fed by its own injector. The scales and instruments used in the trials are frequently checked and maintained in an accurate condition.

IMPROVEMENTS AND ADDITIONS.

After the completion of the World's Fair series of steaming tests a few changes in the settings were made, as follows:

A McClave rocking grate was installed under boiler No. 2. It was thought that some coals could be handled more satisfactorily on a grate of this type and this proved to be the case. The B. F. Sturtevant Company loaned the plant a forced-draft outfit, consisting of blower and direct-connected steam engine. This has been set up so as to discharge air into the closed ash pits under each grate. By the aid of a light draft it has been possible to burn lignites high in moisture with fair results. A series of trials with slack coals and dried lignites is contemplated later.

The brick walls have been given two coats of paint and all cracks and openings have been carefully stopped with asbestos paste. A special air-leakage test box has been used to locate leaks of air in the settings and all leaks have been promptly stopped.

During the first weeks of this series of trials several gas-mixing devices were tried in the combustion chamber, such as fire-brick honeycombs, but they lacked durability, perhaps because of faulty construction and inferior material. A honeycomb wall was then built of very large fire-clay shapes, 6 by 12 by 18 inches, which withstood the heat for six months.

Considering the facts that the floor of the combustion chamber had no special rigidity and that this was our first experience in selecting material for and erecting such a structure, it is fair to assume that it is commercially practicable to use such mixing structures in combustion chambers.

The object of this construction is to subdivide and mix the gases coming from the fuel bed and to cause them to travel a greater distance before striking the cold tubes. These fire-clay masses also absorb heat between firings and give it out just after firings when there is a large rush of cold air and hydrocarbons.

Recently the lowest row of tubes of boiler No. 2 has had the protecting tiles changed from the "C" to the rectangular flat-bottomed type. The "C" tiles gave much trouble from breakage due to radiant heat and were also frequently broken with fire tools. The flat-bottomed tiles are more durable and will be put on the other boiler as soon as its "C" tiles need replacing. The rectangular tiles weigh about the same as the "C" tiles.

On measurement of the areas left between the tubes at the end of the lower and upper baffles where the gases respectively enter and leave the boiler tubes, it was found that a much shorter length of openings would do, so more tube tiles were added below and more iron tiles above until the openings were each reduced nearly one-half; thus forcing the gases to travel a slightly greater length of tube surface.

The following new instruments have been added since the tests of last year: One Crosby recording steam gage, one Bristol recording draft gage, one Bristol recording flue thermometer, one Wanner optical pyrometer.

The instruments have served as a check on the regular observations. They have been checked with the other instruments used for the same readings. The optical pyrometer used for reading combustion-chamber temperatures has been easily handled and has been found exceedingly useful in this work.

These modifications of the equipment have perhaps improved the over-all efficiencies of this year's (1905) tests 2 or 3 per cent over last year's.

PERSONNEL.

Prof. Dwight T. Randall, who had local charge of the steaming tests in 1904, returned to the University of Illinois, and Mr. Walter T. Ray, of the Chicago Edison Company, was appointed to the vacancy. Later Mr. Clyde McClure resigned as boiler-room chemist, to assume duties with the above company, and was replaced by Mr. Ralph Galt, of the University of Michigan. The same fireman, Mr. Henry Arens, has been employed continuously since the tests began. Mr. Robert H. Kuss, until recently instructor on steam boilers at the University of Illinois, has joined our local staff, as have Messrs. Lloyd R. Stowe, W. M. Park, Fred E. Pahmeyer, and R. C. Matthews. The following men have also been with the work from the start: Messrs. Henry Kreisinger, H. W. Weeks, R. H. Post, and C. H. Green.

CHANGES IN METHODS OF TESTING.

The only important change introduced in test procedure consisted in making three trials with each coal, but the three ran so nearly alike that hereafter only two will be made. In the first series only one trial was made with each coal. The feeling has been that some changes in proportions of baffling might increase the over-all efficiency of all the trials. Still the temptation to make any marked changes has been resisted, in the belief that the object for which these tests are being conducted will be better served by keeping to the same ratios in all the tests. The results will then more truly show the comparative value of the various fuels than they would if changes in the setting were attempted.

WORK DONE.

On 64 coals, some of them washed in part, there were made 185 tests, which are included in this report; several tests were thrown out. Coals were tested from Illinois, Indiana, Kentucky, Maryland, North Dakota, Ohio, Pennsylvania, Virginia, West Virginia, and Wyoming.

FEATURES OF THE INVESTIGATION.

It is probable that the general efficiencies obtained are fairly good. But the Survey clearly realizes that it is working with limits imposed by its particular apparatus, though these limits are not the fault of the Heine construction, inasmuch as any combination of grate, furnace, and boiler would have faults. For this reason and others all steaming tests are only approximately comparative and not final as between coals. Steaming tests should be made more with the idea of eliminating them in future years than of accepting them as final. Toward this end engineers should work with the aid of chemistry and physics.

The determination of the calorific capacity of the various steaming coals has shown, during the last few years, that these coals contain a larger number of heat units than were formerly credited to them. This has resulted in somewhat lower efficiencies than have sometimes been reported.

Before closing the present series of trials it is hoped that tests may be made with several standard coals, which will show the effect of changes in certain fundamental ratios on the over-all efficiency of these outfits.

Some of the more important results of the steaming tests are given on pages 53–233, in the detailed report on the various coal samples used.

SPECIAL TESTS.

Attention is called to some special tests made during the period covered by this report, as follows:

TESTS ON MIXED COALS.

Tests Nos. 240, 248, and 254 were made on Virginia No. 4. In the first test the clinker fused onto the grate so as to be very difficult to remove; in the two remaining tests about 200 pounds of nut-sized limestone was spread over the grate before starting, so that the clinker lifted up very easily. The average boiler efficiency for these three tests was 66.6 per cent.

Test No. 242 was run on Pennsylvania No. 8 dried. The boiler efficiency was 68.3 per cent. Cleaning was very easy. The Virginia coal was very free burning and long flaming, and the Pennsylvania coal very short flaming. It was thought that by mixing them, as a matter of experiment, a better result would be attained; but the boiler efficiency was only 61.7 per cent. There were outside reasons for the result being low, but the best that can be said is that the experiment was indeterminate. The grate behavior was improved.

TESTS ON DRIED COALS.

Some of Pennsylvania No. 8 was dried and burned in test No. 242. The moisture to start with was only about 3 per cent and it was reduced to 0.42 per cent by drying in a Bartlett rotary drier at 240° F. At the same time some of the volatile matter was driven off, so that the British thermal units of the dry coal fell from about 14,800 to 14,660; with the average boiler efficiency of the four tests run on the coal as received, the performance was a shade better only, and on the whole there was a considerable loss.

Two tests, Nos. 243 and 244, were run on Ohio No. 9 B, dried after washing, with a slight loss of efficiency, not to speak of the drying having reduced the British thermal units of the dry coal about 1.5 per cent, as in the other case.

These drying tests were made as preliminary to some tests to be run on dried lignites.

TWENTY-FOUR HOUR RUNS.

It can be calculated that from 1 to 2 per cent of the heat generated in a test is lost in heating the brickwork in the morning, notwithstanding that the furnace is fired hard for two hours before starting. To learn something of this, some tests were run on the same coals, starting the very instant the preceding ones ended. The preceding test numbers were 237, 243, and 249; average boiler efficiency, 66.2 per cent; average furnace temperature, 2,388° F. The immediately succeeding test numbers were 238, 244, and 250; average boiler efficiency, 67.3 per cent; average furnace temperature, 2,355° F. These tests show an average gain of 1.1 per cent, which is nonconclusive. The research is being continued.

PRODUCER-GAS TESTS.

By ROBERT H. FERNALD.

EQUIPMENT.

In order that the work outlined for 1905 by the gas-producer division of the fuel-testing plant might be completed in the time allowed, it became necessary to increase the capacity of the plant. Accordingly, a second producer with its economizer was installed, so that the plant now consists of two independent producers, both discharging into the same scrubber. These producers are worked independently, one being charged while the other is in operation. By this arrangement no time is lost in changing from one coal to another at the end of any test, as a simple manipulation of valves brings the second producer into operation when the first is cut out. The remainder of the operating portion of the plant has not been changed, so far as new installations are concerned, though several changes in detail have been made from time to time as the nature of the work demanded. Some of these changes are noted later in this report.

Owing to the fact that the chemical laboratory originally installed in connection with this division of the plant was far from adequate, a special building was erected sufficiently near the gas holder and engine to reduce inaccuracies in gas sampling and other similar work to a minimum and at the same time providing comfortable accommodations for the chemists.

PERSONNEL.

Capt. John A. Laird, a consulting engineer of St. Louis, who has been connected with the plant since September, 1904, has continued the supervision of the operating details of the tests and since December 1, 1905, has also had active charge of the mechanical operation of the producers. Until December 1 the manipulation of the producers was directed by Mr. C. O. Nordensson, of R. D. Wood & Co., who remained with the testing plant about a year. Since the renewal of operations in May, 1905, Mr. J. P. Quam, of the Westinghouse Company, has had supervision of the operations of the gas engine. He has had as assistant engineers Messrs. R. E. Peshak and F. V. Roy. The computations have been in charge of Mr. W. C. Weidmann, assisted by Mr. Kurt Toensfeldt. Until about July 1, 1905, the chemical work of the producer-gas tests was directed by Mr. H. G. Ecker, with Messrs. H. A. Grine and J. G. Goodwin as assistants. Since that date Mr. Grine has been head chemist, with Messrs. J. G. Goodwin and W. L. Hempelmann as assistants. The observations have been made by Messrs. Curt Adler, C. L. Armstrong, L. A. Delano, S. P. Howell, W. B. Lemmon, and Julien Teza.

IMPROVED CONDITIONS OF TESTING.

The operating conditions from May 1 to December 31, 1905, have been far superior to those that were possible during the Exposition period of 1904, and the results presented in this report have been subjected to refinements that were not attainable in the previous operation of the plant. A comparison of these figures with those obtained during 1904, published in Bulletin No. 261 (1905) and Professional Paper No. 48 (1906) of the United States Geological Survey, will show the general increase in efficiency of manipulation due to the improved conditions.

The determination of the amount of coal actually burned in the producer for any given period is, at best, a factor of more or less uncertainty. To reduce the possible error to a

minimum, it was deemed necessary to make the test on each coal as long as consistent. A schedule was therefore adopted at the beginning of this series of tests involving two sixty-hour runs per week. The first eight to twelve hours of each test period are used for getting the fuel bed into uniform and efficient condition. During these preliminary hours records are taken as in the regular tests, but the official test, as reported, includes only the last forty-eight or fifty hours of the run, during which time the conditions are maintained as uniform as possible. Special attention is being directed to the very important item of measurement of the coal actually used and special charts and checking devices have been introduced for this purpose.

Owing to the lack of reliability in the operation of the gas engine, many of the tests conducted during the Exposition period were of a few hours' duration only, but since the present series of tests began (May, 1905) no difficulty has been experienced in starting the engine at 8 a. m. Monday and continuing day and night without a stop until 8 a. m. Saturday. During this period two different coals are tested, and the change of gases is made at 8 p. m. Wednesday without stopping the engine.

NUMBER OF TESTS MADE.

During the period from May 1, 1905, to January 1, 1906, sixty-four producer-gas tests have been made. One of these tests was run on coke breeze and one on Brazil coal. The remaining sixty-two were divided as follows among different States: California, three tests on lignite and locomotive cinders; Illinois, eighteen tests on coal; Indiana, eight tests on coal; Kansas, one test on coal; Kentucky, four tests on coal; North Dakota, three tests on lignite; Ohio, seven tests on coal; Pennsylvania, seven tests on coal; Virginia, four tests on coal; West Virginia, five tests on coal; Wyoming, two tests on coal.

SPECIAL FEATURES OF THE INVESTIGATIONS.

The results of the majority of the tests have been exceedingly gratifying, official records having been made as low as 0.95 pound of dry coal per hour burned in the producer per electrical horsepower developed at the switchboard, or 0.80 pound of dry coal per hour burned in the producer per brake horsepower, on the basis of an assumed efficiency of 85 per cent for generator and belt.

Throughout the tests a constant effort has been made to do away with unnecessary appliances. This effort has furnished valuable and interesting information and has centered attention on several radical changes in the details of producer-gas plant construction.

It was found at an early date that more or less sulphur was passing the purifier and entering the engine cylinders. Investigations by the chemists showed that purifiers consisting of oxidized iron filings and shavings are fairly efficient for coals containing little sulphur—1 per cent or less; but it was found that for coals containing larger percentages of sulphur the purifier became completely exhausted after about six or eight hours. Mixtures of lime and shavings were tried, but with little success. As a result of these investigations the purifier has been discarded, and the gas, carrying its full percentage of sulphur, has been charged directly into the engine cylinders. This method of operating has been going on for many months, and no ill effects have been discovered, though coal has been used containing as high as 8.1 per cent of sulphur.

One feature of the plant as installed was the economizer, used for preheating the air for the blast. A series of experiments has shown no effect on the chemical composition of the gas or on the efficiency of the plant when air at ordinary atmospheric temperature was substituted for preheated air. As a result the economizer, as an economizer, has been discarded and the construction of the plant again simplified.

Other modifications and changes are under investigation at the present time, the most important from an economic standpoint relating to the utilization of slack coal in producers.

The results of the producer-gas tests will be found in the detailed report on each sample presented on pages 53–233.

COKING TESTS.

By A. W. BELDEN.

EQUIPMENT.

The ovens in which the tests of the coking qualities of coals have been made are of the regular beehive pattern. Of the battery of three ovens, two are of standard size, 12 feet in diameter and 7 feet high; the third is 12 feet in diameter and 6 feet 4 inches high. This change was made by raising the bottom of one of the standard ovens 8 inches with well-tamped loam and bottom tile of the usual size. The object of this was to bring the charge nearer the dome of the oven and effect a more rapid penetration of heat.

For the first 19 tests only the small oven was used. In the twentieth charge one of the 7-foot ovens was blown in, and both have been used continuously during the remainder of the work. Owing to the limited supply of coal it has not been possible to use more than two ovens. Both of these ovens may therefore be considered as end ovens, which by some are supposed to yield results less favorable than those from ovens located between other heated ovens; though, were this supposition correct, the difference would be fully balanced by the greater care bestowed on these experimental ovens as compared with ovens operated under normal conditions. Since both of the ovens used are, in the sense indicated, end ovens, the results obtained in each are comparable one with the other.

In charging the ovens for the first nineteen tests the larry used held less than 1 ton. This necessitated the filling and emptying of the larry six to eight times before the charge was completed. Each portion thus became hot and began to gas, invariably, and often to blaze, before the next portion of the charge was added. This unfortunate state of affairs is believed to be responsible, at least in some measure, for cross lamination and cross breakage of the coke, in many of these tests layers of coal as charged showing plainly in each oven drawn. The average time of charging with this device was about one hour; the whole charge should be put in at once and as rapidly as possible.

After the nineteenth charge a standard-size larry, kindly loaned by the H. C. Frick Coke Company, was installed and this lamination and cross breakage disappeared, while the time of charging was reduced to an average of seven minutes.

PERSONNEL.

The writer took charge of this work in May, succeeding Mr. Fred. W. Stammler, of Johnstown, Pa. He was assisted by Mr. W. E. Vickers, of Pocahontas, Va., to whom in large measure is due whatever success has been accomplished during these investigations.

PROCEDURE OF TESTS.

All coal was finely crushed through a Williams mill unless otherwise requested and these exceptions are noted in the subjoined detailed report (pp. 53–233). The coals marked "not crushed" were, when unloaded from the cars, put through rolls having an aperture of $1\frac{1}{4}$ inches. The coals put through the Williams mill will practically all pass through a 10-mesh sieve.

The ovens were always closed, both door and trunnel head, directly after being drawn, and allowed to gather heat, the length of time varying as necessity demanded. The average time was one hour and a half.

The sample of coal was taken at regular intervals as the charge was emptied from bin to larry, using a small shovel holding about a quarter of a pound; the total weight of the sample averaged 45 pounds.

The sample of coke was taken from five different parts of the oven, as nearly as possible from the same location for each test: One piece 2 feet from the oven door; one 2 feet from each side, on a line drawn from the center of the oven; one from the center, and one 2 feet from the back wall, on a line with the point of selection of the pieces taken from the door and the center. The separate pieces of coke extended the whole height of the charge, and were as nearly uniform in size as possible.

In beginning the series of tests the first charges showed a rather large percentage of breeze, this being before the ovens were fully seasoned, and black butts due to cold bottom were produced. It was unfortunate that these first tests should have been on supposedly noncoking coals, as the condition of the oven did not permit it to give as effective service as would probably have been the case under other and more favorable circumstances.

EXTENT OF TESTS.

In the scope of this report, covering the period from July 7 to December 20, are included results from 94 tests of 46 coals from 9 different States, as follows: Illinois, 5; Indiana, 7; Kentucky, 4; Maryland, 1; Ohio, 9; Pennsylvania, 6; Virginia, 4; West Virginia, 9; Wyoming, 1. Of these tests, 60 were of raw coal, 32 of washed coal, 1 of raw coal with the addition of pitch, and 1 of washed coal with the addition of pitch.

Of the 46 different coals, six produced no coke, viz, Illinois No. 16 and No. 19, Indiana No. 3, Ohio No. 3, Maryland No. 1, and Wyoming No. 3. No coke was obtained from Illinois No. 16 owing to an accident to the larry; the test was discontinued. Maryland No. 1 was coked by the addition of 10 per cent pitch to washed coal. Wyoming No. 3 is a lignite. Four tests were made on Pennsylvania No. 9; two gave only a few pieces of coke, a third produced coke of inferior quality, and the fourth, with the addition of 5 per cent pitch to raw coal, produced coke, but of no better quality than that from washed coal.

The results of the coking tests will be found in the detailed report on each sample, presented on pages 53–233.

FURTHER TESTS.

It is intended to experiment further with the addition of volatile hydrocarbons to noncoking coals and coals producing an inferior grade of coke. Conclusions from these experiments will be incorporated in a later and more complete report.

BRIQUETTING TESTS.

By J. A. HOLMES.

CHANGES IN EQUIPMENT.

The briquette machine used in the larger part of the testing work during 1905 was the one built by Wm. Johnson & Sons, of Leeds, England, referred to in the reports of this work for 1904.[a] The American machine referred to in the same report was returned to the owners at the end of 1904. Briquettes made on the English machine during 1904 measured 4¼ by 6¾ by 5½ inches and averaged in weight 6.8 pounds. To obtain a briquette that would more nearly fulfill the requirements of domestic use and of stationary and locomotive boiler practice, it was thought advisable to reduce the size. To this end the mold wheel on the machine was planed down so as to make a briquette 2½ inches (instead of 5½ inches) in thickness, the other dimensions remaining the same. By adjusting the machine to meet this change it was possible to make satisfactory briquettes weighing about 3½ pounds, and these were used in the tests mentioned below.

With a view to obtaining a greater range in the size of the crushed fuel for the briquettes, a series of pulleys was installed on the driving and driven shafts operating the disintegrator, giving approximately 80, 65, and 50 per cent of its original speed. The necessary improvements were also made in the construction of this machine, such as a wider driving belt, extension of the elevator feeding the pug mill, proper drainage for the exhaust pipe, jacketing steam pipes, etc. By these improvements easier and more continuous operation was secured.

To determine with a fair degree of accuracy the percentage of binder being used with each fuel in the English briquetting machine, a gate was placed at the point where the small screw conveyor discharges the pitch into the mixing screw conveyor containing the coal. The percentage of binder was determined by weighing coal and binder, and, by experiment, the proper opening of the gate for each percentage of binder was determined.

PERSONNEL.

Mr. C. T. Malcolmson, the mechanical engineer in charge of the general work about the fuel-testing plant, has made the alterations in the briquetting equipment mentioned above and has also conducted the tests made on the English briquette machine. Prof. A. A. Steel, of the University of Arkansas, who superintended this work during 1904, has aided in the tests of 1905 in an advisory capacity. Dr. J. E. Mills, of the University of North Carolina, who served as chemist of this division from May 1 to October 6, 1905, conducted a series of laboratory experiments on the relative merits of different binding materials referred to in the following section.

[a] Bull. U. S. Geol. Survey No. 261, 1905, p. 13; Prof. Paper U. S. Geol. Survey No. 48, 1906, p. 25.

LABORATORY INVESTIGATIONS.

In the laboratory investigations by Dr. J. E. Mills the substances named below were tested as binding materials in the manufacture of briquettes, both as to the possibility of their being used with the different varieties of bituminous coal and as to the percentage of each binder yielding the best results with each coal. The substances tested in this connection were as follows:

INORGANIC BINDERS.

- Clay.
- Lime.
- Magnesia.
- Magnesia cement (magnesium oxide and magnesium chloride).
- Plaster of Paris.
- Portland cement.
- Natural cement.
- Slag cement.
- Water glass.

ORGANIC BINDERS.

A. Wood products.

- Rosin.
- Pitch (rosin and tar).
- Pine-wood tar.
- Hard-wood tar.
- Douglas-fir tar.
- Wood pulp.
- Sulphite liquor (from paper mills.)

B. Sugar-factory residues.

- Beet pulp.
- Lime cake.
- Beet-sugar molasses.
- Cane-sugar molasses.

C. Starch.

- Corn starch.
- Potato starch.

D. Slaughterhouse refuse.

E. Tars and pitches from coal.

- Blast-furnace tar.
- Producer-gas tar.
- Illuminating-gas tar (from coal).
- By-product coke-oven tar.
- Coal-tar creosote.
- Various grades of pitches from various tars.

F. Natural asphalts.

- Impsonite.
- Gilsonite.
- Maltha.
- Refined Trinidad.
- Refined Bermuda.
- Hard and refined or gum (from impregnated sandstone, etc.).

G. Petroleum products.

- Crude oil.
- Residuum (asphalts, etc.).
- Water-gas tar.
- Water-gas tar pitch.
- Wax tailings.
- Acid sludge.
- Asphalt tar.
- Pintsch-gas tar.
- Pittsburg flux.

These investigations related not only to the nature and the amount of the binder necessary for making satisfactory briquettes with each of the several coals tested, but also to the extent to which the binding quality of certain of these materials might be improved by the admixture of another binding material or another variety of coal.

Unless otherwise stated, 20 grams of each coal to be tested were weighed out and mixed with the different percentages of the binding material and placed in a Battersea crucible. A small amount of water was then added and the mixture heated with sufficient stirring to thoroughly mix the binder and coal until steam came off freely and only a small amount of water was left in the coal. The mixture while still hot was pressed in a small laboratory hand press, on which a pressure of 3,500 to 4,000 pounds per square inch was obtained. Each briquette weighed approximately 5 grams.

TESTS OF BINDING MATERIALS.

There is need for much additional investigation on a larger scale before definite results can be stated concerning the several possible binding materials for briquette manufacture; but the examinations made by Doctor Mills developed certain results which are at least suggestive.

The use of inorganic binding materials such as those mentioned above is not likely to prove practicable under any ordinary conditions, except that in the case of noncoking coals, when coking coals can not be obtained to mix with them, a small percentage of certain of these materials (such as magnesium oxide or carbonate, plaster of Paris, etc.), if added to other binding materials, may cause the briquettes to hold together better in the fire and hence undergo more complete combustion. It was not expected that all of these substances could be successfully used as binding materials in the manufacture of briquettes; nevertheless it was believed that an examination of each substance as to its adaptability for this purpose might throw some light on the general problem under consideration.

Of the more specific results in the testing of different binding materials, the following tentative statements are made, pending further investigations:

The use of clay, lime, and cements as binding materials was found entirely unsatisfactory, for the reason that they add largely to the ash constituent of the briquette. The briquettes made with these materials as bond went to pieces on exposure to water and weather and their waterproofing by soaking in oils, etc., was found difficult and expensive. Water glass (or soda silicate) was also found to be unsuitable for use in this connection.

From 4 to 6 per cent of magnesium oxide used as a binder was found to hold the briquettes together satisfactorily in dry weather and in the fire, but they disintegrated on exposure to rainy weather or when immersed in water.

In the tests with plaster of Paris, from 2 to 12 per cent of this material being used as a binder, the briquettes made were hard but brittle, and quickly disintegrated on exposure to moisture. Three per cent of magnesia mixed with 6 to 8 per cent of water-gas tar pitch seemed to make a stronger briquette than the same percentage of pitch used alone; but the improvement in the quality of the briquette is not considered sufficient to cover the additional cost of the magnesia and the additional percentage of ash which it brings into the briquette. Furthermore, this addition of sulphur to the coal is undesirable.

None of the sugar-factory residues, namely, beet pulp, lime cake, beet-sugar molasses, and cane-sugar molasses, were considered satisfactory as binding materials, for the reason that the briquettes made with them disintegrate on exposure to the weather, and no inexpensive waterproofing has as yet proved satisfactory on a commercial scale.

Nor were any of the wood products, including rosin, pitch, pine-wood tar, hard-wood tar, Douglas-fir tar, wood pulp, and sulphite liquor from paper mills, when used alone regarded as satisfactory, though some of these materials used in combination with other binders gave results of some promise, and deserve further investigation.

The tests made using from 0.5 to 3 per cent of starch as a binding material with different coals gave briquettes which were strong, were smokeless in burning, and held together in the fire until completely consumed; but these briquettes went to pieces when wet or exposed to the weather for a considerable period of time. Experiments as to the possibility of cheaply waterproofing the briquettes bound with starch, so as to make them hold together when exposed to water, were sufficiently successful to warrant further investigation in this direction. Starch is obtainable in large quantities and can be easily produced in almost any part of the country. In its crude form it can probably be obtained at a price less than $20 per ton. At this price, the use of 1 per cent of starch as a binder would add only 20 cents per ton to the cost of the briquettes.

The scarcity and high price of slaughterhouse refuse would prohibit its use as a binding material for briquettes, even if the tests with it were otherwise satisfactory, which was not the case.

The tests with coal tars and the different grades of pitch made from these tars indicate that probably in the pitches the most satisfactory binders for the manufacture of briquettes will be found; and that these can be made at such a price as will bring the cost of the binding material used to not more than 50 to 75 cents per ton of briquettes. Briquettes made from a majority of the bituminous coals with a good grade of pitch as a binder are sufficiently strong to bear ordinary handling; they will stand exposure to the weather for a number of years without serious deterioration; and they burn well in the fire. The supply of pitch is already large and can be easily increased. The price now ranges from $9 to $11 per ton. The pitches obtained from different plants and those obtained at different times from the same plant varied considerably, not only in their boiling points but in other respects; and in the case of similar pitches the percentage necessary for the proper working of different coals seemed to vary according to differences in the quality of the coals. It was found to be better to mix with a noncoking coal 10 to 20 per cent of a coking coal, rather than to increase the percentage of pitch.

In the investigation of the asphalts as binding materials, impsonite from Indian Territory was found to be rather unsatisfactory, though in a number of tests with noncoking coals the result was improved by the addition to such coal of from 5 to 10 per cent of impsonite in addition to from 3 to 5 per cent of ordinary pitch or some other binding material. From 4 to 8 per cent of gilsonite and other asphalts from Utah gave fairly satisfactory results as a binder. This material is said to exist in Utah and elsewhere in large quantities, and while the price is at present too high to permit its extensive use as a binder, doubtless should the demand for it in this connection increase the deposits would be opened up to such an extent that it might be sold at lower prices.

Experiments were made with several other asphaltic materials, and though the results were such as to warrant further investigation they were not altogether satisfactory. Asphaltic tar yielded fairly good results as a waterproofing material in briquettes made with starch. Asphaltic materials yielded the best results in waterproofing.

From 4 to 6 per cent of maltha (a liquid asphalt) used as a binder yielded fairly satisfactory results with coking coals. With noncoking coals it was found to be insufficient for the purpose.

Crude petroleums have been tested as binding materials, with satisfactory results. The asphaltic petroleums were used successfully in waterproofing briquettes made with a starch binder, though it is doubtful whether this practice would prove entirely satisfactory in operations on a commercial scale. In the tests the success of the waterproofing was fairly proportional to the amount of asphaltic material in the petroleum. As a binding material the asphaltic petroleum proved even more successful than when used for waterproofing purposes, from 6 to 8 per cent being entirely satisfactory.

The petroleum residuums proved to be successful binding materials somewhat in proportion as the per cent of asphalt in them increased. That obtained from the Gulf Refining Company, of Port Arthur, Tex., was found to melt at a temperature of 100° C., and about 99.38 per cent of it was found to be soluble in carbon disulphide. Another sample of asphaltic petroleum from the Gulf Refining Company flowed at a temperature of 95° C. and of this it was found that carbon disulphide would dissolve 99.88 per cent. From 4 to 6 per cent of this material gave excellent results as a binder for briquettes.

Water-gas tar, which is obtained from illuminating-gas plants, was not tested sufficiently to give satisfactory results, but it is believed that this material could be used as a binder if properly mixed with other somewhat similar materials. It is necessary, after this material is mixed with the coal, that the mixture should be raised to a sufficiently high temperature to liquefy and perhaps even to vaporize the tar.

The water-gas pitch which was furnished by the Barrett Manufacturing Company flowed at a temperature of 92° C. It was found that 4½ to 7 per cent of this pitch, which would be equivalent to from 6 to 8 per cent of coal-tar pitch, would make satisfactory briquettes. The cost of this binder would be from 45 to 65 cents per ton of briquettes.

The wax tailings used in these investigations were obtained from the Standard Oil Company. They melt at a temperature of about 70° C. From 4 to 6 per cent of this material would prove satisfactory in the briquettes. The amount of this material produced in the United States is small and the price is about 6 cents per gallon. This would make the binding material used in a ton of briquettes cost approximately 45 to 60 cents.

Tests made with acid sludge as a binder were not satisfactory. It not only added the unwelcome sulphur, but its binding qualities were very inferior.

Asphalt tar was found unsatisfactory as a binder even when 8 to 12 per cent was used, inasmuch as the briquettes fell to pieces in the fire; but its use for waterproofing when starch or other material had been used as a binder proved fairly satisfactory.

Pintsch-gas tar, produced by heating petroleum oil in iron retorts at a high temperature, was obtainable in so small a quantity that only preliminary tests were made covering its use as a binder and these were only partially satisfactory.

REQUISITES FOR BINDING MATERIALS.

The results of the investigations in the laboratory of the fuel-testing plant and the writer's observations in briquetting plants in other countries point to certain general conclusions concerning the requisites of satisfactory binding materials for use in the manufacture of briquettes.

In the making of coal briquettes the binding work is best performed when the particles of coal are coated and when the void spaces are filled with the binding material. This is best accomplished when the temperature of the mixture before compression is raised sufficiently to liquefy or vaporize the binder.

The relation between the coal and the binder seems to be physical rather than chemical, though it is possible that certain minor chemical changes may accompany the briquetting operation.

The amount of the binding material necessary will therefore depend on the aggregate of the surfaces of the coal particles to be coated, on the void spaces to be filled, and on the general physical and chemical character of the coal. Coking coals require less binder than noncoking coals, and the percentage of binder necessary for the latter coals may, in many cases, be diminished and the quality of the briquette otherwise improved by the previous admixture with them of from 10 to 20 per cent of some coking coal.

Furthermore, when a coal is finely pulverized, a result which frequently follows protracted slacking on exposure to the weather, the briquetting of such material is facilitated by the mixture of a considerable percentage of the same or another coal—preferably a nonslacking coal—crushed to sizes ranging from one-sixteenth inch to one-fourth inch.

The following are mentioned as the more important requisites of a suitable binding material for use in the manufacture of briquettes:

(1) It must be inexpensive, because of the small difference in the United States between the prices of slack or fine coal and those of lump coal. This difference in some regions is practically nothing, as in the Pocahontas coal fields of West Virginia; while in a number of other fields, as in portions of Indiana, Illinois, Arkansas, etc., it may reach $1 or even $1.50 a ton.

(2) It should be capable of abundant production in different parts of the country, in order to avoid the necessity for long transportation.

(3) It should be of such character as to make it easily handled and applied at workable temperatures. If it is used in solid condition, as in the case of pitch, the melting point should not be lower than the temperature of hot summer days, nor ordinarily above that of live steam.

(4) It should hold the briquette together strongly, not only during ordinary handling and transportation, but also during protracted exposure to the weather and while burning. Certain materials, like starch and molasses, yield fairly satisfactory results as long as the briquettes are kept dry and during their consumption by fire; but as these materials are soluble in water, the briquettes in which they are used as a binder go to pieces under the

action of water unless rendered waterproof through the application of other substances. On the other hand some briquettes which remain firm under the action of water crumble when heated because of the fact that the binding material used volatilizes at a low temperature. Even in the coking coals the binder should hold the particles together at least until the coal itself is sufficiently softened to cohere and begin burning.

(5) It should not add appreciably to the ash of the coal nor increase the clinker formation in the ash. It should not give off fumes nor seriously increase the smoke in the burning of the briquettes. It is generally claimed that owing to the more perfect combustion in burning briquettes, less smoke is produced from the coal and binder together than is given off from the consumption of the unbriquetted or natural coal. Binding materials which have a low melting or boiling temperature give off more smoke because of the fact that this smoke originates at a temperature too low for complete combustion. Briquettes, as in the case of lump coal, give off less smoke when the arrangements for proper draft are such as to facilitate combustion.

(6) The binding material should increase, or certainly should not decrease, the heating quality of the coal which is used in the manufacture of the briquettes.

BRIQUETTING WITHOUT THE USE OF BINDING MATERIALS.

In August, 1904, under the writer's supervision, samples of lignite from Lehigh, N. Dak., and from near Rockdale, Tex., were shipped to Magdeburg and Zeitz, Germany, to be used for experiments to determine the feasibility of briquetting these lignites with the German presses. These tests were conducted by the writer. They were entirely successful and the briquettes made with these lignites, after being crushed and dried, subsequently stood the tests applied to the German lignite briquettes, which are extensively used for domestic purposes.

To a portion of the briquettes made at Magdeburg 2 per cent of ordinary coal-tar pitch was added, with the view of determining what, if any, advantage would result from such an addition. Laboratory tests indicated that the briquettes to which this pitch had been added burned more rapidly, with more flame, and at a higher heat efficiency than those without it, and the North Dakota lignite seemed to give off fewer sparks in burning. It is estimated that the cost of manufacturing these briquettes (not including the cost of the lignite) should not exceed 50 cents per ton. The analyses of the lignite briquettes made at Magdeburg are as follows:

Analyses of lignite briquettes made at Magdeburg, Germany.

[Dried before briquetting.]

		From Lehigh, N. Dak.		From Rockdale, Tex.	
		Without pitch or other binder.	With 2 per cent of pitch added.	Without pitch or other binder.	With 2 per cent of pitch added.
Proximate.	Moisture	12.96	11.22	8.88	8.92
	Volatile matter	37.79	38.68	40.92	41.33
	Fixed carbon	38.63	41.11	41.90	42.35
	Ash	10.62	8.99	8.30	7.40
Ultimate.	Sulphur	.75	1.04	.97	1.07
	Hydrogen	4.99	5.09	5.21	5.23
	Carbon	52.88	56.26	59.06	59.61
	Nitrogen	.65	.73	1.15	1.14
	Oxygen	30.11	27.89	25.31	25.55
Calories		4,941	5,332	5,682	5,828
British thermal units		8,894	9,598	10,228	10,490
Moisture in undried sample of lignite as received at Magdeburg		28.87		32.07	

It is proposed to continue these investigations of the lignites until results are obtained which will show how they can be briquetted economically in the manner indicated above and, in general, how they can be utilized most efficiently.

Concerning the possibility of briquetting bituminous coals without binding materials, by raising the temperature, and also concerning the possibility of decreasing the percentage of binding material by raising the temperature of the coals preliminary to briquetting, a number of tests were made by Doctor Mills in the laboratory of the fuel-testing plant at St. Louis, but the results in each case were unsatisfactory, as they failed to indicate the probability of economic success in that direction.

SOME GENERAL CONCLUSIONS.

The successful development of a coal-briquetting industry in the United States will depend on a number of conditions, some of which are variable.

The condition which more than any other has prevented the development of such an industry in this country is the low price of bituminous coal and especially the small difference between the price of the lump coal and that of the slack, or fine coal. Especially is this latter phase of the problem illustrated by the coking coals of Pennsylvania and West Virginia, where much of the slack coal commands a price equal to or approximating that of the lump coal. Much of the lump coal is finally crushed before being manufactured into coke, and the slack coal even has the advantage in not having to be crushed. Furthermore, even where these coals are not used for the manufacture of coke, but are sold for general power purposes, much of the fine coal can be shipped and burned with the lump coal, for the reason that it fuses as soon as it begins to burn, and therefore does not to any serious extent sift down through the grate bars and either clog the draft or escape with the ashes, as is the case with noncoking coals.

In the territory of the noncoking coals the demand for the slack coal is not so great, and it can in some places be bought at less than 50 cents per ton; while at a number of mines large quantities are thrown on the dump as waste, frequently being burned in order to get rid of it.

Perhaps in no country has specialized equipment for burning fine coal been carried so far as it has in the United States, but the results of a number of tests by engineers seem to indicate that with the noncoking coals the use of the finely powdered coal, even in the modern furnace, is a disadvantage rather than a gain, for the reason that this fine material sifts through onto the grates, is ultimately lost with the ashes, and meanwhile prevents a full draft, which is essential to rapid and complete combustion. This is, therefore, one class of material which should be separated from the coarser coals and made into briquettes, provided the price at which these briquettes can be sold is sufficient to more than cover the cost of manufacture.

With anthracite and semianthracite coals the difference between the price of the lump coal and that of the slack is often more than sufficient to cover the cost of manufacturing briquettes, and in such cases there can be no question as to the possibility of establishing a briquetting industry as soon as the proper binding material and briquetting equipment can be provided.

There are still other cases in which it is claimed that the difference between the prices of the lump coal and of the slack are either just sufficient, or scarcely sufficient, to cover the cost of briquette manufacture, but the fact that the briquettes made from this material present certain advantages over the lump coal make them command a sufficiently higher price to provide a margin of profit.

Unfortunately the high cost of the pitch which is generally used as a binding material is one of the barriers now existing in the way of the development of this industry. One of the purposes of the present investigation is to discover, if possible, some cheaper binding material, and the outlook in that direction is encouraging. The cost of manufacturing briquettes in France, Germany, Belgium, and England, including all necessary items

except that of the coal and binding material, is estimated to range from 25 to 50 cents per ton, varying with the local conditions.

Where pitch is used as a binder, as is almost universally the case in each of these countries, its cost for a ton of briquettes may be said to range from 50 to 80 cents. How far this cost may be reduced by the use on a commercial scale of cheaper binders remains to be seen.

The most favorable outlook for the development of this industry in the United States is in connection with the use of briquettes in locomotives and in domestic furnaces and stoves. It can hardly be expected that, at anything approximating existing prices, briquettes can be manufactured for successful use in the ordinary power-plant furnaces of the country.

In connection with the use of briquettes for domestic purposes, the following advantages are claimed:

1. That the briquettes burn with a higher efficiency and with less smoke, because they allow a better circulation of air and the combustion is more complete and more uniform.
2. That the briquettes are cleaner, and that there is less waste in their use.
3. That they burn with more flame (owing to the added combustible binding material) and at higher temperatures.
4. That they occupy less space (by from 5 to 20 per cent) than does the lump coal.
5. That they stand handling and exposure to weather better.
6. That in their storage there is no risk of spontaneous combustion.

A number of these advantages are also claimed for the use of briquettes in locomotives.

SOME CHARACTERISTICS OF GOOD BRIQUETTES.

In view of the great interest existing in the development of a briquetting industry in the United States at the present time and of the numerous efforts toward such development which are being put forth in different parts of the country, it may not be inopportune to introduce here a brief statement of some of the requisites of a briquette intended for general use:

(1) The cost should be but little, if any, in excess of that of lump coal of the same kind as that from which the material in the briquette was derived.

(2) The strength and binding material of the briquette must be such that it will (*a*) bear handling and railway transportation without serious loss from crumbling, (*b*) stand exposure to the weather without serious deterioration, and (*c*) retain its shape in the fire.

(3) Its density should at least equal that of the lump coal from the same mine and, if practicable, should exceed it. It should not absorb more than about 3 per cent of water.

(4) It should ignite readily and burn with a good, intense flame, and as nearly as possible without odor or smoke.

(5) Its heating value should not be less than that of the best lump coal from the same mine. Naturally its heating value can not exceed that of this coal, except that if the binding material used has a higher heat efficiency, this may slightly increase the heat efficiency of the briquette, and the more complete combustion which is claimed for the briquette as compared with the natural coal may still further slightly increase its relative heat efficiency.

(6) Its ash should not exceed that of the best lump coal from the same mine. Whenever the conditions are favorable, the percentage of ash should be reduced by washing the fine coal preliminary to its use in briquette manufacture.

The sizes of briquettes will vary according to the purposes for which they are intended and with other local conditions. In general, it may be said that the larger the briquette the cheaper its manufacture. Some of the English briquettes shipped to South America weigh as much as 20 pounds each. The English briquettes exported from Swansea average about 10 pounds each in weight. The briquettes commonly used on locomotives in France, Belgium, Germany, and other European countries range from about 3 to 10 pounds in weight. The larger briquettes are generally broken into pieces before being thrown into the furnace or fire box, and this always causes more or less waste, but the large size is adopted for original manufacture owing to the smaller cost and the convenience in handling. The

briquettes for domestic use are not usually more than 2 pounds nor less than one-fourth pound in weight. The smaller briquettes are usually of biscuit or lenticular shape, whereas the larger briquettes for railroad use are generally square or prismatic, with slightly rounded edges.

PRELIMINARY TESTS IN BURNING BRIQUETTES ON LOCOMOTIVES.

Two hundred tons of Arkansas semianthracite slack coal from the mines of the Western Coal and Mining Company were made into briquettes for the purpose of preliminary tests concerning their suitability for use in locomotives. Twelve tons of this coal were made, on a Renfrow machine, into biscuit-shaped briquettes averaging about 10 ounces in weight. The remainder was made into briquettes $4\frac{1}{4}$ by $6\frac{3}{4}$ by $2\frac{1}{2}$ inches, averaging in weight about $3\frac{1}{2}$ pounds. From 6 to $6\frac{1}{2}$ per cent of pitch was used as a binding material in all these briquettes.

After a few tests on a switching engine to determine the best method of firing these briquettes, two tests were made on the locomotive drawing the regular passenger train of the Missouri Pacific Railway from St. Louis to Sedalia, Mo., a distance of 188 miles. On a similar run made by this passenger train, with the same engine and fireman, lump coal was used from the Consolidated Coal Company's mine No. 17, at Collinsville, Ill., this being taken as a good average of the coal ordinarily used by the Missouri Pacific Railway. The water and coal consumed were in each case carefully weighed, but in these preliminary tests no records were made of the steam pressures and temperatures of the feed water.

The engine steamed freely on each of the three tests. No clinkers were formed on the grates or tube sheet with the Illinois bituminous coal. A light clinker was formed over the grates with both runs on the Arkansas coal, which, however, did not interfere with the engine making the required amount of steam. The tube sheet clinkered on the run using Renfrow briquettes, and it was necessary to clean off the clinker at Jefferson City, 125 miles from St. Louis. In both tests with briquettes they burned almost without smoke and were reported as being a satisfactory fuel for locomotives in the service of this railroad. The mechanical engineer of the company, under whose supervision these tests were made, expresses the opinion that the advantages gained in burning the briquettes were more than sufficient to cover the cost of their manufacture.

However, the above tests must be considered as simply preliminary to more careful tests to be made later, and these additional tests must be made at an early date.

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DETAILED REPORT OF TESTS.

The following are the results of tests made on the various samples of coal received from May 1, 1905, to January 1, 1906, arranged alphabetically according to States and showing in succession under the head of each sample all tests made on that sample.

CALIFORNIA NO. 1.

Lignite from Tesla mine, San Francisco and San Joaquin Coal Company, Tesla, Alameda County, Cal.

This sample consisted of run-of-mine lignite, and was shipped under the supervision of E. W. Parker, statistician, United States Geological Survey. It was used in making producer-gas tests Nos. 32, 33, and 34.

Two mine samples (Nos. 1606 and 1607) were taken for chemical analysis at widely separated points in the mine.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1606	1607	1680
Air-drying loss		4.60	4.50	10.40
Proximate.	Moisture	17.59	18.02	18.51
	Volatile matter	41.09	39.22	35.33
	Fixed carbon	23.29	26.39	30.67
	Ash	18.03	16.37	15.49
Ultimate.	Sulphur	2.89	3.07	3.05
	Hydrogen			5.93
	Carbon			47.34
	Nitrogen		.49	.66
	Oxygen			27.53
Calorific value determined:				
	Calories		4,503	4,726
	British thermal units		8,105	

PRODUCER-GAS TESTS.

Test 32, California No. 1.

Duration of test, 42 hours.

Average electrical horsepower		207.4
Average B. T. U. gas, per cubic foot		158.3
Total coal fired	pounds..	23,850

Test 33, California No. 1.

A mixture composed of one-half Tesla lignite and one-half "front-end" cinders from locomotives at San Francisco, furnished by the Southern Pacific Company, was fed into the gas producer under normal conditions, and the test continued for several hours, but it was found impossible to keep up a supply of gas that would operate the engine under ordinary load. The analyses of the lignite, cinders, and resulting gas are given below.

Test 34, California No. 1.

A mixture of two-thirds Tesla lignite and one-third "front-end" cinders, as in test 33, was used in this test.

Duration of test, 24 hours.

Average electrical horsepower		206.2
Average B. T. U. gas, per cubic foot		132.6
Total mixture fired	pounds..	11,850

COAL OR MIXTURE CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 32.			Test 34.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:						
Available for outside purposes	2.91	2.41	1.96	2.50	2.17	1.79
Developed at switch board	2.74	2.26	1.84	2.40	2.08	1.71
Per brake horsepower:						
Available for outside purposes	2.48	2.05	1.66	2.13	1.85	1.52
Developed at engine	2.33	1.92	1.56	2.04	1.77	1.46
Equivalent used by producer plant.						
Per electrical horsepower:						
Available for outside purposes	3.06	2.53	2.06			
Developed at switch board	2.88	2.38	1.94			
Per brake horsepower:						
Available for outside purposes	2.60	2.15	1.75			
Developed at engine	2.45	2.02	1.65			

ANALYSES.

	Test 32.	Test 33.		Test 34.	
		Lignite.	Cinders.	Lignite.	Cinders.
Coal.					
Moisture	17.36	17.41	3.50	17.41	3.50
Volatile matter	38.41	36.06	6.36	36.06	6.36
Fixed carbon	28.76	30.87	74.93	30.87	74.93
Ash	15.47	15.66	15.21	15.66	15.21
	100.00	100.00	100.00	100.00	100.00
Sulphur	2.96	3.10	.63	3.10	.63

	Test 32.	Test 33.	Test 34.
Gas by volume.			
Carbon dioxide (CO_2)	10.0	11.2	9.7
Carbon monoxide (CO)	19.2	17.4	18.1
Hydrogen (H_2)	11.4	8.3	7.9
Methane (CH_4)	3.9	2.7	3.0
Nitrogen (N_2)	55.4	60.4	61.3
Oxygen (O_2)	.1		
	100.0	100.0	100.0

ILLINOIS NO. 6.

Bituminous coal from Coffeen mine, Clover Leaf Coal Company, Coffeen, Montgomery County, Ill., on the Toledo, St. Louis and Western Railroad.

One sample of this coal was shipped to the testing plant in 1904, and of this sample some coal remained after the plant shut down at the end of that year. This coal was used in making steaming test No. 106.

An additional sample was shipped under the supervision of Inspector J. W. Groves, consisting of run-of-mine coal, which was used in making washing test No. 101 and producer gas test No. 35.

One mine sample was taken from this mine by the inspector for chemical analysis. This was cut from the face of the second right entry, 1,500 feet northwest of the shaft.

CHEMICAL ANALYSES.[a]

		Mine sample.	Car sample.
Laboratory number		1661	1702
Air-drying loss		6.60	8.10
Proximate.	Moisture	12.90	11.93
	Volatile matter	33.77	29.99
	Fixed carbon	42.25	43.90
	Ash	11.08	14.18
Ultimate.	Sulphur	3.78	4.29
	Hydrogen		5.21
	Carbon		56.94
	Nitrogen		1.01
	Oxygen		18.37
Calorific value determined:			
	Calories	6,031	5,724
	British thermal units	10,856	10,303

[a] For analyses of mine samples taken during the Exposition period see Bull. U. S. Geol. Survey No. 261, 1905, p. 37.

STEAMING TEST.

Test 106, Illinois No. 6, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 4.7 per cent; ½ inch to 1 inch, 19.3 per cent; ¼ inch to ½ inch, 21.5 per cent; under ¼ inch, 54.5 per cent. Duration of test, 10 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 106.
Heating value of coal, B. T. U. per pound dry coal	12,762
Force of draft:	
Under stack damper, inch water	.55
Above fire, do	.25
Furnace temperature, °F.	2,213
Dry coal used per square foot of grate surface per hour, pounds	25.94
Equivalent water evaporated per square foot of water-heating surface per hour, do	3.39
Percentage of rated horsepower of boiler developed	95.3
Water apparently evaporated per pound of coal as fired, pounds	4.69
Water evaporated from and at 212° F.:[a]	
Per pound of coal as fired, do	5.56
Per pound of dry coal, do	6.56
Per pound of combustible, do	7.45
Efficiency of boiler, including grate, per cent	49.64
Coal as fired:	
Per indicated horsepower hour, pounds	5.09
Per electrical horsepower hour, do	6.28
Dry coal:	
Per indicated horsepower hour, do	4.31
Per electrical horsepower hour, do	5.32

[a] A better evaporation would have been obtained if boilers and gas-sampling apparatus had been in better condition, as they were later.

ANALYSES.

	Test 106.		Test 106.
Proximate.		*Ultimate.*	
Moisture	15.33	Carbon [a]	70.44
Volatile matter	33.76	Hydrogen [a]	4.63
Fixed carbon	42.18	Oxygen [a]	9.66
Ash	8.73	Nitrogen [a]	1.28
	100.00	Sulphur	3.68
Sulphur	3.12	Ash	10.31
			100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 35, Illinois No. 6 B.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 60 hours.

Average electrical horsepower	206.7
Average B. T. U. gas, per cubic foot	152.0
Total coal fired, pounds	23,400

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 35.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	2.00	1.77	1.45
Developed at switch board	1.89	1.67	1.37
Per brake horsepower:			
Available for outside purposes	1.70	1.50	1.23
Developed at engine	1.61	1.42	1.16
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	2.14	1.89	1.55
Developed at switch board	2.02	1.79	1.46
Per brake horsepower:			
Available for outside purposes	1.82	1.61	1.31
Developed at engine	1.72	1.52	1.25

ANALYSES.

	Test 35.		Test 35.
Coal.		*Gas by volume.*	
Moisture	11.47	Carbon dioxide (CO_2)	7.8
Volatile matter	31.67	Carbon monoxide (CO)	20.9
Fixed carbon	40.78	Hydrogen (H_2)	9.0
Ash	16.08	Methane (CH_4)	3.7
	100.00	Nitrogen (N_2)	58.5
Sulphur	4.59	Oxygen (O_2)	.1
			100.0

WASHING TEST.

Test 101, Illinois No. 6.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	14,710
Washed coal	do....	13,586
Refuse	do....	1,124

ANALYSES.

	Test 101.	
	Raw coal.	Washed coal.
Moisture	14.43	15.23
Volatile matter	29.48	.....
Fixed carbon	42.81	.....
Ash	13.28	8.64
Sulphur	4.01	3.30

ILLINOIS NO. 7.

Bituminous coal from mine No. 2, Lumaghi Coal Company, near Collinsville, Madison County, Ill., on the Vandalia Railroad.

Four lots of coal were shipped for testing from this mine. One consisted of slack which had been passed through a 1-inch mesh screen; this lot is designated as Illinois No. 7 A and was used in making producer test No. 26. Sample Illinois No. 7 B consisted of nut coal which had passed over a 1-inch mesh screen and was used in making producer-gas test No. 27. These two lots were shipped under the supervision of Inspector J. S. Burrows. Sample Illinois No. 7 C consisted of another car of slack, which was used in making washing test No. 104, steaming test No. 122, steaming test on washed coal No. 129, and producer-gas test No. 38. This car was not inspected, as it was slack coal. Sample Illinois No. 7 D consisted of run-of-mine coal and was shipped under the supervision of Inspector J. W. Groves. It was used in making washing test No. 108, coking tests Nos. 1 and 4, and steaming tests Nos. 142, 143, and 146.

Two mine samples were collected in this mine for chemical analysis. No. 1608 was taken at the face of room 17, north entry, and No. 1609 at the face of room 14, south entry.

CHEMICAL ANALYSES.

		Mine samples.		Car sample B	Car sample D.
Laboratory number		[a]1608	[a]1609	1611	1780
Air-drying loss		5.90	5.90	5.00	3.50
Proximate.	Moisture	12.27	11.87	11.46	10.86
	Volatile matter	37.22	36.57	34.98	36.24
	Fixed carbon	39.16	39.98	36.25	39.75
	Ash	11.35	11.58	17.31	13.18
	Sulphur	4.66	4.75	4.40	4.53
Ultimate.	Hydrogen	.....	.....	5.05	5.35
	Carbon	.....	.....	54.56	58.59
	Nitrogen	.....	1.02	.94	.99
	Oxygen	.....	.....	17.74	17.37
Calorific value determined:					
Calories		.....	5,982	5,570	6,009
British thermal units		.....	10,768	10,026	10,816

[a] Samples secured by J. S. Burrows.

STEAMING TESTS.

Test 122, Illinois No. 7 C.

Size as shipped, slack. Size as used, ½ inch to 1 inch, 12.8 per cent; ¼ inch to ½ inch, 18.3 per cent; under ¼ inch, 68.9 per cent. Duration of test, 10.07 hours. Kind of grate, rocking.

Test 129, Illinois No. 7 C.

Size as shipped, slack. Size as used, ½ inch to 1 inch, 10.46 per cent; ¼ inch to ½ inch, 25.50 per cent; under ¼ inch, 64.04 per cent. Washed. Duration of test, 8.35 hours. Kind of grate, plain.

Test 142, Illinois No. 7 D.

Size as shipped, run of mine. Size as used, over 1 inch, 33.5 per cent; ½ inch to 1 inch, 23.3 per cent; ¼ inch to ½ inch, 15.0 per cent; under ¼ inch, 28.2 per cent. Duration of test, 10.02 hours. Kind of grate, plain.

Test 143, Illinois No. 7 D.

Size as shipped, run of mine. Size as used, over 1 inch, 32.1 per cent; ½ inch to 1 inch, 22.0 per cent; ¼ inch to ½ inch, 15.6 per cent; under ¼ inch 30.3 per cent. Duration of test, 10.0 hours. Kind of grate, plain.

Test 146, Illinois No. 7 D.

Size as shipped, run of mine. Size as used, over 1 inch, 24.3 per cent; ½ inch to 1 inch, 23.3 per cent; ¼ inch to ½ inch, 18.1 per cent; under ¼ inch, 34.3 per cent. Duration of test, 10.07 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 122.	Test 129.	Test 142.	Test 143.	Test 146.
Heating value of coal.....B. T. U. per pound dry coal..	9,999	12,730	11,673	11,212	11,088
Force of draft:					
Under stack damper.....inch water..	0.58	0.55	0.60	0.58	0.61
Above fire.....do....	.30	.24	.16	.18	.22
Furnace temperature.....°F.					
Dry coal used per square foot of grate surface per hour, pounds.....	20.08	19.92	20.07	18.74	20.21
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.19	3.19	2.97	2.69	2.68
Percentage of rated horsepower of boiler developed.....	61.4	89.6	83.3	75.5	75.2
Water apparently evaporated per pound of coal as fired, pounds.....	4.71	5.75	5.73	5.59	5.68
Water evaporated from and at 212° F.:					
Per pound of coal as fired.....pounds..	5.44	6.70	6.65	6.46	6.64
Per pound of dry coal.....do....	6.08	8.02	7.42	7.20	7.40
Per pound of combustible.....do....	8.97	9.17	9.25	9.27	9.80
Efficiency of boiler, including grate.....per cent..	58.71	60.84	61.39	62.01	64.45
Coal as fired:					
Per indicated horsepower hour.....pounds..	5.20	4.22	4.25	4.38	4.26
Per electrical horsepower hour.....do....	6.42	5.21	5.25	5.40	5.26
Dry coal:					
Per indicated horsepower hour.....do....	4.65	3.53	3.81	3.93	3.82
Per electrical horsepower hour.....do....	5.74	4.36	4.70	4.85	4.72

ANALYSES.

	Test 122.	Test 129.	Test 142.	Test 143.	Test 146.
Proximate.					
Moisture	10.54	16.45	10.38	10.29	10.29
Volatile matter	31.18	34.43	34.33	32.34	32.16
Fixed carbon	32.98	40.18	39.08	38.95	38.35
Ash	25.30	8.94	16.21	18.42	19.20
	100.00	100.00	100.00	100.00	100.00
Sulphur	4.18	3.22	4.28	4.66	5.01

ANALYSES—continued.

	Test 122.	Test 129.	Test 142.	Test 143.	Test 146.
Ultimate.					
Carbon [a]	54.93	70.00	63.24	60.90	59.86
Hydrogen [a]	3.88	4.95	4.49	4.31	4.24
Oxygen [a]	7.31	9.33	8.33	8.02	7.91
Nitrogen [a]	.92	1.16	1.07	1.04	1.01
Sulphur	4.67	3.86	4.78	5.20	5.58
Ash	28.29	10.70	18.09	20.53	21.40
	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 26, Illinois No. 7 A.

Size as shipped, slack. Size as used, not determined. Duration of test, 11½ hours.

Average electrical horsepower..... 138.6
Average B. T. U. gas, per cubic foot..... 109.3
Total coal fired, pounds..... 7,350

Test 27, Illinois No. 7 B.

Size as shipped, nut and pea. Size as used, not determined. Duration of test, 30 hours.

Average electrical horsepower..... 204.1
Average B. T. U. gas, per cubic foot..... 138.6
Total coal fired, pounds..... 13,650

Test 38, Illinois No. 7C.

Size as shipped, slack. Size as used, not determined. Duration of test, 33 hours.

Average electrical horsepower..... 174.8
Average B. T. U. gas, per cubic foot..... 120.2
Total coal fired, pounds..... 15,750

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 26.			Test 27.			Test 38.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:									
Available for outside purposes	4.98	4.35	3.27	2.33	2.06	1.65	2.93	2.63	2.08
Developed at switch board	4.69	4.09	3.07	2.23	1.97	1.58	2.73	2.45	1.94
Per brake horsepower:									
Available for outside purposes	4.24	3.69	2.78	1.98	1.75	1.40	2.49	2.24	1.77
Developed at engine	3.98	3.47	2.61	1.89	1.67	1.34	2.32	2.09	1.65
Equivalent used by producer plant.									
Per electrical horsepower:									
Available for outside purposes	5.25	4.58	3.45	2.52	2.22	1.78	3.12	2.80	2.21
Developed at switch board	4.94	4.30	3.24	2.41	2.12	1.70	2.91	2.61	2.06
Per brake horsepower:									
Available for outside purposes	4.46	3.89	2.93	2.14	1.89	1.51	2.65	2.38	1.88
Developed at engine	4.20	3.66	2.76	2.05	1.81	1.45	2.47	2.22	1.75

ANALYSES.

	Test 26.	Test 27.	Test 38.		Test 26.	Test 27.	Test 38.
Coal.				*Gas by volume.*			
Moisture	12.76	11.92	10.08	Carbon dioxide (CO_2)	11.9	10.9	11.2
Volatile matter	32.35	33.95	32.71	Carbon monoxide (CO)	10.7	12.6	14.5
Fixed carbon	33.37	36.67	38.26	Hydrogen (H_2)	7.9	9.4	7.7
Ash	21.52	17.46	18.95	Methane (CH_4)	3.8	4.9	3.2
				Nitrogen (N_2)	65.7	62.1	63.4
	100.00	100.00	100.00	Oxygen (O_2)	.....	.1	.....
Sulphur	3.82	4.15	4 15				
					100.0	100.0	100.0

WASHING TESTS.

Test 104, Illinois No. 7 C.

Size as shipped, slack. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds	15,809
Washed coal	do	11,238
Refuse	do	4,571

Test 108, Illinois No. 7 D.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds	14,000
Washed coal	do	11,790
Refuse	do	2,210

ANALYSES.

	Test 104.		Test 108.	
	Raw coal.	Washed coal.	Raw coal.	Washed coal.
Moisture	10.69	16.64	10.83	12.45
Volatile matter	33.08	.....	36.24	.....
Fixed carbon	36.14	.....	39.75	.....
Ash	20.09	8.59	13.18	9.30
Sulphur	4.06	3.25	4.53	3.65

COKING TESTS.

Test 1, Illinois No. 7 D.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 43 hours.

Coal charged	pounds	8,000
Coke produced	do	3,907
Breeze produced	do	452
Coke produced	per cent	48.84
Breeze produced	do	5.65
Total percentage yield		54.49

Remarks.—Good, hard coke. Sulphur and ash too high. First charge after ovens put in commission. One-inch black butts on coke. More seasoned ovens would probably give better results.

Test 4, Illinois No. 7 D, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 65 hours.

Coal charged	pounds	10,000
Coke produced	do	5,200
Breeze produced	do	260
Coke produced	per cent	52.00
Breeze produced	do	2.60
Total percentage yield		54.60

Remarks.—Light-gray and silvery color. Good, strong coke. Ash reduced by washing. Sulphur reduction small.

ANALYSES.

	Test 1.		Test 4.	
	Coal.	Coke.	Coal.	Coke.
Moisture	10.88	2.26	12.45	1.04
Volatile matter	35.27	1.86	36.17	.61
Fixed carbon	38.44	72.68	42.08	82.10
Ash	15.41	23.20	9.30	16.25
Sulphur	4.53	3.95	3.64	3.24

ILLINOIS NO. 8.

Bituminous coal from Paisley mine, Dering Coal Company, Paisley, Montgomery County, Ill., on the Big Four Railroad.

This sample consisted of nut coal. It was shipped before the corps of inspectors was organized, and consequently the loading of the car was not supervised by a representative of the plant. This sample was used in making steaming tests Nos. 101 and 102 and producer-gas test No. 29.

No mine samples have as yet been taken from this mine, but before the final report of the testing plant is prepared the mine will be examined and the samples obtained.

CHEMICAL ANALYSES.

		Car sample.
Laboratory number		1627
Air-drying loss		4.40
Proximate.	Moisture	13.20
	Volatile matter	34.33
	Fixed carbon	39.94
	Ash	12.53
Ultimate.	Sulphur	4.47
	Hydrogen	5.51
	Carbon	57.25
	Nitrogen	1.02
	Oxygen	19.22
Calorific value determined:		
	Calories	5,841
	British thermal units	10,514

STEAMING TESTS.

Test 101, Illinois No. 8.

Size as shipped, nut. Size as used, over 1 inch, 58 per cent; ½ inch to 1 inch, 21.9 per cent; ¼ inch to ½ inch, 8.7 per cent; under ¼ inch, 11.4 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 102, Illinois No. 8.

Size as shipped, nut. Size as used, over 1 inch 50.4 per cent; ½ inch to 1 inch, 25.5 per cent; ¼ inch to ½ inch, 10.6 per cent; under ¼ inch, 13.5 per cent. Duration of test, 10 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 101.	Test 102.
Heating value of coal, B. T. U. per pound dry coal	12,047	12,002
Force of draft:		
Under stack damper, inch water	0.63	0.63
Above fire, do	.31	.25
Furnace temperature, °F		
Dry coal used per square foot of grate surface per hour, pounds	28.82	28.36
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.21	3.62
Percentage of rated horsepower of boiler developed	90.1	101.5
Water apparently evaporated per pound of coal as fired, pounds	4.56	4.71
Water evaporated from and at 212 °F.:[a]		
Per pound of coal as fired, do	5.39	5.58
Per pound of dry coal, do	6.22	6.39
Per pound of combustible, do	7.75	7.70
Efficiency of boiler, including grate, per cent	49.86	51.41
Coal as fired:		
Per indicated horsepower hour, do	5.25	5.07
Per electrical horsepower hour, do	6.48	6.26
Dry coal:		
Per indicated horsepower hour, do	4.55	4.42
Per electrical horsepower hour, do	5.61	5.46

[a] A better evaporation would have been obtained if boilers and gas-sampling apparatus had been in better condition, as they were later.

ANALYSES.

	Test 101.	Test 102.		Test 101.	Test 102.
Proximate.			*Ultimate.*		
Moisture	13.31	12.67	Carbon [a]	65.13	65.31
Volatile matter	34.61	34.23	Hydrogen [a]	4.59	4.61
Fixed carbon	39.39	40.00	Oxygen [a]	8.53	8.56
Ash	12.69	13.10	Nitrogen [a]	1.16	1.16
	100.00	100.00	Sulphur	5.95	5.36
Sulphur	5.16	4.68	Ash	14.64	15.00
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 29, Illinois No. 8.

Size as shipped, nut. Size as used, not determined. Duration of test, 42 hours.

Average electrical horsepower	208.0
Average B. T. U. gas, per cubic foot	147.0
Total coal fired, pounds	16,050

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 29.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.93	1.68	1.46
Developed at switch board	1.84	1.60	1.39
Per brake horsepower:			
Available for outside purposes	1.64	1.43	1.24
Developed at engine	1.56	1.36	1.18
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	2.08	1.81	1.57
Developed at switch board	1.98	1.72	1.50
Per brake horsepower:			
Available for outside purposes	1.77	1.54	1.34
Developed at engine	1.68	1.47	1.27

ANALYSES.

	Test 29.		Test 29.
Coal.		*Gas by volume.*	
Moisture	12.91	Carbon dioxide (CO_2)	8.0
Volatile matter	33.83	Carbon monoxide (CO)	19.8
Fixed carbon	41.67	Hydrogen (H_2)	10.3
Ash	11.59	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	58.7
Sulphur	4.64	Oxygen (O_2)	0.1
			100.0

ILLINOIS NO. 9.

Bituminous coal from mine No. 2, Mount Olive and Staunton Coal Company, Staunton, Macoupin County, Ill., on the Litchfield and Madison Railroad.

Two separate samples of coal were shipped from this mine under the supervision of Inspector J. S. Burrows. One sample consisted of run-of-mine coal and is called Illinois No. 9 A. The following tests were made on this sample: Washing test No. 102, steaming tests Nos. 103, 104, and 105, and steaming test on washed coal No. 113. The second sample, designated as Illinois No. 9 B, consisted of lump coal and was used in making steaming test No. 121 and producer-gas test No. 28.

Two samples for chemical analysis were taken in this mine from two widely separated points as follows: No. 1625 from the face of room 11 off the first entry north; No. 1626 from the face of the main air course.

CHEMICAL ANALYSES.

		Mine samples.		Car sample A.	Car sample B.
	Laboratory number	1625	1626	1635	1639
	Air-drying loss	7.70	7.70	9.00	10.10
Proximate.	Moisture	13.29	15.27	13.54	13.72
Proximate.	Volatile matter	37.07	36.19	35.69	36.24
Proximate.	Fixed carbon	40.74	39.34	40.03	39.72
Proximate.	Ash	8.90	9.20	10.74	10.32
Proximate.	Sulphur	4.12	3.70	4.03	3.96
Ultimate.	Hydrogen	.....	.....	5.71	5.74
Ultimate.	Carbon	.....	.....	58.69	58.95
Ultimate.	Nitrogen	.....	.....	.95	.98
Ultimate.	Oxygen	.....	.....	19.88	20.05
	Calorific value determined:				
	Calories	6,201	.....	6,004	6,039
	British thermal units	11,162	.....	10,807	10,870

STEAMING TESTS.

Test 103, Illinois No. 9 A.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 10.02 hours. Kind of grate, plain.

Test 104, Illinois No. 9 A.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 9.9 hours. Kind of grate, plain.

Test 105, Illinois No. 9 A.

Size as shipped, run of mine. Size as used, over 1 inch, 33.3 per cent; ½ inch to 1 inch, 26.0 per cent; ¼ inch to ½ inch, 15.8 per cent; under ¼ inch, 24.9 per cent. Duration of test, 10.03 hours. Kind of grate, plain.

Test 113, Illinois No. 9 A, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 24.6 per cent; ½ inch to 1 inch, 27.8 per cent; ¼ inch to ½ inch, 20.4 per cent; under ¼ inch, 27.2 per cent. Duration of test, 9.98 hours. Kind of grate, rocking.

Test 121, Illinois No. 9 B.

Size as shipped, lump. Size as used, over 1 inch 35.7 per cent; ½ inch to 1 inch, 29.1 per cent; ¼ inch to ½ inch, 15.0 per cent; under ¼ inch, 20.2 per cent. Duration of test, 9.93 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 103.	Test 104.	Test 105.	Test 113.	Test 121.
Heating value of coal..B. T. U. per pound dry coal	12,506	12,483	12,555	12,947	12,438
Force of draft:					
Under stack damper.....inch water..	0.56	0.37	0.66	0.50	0.59
Above fire.....do....	.27	.19	.25	.20	.19
Furnace temperature.....°F..	2,218	2,155	2,220	.....	.....
Dry coal used per square foot of grate surface per hour.....pounds..	26.53	23.22	30.26	25.60	26.60
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.61	3.01	4.08	3.05	3.57
Percentage of rated horsepower of boiler developed.	101.1	84.4	114.3	85.6	100.0
Water apparently evaporated per pound of coal as fired.....pounds..	5.06	4.85	4.99	4.84	5.72
Water evaporated from and at 212° F.: [a]					
Per pound of coal as fired.....do....	5.94	5.70	5.93	5.68	6.69
Per pound of dry coal.....do....	6.81	6.50	6.75	6.66	7.49
Per pound of combustible.....do....	7.87	7.63	7.79	7.50	8.83
Efficiency of boiler, including grate.....per cent..	52.59	50.28	51.92	49.67	58.15
Coal as fired:					
Per indicated horsepower hour.....pounds..	4.76	4.96	4.77	4.98	4.23
Per electrical horsepower hour.....do....	5.88	6.12	5.89	6.15	5.22
Dry coal:					
Per indicated horsepower hour.....do....	4.15	4.35	4.19	4.25	3.77
Per electrical horsepower hour.....do....	5.13	5.37	5.17	5.24	4.66

[a] A better evaporation would have been obtained if boilers and gas-sampling apparatus had been in better condition, as they were later.

ANALYSES.

	Test 103.	Test 104.	Test 105.	Test 113.	Test 121.
Proximate.					
Moisture	12.76	12.21	12.10	14.66	10.70
Volatile matter	36.12	36.38	36.23	36.71	35.84
Fixed carbon	40.78	40.27	41.05	41.19	41.82
Ash	10.34	11.14	10.62	7.44	11.64
	100.00	100.00	100.00	100.00	100.00
Sulphur	3.94	3.89	4.08	3.34	4.11
Ultimate.					
Carbon [a]	68.45	67.83	68.17	71.54	67.42
Hydrogen [a]	4.92	4.88	4.89	5.13	4.83
Oxygen [a]	9.16	9.08	9.13	9.55	8.99
Nitrogen [a]	1.10	1.09	1.10	1.15	1.12
Sulphur	4.52	4.43	4.64	3.91	4.60
Ash	11.85	12.69	12.07	8.72	13.04
	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 28, Illinois No. 9 B.

Size as shipped, lump. Size as used, not determined. Duration of test, 60 hours.

Average electrical horsepower	208.0
Average B. T. U. gas, per cubic foot	143.7
Total coal fired, pounds	23,700

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 28.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.99	1.76	1.53
Developed at switch board	1.90	1.67	1.45
Per brake horsepower:			
Available for outside purposes	1.70	1.49	1.30
Developed at engine	1.61	1.42	1.23
Equivalent used by producer.			
Per electrical horsepower:			
Available for outside purposes	2.11	1.86	1.62
Developed at switch board	2.01	1.77	1.54
Per brake horsepower:			
Available for outside purposes	1.79	1.58	1.37
Developed at engine	1.71	1.50	1.31

ANALYSES.

	Test 28.		Test 28.
Coal.		*Gas by volume.*	
Moisture	11.99	Carbon dioxide (CO_2)	8.9
Volatile matter	35.90	Carbon monoxide (CO)	16.0
Fixed carbon	40.63	Hydrogen (H_2)	9.4
Ash	11.48	Methane (CH_4)	5.1
	100.00	Nitrogen (N_2)	60.5
Sulphur	4.92	Oxygen (O_2)	0.1
			100.0

WASHING TEST.

Test 102, Illinois No. 9 A.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	18,000
Washed coal	do....	13,920
Refuse	do....	4,080

ANALYSES.

	Test 102.	
	Raw coal.	Washed coal.
Moisture	13.54	15.65
Volatile matter	35.69	.....
Fixed carbon	40.03	.....
Ash	10.74	7.57
Sulphur	4.03	3.38

ILLINOIS NO. 10.

Bituminous coal from West Frankfort mine, Dering Coal Company, West Frankfort, Franklin County, Ill., on the Chicago and Eastern Illinois Railroad.

This sample consisted of one car of slack coal. It was shipped without inspection, as the corps of inspectors was not organized at the time the coal was asked for. The following tests were made on this sample: Washing test No. 103, steaming tests Nos. 107, 108, 109, and 110, steaming test on washed coal No. 114, and producer-gas test No. 31.

No mine samples have as yet been obtained from this mine.

CHEMICAL ANALYSES.

		Car sample.
Laboratory number		1648
Air-drying loss		6.90
Proximate.	Moisture	9.50
	Volatile matter	31.98
	Fixed carbon	47.08
	Ash	11.44
Ultimate.	Sulphur	1.45
	Hydrogen	5.31
	Carbon	63.83
	Nitrogen	1.36
	Oxygen	16.61
Calorific value determined:		
	Calories	6,392
	British thermal units	11,506

STEAMING TESTS.

Test 107, Illinois No. 10.

Size as shipped, slack. Size as used, over 1 inch, 2.9 per cent; ½ inch to 1 inch, 23.1 per cent; ¼ inch to ½ inch, 26.4 per cent; under ¼ inch, 47.6 per cent. Duration of test, 10.17 hours. Kind of grate, plain.

Test 108, Illinois No. 10.

Size as shipped, slack. Size as used, over 1 inch, 7.6 per cent; ½ inch to 1 inch, 19.2 per cent; ¼ inch to ½ inch, 21.1 per cent; under ¼ inch, 52.1 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 109, Illinois No. 10.

Size as shipped, slack. Size as used, over 1 inch, 22.8 per cent; ½ inch to 1 inch, 30.1 per cent; ¼ inch to ½ inch, 17.3 per cent; under ¼ inch, 29.8 per cent. Duration of test, 9.98 hours. Kind of grate, rocking.

Test 110, Illinois No. 10.

Size as shipped, slack. Size as used, over 1 inch, 19.2 per cent; ½ inch to 1 inch, 32.6 per cent; ¼ inch to ½ inch, 18.4 per cent; under ¼ inch, 29.8 per cent. Duration of test, 9.95 hours. Kind of grate, rocking.

Test 114, Illinois No. 10, washed.

Size as shipped, slack. Size as used, over 1 inch, 12.8 per cent; ½ inch to 1 inch, 27.5 per cent; ¼ inch to ½ inch, 23.4 per cent; under ¼ inch, 36.3 per cent. Duration of test, 10.05 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 107.	Test 108.	Test 109.	Test 110.	Test 114.
Heating value of coal, B. T. U. per pound dry coal	12,429	12,685	12,373	12,929	13,545
Force of draft:					
Under stack damper, inch water	0.59	0.42	0.51	0.45	0.51
Above fire, do	.32	.21	.29	.26	.21
Furnace temperature, °F.	2,229	.....	.....	.....	.....
Dry coal used per square foot of grate surface per hour, pounds	21.00	22.24	21.46	20.66	24.23
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.20	3.13	2.96	2.48	3.52
Percentage of rated horsepower of boiler developed	89.9	87.6	83.0	69.6	98.7
Water apparently evaporated per pound of coal as fired, pounds	5.73	5.41	5.83	5.16	6.07
Water evaporated from and at 212° F.:[a]					
Per pound of coal as fired, do	6.76	6.39	6.90	6.08	7.16
Per pound of dry coal, do	7.65	7.04	7.70	6.71	8.11
Per pound of combustible, do	9.17	8.28	9.52	8.05	8.94
Efficiency of boiler, including grate, per cent	59.44	53.60	60.10	50.12	57.82
Coal as fired:					
Per indicated horsepower hour, pounds	4.18	4.43	4.10	4.65	3.95
Per electrical horsepower hour, do	5.16	5.46	5.06	5.74	4.88
Dry coal:					
Per indicated horsepower hour, do	3.70	4.02	3.67	4.21	3.49
Per electrical horsepower hour, do	4.56	4.96	4.53	5.20	4.30

[a] A better evaporation would have been obtained if boilers and gas-sampling apparatus had been in better condition, as they were later.

ANALYSES.

	Test 107.	Test 108.	Test 109.	Test 110.	Test 114.
Proximate.					
Moisture	11.62	9.29	10.32	9.29	11.67
Volatile matter	30.59	31.24	30.01	32.54	32.37
Fixed carbon	44.93	47.84	46.27	48.11	49.87
Ash	12.86	11.63	13.40	10.06	6.09
	100.00	100.00	100.00	100.00	100.00
Sulphur	1.45	1.44	1.46	1.40	1.22

ANALYSES—continued.

	Test 107.	Test 108.	Test 109.	Test 110.	Test 114.
Ultimate.					
Carbon[a]	68.93	70.38	68.61	71.87	75.42
Hydrogen[a]	4.59	4.69	4.57	4.78	5.03
Oxygen[a]	8.86	9.06	8.83	9.23	9.67
Nitrogen[a]	1.43	1.46	1.42	1.49	1.61
Sulphur	1.64	1.59	1.63	1.54	1.38
Ash	14.55	12.82	14.94	11.09	6.89
	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 31, Illinois No. 10.

Size as shipped, slack. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	207.5
Average B. T. U. gas, per cubic foot	140.7
Total coal fired, pounds	15,600

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 31.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.60	1.46	1.29
Developed at switch board	1.50	1.38	1.22
Per brake horsepower:			
Available for outside purposes	1.36	1.24	1.10
Developed at engine	1.28	1.17	1.03
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.69	1.54	1.36
Developed at switch board	1.59	1.45	1.28
Per brake horsepower:			
Available for outside purposes	1.44	1.31	1.16
Developed at engine	1.35	1.23	1.09

ANALYSES.

	Test 31.		Test 31.
Coal.		*Gas by volume.*	
Moisture	8.57	Carbon dioxide (CO_2)	9.0
Volatile matter	32.31	Carbon monoxide (CO)	18.5
Fixed carbon	48.45	Hydrogen (H_2)	11.5
Ash	10.67	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	57.9
Sulphur	1.35		100.00

WASHING TEST.

Test 103, Illinois No. 10.

Size as shipped, slack. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds	14,710
Washed coal	do	12,795
Refuse	do	1,915

ANALYSES.

	Test 103.	
	Raw coal.	Washed coal.
Moisture	9.50	11.86
Volatile matter	31.98	.....
Fixed carbon	47.08	.....
Ash	11.44	6.67
Sulphur	1.45	1.38

ILLINOIS NO. 11.

Bituminous coal from Daw's shaft, St. Louis and Big Muddy Coal Company, near Carterville, Williamson County, Ill., on the Illinois Central Railroad.

Four samples of coal were shipped as follows: Illinois No. 11 A, one-half screenings and one-half egg coal; Illinois No. 11 B, one-half run-of-mine and one-half lump coal; Illinois No. 11 C, one-half No. 4 washed coal and one-half No. 5 washed coal; Illinois No. 11 D, No. 3 washed coal. These samples were shipped under the supervision of J. S. Burrows, and were used in making the following tests: Illinois No. 11 A, steaming tests Nos. 137, 138, 139, and 141, and producer-gas test No. 30; Illinois No. 11 B, steaming tests Nos. 111, 112, 115, 116, 117, 118, and 119; Illinois No. 11 C, steaming test No. 120, and producer-gas test No. 36; Illinois No. 11 D, coking test No. 5, and producer-gas tests Nos. 42 and 48.

Two mine samples were taken in this mine, but one of them was lost in transit. The one received at the laboratory (No. 1634) was cut from the face of the north entry off the straight west heading.

CHEMICAL ANALYSES.

		Mine sample.	Car sample A.	Car sample B.	Car sample C.
Laboratory number		1634	1654	1660	1718
Air-drying loss		4.90	4.80	5.80	6.40
Proximate.	Moisture	8.30	7.76	8.86	8.61
	Volatile matter	33.75	31.44	31.25	32.40
	Fixed carbon	48.69	50.19	48.23	51.33
	Ash	9.26	10.61	11.66	7.66
Ultimate.	Sulphur	2.82	1.97	2.46	1.65
	Hydrogen	.....	5.14	5.24	5.38
	Carbon	.....	66.55	64.29	68.14
	Nitrogen	.....	1.32	1.29	1.34
	Oxygen	.....	14.41	15.06	15.83
Calorific value determined:					
	Calories	6,666	6,643	6,501	6,798
	British thermal units	11,999	11,957	.....	12,236

STEAMING TESTS.

Test 137, Illinois No. 11 A.

Size as shipped, screenings. Size as used, over 1 inch, 21.2 per cent; ½ inch to 1 inch, 23.6 per cent; ¼ inch to ½ inch, 18.2 per cent; under ¼ inch, 37.0 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 138, Illinois No. 11 A.

Size as shipped, screenings. Size as used, over 1 inch, 17.4 per cent; ½ inch to 1 inch, 21.9 per cent; ¼ inch to ½ inch, 15.6 per cent; under ¼ inch, 45.1 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 139, Illinois No. 11 A.

Size as shipped, screenings. Size as used, over 1 inch, 17.3 per cent; ½ inch to 1 inch, 19.1 per cent; ¼ inch to ½ inch, 15.8 per cent; under ¼ inch, 47.8 per cent. Duration of test, 9.93 hours. Kind of grate, rocking.

Test 141, Illinois No. 11 A.

Size as shipped, screenings. Size as used, over 1 inch, 20.4 per cent; ½ inch to 1 inch, 25.3 per cent; ¼ inch to ½ inch, 18.5 per cent; under ¼ inch, 35.8 per cent. Duration of test, 7.08 hours. Kind of grate, plain.

Test 111, Illinois No. 11 B.

Size as shipped, run of mine. Size as used, over 1 inch, 39.4 per cent; ½ inch to 1 inch, 25.2 per cent; ¼ inch to ½ inch, 14.5 per cent; under ¼ inch, 20.9 per cent. Duration of test, 10.08 hours. Kind of grate, rocking.

Test 112, Illinois No. 11 B.

Size as shipped, run of mine. Size as used, over 1 inch, 28.9 per cent; ½ inch to 1 inch, 21.3 per cent; ¼ inch to ½ inch, 17.8 per cent; under ¼ inch, 32.0 per cent. Duration of test, 10.07 hours. Kind of grate, rocking.

Test 115, Illinois No. 11 B.

Size as shipped, run of mine. Size as used, over 1 inch, 24.6 per cent; ½ inch to 1 inch, 24.0 per cent; ¼ inch to ½ inch, 18.2 per cent; under ¼ inch, 33.2 per cent. Duration of test, 9.87 hours. Kind of grate, plain.

Test 116, Illinois No. 11 B.

Size as shipped, run of mine. Size as used, over 1 inch, 40.1 per cent; ½ inch to 1 inch, 21.6 per cent; ¼ inch to ½ inch, 15.2 per cent; under ¼ inch, 23.1 per cent. Duration of test, 6.05 hours. Kind of grate, plain.

Test 117, Illinois No. 11 B.

Size as shipped, lump. Size as used, over 1 inch, 33.6 per cent; ½ inch to 1 inch, 24.8 per cent; ¼ inch to ½ inch, 16.3 per cent; under ¼ inch, 25.3 per cent. Duration of test, 10.1 hours. Kind of grate, plain.

Test 118, Illinois No. 11 B.

Size as shipped, lump. Size as used, over 1 inch, 20.4 per cent; ½ inch to 1 inch, 18.2 per cent; ¼ inch to ½ inch, 17.4 per cent; under ¼ inch, 44.0 per cent. Duration of test, 9.9 hours. Kind of grate, plain.

Test 119, Illinois No. 11 B.

Size as shipped, lump. Size as used, over 1 inch, 27.6 per cent; ½ inch to 1 inch, 24.5 per cent; ¼ inch to ½ inch, 18.3 per cent; under ¼ inch, 29.6 per cent. Duration of test, 10.07 hours. Kind of grate, plain.

Test 120, Illinois No. 11 C, washed.

Size as shipped, No. 4 washed. Size as used, over 1 inch, 0 per cent; ½ inch to 1 inch, 16.4 per cent; ¼ inch to ½ inch, 45.8 per cent; under ¼ inch, 37.8 per cent. Washed at mine. Duration of test, 9.95 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 137.	Test 138.	Test 139.	Test 141.	Test 111.	Test 112.
Heating value of coal, B. T. U. per pound dry coal	12,348	12,159	12,254	12,505	12,643	12,775
Force of draft:						
Under stack damper....inch water..	0.60	0.60	0.62	0.60	0.55	0.48
Above fire.....do....	.16	.18	.18	.15	.28	.27
Furnace temperature.....°F..	.....	2376	2435	.....	.....	.....
Dry coal used per square foot of grate surface per hour.....pounds..	20.98	19.94	19.70	18.81	24.35	22.36
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.17	2.97	3.06	3.11	2.93	2.90
Percentage of rated horsepower of boiler developed.....	88.8	83.4	85.8	87.3	82.0	81.2
Water apparently evaporated per pound of coal as fired.....pounds..	6.65	6.59	6.86	6.58	5.23	5.59
Water evaporated from and at 212° F.:						
Per pound of coal as fired...pounds..	7.76	7.68	8.02	7.66	[a] 6.15	[a] 6.59
Per pound of dry coal.....do....	8.42	8.32	8.67	8.29	6.70	7.23
Per pound of combustible.....do....	10.19	10.13	10.42	9.70	8.21	8.99
Efficiency of boiler, including grate, per cent.....	64.51	66.08	68.33	64.02	51.18	54.65
Coal as fired:						
Per indicated horsepower hour..lbs..	3.64	3.68	3.53	3.69	4.60	4.29
Per electrical horsepower hour...do..	4.50	4.55	4.35	4.56	5.68	5.30
Dry coal:						
Per indicated horsepower hour...do..	3.36	3.40	3.26	3.41	4.22	3.91
Per electrical horsepower hour...do..	4.14	4.20	4.03	4.21	5.21	4.83

	Test 115.	Test 116.	Test 117.	Test 118.	Test 119.	Test 120.
Heating value of coal, B. T. U. per pound dry coal	12,321	12,933	12,537	12,801	13,079	13,370
Force of draft:						
Under stack damper....inch water..	0.61	0.49	0.50	0.39	0.57	0.58
Above fire.....do....	.26	.22	.20	.16	.25	.23
Furnace temperature.....°F..	.....	.....	.....	.....	.....	.....
Dry coal used per square foot of grate surface per hour.....pounds..	22.89	24.19	23.80	23.16	25.70	25.41
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.42	3.61	3.42	3.32	3.75	3.55
Percentage of rated horsepower of boiler developed.....	96.0	101.3	95.8	93.1	105.0	99.5
Water apparently evaporated per pound of coal as fired.....pounds..	5.82	5.86	5.73	5.76	5.81	6.03
Water evaporated from and at 212° F.:						
Per pound of coal as fired...pounds..	[a] 6.83	[a] 6.94	[a] 6.71	[a] 6.74	[a] 6.84	[a] 7.08
Per pound of dry coal.....do....	7.49	7.48	7.19	7.19	7.31	7.79
Per pound of combustible.....do....	9.20	8.79	8.51	8.46	8.46	8.74
Efficiency of boiler, including grate, per cent.....	58.71	55.85	55.38	54.26	53.97	56.27
Coal as fired:						
Per indicated horsepower hour..lbs..	4.14	4.07	4.21	4.19	4.13	3.99
Per electrical horsepower hour...do..	5.11	5.03	5.20	5.18	5.10	4.93
Dry coal:						
Per indicated horsepower hour...do..	3.78	3.78	3.93	3.94	3.87	3.63
Per electrical horsepower hour...do..	4.66	4.67	4.85	4.85	4.78	4.48

[a] A better evaporation would have been obtained if boilers and gas-sampling apparatus had been in better condition, as they were later.

ANALYSES.

	Test 137.	Test 138.	Test 139.	Test 141.	Test 111.	Test 112.
Proximate.						
Moisture	7.84	7.66	7.54	7.65	8.17	8.93
Volatile matter	28.08	29.76	30.09	30.06	31.53	30.73
Fixed carbon	51.54	48.65	49.31	50.50	48.21	48.21
Ash	12.54	13.93	13.06	11.79	12.09	12.13
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	2.35	2.16	2.57	2.09	2.82	2.33
Ultimate.						
Carbon[a]	70.06	69.00	69.44	70.99	70.54	70.22
Hydrogen[a]	4.50	4.43	4.46	4.56	4.57	4.65
Oxygen[a]	7.89	7.76	7.83	8.01	7.20	7.84
Nitrogen[a]	1.39	1.38	1.37	1.41	1.46	1.41
Sulphur[a]	2.55	2.34	2.78	2.26	3.07	2.56
Ash	13.61	15.09	14.12	12.77	13.16	13.32
	100.00	100.00	100.00	100.00	100.00	100.00

	Test 115.	Test 116.	Test 117.	Test 118.	Test 119.	Test 120.
Proximate.						
Moisture	8.85	7.29	6.69	6.16	6.43	9.14
Volatile matter	28.12	31.34	32.95	33.21	32.23	31.03
Fixed carbon	48.08	50.07	47.59	48.91	50.58	52.33
Ash	14.95	11.30	12.77	11.72	10.76	7.50
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	2.24	2.50	3.47	3.14	2.22	1.64
Ultimate.						
Carbon[a]	67.72	71.07	69.56	70.90	71.96	74.65
Hydrogen[a]	4.49	4.70	4.52	4.60	4.77	4.85
Oxygen[a]	7.57	7.92	7.08	7.20	7.95	8.98
Nitrogen[a]	1.36	1.42	1.44	1.46	1.44	1.47
Sulphur	2.46	2.70	3.72	3.35	2.37	1.80
Ash	16.40	12.19	13.68	12.49	11.51	8.25
	100.00	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TESTS.

Test 30, Illinois No. 11 A.

Size as shipped, egg. Size as used, not determined. Duration of test, 53 hours.

Average electrical horsepower		210.0
Average B. T. U. gas, per cubic foot		173.4
Total coal fired	pounds..	15,450

Test 36, Illinois No. 11 C.

Size as shipped, No. 5 washed. Size as used, not determined. Duration of test, 54 hours.

Average electrical horsepower		173.9
Average B. T. U. gas, per cubic foot		109.8
Total coal fired	pounds..	13,650

Test 42, Illinois No. 11 D.

Size as shipped, No. 3 washed. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower		201.0
Average B. T. U. gas, per cubic foot		146.1
Total coal fired	pounds..	12,600

Test 48, Illinois No. 11 D.

Size as shipped, No. 3 washed. Size as used, not determined. Duration of test; 50 hours.

Average electrical horsepower		202.5
Average B. T. U. gas, per cubic foot		154.9
Total coal fired	pounds..	12,450

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 30.			Test 36.			Test 42.			Test 48.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:												
Available for outside purposes	1.49	1.38	1.22	3.50	3.06	2.65	1.34	1.22	1.12	1.31	1.20	1.11
Developed at switch board	1.39	1.29	1.14	3.27	2.85	2.47	1.25	1.15	1.05	1.23	1.13	1.04
Per brake horsepower:												
Available for outside purposes	1.26	1.18	1.04	2.98	2.60	2.25	1.14	1.04	.96	1.11	1.02	.94
Developed at engine	1.18	1.10	.97	2.78	2.43	2.10	1.07	.97	.90	1.05	.96	.89
Equivalent used by producer plant.												
Per electrical horsepower:												
Available for outside purposes	1.56	1.45	1.28	3.66	3.19	2.77	1.47	1.34	1.24	1.46	1.34	1.24
Developed at switch board	1.46	1.36	1.19	3.42	2.98	2.59	1.38	1.26	1.16	1.37	1.26	1.16
Per brake horsepower:												
Available for outside purposes	1.33	1.23	1.09	3.13	2.72	2.36	1.25	1.14	1.05	1.24	1.14	1.05
Developed at engine	1.24	1.15	1.02	2.91	2.54	2.20	1.17	1.07	.98	1.16	1.07	.99

ANALYSES.

	Test 30.	Test 36.	Test 42.	Test 48.
Coal.				
Moisture	7.08	12.78	8.67	7.99
Volatile matter	32.62	28.03	30.69	32.08
Fixed carbon	49.44	47.63	53.36	52.76
Ash	10.86	11.56	7.28	7.17
	100.00	100.00	100.00	100.00
Sulphur	2.09	1.65	1.53	1.56
Gas by volume.				
Carbon dioxide (CO_2)	6.3	12.2	10.2	7.4
Carbon monoxide (CO)	19.7	12.6	18.3	22.9
Hydrogen (H_2)	9.7	9.5	13.2	13.4
Methane (CH_4)	6.2	3.5	2.6	2.4
Nitrogen (N_2)	58.1	62.1	55.7	53.9
Oxygen (O_2)	.....	.1	.....	.....
	100.0	100.0	100.0	100.0

COKING TEST.

Test 5, Illinois No. 11 D.

Size as shipped, No. 3 washed. Size as used, finely crushed. Duration of test, 48 hours.

Coal charged	pounds	10,000
Coke produced	do	5,400
Breeze produced	do	300
Coke produced	per cent	54.00
Breeze produced	do	3.00
Total percentage yield		57.00

Remarks.—Light-gray and silvery color. Good, strong coke. Might be improved by washing, reducing ash.

ANALYSES.

	Test 5.	
	Coal.	Coke.
Moisture	8.24	1.19
Volatile matter	31.64	.93
Fixed carbon	52.81	85.97
Ash	7.31	11.91
Sulphur	1.55	1.44

ILLINOIS NO. 12.

Bituminous coal from Bush No. 1 mine, Western Coal and Mining Company, Bush, Williamson County, Ill., on the St. Louis, Iron Mountain and Southern Railway.

This sample consisted of run-of-mine coal and was shipped under the supervision of Inspector J. W. Groves. The following tests were made: Washing test No. 106, steaming tests Nos. 127, 128, 131, 133, 136, and steaming test on washed coal No. 135.

Two mine samples were taken from the following places in the mine: No. 1683 from room 10 off the first entry east, on the east side, 1,000 feet northeast of the shaft; No. 1688 from the first north entry, 1,000 feet northwest of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1683	1688	1762
Air-drying loss		5.20	5.60	3.60
Proximate.	Moisture	8.29	8.41	8.20
	Volatile matter	31.19	34.27	32.26
	Fixed carbon	49.69	45.44	46.59
	Ash	10.83	11.88	12.95
Ultimate.	Sulphur	2.81	3.63	3.48
	Hydrogen	.....	.....	5.09
	Carbon	.....	.....	62.52
	Nitrogen	.....	.....	1.10
	Oxygen	.....	.....	14.86
Calorific value determined:				
	Calories	6,576	.....	6,312
	British thermal units	11,837	.....	11,362

STEAMING TESTS.

Test 127, Illinois No. 12.

Size as shipped, run of mine. Size as used, over 1 inch, 30.8 per cent; ½ inch to 1 inch, 26.5 per cent; ¼ inch to ½ inch, 17.1 per cent; under ¼ inch, 25.6 per cent. Duration of test, 10.03 hours. Kind of grate, plain.

Test 128, Illinois No. 12.

Size as shipped, run of mine. Size as used, over 1 inch, 46.4 per cent; ½ inch to 1 inch, 21.2 per cent; ¼ inch to ½ inch, 12.3 per cent; under ¼ inch, 20.1 per cent. Duration of test, 10.05 hours. Kind of grate, plain.

Test 131, Illinois No. 12.

Size as shipped, run of mine. Size as used, over 1 inch, 23.8 per cent; ½ inch to 1 inch, 18.1 per cent; ¼ inch to ½ inch, 16.6 per cent; under ¼ inch, 41.5 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 133, Illinois No. 12.

Size as shipped, run of mine. Size as used, over 1 inch, 26.4 per cent; ½ inch to 1 inch, 24.3 per cent; ¼ inch to ½ inch, 17.9 per cent; under ¼ inch 31.4 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 135, Illinois No. 12, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 22.5 per cent; ½ inch to 1 inch, 28.6 per cent; ¼ inch to ½ inch, 24.1 per cent; under ¼ inch, 24.8 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 136, Illinois No. 12.

Size as shipped, run of mine. Size as used, over 1 inch, 15.3 per cent; ½ inch to 1 inch, 22.9 per cent; ¼ inch to ½ inch, 20.8 per cent; under ¼ inch, 41 per cent. Duration of test, 9.68 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 127.	Test 128.	Test 131.	Test 133.	Test 135.	Test 136.
Heating value of coal, B. T. U. per pound dry coal	11,963	12,154	11,709	11,849	13,104	11,867
Force of draft:						
Under stack damper....inch water	0.59	0.46	0.57	0.65	0.63	0.67
Above fire.....do....	.19	.19	.19	.22	.18	.21
Furnace temperature.....°F.						
Dry coal used per square foot of grate surface per hour.....pounds	21.49	21.45	20.87	22.91	23.09	20.77
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.35	3.51	2.91	3.15	3.62	2.91
Percentage of rated horsepower of boiler developed	94.00	98.3	81.5	88.20	101.3	81.5
Water apparently evaporated per pound of coal, as fired.....pounds	6.17	6.45	6.06	5.99	6.69	6.00
Water evaporated from and at 212 ° F.:						
Per pound of coal as fired..pounds	7.15	7.54	7.04	7.00	7.86	7.00
Per pound of dry coal.....do....	7.81	8.19	7.77	7.67	8.75	7.81
Per pound of combustible.....do....	9.60	9.84	10.19	9.73	9.99	9.88
Efficiency of boiler, including grate, per cent	63.04	65.07	64.08	62.51	64.48	63.56
Coal as fired:						
Per indicated horsepower hour, pounds	3.96	3.75	4.02	4.04	3.60	4.04
Per electrical horsepower hour, pounds	4.88	4.63	4.96	4.99	4.44	4.99
Dry coal:						
Per indicated horsepower hour, pounds	3.50	3.45	3.64	3.69	3.23	3.62
Per electrical horsepower hour, pounds	4.50	4.26	4.49	4.55	3.99	4.47

ANALYSES.

	Test 127.	Test 128.	Test 131.	Test 133.	Test 135	Test 136.
Proximate.						
Moisture	8.49	7.93	9.54	8.79	10.19	10.39
Volatile matter	31.04	31.85	29.52	30.70	33.30	29.39
Fixed carbon	45.25	46.18	43.97	44.90	47.27	44.64
Ash	15.22	14.04	16.97	15.61	9.24	15.58
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	3.79	3.92	4.18	4.14	2.58	3.56
Ultimate.						
Carbon[a]	65.71	66.76	63.55	65.00	72.02	65.23
Hydrogen[a]	4.39	4.45	4.24	4.33	4.82	4.36
Oxygen[a]	7.97	8.11	7.71	7.87	8.73	7.91
Nitrogen[a]	1.16	1.17	1.12	1.14	1.27	1.15
Sulphur	4.14	4.26	4.62	4.54	2.87	3.97
Ash	16.63	15.25	18.76	17.12	10.29	17.38
	100.00	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 106, Illinois No. 12.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	18,000
Washed coal	do....	15,900
Refuse	do....	2,100

ANALYSES.

	Test 106.	
	Raw coal.	Washed coal.
Moisture	8.20	13.30
Volatile matter	32.26	.....
Fixed carbon	46.59	.....
Ash	12.95	8.91
Sulphur	3.48	2.48

ILLINOIS NO. 13.

Bituminous coal from Benton mine, Benton Coal Company, Benton, Franklin County, Ill., on the Chicago and Eastern Illinois Railroad.

This sample was shipped as egg coal, which at this mine passes through a 6-inch screen and over a 1½-inch screen. It was loaded under the supervision of Inspector J. W. Groves, and used in making the following tests: Washing test No. 107, coking tests Nos. 2 and 3, steaming tests Nos. 132, 134, and 144, and steaming test on washed coal No. 145; also producer-gas test No. 41.

A sample for chemical analysis was taken on each side of the mine. No. 1695 was cut from the main entry, 80 feet south from the shaft, and No. 1694 was cut in the main entry, 100 feet north of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1695	1694	1786
Air-drying loss		5.30	5.20	4.60
Proximate.	Moisture	10.28	9.46	8.31
	Volatile matter	32.04	33.55	31.65
	Fixed carbon	49.74	48.87	49.56
	Ash	7.94	8.12	10.48
Ultimate.	Sulphur	1.06	1.63	1.55
	Hydrogen			5.18
	Carbon			65.83
	Nitrogen			1.48
	Oxygen			15.48
Calorific value determined:				
	Calories		6,661	6,515
	British thermal units		11,990	11,727

STEAMING TESTS.

Test 132, Illinois No. 13.

Size as shipped, 1½ inch to 6 inch, egg. Size as used, over 1 inch, 31.0 per cent; ½ inch to 1 inch, 22.6 per cent; ¼ inch to ½ inch, 15.0 per cent; under ¼ inch, 31.4 per cent. Duration of test, 9.98 hours. Kind of grate, rocking.

Test 134, Illinois No. 13.

Size as shipped, 1½ inch to 6 inch, egg. Size as used, over 1 inch, 23.8 per cent; ½ inch to 1 inch, 23.8 per cent; ¼ inch to ½ inch, 20.8 per cent; under ¼ inch, 31.6 per cent. Duration of test, 10.02 hours. Kind of grate, rocking.

Test 144, Illinois No. 13, washed.

Size as shipped, 1½ inch to 6 inch, egg. Size as used, over 1 inch, 30.0 per cent; ½ inch to 1 inch, 27.2 per cent; ¼ inch to ½ inch, 19.0 per cent; under ¼ inch, 23.8 per cent. Duration of test, 8.95 hours. Kind of grate, plain.

Test 145, Illinois No. 13, washed.

Size as shipped, 1½ inch to 6 inch, egg. Size as used, over 1 inch, 25.2 per cent; ½ inch to 1 inch, 18.7 per cent; ¼ inch to ½ inch, 20.1 per cent; under ¼ inch, 36.0 per cent. Duration of test, 7.63 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 132.	Test 134.	Test 144.	Test 145.
Heating value of coal.....B. T. U. per pound dry coal..	12,528	12,667	13,261	13,306
Force of draft:				
Under stack damper.....inch water..	0.48	0.65	0.45	0.46
Above fire.....do....	.13	.18	.10	.13
Furnace temperature.....°F..				
Dry coal used per square foot of grate surface per hour, pounds.....	22.06	22.55	20.42	20.14
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.37	3.39	3.70	3.38
Percentage of rated horsepower of boiler developed.....	94.5	95.0	103.8	94.7
Water apparently evaporated per pound of coal as fired, pounds.....	6.57	6.48	7.05	7.16
Water evaporated from and at 212° F.:				
Per pound of coal as fired.....pounds..	7.67	7.58	8.20	8.37
Per pound of dry coal.....do....	8.52	8.39	9.08	9.36
Per pound of combustible.....do....	10.16	9.83	10.09	10.36
Efficiency of boiler, including grate.....per cent..	65.67	63.96	66.12	67.93
Coal as fired:				
Per indicated horsepower hour.....pounds..	3.69	3.73	3.45	3.38
Per electrical horsepower hour.....do....	4.55	4.61	4.26	4.17
Dry coal:				
Per indicated horsepower hour.....do....	3.32	3.37	3.12	3.02
Per electrical horsepower hour.....do....	4.10	4.16	3.84	3.73

ANALYSES.

	Test 132.	Test 134.	Test 144.	Test 145.
Proximate.				
Moisture	9.95	9.64	9.67	10.60
Volatile matter	30.22	30.50	32.59	31.38
Fixed carbon	47.73	48.81	50.18	50.84
Ash	12.10	11.05	7.56	7.18
	100.00	100.00	100.00	100.00
Sulphur	1.32	1.59	1.30	1.34
Ultimate.				
Carbon[a]	70.32	71.07	74.52	74.77
Hydrogen[a]	4.55	4.60	4.83	4.84
Oxygen[a]	8.64	8.75	9.17	9.18
Nitrogen[a]	1.58	1.59	1.67	1.68
Sulphur	1.47	1.76	1.44	1.50
Ash	13.44	12.23	8.37	8.03
	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 41, Illinois No. 13.

Size as shipped, 1½ inch to 6 inch, egg. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower 208.7
Average B. T. U. gas, per cubic foot 156.8
Total coal fired ..... pounds.. 16,950

	Test 41.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.72	1.57	1.39
Developed at switch board	1.63	1.48	1.32
Per brake horsepower:			
Available for outside purposes	1.46	1.33	1.18
Developed at engine	1.38	1.26	1 12
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.84	1.68	1.49
Developed at switch board	1.74	1.59	1 41
Per brake horsepower:			
Available for outside purposes	1.56	1.42	1.26
Developed at engine	1.48	1.35	1.20

ANALYSES.

	Test 41.		Test 41.
Coal.		*Gas by volume.*	
Moisture	8.72	Carbon dioxide (CO_2)	8.1
Volatile matter	31.07	Carbon monoxide (CO)	21.0
Fixed carbon	49.94	Hydrogen (H_2)	11.6
Ash	10.27	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	56.2
Sulphur	1.66		100.0

WASHING TEST.

Test 107, Illinois No. 13.

Size as shipped, 1½ inch to 6 inch, egg. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds.	29,950
Washed coal	do	27,550
Refuse	do	2,400

ANALYSES.

	Test 107.	
	Raw coal.	Washed coal.
Moisture	8.31	11.15
Volatile matter	31.65	.....
Fixed carbon	49.56	.....
Ash	10.48	7.49
Sulphur	1.55	1.27

COKING TESTS.

Test 2, Illinois No. 13, washed.

Size as shipped, 1½-inch to 6-inch egg. Size as used, finely crushed. Duration of test, 65 hours.

Coal charged	pounds.	10,000
Coke produced	do	4,600
Breeze produced	do	718
Coke produced	per cent.	46.00
Breeze produced	do	7.18
Total percentage yield		53.18

Remarks.—Good hard coke. Washing improves product both in ash and sulphur.

Test 3, Illinois No. 13.

Size as shipped, 1½-inch to 6-inch egg. Size as used, finely crushed. Raw. Duration of test, 65 hours.

Coal charged	pounds.	12,000
Coke produced	do	5,358
Breeze produced	do	1,327
Coke produced	per cent.	44.65
Breeze produced	do	11.06
Total percentage yield		55.71

Remarks.—Coke has dull appearance. Softer than coke from washed coal. Seasoned ovens would probably give better results.

ANALYSES.

	Test 2.		Test 3.	
	Coal.	Coke.	Coal.	Coke.
Moisture	11.44	4.60	10.56	2.73
Volatile matter	30.95	1.68	30.08	1.36
Fixed carbon	50.16	82.08	49.08	79.30
Ash	7.45	11.64	10.28	16.61
Sulphur	1.25	1.27	1.71	1.77

ILLINOIS NO. 14.[a]

Bituminous coal from No. 2 mine, Capital Coal Company, east side of Springfield, Sangamon County, Ill., on the Illinois Central Railroad.

This sample was shipped under the supervision of Inspector J. W. Groves and consisted of lump coal. In making lump coal at this mine it is passed over a 1½-inch bar screen. The following tests were made on this coal: Washing test No. 105, steaming tests Nos. 123 and 125, and steaming test on washed coal No. 130; also producer-gas test No. 37.

Two mine samples were cut from widely separated points in the mine. No. 1704 was taken from the face of room 30 off the twenty-first south entry, 1 mile southeast of the shaft; No. 1705 was taken in the sixteenth entry off the fourth "stub" entry, 4,000 feet northeast of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1704	1705	1740
Air-drying loss		10.80	11.20	8.00
Proximate.	Moisture	13.89	14.45	12.77
	Volatile matter	33.96	34.79	34.68
	Fixed carbon	40.89	40.10	40.77
	Ash	11.26	10.66	11.78
Ultimate.	Sulphur	3.83	3.46	4.16
	Hydrogen	.....	.....	5.49
	Carbon	.....	.....	58.74
	Nitrogen	.....	.....	1.09
	Oxygen	.....	.....	18.74
Calorific value determined:				
	Calories	5,909	.....	5,976
	British thermal units	10,636	.....	10,757

[a] This sample was furnished by the Illinois Central Railroad.

STEAMING TESTS.

Test 123, Illinois No. 14.

Size as shipped, lump. Size as used, over 1 inch, 23.3 per cent; ½ inch to 1 inch, 27.9 per cent; ¼ inch to ½ inch, 19.6 per cent; under ¼ inch, 29.2 per cent. Duration of test, 9.95 hours. Kind of grate, rocking.

Test 125, Illinois No. 14.

Size as shipped, lump. Size as used, over 1 inch, 30.4 per cent; ½ inch to 1 inch, 25.2 per cent; ¼ inch to ½ inch, 17.7 per cent; under ¼ inch, 26.7 per cent. Duration of test, 9.87 hours. Kind of grate, plain.

Test 130, Illinois No. 14, washed

Size as shipped, lump. Size as used, over 1 inch, 21.4 per cent; ½ inch to 1 inch, 27.7 per cent; ¼ inch to ½ inch, 25 per cent; under ¼ inch, 25.9 per cent. Duration of test, 9.92 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 123.	Test 125.	Test 130.
Heating value of coal ..... B. T. U. per pound dry coal	12,008	12,125	12,731
Force of draft:			
Under stack damper ..... inch water	0.60	0.57	0.52
Above fire ..... do	.28	.20	.14
Furnace temperature ..... °F	.....	.....	.....
Dry coal used per square foot of grate surface per hour ..... pounds	23.60	20.30	21.63
Equivalent water evaporated per square foot of water-heating surface per hour ..... pounds	3.10	3.08	3.33
Percentage of rated horsepower of boiler developed	87.0	86.2	93.3
Water apparently evaporated per pound of coal as fired ..... pounds	5.57	5.70	5.57
Water evaporated from and at 212° F.:			
Per pound of coal as fired ..... do	6.49	6.62	6.49
Per pound of dry coal ..... do	7.34	7.58	7.71
Per pound of combustible ..... do	8.99	9.05	8.86
Efficiency of boiler, including grate ..... per cent	59.03	60.37	58.48
Coal as fired:			
Per indicated horsepower hour ..... pounds	4.36	4.27	4.36
Per electrical horsepower hour ..... do	5.38	5.27	5.38
Dry coal:			
Per indicated horsepower hour ..... do	3.85	3.73	3.67
Per electrical horsepower hour ..... do	4.76	4.61	4.53

ANALYSES.

	Test 123.	Test 125.	Test 130.		Test 123.	Test 125.	Test 130.
Proximate.				*Ultimate.*			
Moisture	11.65	12.61	15.83	Carbon [a]	65.44	66.72	70.11
Volatile matter	34.67	33.60	33.50	Hydrogen [a]	4.53	4.62	4.86
Fixed carbon	40.12	41.30	41.38	Oxygen [a]	8.24	8.38	8.83
Ash	13.56	12.49	9.29	Nitrogen [a]	1.22	1.25	1.31
	100.00	100.00	100.00	Sulphur	5.23	4.74	3.85
Sulphur	4.62	4.13	3.24	Ash	15.34	14.29	11.04
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 37, Illinois No. 14.

Size as shipped, lump. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	199.0
Average B. T. U. gas, per cubic foot	150.6
Total coal fired, pounds	16,650

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 37.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.78	1.55	1.33
Developed at switch board	1.67	1.46	1.25
Per brake horsepower:			
Available for outside purposes	1.51	1.32	1.13
Developed at engine	1.42	1.24	1.07
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.90	1.66	1.42
Developed at switch board	1.79	1.56	1.34
Per brake horsepower:			
Available for outside purposes	1.61	1.41	1.21
Developed at engine	1.52	1.33	1.14

ANALYSES.

	Test 37.		Test 37.
Coal.		*Gas by volume.*	
Moisture	12.68	Carbon dioxide (CO_2)	8.2
Volatile matter	33.36	Carbon monoxide (CO)	21.0
Fixed carbon	41.57	Hydrogen (H_2)	10.7
Ash	12.39	Methane (CH_4)	3.2
	100.00	Nitrogen (N_2)	56.9
Sulphur	4.16		100.0

WASHING TEST.

Test 105, Illinois No. 14.

Size as shipped, lump. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	18,000
Washed coal	do....	15,955
Refuse	do....	2,045

ANALYSES.

	Test 105.	
	Raw coal.	Washed coal.
Moisture	12.77	16.32
Volatile matter	34.68	.....
Fixed carbon	40.77	.....
Ash	11.78	9.37
Sulphur	4.16	3.29

ILLINOIS NO. 15.[a]

Bituminous coal from south mine of Pettinger & Davis, Centralia, Marion County, Ill., on the Illinois Central Railroad.

This sample was shipped as lump coal (over 6-inch screen), but it was necessary to close one-half of the screen while the car was being loaded, and consequently a large amount of the smaller sizes of coal, which should have gone through the screen, passed into the car. The sample was inspected by Inspector J. S. Burrows and was used in making the following tests: Washing test No. 110, steaming test No. 126, steaming test on washed coal No. 152, and producer-gas test No. 40.

One of the mine samples taken in this mine (No. 1725) came from the sixteenth east entry, 3,000 feet southeast of the shaft, and the other (No. 1726) was cut from the fourteenth south entry, 4,500 feet southwest of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1725	1726	1761
Air-drying loss		7.20	7.80	4.20
Proximate.	Moisture	10.25	11.88	9.95
	Volatile matter	37.43	35.84	34.76
	Fixed carbon	39.79	43.45	42.06
	Ash	12.53	8.83	13.23
Ultimate.	Sulphur	3.70	3.25	3.87
	Hydrogen	.....	.....	5.25
	Carbon	.....	.....	59.64
	Nitrogen	.....	.....	1.04
	Oxygen	.....	.....	16.97
Calorific value determined:				
	Calories	6,154	.....	6,089
	British thermal units	11,077	.....	10,960

[a] Sample furnished by the Illinois Central Railroad.

STEAMING TESTS.

Test 126, Illinois No. 15.

Size as shipped, lump and egg. Size as used, over 1 inch, 20.5 per cent; ½ inch to 1 inch, 25.9 per cent; ¼ inch to ½ inch, 21.1 per cent; under ¼ inch, 32.5 per cent. Duration of test, 9.88 hours. Kind of grate, plain.

Test 152, Illinois No. 15, washed.

Size as shipped, lump and egg. Size as used, over 1 inch, 25.5 per cent; ½ inch to 1 inch, 31.3 per cent; ¼ inch to ½ inch, 21.8 per cent; under ¼ inch, 21.4 per cent. Duration of test, 10.03 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 126.	Test 152.
Heating value of coal.....B. T. U. per pound dry coal..	11,749	13,104
Force of draft:		
Under stack damper.....inch water..	0.55	0.46
Above fire.....do....	.18	.13
Furnace temperature.....°F..	.....	2,439
Dry coal used per square foot of grate surface, per hour.....pounds..	20.44	19.63
Equivalent water evaporated per square foot of water-heating surface, per hour.....pounds..	3.11	3.36
Percentage of rated horsepower of boiler developed.....	87.2	94.3
Water apparently evaporated per pound of coal as fired.....pounds..	5.94	6.51
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	6.86	7.57
Per pound of dry coal.....do....	7.62	8.59
Per pound of combustible.....do....	9.49	9.64
Efficiency of boiler, including grate.....per cent..	62.63	63.30
Coal as fired:		
Per indicated horsepower hour.....pounds..	4.12	3.74
Per electrical horsepower hour.....do....	5.09	4.61
Dry coal:		
Per indicated horsepower hour.....do....	3.71	3.29
Per electrical horsepower hour.....do....	4.58	4.06

ANALYSES.

	Test 126.	Test 152.		Test 126.	Test 152.
Proximate.			*Ultimate.*		
Moisture	10.00	11.81	Carbon[a]	63.78	71.17
Volatile matter	33.39	37.09	Hydrogen[a]	4.43	4.94
Fixed carbon	41.20	42.69	Oxygen[a]	8.70	9.71
Ash	15.41	8.41	Nitrogen[a]	1.12	1.24
	100.00	100.00	Sulphur	4.85	3.40
Sulphur	4.36	3.00	Ash	17.12	9.54
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 40, Illinois No. 15.

Size as shipped, lump and egg. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	200.5
Average B. T. U. gas, per cubic foot	142.9
Total coal fired, pounds	16,950

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 40.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.80	1.63	1.39
Developed at switch board	1.69	1.53	1.30
Per brake horsepower:			
Available for outside purposes	1.53	1.39	1.18
Developed at engine	1.44	1.30	1.11
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.91	1.73	1.45
Developed at switch board	1.80	1.63	1.36
Per brake horsepower:			
Available for outside purposes	1.63	1.47	1.23
Developed at engine	1.53	1.38	1.16

ANALYSES.

	Test 40.		Test 40.
Coal.		*Gas by volume.*	
Moisture	9.44	Carbon dioxide (CO_2)	11.1
Volatile matter	35.48	Carbon monoxide (CO)	16.1
Fixed carbon	41.53	Hydrogen (H_2)	11.2
Ash	13.55	Methane (CH_4)	3.3
		Nitrogen (N_2)	58.3
	100.00		
Sulphur	4.06		100.0

WASHING TEST.

Test 110, Illinois No. 15.

Size as shipped, lump and egg. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	18,000
Washed coal	do....	13,035
Refuse	do....	4,965

ANALYSES.

	Test 110.	
	Raw coal.	Washed coal.
Moisture	9.95	11.81
Volatile matter	34.76	.....
Fixed carbon	42.06	.....
Ash	13.23	8.41
Sulphur	3.87	3.00

ILLINOIS NO. 16.[a]

Bituminous coal from mine No. 7, Big Muddy Coal and Iron Company, Herrin, Williamson County, Ill., on the Illinois Central Railroad.

Lump and egg coal were shipped for testing under the supervision of Inspector J. S. Burrows. This mixture is made by passing the run-of-mine coal over a screen with a 3-inch mesh. The coal was used in making washing test No. 111, coking tests Nos. 7 and 10, steaming test No. 150, and producer-gas test No. 43.

Two mine samples were taken for chemical analyses at working faces in the mine, as follows: No. 1731 in room 17 off the sixth south entry on the west side, 2,300 feet southwest of the shaft; No. 1732 in room 14 off the fifth north entry on the east side, 2,400 feet northeast of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car samples.
Laboratory number		1731	1732	1820
Air-drying loss		5.70	4.80	4.00
Proximate.	Moisture	9.37	8.59	8.43
	Volatile matter	30.69	31.07	30.08
	Fixed carbon	52.57	53.37	51.89
	Ash	7.37	6.97	9.60
Ultimate.	Sulphur	1.25	1.78	1.14
	Hydrogen	.....	.....	5.18
	Carbon	.....	.....	67.33
	Nitrogen	.....	.....	1.50
	Oxygen	.....	.....	15.25
Calorific value determined:				
	Calories	6,699	.....	6,644
	British thermal units	12,058	.....	11,959

[a] Furnished by the Illinois Central Railroad Company.

STEAMING TEST.

Test 150, Illinois No. 16.

Size as shipped, lump and egg. Size as used, over 1 inch, 48.1 per cent; ½ inch to 1 inch, 21.0 per cent; ¼ inch to ½ inch, 12.3 per cent; under ¼ inch, 18.6 per cent. Duration of test, 7.53 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 150.
Heating value of coal.....B. T. U. per pound dry coal..	12,874
Force of draft:	
Under stack damper.....inch water..	0.48
Above fire.....do....	.11
Furnace temperature.....°F..	.....
Dry coal used per square foot of grate surface per hour.....pounds..	19.63
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	3.56
Percentage of rated horsepower of boiler developed.....	99.8
Water apparently evaporated per pound of coal as fired.....pounds..	7.11
Water evaporated from and at 212° F.:	
Per pound of coal as fired.....do....	8.24
Per pound of dry coal.....do....	9.08
Per pound of combustible.....do....	10.42
Efficiency of boiler, including grate.....per cent..	68.11
Coal as fired:	
Per indicated horsepower hour.....pounds..	3.43
Per electrical horsepower hour.....do....	4.24
Dry coal:	
Per indicated horsepower hour.....do....	3.11
Per electrical horsepower hour.....do....	3.85

ANALYSES.

	Test 150.		Test 150.
Proximate.		*Ultimate.*	
Moisture	9.16	Carbon[a]	72.31
Volatile matter	29.57	Hydrogen[a]	4.56
Fixed carbon	51.04	Oxygen[a]	8.33
Ash	10.23	Nitrogen[a]	1.60
		Sulphur	1.94
	100.00	Ash	11.26
Sulphur	1.76		
			100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 43, Illinois No. 16.

Size as shipped, lump and egg. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	201.1
Average B. T. U. gas, per cubic foot	149.5
Total coal fired.....pounds..	17,250

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 43.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.81	1.67	1.48
Developed at switch board	1.72	1.58	1.41
Per brake horsepower:			
Available for outside purposes	1.54	1.42	1.26
Developed at engine	1.46	1.35	1.19
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.91	1.77	1.57
Developed at switch board	1.81	1.67	1.48
Per brake horsepower:			
Available for outside purposes	1.62	1.50	1.33
Developed at engine	1.54	1.42	1.26

ANALYSES.

	Test 43.		Test 43.
Coal.		*Gas by volume.*	
Moisture	7.68	Carbon dioxide (CO_2)	8.0
Volatile matter	30.62	Carbon monoxide (CO)	21.6
Fixed carbon	51.33	Hydrogen (H_2)	12.9
Ash	10.37	Methane (CH_4)	2.7
	100.00	Nitrogen (N_2)	54.8
Sulphur	1.47		100.0

WASHING TEST.

Test 111, Illinois No. 16.

Size as shipped, lump and egg. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds	14,000
Washed coal	do	12,500
Refuse	do	1,500

ANALYSES.

	Test 111.	
	Raw coal.	Washed coal.
Moisture	8.43	10.14
Volatile matter	30.08	.....
Fixed carbon	51.89	.....
Ash	9.60	8.06
Sulphur	1.14	1.02

COKING TESTS.

Test 7, Illinois No. 16.

Size as shipped, lump and egg. Size as used, finely crushed. Raw. Duration of test, —hours.

Remarks.—Accident to charging larry necessitated discontinuing test. Coal burned to keep oven hot.

Test 10, Illinois No. 16, washed.

Size as shipped, lump and egg. Size as used, finely crushed. Duration of test, 66 hours.

Coal charged	pounds..	10,000
Coke produced	do....	5,579
Breeze produced	do....	910
Coke produced	per cent..	55.79
Breeze produced	do....	9.10
Total percentage yield		64.89

Remarks.—Dull-gray color. Poor coke physically.

ANALYSES.

	Test 10.	
	Coal.	Coke.
Moisture	9.79	2.14
Volatile matter	30.35	1.46
Fixed carbon	51.79	83.96
Ash	8.07	12.44
Sulphur	1.09	1.02

ILLINOIS NO. 18.[a]

Bituminous coal from La Salle shaft mine, La Salle County Carbon Cor[1] Company, La Salle, La Salle County, Ill., on the Illinois Central Railroad.

The sample shipped for testing consisted of lump coal passed over a 6-inch mesh screen. It was loaded under the supervision of Inspector J. S. Burrows, and used for the following tests: Washing test No. 109, steaming tests Nos. 140 and 148, steaming tests on washed coal Nos. 147 and 149, and producer-gas test No. 45.

Two mine samples were taken for chemical analysis, as follows: No. 1741 was cut in the twelfth west entry off the north entry; No. 1742 was cut in the third east entry off the third south entry, 4,000 feet from the shaft and 8,000 feet from No. 1741.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1741	1742	1779
Air-drying loss		11.00	11.20	8.40
Proximate.	Moisture	13.87	15.55	12.39
	Volatile matter	37.26	36.21	36.89
	Fixed carbon	38.56	40.66	41.80
	Ash	10.31	7.58	8.92
Ultimate.	Sulphur	3.44	3.01	3.92
	Hydrogen	.....	.....	5.85
	Carbon	.....	.....	61.29
	Nitrogen	.....	.....	1.00
	Oxygen	.....	.....	19.02
Calorific value determined:				
	Calories	6,103	.....	6,333
	British thermal units	10,985	.....	11,399

[a] Sample furnished by Illinois Central Railroad.

STEAMING TESTS.

Test 140, Illinois No. 18.

Size as shipped, lump. Size as used, over 1 inch, 37.3 per cent; ½ inch to 1 inch, 22.2 per cent; ¼ inch to ½ inch, 15.9 per cent; under ¼ inch, 24.6 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 147, Illinois No. 18, washed.

Size as shipped, lump. Size as used, over 1 inch, 9.5 per cent; ½ inch to 1 inch, 25.5 per cent; ¼ inch to ½ inch, 29.6 per cent; under ¼ inch, 35.4 per cent. Duration of test, 9.95 hours. Kind of grate, rocking.

Test 148, Illinois No. 18.

Size as shipped, lump. Size as used, over 1 inch, 27.1 per cent; ½ inch to 1 inch, 25.7 per cent; ¼ inch to ½ inch, 17.9 per cent; under ¼ inch, 29.3 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 149, Illinois No. 18, washed.

Size as shipped, lump. Size as used, over 1 inch, 21.7 per cent; ½ inch to 1 inch, 22.7 per cent; ¼ inch to ½ inch, 28.8 per cent; under ¼ inch, 26.8 per cent. Duration of test, 5.32 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 140.	Test 147.	Test 148.	Test 149.
Heating value of coal.....B. T. U. per pound dry coal..	12,951	13,554	12,991	13,432
Force of draft:				
Under stack damper.....inch water..	0.63	0.57	0.53	0.56
Above fire.....do....	.18	.17	.19	.14
Furnace temperature.....°F..	.....	.....	.....	2060
Dry coal used per square foot of grate surface per hour, pounds.....	18.51	19.53	18.86	17.83
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.86	3.12	2.99	3.29
Percentage of rated horsepower of boiler developed.....	80.1	87.4	83.9	92.2
Water apparently evaporated per pound of coal as fired, pounds.....	6.51	6.49	6.13	6.61
Water evaporated from and at 212° F.:				
Per pound of coal as fired.....pounds..	7.60	7.57	7.06	7.70
Per pound of dry coal.....do....	8.61	8.91	7.94	9.23
Per pound of combustible.....do....	9.90	9.86	9.13	10.08
Efficiency of boiler, including grate.....per cent..	64.20	63.48	59.02	66.36
Coal as fired:				
Per indicated horsepower hour.....pounds..	3.72	3.74	4.01	3.67
Per electrical horsepower hour.....do....	4.59	4.61	4.95	4.53
Dry coal:				
Per indicated horsepower hour.....do....	3.28	3.17	3.56	3.06
Per electrical horsepower hour.....do....	4.06	3.92	4.40	3.78

ANALYSES.

	Test 140.	Test 147.	Test 148.	Test 149.
Proximate.				
Moisture.....	11.72	14.99	11.10	16.64
Volatile matter.....	37.27	37.24	37.11	36.13
Fixed carbon.....	41.73	42.00	42.14	41.51
Ash.....	9.28	5.77	9.65	5.72
	100.00	100.00	100.00	100.00
Sulphur.....	4.07	2.98	3.37	2.72

ANALYSES—continued.

	Test 140.	Test 147.	Test 148.	Test 149.
Ultimate.				
Carbon[a]	69.57	73.53	69.97	73.68
Hydrogen[a]	5.09	5.36	5.11	5.37
Oxygen[a]	9.09	9.61	9.14	9.63
Nitrogen[a]	1.13	1.20	1.14	1.20
Sulphur	4.61	3.51	3.79	3.26
Ash	10.51	6.79	10.85	6.86
	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 45, Illinois No. 18.

Size as shipped, lump. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower		201.7
Average B. T. U. gas, per cubic foot		147.7
Total coal fired	pounds	16,200

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 45.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.71	1.49	1.31
Developed at switch board	1.61	1.40	1.23
Per brake horsepower:			
Available for outside purposes	1.45	1.26	1.12
Developed at engine	1.37	1.19	1.05
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.85	1.61	1.42
Developed at switch board	1.74	1.51	1.33
Per brake horsepower:			
Available for outside purposes	1.57	1.36	1.21
Developed at engine	1.48	1.28	1.13

ANALYSES.

	Test 45.		Test 45.
Coal.		*Gas by volume.*	
Moisture	13.19	Carbon dioxide (CO_2)	11.4
Volatile matter	35.93	Carbon monoxide (CO)	17.2
Fixed carbon	40.84	Hydrogen (H_2)	12.8
Ash	10.04	Methane (CH_4)	3.2
	100.00	Nitrogen (N_2)	55.4
Sulphur	4.59		100.0

WASHING TEST.

Test 109, Illinois No. 18.

Size as shipped, lump. Size as used, crushed to 2 inches. Jig used, Stewart modified

Raw coal	pounds..	18,000
Washed coal	do...	14,400
Refuse	do...	3,600

ANALYSES.

	Test 109.	
	Raw coal.	Washed coal.
Moisture	12.39	14.99
Volatile matter	36.89	.....
Fixed carbon	41.80	.....
Ash	8.92	5.77
Sulphur	3.92	2.98

ILLINOIS NO. 19.

Bituminous coal from Zeigler mine, Zeigler Coal Company, Zeigler, Franklin County, Ill., on the Illinois Central Railroad.

Two samples were loaded under the supervision of Inspector J. W. Groves as follows: Illinois No. 19 A was shipped as "three-fourths inch coal," which had passed over a three-fourths inch perforated shaking screen. It was used in making coking tests Nos. 11 and 15 and steaming tests Nos. 160, 161, 163, 170, and 171. Illinois No. 19 B was shipped as "3-inch coal" which had passed over a 1½-inch perforated shaking screen. It was used in making steaming tests Nos. 175, 204, and 205, producer-gas test No. 55, and coking test No. 19.

Two mine samples were collected from this mine for chemical analysis. No. 1871 was cut from the face of room 5, off the first west entry on the north side, 600 feet northwest of the shaft. No. 1872 was cut from room 5, off the third west entry on the south side, 1,050 feet southwest of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car samples.	
Laboratory number		1871	1872	1926	2020
Air-drying loss		5.20	5.60	9.10	5.60
Proximate.	Moisture	9.90	10.53	14.91	10.72
	Volatile matter	28.67	29.06	26.66	29.86
	Fixed carbon	53.69	53.01	49.50	50.06
	Ash	7.74	7.40	8.93	9.36
Ultimate.	Sulphur	.48	.47	.52	.91
	Hydrogen	.....	.....	5.42	5.30
	Carbon	.....	.....	62.76	66.74
	Nitrogen	.....	.....	1.35	1.40
	Oxygen	.....	.....	21.02	16.29
Calorific value determined:					
Calories		6,667	.....	6,088	6,492
British thermal units		12,001	.....	10,958	11,686

STEAMING TESTS.

Test 160, Illinois No. 19 A.

Size as shipped, ¾-inch coal. Size as used, ½ inch to 1 inch, 21.3 per cent; ¼ inch to ½ inch, 32.0 per cent; under ¼ inch, 46.7 per cent. Duration of test, 10.02 hours. Kind of grate, plain.

Test 161, Illinois No. 19 A.

Size as shipped, ¾-inch coal. Size as used, over 1 inch, 0 per cent; ½ inch to 1 inch, 13.6 per cent; ¼ inch to ½ inch, 27.2 per cent; under ¼ inch, 59.2 per cent. Duration of test, 9.97 hours. Kind of grate, plain.

Test 163, Illinois No. 19 A.

Size as shipped, ¾-inch coal. Size as used, over 1 inch, 0 per cent; ½ inch to 1 inch, 17.7 per cent; ¼ inch to ½ inch, 34.7 per cent; under ¼ inch, 47.6 per cent. Duration of test, 9.98 hours. Kind of grate, plain.

Test 170, Illinois No. 19 A.

Size as shipped, ¾-inch coal. Size as used, over 1 inch, 0 per cent; ½ inch to 1 inch, 13.6 per cent; ¼ inch to ½ inch, 31.3 per cent; under ¼ inch, 55.1 per cent. Duration of test, 9.07 hours. Kind of grate, rocking.

Test 171, Illinois No. 19 A.

Size as shipped, ¾-inch coal. Size as used, over 1 inch, 0 per cent; ½ inch to 1 inch, 13.6 per cent; ¼ inch to ½ inch, 31.8 per cent; under ¼ inch, 54.6 per cent. Duration of test, 9.97 hours. Kind of grate, rocking.

Test 175, Illinois No. 19 B.

Size as shipped, 3-inch coal. Size as used, over 1 inch, 60.2 per cent; ½ inch to 1 inch, 15.7 per cent; ¼ inch to ½ inch, 9.2 per cent; under ¼ inch, 14.9 per cent. Duration of test, 9.9 hours. Kind of grate, plain.

Test 204, Illinois No. 19 B.

Size as shipped, 3-inch coal. Size as used, over 1 inch, 44.0 per cent; ½ inch to 1 inch, 17.2 per cent; ¼ inch to ½ inch, 12.3 per cent; under ¼ inch, 26.5 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 205, Illinois No. 19 B.

Size as shipped, 3-inch coal. Size as used, over 1 inch, 54.4 per cent; ½ inch to 1 inch, 15.1 per cent; ¼ inch to ½ inch, 10.7 per cent; under ¼ inch, 19.8 per cent. Duration of test, 9.93 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 160.	Test 161.	Test 163.	Test 170.	Test 171.	Test 175.	Test 204.	Test 205.
Heating value of coal, B. T. U. per pound dry coal	13,036	12,911	13,068	12,857	12,917	13,005	13,050	13,001
Force of draft:								
Under stack damper, inch water	0.40	0.54	0.67	0.56	0.49	0.41	0.41	0.40
Above fire ....inch water	.14	.20	.17	.16	.17	.09	.11	.12
Furnace temperature....°F	2,428	2,080	2,227	2,039	.....	2,470	2,447	2,448
Dry coal used per square foot of grate surface per hour...pounds	18.47	17.77	20.79	20.22	20.08	20.54	20.69	20.38
Equivalent water evaporated per square foot of water-heating surface per hour ....pounds	3.07	3.12	3.57	3.10	3.23	3.73	3.50	3.38
Percentage of rated horsepower of boiler developed	86.1	87.6	100.2	87.0	90.6	104.7	98.2	94.9
Water apparently evaporated per pound of coal as fired....pounds	6.27	6.54	6.45	6.37	6.71	6.96	7.27	7.11
Water evaporated from and at 212 °F.:								
Per pound of coal as fired, pounds	7.27	7.62	7.50	7.42	7.79	8.13	8.54	8.32
Per pound of dry coal..pounds	8.33	8.80	8.61	8.56	8.97	9.10	9.45	9.27
Per pound of combustible..do	9.45	10.17	9.70	9.85	10.30	10.53	10.83	10.83
Efficiency of boiler, including grate, per cent	61.71	65.82	63.63	64.29	67.06	67.50	69.93	68.86
Coal as fired:								
Per indicated horsepower hour, pounds	3.89	3.71	3.77	3.81	3.63	3.48	3.31	3.40
Per electrical horsepower hour, pounds	4.80	4.58	4.66	4.71	4.48	4.30	4.09	4.20
Dry coal:								
Per indicated horsepower hour, pounds	3.40	3.21	3.28	3.30	3.15	3.11	2.99	3.05
Per electrical horsepower hour, pounds	4.19	3.97	4.06	4.08	3.89	3.84	3.70	3.77

ANALYSES.

	Test 160.	Test 161.	Test 163.	Test 170.	Test 171.	Test 175.	Test 204.	Test 205.
Proximate.								
Moisture	12.79	13.43	12.86	13.28	13.19	10.72	9.56	10.30
Volatile matter	27.24	27.60	28.30	27.72	27.56	29.77	29.40	29.20
Fixed carbon	51.73	50.08	50.80	49.75	50.33	49.30	51.11	50.27
Ash	8.24	8.89	8.04	9.25	8.92	10.21	9.93	10.23
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	.49	.50	.51	.50	.50	.47	.61	.55
Ultimate.								
Carbon[a]	74.67	73.99	74.83	73.65	73.97	74.37	74.62	74.33
Hydrogen[a]	4.47	4.44	4.49	4.42	4.44	4.59	4.60	4.58
Oxygen[a]	9.24	9.16	9.25	9.10	9.14	7.52	7.56	7.51
Nitrogen[a]	1.61	1.58	1.61	1.58	1.59	1.56	1.57	1.56
Sulphur	.56	.58	.59	.58	.58	.53	.67	.61
Ash	9.45	10.25	9.23	10.67	10.28	11.43	10.98	11.41
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 55, Illinois No. 19 B.

Size as shipped, lump, 3 inch. Size as used, over 1 inch, 77 per cent; ½ inch to 1 inch, 9 per cent; ¼ inch to ½ inch, 5 per cent; under ¼ inch, 9 per cent. Duration of test, 50 hours.

Average electrical horsepower 201.1
Average B. T. U. gas, per cubic foot 164.1
Total coal fired ..... pounds.. 13,950

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 55.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.47	1.33	1.19
Developed at switch board	1.39	1.26	1.12
Per brake horsepower:			
Available for outside purposes	1.25	1.13	1.01
Developed at engine	1.18	1.07	.95
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.55	1.40	1.26
Developed at switch board	1.47	1.33	1.19
Per brake horsepower:			
Available for outside purposes	1.32	1.19	1.07
Developed at engine	1.25	1.13	1.01

ANALYSES.

	Test 55.		Test 55.
Coal.		*Gas by volume.*	
Moisture	9.64	Carbon dioxide (CO_2)	7.4
Volatile matter	30.68	Carbon monoxide (CO)	23.9
Fixed carbon	50.22	Hydrogen (H_2)	15.7
Ash	9.46	Methane (CH_4)	2.1
	100.00	Nitrogen (N_2)	50.9
Sulphur	.53		100.00

COKING TESTS.

Test 11, Illinois No. 19 A.

Size as shipped, ¾ inch. Size as used, finely crushed. Raw. Duration of test, 48 hours. Coal charged, 10,000 pounds.

Remarks.—No coke produced.

Test 15, Illinois No. 19 A.

Size as shipped, ¾ inch. Size as used, finely crushed. Raw. Duration of test, 24 hours. Coal charged, 6,000 pounds.

Remarks.—No coke produced.

Test 19, Illinois No. 19 B.

Size as shipped, 3 inches. Size as used, finely crushed. Raw. Duration of test, 47 hours. Coal charged, 6,000 pounds.

Remarks.—No coke produced from this coal. Three trials.

INDIANA NO. 3.

Bituminous coal from mine No. 3, J. Woolley Coal Company, near Boonville, Warrick County, Ind., on the Southern Railway.

This sample, which was shipped under the supervision of Inspector J. W. Groves, consisted of nut and slack coal mixed. It was used in making washing test No. 115, coking test No. 14, steaming test No. 162, and producer-gas test No. 53.

Two mine samples were sent to the laboratory for chemical analysis; they were taken from the mine as follows: No. 1759 was taken from a point 1,500 feet northeast of the shaft; No. 1760 was taken from the face of a room 600 feet northwest of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1759	1760	1941
Air-drying loss		7.60	7.00	8.50
Proximate.	Moisture	11.28	11.10	13.18
	Volatile matter	38.04	37.04	31.92
	Fixed carbon	43.05	42.18	39.27
	Ash	7.63	9.68	15.63
	Sulphur	3.58	4.33	4.79
Ultimate.	Hydrogen	.....	.....	5.36
	Carbon	.....	.....	54.52
	Nitrogen	.....	.....	1.08
	Oxygen	.....	.....	18.62
Calorific value determined:				
	Calories	6,551	.....	5,572
	British thermal units	11,792	.....	10,030

STEAMING TEST.

Test 162, Indiana No. 3.

Size as shipped, nut and slack. Size as used, over 1 inch, 28.4 per cent; ½ inch to 1 inch, 25.8 per cent; ¼ inch to ½ inch, 16.4 per cent; under ¼ inch, 29.4 per cent. Duration of test, 9.65 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 162.
Heating value of coal.....B. T. U. per pound dry coal..	11,669
Force of draft:	
Under stack damper.....inch water..	0.51
Above fire.....do....	.15
Furnace temperature.....°F..	23.51
Dry coal used per square foot of grate surface per hour.....pounds..	20.05
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	3.25
Percentage of rated horsepower of boiler developed.....	91.1
Water apparently evaporated per pound of coal as fired.....pounds..	6.14
Water evaporated from and at 212° F.:	
Per pound of coal as fired.....do....	7.10
Per pound of dry coal.....do....	8.11
Per pound of combustible.....do....	10.15
Efficiency of boiler, including grate.....per cent..	67.12
Coal as fired:	
Per indicated horsepower hour.....pounds..	3.98
Per electrical horsepower hour.....do....	4.92
Dry coal:	
Per indicated horsepower hour.....do....	3.49
Per electrical horsepower hour.....do....	4.30

ANALYSES.

	Test 162.		Test 162.
Proximate.		*Ultimate.*	
Moisture	12.42	Carbon[a]	63.44
Volatile matter	31.83	Hydrogen[a]	4.53
Fixed carbon	40.68	Oxygen[a]	8.03
Ash	15.07	Nitrogen[a]	1.26
	100.00	Sulphur	5.53
Sulphur	4.84	Ash	17.21
			100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 53, Indiana No. 3, washed.

Size as shipped, nut and slack. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower		189.7
Average B. T. U. gas, per cubic foot		137.2
Total coal fired	pounds..	17,550

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 53.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.97	1.74	1.57
Developed at switch board	1.85	1.63	1.48
Per brake horsepower:			
Available for outside purposes	1.67	1.47	1.34
Developed at engine	1.57	1.39	1.26
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	2.09	1.84	1.67
Developed at switch board	1.97	1.73	1.57
Per brake horsepower:			
Available for outside purposes	1.78	1.56	1.42
Developed at engine	1.67	1.47	1.33

ANALYSES.

	Test 53.		Test 53.
Coal.		*Gas by volume.*	
Moisture	11.85	Carbon dioxide (CO_2)	10.7
Volatile matter	36.85	Carbon monoxide (CO)	18.1
Fixed carbon	43.15	Hydrogen (H_2)	10.6
Ash	8.15	Methane (CH_4)	2.7
	100.00	Nitrogen (N_2)	57.9
Sulphur	3.64		100.0

WASHING TEST.

Test 115, Indiana No. 3.

Size as shipped, nut and slack. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	50,000
Washed coal	do....	36,000
Refuse	do....	14,000

ANALYSES.

	Test 115.	
	Raw coal.	Washed coal.
Moisture	13.18	15.02
Volatile matter	31.92	.....
Fixed carbon	39.27	.....
Ash	15.63	8.61
Sulphur	4.79	3.25

COKING TEST.

Test 14, Indiana No. 3.

Size as shipped, nut and slack. Size as used, finely crushed.
Remarks.—Burned for 24 hours. Ashed down about 10 inches. No coke produced.

INDIANA NO. 4.

Bituminous coal from mine No. 29, Consolidated Indiana Coal Company, Star City, Sullivan County, Ind., on the Evansville and Terre Haute Railroad.

This sample was loaded under the supervision of Inspector J. S. Burrows and consisted of screenings which had passed through a 1¼-inch bar screen. The tests made on this sample were as follows: Washing test No. 112, coking tests Nos. 6 and 9, steaming tests Nos. 151, 165, and 166, and steaming test on washed coal No. 154.

Two mine samples were taken from this mine for chemical analysis. No. 1807 was obtained at a point in the eighth east entry on the south side of the mine, 4,000 feet southeast of the shaft, and No. 1775 was cut from the face of room 1 off the thirteenth east entry, 3,900 feet north of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1775	1807	1844
Air-drying loss		9.00	8.90	10.80
Proximate.	Moisture	14.86	13.37	13.99
	Volatile matter	31.65	35.06	29.40
	Fixed carbon	46.14	44.15	42.29
	Ash	7.35	7.42	14.32
Ultimate.	Sulphur	2.26	2.10	2.31
	Hydrogen	.....	.....	5.36
	Carbon	.....	.....	57.18
	Nitrogen	.....	.....	1.11
	Oxygen	.....	.....	19.72
Calorific value determined:				
	Calories	6,291	.....	5,732
	British thermal units	11,324	.....	10,318

STEAMING TESTS.

Test 151, Indiana No. 4.

Size as shipped, screenings. Size as used, over 1 inch, 36.5 per cent; ½ inch to 1 inch, 21 per cent; ¼ inch to ½ inch, 15.4 per cent; under ¼ inch, 27.1 per cent. Duration of test, 10.05 hours. Kind of grate, plain.

Test 154, Indiana No. 4, washed.

Size as shipped, screenings. Size as used, over 1 inch, 18.5 per cent; ½ inch to 1 inch, 29.9 per cent; ¼ inch to ½ inch, 24.4 per cent; under ¼ inch, 27.2 per cent. Duration of test, 9.95 hours. Kind of grate, plain.

Test 165, Indiana No. 4.

Size as shipped, screenings. Size as used, over 1 inch, 19 per cent; ½ inch to 1 inch, 22.4 per cent; ¼ inch to ½ inch, 18.6 per cent; under ¼ inch, 40 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 166, Indiana No. 4.

Size as shipped, screenings. Size as used, over 1 inch, 8.1 per cent; ½ inch to 1 inch, 18.3 per cent; ¼ inch to ½ inch, 18.8 per cent; under ¼ inch, 54.8 per cent. Duration of test, 8.80 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 151.	Test 154.	Test 165.	Test 166.
Heating value of coal.....B. T. U. per pound dry coal..	11,977	13,421	11,486	11,693
Force of draft:				
Under stack damper.....inch water..	0.48	0.45	0.61	0.60
Above fire.....do....	.12	.11	.19	.22
Furnace temperature.....°F..	2,023	2,390	2,062	1,870
Dry coal used per square foot of grate surface per hour, pounds.....	18.64	19.21	21.98	19.62
Equivalent water evaporated per square foot of wate -heating surface per hour.....pounds..	2.88	3.40	3.17	2.67
Percentage of rated horsepower of boiler developed.....	80.8	95.3	88.9	74.7
Water apparently evaporated per pound of coal as fired, pounds.....	5.74	6.45	5.94	5.57
Water evaporated from and at 212° F.:				
Per pound of coal as fired.....pounds..	6.64	7.55	6.94	6.46
Per pound of dry coal.....do....	7.74	8.86	8.05	7.58
Per pound of combustible.....do....	9.57	9.86	10.43	9.86
Efficiency of boiler, including grate.....per cent..	62.41	63.75	67.68	62.60
Coal as fired:				
Per indicated horsepower hour.....pounds..	4.26	3.75	4.08	4.38
Per electrical horsepower hour.....do....	5.26	4.62	5.03	5.40
Dry coal:				
Per indicated horsepower hour.....do....	3.65	3.19	3.51	3.73
Per electrical horsepower hour.....do....	4.51	3.94	4.34	4.60

ANALYSES.

	Test 151.	Test 154.	Test 165.	Test 166.
Proximate.				
Moisture.....	14.24	14.80	13.82	14.79
Volatile matter.....	31.59	33.10	29.12	29.76
Fixed carbon.....	39.96	44.91	39.80	39.69
Ash.....	14.21	7.19	17.26	15.76
	100.00	100.00	100.00	100.00
Sulphur.....	2.52	2.12	2.43	2.52

ANALYSES—continued.

	Test 151.	Test 154.	Test 165.	Test 166.
Ultimate.				
Carbon[a]	66.31	73.41	63.59	64.73
Hydrogen[a]	4.42	4.89	4.24	4.31
Oxygen[a]	8.46	9.35	8.09	8.25
Nitrogen[a]	1.30	1.42	1.23	1.26
Sulphur	2.94	2.49	2.82	2.96
Ash	16.57	8.44	20.03	18.49
	100.00	100.00	100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 112, Indiana No. 4.

Size as shipped, screenings. Size as used, screenings (1¼-inch). Jig used, Stewart modified.

Raw coal	pounds..	32,000
Washed coal	do....	24,000
Refuse	do....	8,000

ANALYSES.

	Test 112.	
	Raw coal.	Washed coal.
Moisture	13.99	16.49
Volatile matter	29.40	.....
Fixed carbon	42.29	.....
Ash	14.32	7.25
Sulphur	2.31	1.94

COKING TESTS.

Test 6, Indiana No. 4.

Size as shipped, screenings. Size as used, finely crushed. Raw. Duration of test, 62 hours.

Coal charged	pounds..	10,000
Coke produced	do....	5,010
Breeze produced	do....	536
Coke produced	per cent..	50.10
Breeze produced	do....	5.36
Total percentage yield		55.46

Remarks.—Light-gray color. High ash and sulphur. Medium coke.

Test 9, Indiana No. 4, washed.

Size as shipped, screenings. Size as used, finely crushed. Duration of test, 58 hours.

Coal charged	pounds..	10,000
Coke produced	do....	5,153
Breeze produced	do....	332
Coke produced	per cent..	51.53
Breeze produced	do....	3.32
Total percentage yield		54.85

Remarks.—Light-gray and silvery color. Ash reduced materially by washing; a little too much sulphur.

ANALYSES.

	Test 6.		Test 9.	
	Coal.	Coke.	Coal.	Coke.
Moisture	14.30	6.31	16.33	0.55
Volatile matter	29.48	1.60	31.89	.38
Fixed carbon	40.96	68.35	44.19	85.91
Ash	15.26	23.74	7.59	13.16
Sulphur	2.60	2.80	2.08	2.06

INDIANA NO. 5.

Bituminous coal from mine No. 33, Consolidated Indiana Coal Company, Hymera, Sullivan County, Ind., on the Evansville and Terre Haute Railroad.

This sample, which consisted of run-of-mine coal, was shipped under the supervision of Inspector J. S. Burrows and was used in making coking test No. 8, steaming tests Nos. 153, 155, and 156, and producer-gas tests Nos. 46 and 47.

Two mine samples were taken in the mine, one of which, No. 1774, came from the second east entry on the north side of the mine, 1,200 feet from the shaft, and the other, No. 1773, from room 16 off the second east entry, 1,600 feet southwest of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
	Laboratory number	1773	1774	1859
	Air-drying loss	9.10	8.40	7.20
Proximate.	Moisture	12.14	12.17	12.03
Proximate.	Volatile matter	35.17	35.53	35.65
Proximate.	Fixed carbon	43.73	43.14	41.44
Proximate.	Ash	8.96	9.16	10.88
Ultimate.	Sulphur	3.54	4.66	4.27
Ultimate.	Hydrogen			5.50
Ultimate.	Carbon			60.73
Ultimate.	Nitrogen			1.08
Ultimate.	Oxygen			17.54
	Calorific value determined:			
	Calories	6,398		6,218
	British thermal units	11,516		11,192

STEAMING TESTS.

Test 153, Indiana No. 5.

Size as shipped, run of mine. Size as used, over 1 inch, 29.0 per cent; ½ inch to 1 inch, 23.2 per cent; ¼ inch to ½ inch, 16.2 per cent; under ¼ inch, 31.6 per cent. Duration of test, 10.02 hours. Kind of grate, plain.

Test 155, Indiana No. 5.

Size as shipped, run of mine. Size as used, over 1 inch, 27.7 per cent; ½ inch to 1 inch, 20.0 per cent; ¼ inch to ½ inch, 20.4 per cent; under ¼ inch, 31.9 per cent. Duration of test, 9.98 hours. Kind of grate, plain.

Test 156, Indiana No. 5.

Size as shipped, run of mine. Size as used, over 1 inch, 33.7 per cent; ½ inch to 1 inch, 23.2 per cent; ¼ inch to ½ inch, 15.4 per cent; under ¼ inch, 27.7 per cent. Duration of test, 9.92 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 153.	Test 155.	Test 156.
Heating value of coal, B. T. U. per pound dry coal	12,564	12,546	12,730
Force of draft:			
Under stack damper, inch water	0.51	0.50	0.53
Above fire, do	.22	.18	.18
Furnace temperature, °F.	2,391	2,223	2,317
Dry coal used per square foot of grate surface per hour, pounds	19.21	17.41	19.14
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.16	2.90	3.10
Percentage of rated horsepower of boiler developed	88.6	81.3	87.0
Water apparently evaporated per pound of coal as fired, pounds	6.26	6.32	6.20
Water evaporated from and at 212° F.:			
Per pound of coal as fired, do	7.30	7.36	7.23
Per pound of dry coal, do	8.24	8.35	8.13
Per pound of combustible, do	9.61	9.91	9.49

MISCELLANEOUS ITEMS—continued.

	Test 153.	Test 155.	Test 156.
Efficiency of boiler, including grate.....per cent..	63.25	64.27	61.67
Coal as fired:			
Per indicated horsepower hour.....pounds..	3.87	3.84	3.91
Per electrical horsepower hour.....do....	4.78	4.74	4.83
Dry coal:			
Per indicated horsepower hour.....do....	3.43	3.39	3.48
Per electrical horsepower hour.....do....	4.24	4.18	4.30

ANALYSES.

	Test 153.	Test 155.	Test 156.		Test 153.	Test 155.	Test 156.
Proximate.				*Ultimate.*			
Moisture.....	11.31	11.83	11.01	Carbon[a].....	68.25	67.95	69.06
Volatile matter....	36.36	34.23	35.02	Hydrogen[a].....	4.68	4.66	4.73
Fixed carbon.....	41.29	42.27	43.01	Oxygen[a].....	7.68	7.66	7.79
Ash.....	11.04	11.67	10.96	Nitrogen[a].....	1.22	1.21	1.22
	100.00	100.00	100.00	Sulphur.....	5.72	5.29	4.89
Sulphur.....	5.07	4.65	4.35	Ash.....	12.45	13.23	12.31
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TESTS.

Test 46, Indiana No. 5.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 30 hours.

Average electrical horsepower.....	199.0
Average B. T. U. gas, per cubic foot.....	136.7
Total coal fired.....pounds..	11,850

Test 47, Indiana No. 5.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower.....	202.2
Average B. T. U. gas, per cubic foot.....	145.0
Total coal fired.....pounds..	14,250

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 46.			Test 47.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:						
Available for outside purposes.....	2.12	1.91	1.64	1.51	1.35	1.20
Developed at switch board.....	1.99	1.79	1.54	1.41	1.26	1.12
Per brake horsepower:						
Available for outside purposes.....	1.80	1.62	1.39	1.29	1.15	1.02
Developed at engine.....	1.69	1.52	1.31	1.20	1.07	.95
Equivalent used by producer plant.						
Per electrical horsepower:						
Available for outside purposes.....	2.29	2.06	1.78	1.62	1.45	1.28
Developed at switch board.....	2.15	1.93	1.66	1.51	1.35	1.19
Per brake horsepower:						
Available for outside purposes.....	1.95	1.75	1.51	1.37	1.23	1.09
Developed at engine.....	1.83	1.64	1.41	1.28	1.15	1.01

Note.—Producer-gas tests 46 and 47 are on the same coal. Test 46 was cut short owing to the clogging up of the economizer.

ANALYSES.

	Test 46.	Test 47.		Test 46.	Test 47.
Coal.			*Gas by volume.*		
Moisture	10.02	10.49	Carbon dioxide (CO_2)	12.0	10.1
Volatile matter	35.49	35.90	Carbon monoxide (CO)	15.2	18.8
Fixed carbon	41.98	43.25	Hydrogen (H_2)	11.8	11.5
Ash	12.51	10.36	Methane (CH_4)	3.0	2.9
	100.00	100.00	Nitrogen (N_2)	58.0	56.7
Sulphur	6.04	4.14		100.0	100.0

COKING TEST.

Test 8, Indiana No. 5.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 49 hours.

Coal charged	pounds	10,000
Coke produced	do	5,340
Breeze produced	do	232
Coke produced	per cent	53.40
Breeze produced	do	2.32
Total percentage yield		55.72

Remarks.—Light-gray and silvery color. Good, strong coke. High ash and sulpher.

ANALYSES.

	Test 8.	
	Coal.	Coke.
Moisture	10.74	0.76
Volatile matter	36.71	.54
Fixed carbon	41.95	81.29
Ash	10.60	17.41
Sulphur	4.61	4.21

INDIANA NO. 6.

Bituminous coal from mine No 34, Consolidated Indiana Coal Company, Hymera, Sullivan County, Ind., on the Evansville and Terre Haute Railroad.

This sample consisted of run-of-mine coal and was loaded under the supervision of Inspector J. S. Burrows. It was used in making washing test No. 113, coke test No. 12, steaming test No. 157, steaming test on washed coal No. 159, and producer-gas test No. 49.

Two mine samples were selected from widely separated points in this mine. No. 1772 came from room 2, off the second east entry on the south side, 300 feet southeast of the shaft; No. 1776 from the main north entry, 425 feet north of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1772	1776	1875
Air-drying loss		7.20	4.70	5.20
Proximate.	Moisture	10.45	9.22	10.80
	Volatile matter	38.62	37.76	36.09
	Fixed carbon	41.35	41.85	40.49
	Ash	9.58	11.17	12.62
Ultimate.	Sulphur	4.04	3.94	4.39
	Hydrogen	.....	.....	5.46
	Carbon	.....	.....	60.88
	Nitrogen	.....	.....	1.13
	Oxygen	.....	.....	15.52
Calorific value determined:				
	Calories	6,525	.....	6,214
	British thermal units	11,745	.....	11,185

STEAMING TESTS.

Test 157, Indiana No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 29.9 per cent; ½ inch to 1 inch, 19.9 per cent; ¼ inch to ½ inch, 14.2 per cent; under ¼ inch, 36 per cent. Duration of test, 9.97 hours. Kind of grate, plain.

Test 159, Indiana No. 6, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 39.8 per cent; ½ inch to 1 inch, 27.1 per cent; ¼ inch to ½ inch, 15.8 per cent; under ¼ inch, 17.3 per cent. Duration of test, 9.92 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

		Test 157.	Test 159.
Heating value of coal	B. T. U. per pound dry coal	12,505	13,091
Force of draft:			
Under stack damper	inch water	0.49	0.43
Above fire	do	.15	.11
Furnace temperature	°F.	2,410	2,522
Dry coal used per square foot of grate surface per hour	pounds	18.59	21.40
Equivalent water evaporated per square foot of water-heating surface per hour, pounds		3.03	3.45
Percentage of rated horsepower of boiler developed		84.9	96.7
Water apparently evaporated per pound of coal as fired	pounds	6.30	6.15
Water evaporated from and at 212° F.:			
Per pound of coal as fired	do	7.30	7.15
Per pound of dry coal	do	8.16	8.06
Per pound of combustible	do	9.72	9.18
Efficiency of boiler, including grate	per cent	63.02	59.46
Coal as fired:			
Per indicated horsepower hour	pounds	3.87	3.96
Per electrical horsepower hour	do	4.78	4.88
Dry coal:			
Per indicated horsepower hour	do	3.47	3.51
Per electrical horsepower hour	do	4.28	4.33

ANALYSES.

	Test 157.	Test 159.		Test 157.	Test 159.
Proximate.			*Ultimate.*		
Moisture	10.51	11.27	Carbon [a]	68.03	71.77
Volatile matter	34.80	37.90	Hydrogen [a]	4.76	5.02
Fixed carbon	41.93	41.20	Oxygen [a]	6.61	7.01
Ash	12.76	9.63	Nitrogen [a]	1.26	1.33
	100.00	100.00	Sulphur	5.08	4.02
Sulphur	4.55	3.57	Ash	14.26	10.85
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 49, Indiana No. 6.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	199.6
Average B. T. U. gas, per cubic foot	150.9
Total coal fired, pounds	17,850

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 49.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.89	1.68	1.45
Developed at switch board	1.79	1.59	1.37
Per brake horsepower:			
Available for outside purposes	1.61	1.43	1.23
Developed at engine	1.52	1.35	1.16
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	2.05	1.83	1.57
Developed at switch board	1.94	1.73	1.49
Per brake horsepower:			
Available for outside purposes	1.74	1.55	1.33
Deevloped at engine	1.65	1.47	1.26

ANALYSES.

	Test 49.		Test 49.
Coal.		*Gas by volume.*	
Moisture	10.89	Carbon dioxide (CO_2)	9.8
Volatile matter	36.19	Carbon monoxide (CO)	18.1
Fixed carbon	40.43	Hydrogen (H_2)	12.8
Ash	12.49	Methane (CH_4)	2.4
	100.00	Nitrogen (N_2)	56.9
Sulphur	4.71		100.00

WASHING TEST.

Test 113, Indiana No. 6.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	24,000
Washed coal	do....	19,100
Refuse	do....	4,900

ANALYSES.

	Test 113.	
	Raw coal.	Washed coal.
Moisture	10.80	11.65
Volatile matter	36.09	.....
Fixed carbon	40.49	.....
Ash	12.62	9.83
Sulphur	4.39	3.49

COKING TEST.

Test 12, Indiana No. 6, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 49 hours.

Coal charged	pounds..	10,000
Coke produced	do....	5,434
Breeze produced	do....	501
Coke produced	per cent..	54.34
Breeze produced	do....	5.01
Total percentage yield		59.35

Remarks.—Light-gray and silvery color. Good coke, but ash and sulphur high.

ANALYSES.

	Test 12.	
	Coal.	Coke.
Moisture	12.39	0.75
Volatile matter	36.77	.73
Fixed carbon	40.85	81.90
Ash	9.99	16.62
Sulphur	3.59	3.16

INDIANA NO. 7.

Bituminous coal from Little's mine, S. W. Little Coal Company, Littles, Pike County, Ind., on the Evansville and Terre Haute Railroad.

Two samples of coal were shipped from this mine under the supervision of Inspector W. J. Von Borries, as follows: Indiana No. 7 A was made up of lump coal which had been passed over a 1⅜-inch screen. This sample was used in making washing test No. 114, coking test No. 13, steaming test No. 158, and producer-gas test No. 51. Indiana No. 7 B consisted of screenings which had passed through a 1⅜-inch screen and was used in making steaming tests Nos. 164 and 176, the rest being reserved for briquette experiments.

Two mine samples were taken in this mine. No. 1824 was obtained at a point 2,000 feet southeast of the shaft, off the eighth south entry, and No. 1825 at a point in the main entry 2,600 feet east of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample A.	Car sample B.
Laboratory number		1824	1825	1881	1882
Air-drying loss		6.40	6.20	3.60	8.60
Proximate.	Moisture	10.18	9.99	8.90	11.12
	Volatile matter	38.86	37.86	38.52	36.98
	Fixed carbon	42.84	44.18	43.37	42.55
	Ash	8.12	7.97	9.21	9.35
Ultimate.	Sulphur	3.96	3.25	3.74	3.78
	Hydrogen			5.61	5.63
	Carbon			65.54	63.01
	Nitrogen			1.20	1.13
	Oxygen			14.70	17.10
Calorific value determined:					
	Calories	6,767		6,671	6,416
	British thermal units	12,181		12,008	11,549

STEAMING TESTS.

Test 158, Indiana No. 7 A.

Size as shipped, lump, egg, and nut. Size as used, over 1 inch, 44.3 per cent; ½ inch to 1 inch, 25 per cent; ¼ inch to ½ inch, 14.2 per cent; under ¼ inch, 16.5 per cent. Duration of test, 10.02 hours. Kind of grate, plain.

Test 164, Indiana No. 7 B.

Size as shipped, screenings. Size as used, over 1 inch, 5.6 per cent; ½ inch to 1 inch, 25.3 per cent; ¼ inch to ½ inch, 25.8 per cent; under ¼ inch, 43.3 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

Test 176, Indiana No. 7 B.

Size as shipped, screenings. Size as used, over 1 inch, 5.1 per cent; ½ inch to 1 inch, 23.1 per cent; ¼ inch to ½ inch, 24.4 per cent; under ¼ inch, 47.4 per cent. Duration of test, 10.07 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 158.	Test 164.	Test 176.
Heating value of coal.....B. T. U. per pound dry coal..	13,248	12,838	12,710
Force of draft:			
Under stack damper.....inch water..	0.44	0.62	0.56
Above fire.....do....	.12	.23	.17
Furnace temperature.....°F..	2,579	1,880	2,033
Dry coal used per square foot of grate surface per hour.....pounds..	19.85	19.01	17.48
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.45	2.69	2.80
Percentage of rated horsepower of boiler developed	96.9	75.5	78.6
Water apparently evaporated per pound of coal as fired.....pounds..	6.80	6.05	6.27
Water evaporated from and at 212 °F.:			
Per pound of coal as fired.....do....	7.95	7.06	7.27
Per pound of dry coal.....do....	8.72	7.91	8.02
Per pound of combustible.....do....	9.83	9.14	9.32
Efficiency of boiler, including grate.....per cent..	63.56	59.49	60.94
Coal as fired:			
Per indicated horsepower hour.....pounds..	3.56	4.01	3.89
Per electrical horsepower hour.....do....	4.39	4.95	4.80
Dry coal:			
Per indicated horsepower hour.....do....	3.24	3.57	3.53
Per electrical horsepower hour.....do....	4.00	4.41	4.35

ANALYSES.

	Test 158.	Test 164.	Test 176.		Test 158.	Test 164.	Test 176.
Proximate.				*Ultimate.*			
Moisture	8.81	10.74	9.37	Carbon [a]	72.37	70.01	69.21
Volatile matter	38.98	37.78	38.40	Hydrogen [a]	5.10	4.88	4.82
Fixed carbon	43.37	41.27	41.18	Oxygen [a]	7.49	8.03	7.94
Ash	8.84	10.21	11.05	Nitrogen [a]	1.33	1.25	1.24
	100.00	100.00	100.00	Sulphur	4.02	4.39	4.60
Sulphur	3.67	3.92	4.17	Ash	9.69	11.44	12.19
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 51, Indiana No. 7 A.

Size as shipped, lump, egg, and nut. Size as used, over 1 inch, 69 per cent; ½ inch to 1 inch, 13 per cent; ¼ inch to ½ inch, 7 per cent; under ¼ inch, 11 per cent. Duration of test, 45 hours.

Average electrical horsepower	198.1
Average B. T. U. gas, per cubic foot	158.5
Total coal fired, pounds	13,650

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 51.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.61	1.49	1.32
Developed at switch board	1.53	1.41	1.25
Per brake horsepower:			
Available for outside purposes	1.37	1.26	1.12
Developed at engine	1.30	1.20	1.06
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.74	1.60	1.42
Developed at switch board	1.65	1.52	1.35
Per brake horsepower:			
Available for outside purposes	1.47	1.36	1.20
Developed at engine	1.40	1.26	1.14

ANALYSES.

	Test 51.		Test 51.
Coal.		*Gas by volume.*	
Moisture	7.73	Carbon dioxide (CO_2)	8.2
Volatile matter	39.19	Carbon monoxide (CO)	22.2
Fixed carbon	42.47	Hydrogen (H_2)	11.9
Ash	10.61	Methane (CH_4)	3.2
	100.00	Nitrogen (N_2)	54.5
Sulphur	5.20		100.0

WASHING TEST.

Test 114, Indiana No. 7 A.

Size as shipped, lump, egg, and nut. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	14,000
Washed coal	do....	12,240
Refuse	do....	1,760

ANALYSES.

	Test 114.	
	Raw coal.	Washed coal.
Moisture	8.90	10.16
Volatile matter	38.52	.....
Fixed carbon	43.37	.....
Ash	9.21	7.89
Sulphur	3.74	3.24

COKING TEST.

Test 13, Indiana No. 7 A, washed.

Size as shipped, lump, egg, and nut. Size as used, finely crushed. Duration of test, 112 hours.

Coal charged	pounds..	12,240
Coke produced	do....	6,993
Breeze produced	do....	640
Coke produced	per cent..	57.13
Breeze produced	do....	5.23
Total percentage yield		62.36

Remarks.—Light-gray and silvery color. Somewhat brittle. High ash and sulphur.

ANALYSES.

	Test 13.	
	Coal.	Coke.
Moisture	10.33	1.13
Volatile matter	38.35	2.35
Fixed carbon	42.93	83.23
Ash	8.39	13.29
Sulphur	3.12	2.69

INDIANA NO. 8.

Bituminous coal from Deep Vein mine, Deep Vein Coal Company, 2 miles west of Terre Haute, Vigo County, Ind., on the Vandalia Railroad.

The sample for testing was shipped as lump coal, which at this mine is run over a 1¼-inch bar screen. The coal was inspected by Inspector J. W. Groves, and was used in making washing test No. 118 steaming tests Nos. 182, 183, and 185, steaming test on washed coal No. 184, and producer-gas test No. 57.

Two mine samples were taken. No. 1828 came from room 8 off the fourth south entry on the east side, 700 feet southeast of the shaft, and No. 1829 came from the sixth west entry on the north side, 800 feet northwest of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1828	1829	2037
Air-drying loss		7.40	8.00	4.60
Proximate.	Moisture	10.68	11.13	9.55
	Volatile matter	37.17	36.86	36.19
	Fixed carbon	39.91	41.80	43.65
	Ash	12.24	10.21	10.61
Ultimate.	Sulphur	4.38	3.76	3.72
	Hydrogen	.....	.....	5.49
	Carbon	.....	.....	64.08
	Nitrogen	.....	.....	1.08
	Oxygen	.....	.....	15.02
Calorific value determined:				
	Calories	6,256	.....	6,533
	British thermal units	11,261	.....	11,759

STEAMING TESTS.

Test 182, Indiana No. 8.

Size as shipped, lump. Size as used, over 1 inch, 30.5 per cent; ½ inch to 1 inch, 23.1 per cent; ¼ inch to ½ inch, 16.7 per cent; under ¼ inch 29.7 per cent. Duration of test, 9.98 hours. Kind of grate, plain.

Test 183, Indiana No. 8.

Size as shipped, lump. Size as used, over 1 inch, 39.5 per cent; ½ inch to 1 inch, 23.3 per cent; ¼ inch to ½ inch, 13.4 per cent; under ¼ inch, 23.8 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 185, Indiana No. 8.

Size as shipped, lump. Size as used, over 1 inch, 27.7 per cent; ½ inch to 1 inch, 21.4 per cent; ¼ inch to ½ inch, 17.2 per cent; under ¼ inch, 33.7 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 184, Indiana No. 8, washed.

Size as shipped, lump. Size as used, over 1 inch, 20.1 per cent; ½ inch to 1 inch, 29.9 per cent; ¼ inch to ½ inch, 24.3 per cent, under ¼ inch, 25.7 per cent. Duration of test, 10 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 182.	Test 183.	Test 185.	Test 184.
Heating value of coal.....B. T. U. per pound dry coal..	12,838	12,587	12,622	13,091
Force of draft:				
Under stack damper.....inch water..	0.49	0.41	0.51	0.43
Above fire.....do....	.16	.13	.16	.10
Furnace temperature.....°F..	2,384	2,279	2,304	2,354
Dry coal used per square foot of grate surface per hour, pounds.....	19.78	17.24	19.63	19.78
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.22	2.88	3.18	3.46
Percentage of rated horsepower of boiler developed.....	90.2	80.7	89.0	97.0
Water apparently evaporated per pound of coal as fired, pounds.....	6.34	6.43	6.24	6.61
Water evaporated from and at 212° F.:				
Per pound of coal as fired.....pounds..	7.38	7.48	7.28	7.72
Per pound of dry coal.....do....	8.15	8.36	8.10	8.76
Per pound of combustible.....do....	9.52	9.85	9.63	9.94
Efficiency of boiler, including grate.....per cent..	61.31	64.14	61.97	64.62
Coal as fired:				
Per indicated horsepower hour.....pounds..	3.83	3.78	3.89	3.66
Per electrical horsepower hour.....do....	4.73	4.67	4.80	4.52
Dry coal:				
Per indicated horsepower hour.....do....	3.47	3.38	3.49	3.23
Per electrical horsepower hour.....do....	4.28	4.18	4.31	3.99

ANALYSES.

	Test 182.	Test 183.	Test 185.	Test 184.
Proximate.				
Moisture	9.37	10.54	10.12	11.87
Volatile matter	36.93	35.48	35.55	37.17
Fixed carbon	42.33	41.46	41.44	41.67
Ash	11.37	12.52	12.89	9.29
	100.00	100.00	100.00	100.00
Sulphur	4.05	4.22	3.54	2.87
Ultimate.				
Carbon [a]	69.86	68.42	68.80	72.57
Hydrogen [a]	4.83	4.73	4.76	5.01
Oxygen [a]	7.11	6.98	7.00	7.39
Nitrogen [a]	1.18	1.15	1.16	1.23
Sulphur	4.47	4.72	3.94	3.26
Ash	12.55	14.00	14.34	10.54
	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 57, Indiana No. 8.

Size as shipped, lump. Size as used, over 1 inch, 78 per cent; ½ inch to 1 inch, 9 per cent; ¼ inch to ½ inch, 5 per cent; under ¼ inch, 8 per cent. Duration of test, 59 hours.

Average electrical horsepower	200.2
Average B. T. U. gas, per cubic foot	151.5
Total coal fired, pounds	15,300

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 57.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.61	1.46	1.28
Developed at switch board	1.53	1.39	1.22
Per brake horsepower:			
Available for outside purposes	1.37	1.24	1.09
Developed at engine	1.30	1.18	1.03
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.70	1.54	1.35
Developed at switch board	1.61	1.46	1.28
Per brake horsepower:			
Available for outside purposes	1.45	1.31	1.15
Developed at engine	1.37	1.24	1.09

ANALYSES.

	Test 57.		Test 57.
Coal.		*Gas by volume.*	
Moisture	9.21	Carbon dioxide (CO_2)	9.5
Volatile matter	36.78	Carbon monoxide (CO)	20.1
Fixed carbon	42.66	Hydrogen (H_2)	11.3
Ash	11.35	Methane (CH_4)	2.8
	100.00	Nitrogen (N_2)	56.3
Sulphur	3.80		100.0

WASHING TEST.

Test 118, Indiana No. 8.

Size as shipped, lump. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	16,000
Washed coal	do....	15,080
Refuse	do....	920

ANALYSES.

	Test 118.	
	Raw coal.	Washed coal.
Moisture	9.55	11.76
Volatile matter	36.19	.....
Fixed carbon	43.65	.....
Ash	10.61	9.52
Sulphur	3.72	3.18

INDIANA NO. 9.

Bituminous coal from Red Bird mine, Fauvre Coal Company, Macksville, Vigo County, Ind., on the Vandalia Railroad.

Two separate samples were shipped under the supervision of Inspector W. J. Von Borries for testing purposes, as follows: Indiana No. 9 A consisted of lump coal which had been passed over a 1¼-inch screen. The following tests were made on this sample: Coking test No. 16, steaming tests Nos. 168 and 169, and producer-gas test No. 52. Indiana No. 9 B was made up of run-of-mine coal. The tests made on this sample were washing test No. 117, coking tests Nos. 17 and 18, and steaming test No. 174.

Two mine samples were collected from the mine for chemical analysis. No. 1848 was taken in room 18 off the fifth north entry, 900 feet north of the shaft, and No. 1849 from a point 2,000 feet N. 10° E., in the fourth east entry off the sixth north entry.

CHEMICAL ANALYSES.

		Mine sample.		Car sample A.	Car sample B.
Laboratory number		1848	1849	1973	1960
Air-drying loss		10.80	11.00	8.00	10.70
Proximate.	Moisture	13.73	14.33	12.82	13.53
	Volatile matter	35.54	35.18	34.80	34.80
	Fixed carbon	42.08	42.02	42.08	40.91
	Ash	8.65	8.47	10.30	10.76
Ultimate.	Sulphur	3.00	2.70	3.27	3.15
	Hydrogen			5.66	5.78
	Carbon			61.16	59.64
	Nitrogen			1.03	1.06
	Oxygen			18.58	19.61
Calorific value determined:					
	Calories	6,311		6,177	6,082
	British thermal units	11,360		11,119	10,948

STEAMING TESTS.

Test 168, Indiana No. 9 A.

Size as shipped, lump. Size as used, over 1 inch, 40.6 per cent; ½ inch to 1 inch, 24.2 per cent; ¼ inch to ½ inch, 15 per cent; under ¼ inch, 20.2 per cent. Duration of test, 9.92 hours. Kind of grate, rocking.

Test 169, Indiana No. 9 A.

Size as shipped, lump. Size as used, over 1 inch, 31.2 per cent; ½ inch to 1 inch, 21.6 per cent; ¼ inch to ½ inch, 16 per cent; under ¼ inch, 31.2 per cent. Duration of test, 10.02 hours. Kind of grate, rocking.

Test 174, Indiana No. 9 B.

Size as shipped, run of mine. Size as used, over 1 inch 23.8 per cent; ½ inch to 1 inch, 21.7 per cent; ¼ inch to ½ inch, 18.2 per cent; under ¼ inch, 36.3 per cent. Duration of test, 6.7 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 168.	Test 169.	Test 174.
Heating value of coal.....B. T. U. per pound dry coal..	12,181	12,447	12,740
Force of draft:			
Under stack damper.....inch water..	.53	.49	.56
Above fire.....do....	.12	.13	.15
Furnace temperature.....°F..	2,349	2,239	2,064
Dry coal used per square foot of grate surface per hour.....pounds..	23.87	21.13	19.19
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.62	3.26	3.14
Percentage of rated horsepower of boiler developed	101.4	91.5	87.9
Water apparently evaporated per pound of coal as fired.....pounds..	6.37	6.46	6.23
Water evaporated from and at 212 °F.:			
Per pound of coal as fired.....do....	7.44	7.54	7.24
Per pound of dry coal.....do....	8.45	8.62	8.19
Per pound of combustible.....do....	10.17	10.18	9.50
Efficiency of boiler, including grate.....per cent..	66.99	66.88	62.08
Coal as fired:			
Per indicated horsepower hour.....pounds..	3.80	3.75	3.91
Per electrical horsepower hour.....do....	4.69	4.63	4.82
Dry coal:			
Per indicated horsepower hour.....do....	3.35	3.28	3.45
Per electrical horsepower hour.....do....	4.14	4.05	4.26

ANALYSES.

	Test 168.	Test 169.	Test 174.		Test 168.	Test 169.	Test 174.
Proximate.				*Ultimate.*			
Moisture	11.99	12.53	11.62	Carbon [a]	66.85	68.40	69.48
Volatile matter	34.76	34.80	36.33	Hydrogen [a]	4.64	4.74	4.98
Fixed carbon	39.88	40.73	41.33	Oxygen [a]	7.86	8.03	8.84
Ash	13.37	11.94	10.72	Nitrogen [a]	1.12	1.16	1.23
	100.00	100.00	100.00	Sulphur	4.34	4.02	3.34
Sulphur	3.82	3.52	2.95	Ash	15.19	13.65	12.13
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 52, Indiana No. 9 A.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 78 per cent; ½ inch to 1 inch, 10 per cent; ¼ inch to ½ inch, 5 per cent; under ¼ inch, 7 per cent. Duration of test, 45 hours.

Average electrical horsepower	195.8
Average B. T. U. gas, per cubic foot	151.8
Total coal fired, pounds	15,450

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 52.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.84	1.61	1.43
Developed at switch board	1.75	1.53	1.36
Per brake horsepower:			
Available for outside purposes	1.57	1.37	1.21
Developed at engine	1.49	1.30	1.15
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.94	1.70	1.50
Developed at switch board	1.84	1.61	1.43
Per brake horsepower:			
Available for outside purposes	1.65	1.44	1.27
Developed at engine	1.57	1.37	1.21

ANALYSES.

	Test 52.		Test 52.
Coal.		*Gas by volume.*	
Moisture	12.52	Carbon dioxide (CO_2)	10.6
Volatile matter	36.13	Carbon monoxide (CO)	18.0
Fixed carbon	41.25	Hydrogen (H_2)	11.5
Ash	10.10	Methane (CH_4)	2.8
	100.00	Nitrogen (N_2)	57.1
Sulphur	2.76		100.00

WASHING TEST.

Test 117, Indiana No. 9 B.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds...	18,000
Washed coal	do....	15,460
Refuse	do....	2,540

ANALYSES.

	Test 117.	
	Raw coal.	Washed coal.
Moisture	13.53	14.55
Volatile matter	34.80	.....
Fixed carbon	40.91	.....
Ash	10.76	8.14
Sulphur	3.15	2.56

COKING TESTS.

Test 16, Indiana No. 9 A.

Size as shipped over 1¼ inches. Size as used, finely crushed. Raw. Duration of test, 90 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,034
Breeze produced	do....	455
Coke produced	per cent..	58.62
Breeze produced	do....	3.79
Total percentage yield		62.41

Remarks.—Light-gray and silvery color. Somewhat brittle. High ash and sulphur.

Test 17, Indiana No. 9 B.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 112 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,006
Breeze produced	do....	464
Coke produced	per cent..	58.38
Breeze produced	do....	3.87
Total percentage yield		62.25

Remarks.—Light gray and silvery. Fingered coke. Heavy. High ash and sulphur.

Test 18, Indiana No. 9 B, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 90 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,915
Breeze produced	do....	442
Coke produced	per cent..	57.63
Breeze produced	do....	3.68
Total percentage yield		61.31

Remarks.—Light-gray and silvery color. Coal needs oven with bottom flues. Of 3 charges of Indiana No. 9 none could be made to coke entirely to bottom. High ash and sulphur. Not much improved by washing.

ANALYSES.

	Test 16.		Test 17.		Test 18.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	12.30	0.81	12.51	0.68	14.14	0.91
Volatile matter	34.96	2.00	35.65	2.85	36.70	.97
Fixed carbon	41.62	78.74	40.48	78.44	40.90	84.60
Ash	11.12	18.45	11.36	18.03	8.26	13.52
Sulphur	3.41	3.41	3.26	3.50	2.61	2.24

INDIANA NO. 10.

Bituminous coal from mine of Park County Coal Company, Rosedale, Park County, Ind., on the Vandalia Railroad.

A sample of lump coal (over 1¼-inch diamond bar screen) was shipped under the supervision of Inspector J. W. Groves and was used in making washing test No. 116, steaming test No. 167, and steaming test on washed coal No. 177.

Of the two mine samples taken, No. 1853 is from the sixteenth south entry, 3,000 feet southeast of the shaft, and No. 1854 is from the eighteenth north entry, 3,000 feet northeast of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1853	1854	1979
Air-drying loss		8.60	9.60	8.10
Proximate.	Moisture	11.54	12.26	10.72
	Volatile matter	39.49	38.62	39.29
	Fixed carbon	39.35	40.80	41.42
	Ash	9.62	8.32	8.57
Ultimate.	Sulphur	4.41	4.71	3.83
	Hydrogen	.....	.....	5.86
	Carbon	.....	.....	63.48
	Nitrogen	.....	.....	1.16
	Oxygen	.....	.....	17.10
Calorific value determined:				
	Calories	6,475	.....	6,537
	British thermal units	11,655	.....	11,767

STEAMING TESTS.

Test 167, Indiana No. 10.

Size as shipped, lump. Size as used, over 1 inch, 27.5 per cent; ½ inch to 1 inch, 25.8 per cent; ¼ inch to ½ inch, 19.2 per cent; under ¼ inch, 27.5 per cent. Duration of test, 10.05 hours. Kind of grate, rocking.

Test 177, Indiana No. 10, washed.

Size as shipped, lump. Size as used, over 1 inch, 26.2 per cent; ½ inch to 1 inch, 33.6 per cent; ¼ inch to ½ inch, 24.6 per cent; under ¼ inch, 15.6 per cent. Duration of test, 10 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 167.	Test 177.
Heating value of coal, B. T. U. per pound dry coal	12,866	13,595
Force of draft:		
Under stack damper, inch water	0.60	0.45
Above fire, do	.18	.09
Furnace temperature, °F	2,201	2,473
Dry coal used per square foot of grate surface per hour, pounds	22.85	23.05
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.55	3.76
Percentage of rated horsepower of boiler developed	99.4	105.3
Water apparently evaporated per pound of coal as fired, pounds	6.63	6.25
Water evaporated from and at 212° F.:		
Per pound of coal as fired, do	7.74	7.27
Per pound of dry coal, do	8.66	8.17
Per pound of combustible, do	10.01	8.89
Efficiency of boiler, including grate, per cent	65.00	58.03

MISCELLANEOUS ITEMS—continued.

	Test 167.	Test 177.
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.65	3.89
Per electrical horsepower hour.....do....	4.51	4.80
Dry coal:		
Per indicated horsepower hour.....do....	3.27	3.46
Per electrical horsepower hour.....do....	4.03	4.27

ANALYSES.

	Test 167.	Test 177.		Test 167.	Test 177.
Proximate.			*Ultimate.*		
Moisture	10.60	10.98	Carbon [a]	69.32	73.54
Volatile matter	37.90	41.13	Hydrogen [a]	5.10	5.40
Fixed carbon	41.34	41.65	Oxygen [a]	8.25	8.78
Ash	10.16	6.24	Nitrogen [a]	1.26	1.34
	100.00	100.00	Sulphur	4.71	3.93
Sulphur	4.21	3.50	Ash	11.36	7.01
				100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 116, Indiana No. 10.

Size as shipped, lump. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal.....pounds..	18,000
Washed coal.....do....	15,300
Refuse.....do....	2,700

ANALYSES.

	Test 116.	
	Raw coal.	Washed coal.
Moisture	10.72	10.67
Volatile matter	39.29	.....
Fixed carbon	41.42	.....
Ash	8.57	6.15
Sulphur	3.83	3.34

INDIANA NO. 11.

Bituminous coal from mine No. 4, Island Coal Company, Dugger, Sullivan County, Ind., on the Vandalia Railroad.

The sample was shipped as lump coal (over 1½-inch and 3-inch screens) and loaded under the supervision of Inspector J. W. Groves. It was used in making coking test No. 51; steaming tests Nos. 233, 234, and 235, and producer-gas test No. 61.

Two mine samples were taken for chemical analysis, one of which, No. 1883, was from room 1, first west entry, 600 feet northwest of the shaft, and the other, No. 1884, from room 8, first east entry, 500 feet northeast of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1883	1884	2087
Air-drying loss		10.60	9.60	4.00
Proximate.	Moisture	14.23	12.62	12.15
	Volatile matter	33.04	34.92	33.48
	Fixed carbon	47.01	45.48	46.23
	Ash	5.72	6.98	8.14
Ultimate.	Sulphur	.89	2.35	1.41
	Hydrogen	.....	.....	5.46
	Carbon	.....	.....	64.92
	Nitrogen	.....	.....	1.38
	Oxygen	.....	.....	18.69
Calorific value determined:				
	Calories	6,512	.....	6,534
	British thermal units	11,722	.....	11,761

STEAMING TESTS.

Test 233, Indiana No. 11.

Size as shipped, lump. Size as used, over 1 inch, 27.4 per cent; ½ inch to 1 inch, 25.1 per cent; ¼ inch to ½ inch, 18.6 per cent; under ¼ inch, 28.9 per cent. Duration of test, 9.65 hours. Kind of grate, rocking.

Test 234, Indiana No. 11.

Size as shipped, lump. Size as used, over 1 inch, 22.1 per cent; ½ inch to 1 inch, 19.9 per cent; ¼ inch to ½ inch, 19.2 per cent; under ¼ inch, 38.8 per cent. Duration of test, 9.62 hours. Kind of grate, rocking.

Test 235, Indiana No. 11.

Size as shipped, lump. Size as used, over 1 inch 20.8 per cent; ½ inch to 1 inch, 19 per cent; ¼ inch to ½ inch, 19.4 per cent; under ¼ inch, 40.8 per cent. Duration of test, 9.95 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 233.	Test 234.	Test 235.
Heating value of coal, B. T. U. per pound dry coal	13,423	13,333	13,473
Force of draft:			
Under stack damper, inch water	0.51	0.48	0.50
Above fire, do.	.11	.12	.15
Furnace temperature, °F.	2,577	2,378	2,494
Dry coal used per square foot of grate surface per hour, pounds	22.80	20.22	21.18
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.66	3.66	3.43
Percentage of rated horsepower of boiler developed	102.5	91.4	96.1
Water apparently evaporated per pound of coal as fired, pounds	6.61	6.71	6.66
Water evaporated from and at 212 °F.:			
Per pound of coal as fired, do.	7.88	7.99	7.94
Per pound of dry coal, do.	8.94	8.99	9.03
Per pound of combustible, do.	9.98	10.06	10.00
Efficiency of boiler, including grate, per cent	64.32	65.11	64.72
Coal as fired:			
Per indicated horsepower hour, pounds	3.59	3.54	3.56
Per electrical horsepower hour, do.	4.43	4.37	4.40
Dry coal:			
Per indicated horsepower hour, do.	3.16	3.15	3.13
Per electrical horsepower hour, do.	3.91	3.89	3.87

ANALYSES.

	Test 233.	Test 234.	Test 235.		Test 233.	Test 234.	Test 235.
Proximate.				*Ultimate.*			
Moisture	11.93	11.15	12.14	Carbon[a]	74.07	73.55	74.38
Volatile matter	33.01	33.18	31.29	Hydrogen[a]	4.69	4.66	4.71
Fixed carbon	47.16	47.23	48.83	Oxygen[a]	8.99	8.95	9.06
Ash	7.90	8.44	7.74	Nitrogen[a]	1.58	1.56	1.58
	100.00	100.00	100.00	Sulphur	1.70	1.78	1.46
Sulphur	1.50	1.58	1.28	Ash	8.97	9.50	8.81
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 61, Indiana No. 11.

Size as shipped, lump. Size as used, not determined. Duration of test, 40 hours.

Average electrical horsepower	200.2
Average B. T. U. gas, per cubic foot	147.1
Total coal fired, pounds	12,750

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 61.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.68	1.46	1.32
Developed at switch board	1.59	1.39	1.25
Per brake horsepower:			
Available for outside purposes	1.43	1.25	1.13
Developed at engine	1.35	1.18	1.06
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.83	1.59	1.44
Developed at switch board	1.73	1.51	1.36
Per brake horsepower:			
Available for outside purposes	1.56	1.35	1.22
Developed at engine	1.47	1.28	1.16

ANALYSES.

	Test 61.		Test 61.
Coal.		*Gas by volume.*	
Moisture	13.03	Carbon dioxide (CO_2)	10.6
Volatile matter	32.52	Carbon monoxide (CO)	18.3
Fixed carbon	46.19	Hydrogen (H_2)	13.9
Ash	8.26	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	54.1
Sulphur	1.68		100.0

COKING TEST.

Test 51, Indiana No. 11.

Size as shipped, lump. Size as used, finely crushed. Raw. Duration of test, 50 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,600
Breeze produced	do....	460
Coke produced	per cent..	55.00
Breeze produced	do....	3.83
Total percentage yield		58.83

Remarks.—Fine-fingered coke. Sulphur and ash high. Washing would probably reduce both and make a good grade of coke.

ANALYSES.

	Test 51.	
	Coal.	Coke.
Moisture	11.90	1.55
Volatile matter	32.50	1.66
Fixed carbon	46.94	84.09
Ash	8.66	12.70
Sulphur	1.53	1.34

KANSAS NO. 5.

Bituminous coal from mine No. 11, Southwestern Development Company, West Mineral, Kans., on the Missouri, Kansas and Texas Railway.

This sample was shipped in 1904 by M. R. Campbell, of the United States Geological Survey, and consisted of coal that had been passed over a five-eighths inch screen. During the Exposition period a steaming test was made on this coal [a], and at the beginning of 1905 producer-gas test No. 25 was run.

Mine samples were taken at widely separated points in the mine, the analyses of which are given under Nos. 1411 and 1413.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1411	1413	1567
Air-drying loss		3.20	4.30	2.30
Proximate.	Moisture	5.11	5.79	4.10
	Volatile matter	32.60	32.34	31.65
	Fixed carbon	53.39	49.32	53.71
	Ash	8.90	12.55	10.54
Ultimate.	Sulphur	4.34	3.84	3.77
	Hydrogen	.....	.....	5.10
	Carbon	.....	.....	70.25
	Nitrogen	.....	.....	1.06
	Oxygen	.....	.....	9.28
Calorific value determined:				
	Calories	7,181	.....	7,164
	British thermal units	12,926	.....	12,895

[a] See Bull. U. S. Geol. Survey No. 261, 1905, p. 81.

PRODUCER-GAS TEST.

Test 25, Kansas No. 5.

Size as shipped, over ⅝ inch. Duration of test, 30 hours.

Average electrical horsepower	208.0
Average B. T. U. gas, per cubic foot	128.9
Total coal fired, pounds	8,650

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 25.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.46	1.40	1.25
Developed at switch board	1.39	1.33	1.19
Per brake horsepower:			
Available for outside purposes	1.24	1.19	1.06
Developed at engine	1.18	1.13	1.01
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.65	1.58	1.41
Developed at switch board	1.57	1.50	1.34
Per brake horsepower:			
Available for outside purposes	1.40	1.34	1.20
Developed at engine	1.33	1.27	1.14

ANALYSES.

	Test 25.		Test 25.
Coal.		*Gas by volume.*	
Moisture	4.23	Carbon dioxide (CO_2)	9.1
Volatile matter	31.49	Carbon monoxide (CO)	15.5
Fixed carbon	54.09	Hydrogen (H_2)	10.8
Ash	10.19	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	61.2
Sulphur	3.18	Oxygen (O_2)	.3
			100.0

KENTUCKY NO. 1.[a]

Bituminous coal from mine No. 2, Straight Creek Coal and Coke Company, Straight Creek, Bell County, Ky., on the Louisville and Nashville Railroad.

Two samples of coal were shipped from this mine under the supervision of Inspector J. W. Groves, as follows: Kentucky No. 1 B consisted of half 3-inch and 1-inch coal and half three-fourths inch coal, and was used in making producer-gas test No. 79 and coking test No. 76. Kentucky No. 1 C consisted of 1¼-inch slack coal, and the tests made on this sample were as follows: Coking test No. 71 and steaming tests Nos. 255, 263, and 265.

Two mine samples were taken from this mine for chemical analysis. No. 2350 was taken in room 99 off the main entry, 3,000 feet northeast of the drift mouth, and No. 2351 was taken in room 48 off the fourth north butt entry, 3,600 feet from the drift mouth.

[a] For tests made during 1904 see Bull. U. S. Geol. Survey No. 261, 1905, pp. 81, 126, 159.

CHEMICAL ANALYSES.

	Mine samples.		Car sample.
Laboratory number	2350	2351	2445
Air-drying loss	1.50	1.20	3.70
Proximate. Moisture	3.42	3.25	5.21
Proximate. Volatile matter	35.90	36.08	33.47
Proximate. Fixed carbon	57.50	57.74	53.10
Proximate. Ash	3.18	2.93	8.22
Ultimate. Sulphur	1.53	.91	1.12
Ultimate. Hydrogen	.....	.....	5.28
Ultimate. Carbon	.....	.....	73.08
Ultimate. Nitrogen	.....	.....	1.67
Ultimate. Oxygen	.....	.....	10.63
Calorific value determined:			
Calories	7,986	.....	7,341
British thermal units	14,375	.....	13,214

STEAMING TESTS.

Test 255, Kentucky No. 1 C.

Size as shipped, 1¼-inch slack. Size as used, over 1 inch, 21.1 per cent; ½ inch to 1 inch, 26.7 per cent; ¼ inch to ½ inch, 20.0 per cent; under ¼ inch, 32.2 per cent. Duration of test, 8.13 hours. Kind of grate, plain.

Test 263, Kentucky No. 1 C.

Size as shipped, 1¼-inch slack. Size as used, over 1 inch, 18.4 per cent; ½ inch to 1 inch, 22.2 per cent; ¼ inch to ½ inch, 21.2 per cent; under ¼ inch 38.2 per cent. Duration of test, 9.98 hours. Kind of grate, rocking

Test 265, Kentucky No. 1 C.

Size as shipped, 1¼-inch slack. Size as used, over 1 inch 35.8 per cent; ½ inch to 1 inch, 24.4 per cent; ¼ inch to ½ inch, 17.0 per cent; under ¼ inch, 22.8 per cent. Duration of test, 6.83 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 255.	Test 263.	Test 265.
Heating value of coal ..... B. T. U. per pound dry coal	14,414	14,272	14,245
Force of draft:			
Under stack damper ..... inch water	0.44	0.47	0.46
Above fire ..... do	.12	.23	.13
Furnace temperature ..... ° F.	.....	.....	2,118
Dry coal used per square foot of grate surface per hour ..... pounds	17.73	16.02	14.43
Equivalent water evaporated per square foot of water-heating surface per hour ..... pounds	3.30	2.82	2.76
Percentage of rated horsepower of boiler developed	92.7	78.9	77.2
Water apparently evaporated per pound of coal as fired ..... pounds	7.53	7.82	7.74
Water evaporated from and at 212° F.:			
Per pound of coal as fired ..... do	8.94	9.38	9.18
Per pound of dry coal ..... do	9.34	9.81	9.57
Per pound of combustible ..... do	10.08	10.83	10.44
Efficiency of boiler, including grate ..... per cent	62.58	66.38	64.88
Coal as fired:			
Per indicated horsepower hour ..... pounds	3.16	3.01	3.08
Per electrical horsepower hour ..... do	3.91	3.72	3.80
Dry coal:			
Per indicated horsepower hour ..... do	3.03	2.88	2.95
Per electrical horsepower hour ..... do	3.74	3.56	3.65

ANALYSES.

	Test 255.	Test 263.	Test 265.		Test 255.	Test 263.	Test 265.
Proximate.				*Ultimate.*			
Moisture	4.26	4.45	4.14	Carbon[a]	79.78	78.98	78.82
Volatile matter	34.48	34.51	33.92	Hydrogen[a]	5.14	5.08	5.07
Fixed carbon	55.70	54.72	55.40	Oxygen[a]	6.54	6.49	6.47
Ash	5.56	6.32	6.54	Nitrogen[a]	1.82	1.80	1.80
	100.00	100.00	100.00	Sulphur	.91	1.03	1.02
Sulphur	.87	.98	.98	Ash	5.81	6.62	6.82
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 79, Kentucky No. 1 B.

Size as shipped, ¾ inch to 3 inches. Size as used, over 1 inch, 94 per cent; ½ inch to 1 inch, 5 per cent; ¼ inch to ½ inch, 1 per cent. Duration of test, 50 hours.

Average electrical horsepower	196.9
Average B. T. U. gas, per cubic foot	166.5
Total coal fired ..... pounds..	13,050

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 79.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.40	1.37	1.32
Developed at switch board	1.33	1.29	1.25
Per brake horsepower:			
Available for outside purposes	1.19	1.16	1.12
Developed at engine	1.13	1.10	1.06
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.49	1.45	1.40
Developed at switch board	1.41	1.37	1.32
Per brake horsepower:			
Available for outside purposes	1.26	1.23	1.19
Developed at engine	1.19	1.16	1.12

ANALYSES.

	Test 79.		Test 79.
Coal.		*Gas by volume.*	
Moisture	2.61	Carbon dioxide (CO_2)	9.2
Volatile matter	36.29	Carbon monoxide (CO)	20.3
Fixed carbon	57.73	Hydrogen (H_2)	14.2
Ash	3.37	Methane (CH_4)	3.5
	100.00	Nitrogen (N_2)	52.8
Sulphur	.88		100.00

COKING TESTS.

Test 76, Kentucky No. 1 B.

Size as shipped, ¾ inch to 3 inches. Size as used, finely crushed. Raw. Duration of test, 51 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,026
Breeze produced	do....	257
Coke produced	per cent..	66.88
Breeze produced	do....	2.14
Total percentage yield		69.02

Remarks.—Fine-fingered coke. Light gray, silvery, somewhat brittle. High yield due to deposited carbon.

Test 71, Kentucky No. 1 C.

Size as shipped, 1¼ inches slack. Size as used, finely crushed. Raw. Duration of test, 64 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,319
Breeze produced	do....	355
Coke produced	per cent..	60.99
Breeze produced	do....	2.96
Total percentage yield		63.95

Remarks.—Light gray, with some little deposited carbon. Good coke. Washing would probably reduce ash and improve quality of coke.

ANALYSES.

	Test 76.		Test 71.	
	Coal.	Coke.	Coal.	Coke.
Moisture	3.55	0.93	5.64	1.32
Volatile matter	35.49	1.25	32.41	1.53
Fixed carbon	55.88	91.40	52.77	84.68
Ash	5.08	6.42	9.18	12.47
Sulphur	1.17	1.05	1.11	.96

KENTUCKY NO. 5.

Bituminous coal from Gilliam's Rockhouse prospect, Interstate Investment Company, on Big Black Mountain, Harlan County, Ky., 15 miles from the Louisville and Nashville Railroad.

This was a sample of run-of-mine coal that was mined from a small prospect hole on the outcrop and hauled in wagons to the railroad under the supervision of Inspector J. S. Burrows. The following tests were made on this sample: Coking test No. 75, steaming tests nos. 276 and 277, and producer-gas test No. 81.

Three samples for chemical analysis were obtained by the inspector from this deposit of coal, which is locally known as the "High Splint bed," as follows: No. 2271 was taken from a prospect hole 1 mile south of Gilliam's Rockhouse; No. 2272 from the face of Gilliam's Rockhouse prospect hole, 25 feet from the outcrop; and No. 2270 was selected from a quantity of weathered coal lying in the ravine below the point from which No. 2271 was taken.

CHEMICAL ANALYSES.

		Mine samples.			Car sample.
Laboratory number		2271	2272	2270	2528
Air-drying loss		2.10	2.50	2.20	2.80
Proximate.	Moisture	4.45	4.72	4.32	4.36
	Volatile matter	36.27	35.74	36.04	35.02
	Fixed carbon	56.05	57.06	57.36	56.92
	Ash	3.23	2.48	2.28	3.70
Ultimate.	Sulphur	.54	.54	.48	.67
	Hydrogen				5.16
	Carbon				77.44
	Nitrogen				1.57
	Oxygen				11.46
Calorific value determined:					
	Calories			7,845	7,735
	British thermal units			14,121	13,923

STEAMING TESTS.

Test 276, Kentucky No. 5.

Size as shipped, run of mine. Size as used, over 1 inch, 67.5 per cent; ½ inch to 1 inch, 11.6 per cent; ¼ inch to ½ inch, 7.4 per cent; under ¼ inch, 13.5 per cent. Duration of test, 9.78 hours. Kind of grate, rocking.

Test 277, Kentucky No. 5.

Size as shipped, run of mine. Size as used, over 1 inch, 54.4 per cent; ½ inch to 1 inch, 14.7 per cent; ¼ inch to ½ inch, 11.8 per cent; under ¼ inch, 19.1 per cent. Duration of test, 9.30 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 276.	Test 277.
Heating value of coal.....B. T. U. per pound dry coal..	14,571	14,510
Force of draft:		
Under stack damper.....inch water..	0.45	0.36
Above fire.....do....	.15	.08
Furnace temperature.....°F..	2,799	.....
Dry coal used per square foot of grate surface per hour.....pounds..	21.98	15.39
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	3.98	3.20
Percentage of rated horsepower of boiler developed.....	111.6	89.7
Water apparently evaporated per pound of coal as fired.....pounds..	8.01	8.28
Water evaporated from and at 212 °F.:		
Per pound of coal as fired.....do....	9.63	9.86
Per pound of dry coal.....do....	10.10	10.42
Per pound of combustible.....do....	10.62	11.13
Efficiency of boiler, including grate.....per cent..	66.94	69.35
Coal as fired:		
Per indicated horsepower hour.....pounds..	2.94	2.87
Per electrical horsepower hour.....do....	3.63	3.54
Dry coal:		
Per indicated horsepower hour.....do....	2.80	2.71
Per electrical horsepower hour.....do....	3.46	3.35

ANALYSES.

	Test 276.	Test 277.		Test 276.	Test 277.
Proximate.			*Ultimate.*		
Moisture	4.72	5.40	Carbon[a]	81.08	80.72
Volatile matter	34.96	34.57	Hydrogen[a]	4.90	4.87
Fixed carbon	56.57	56.06	Oxygen[a]	7.93	7.90
Ash	3.75	3.97	Nitrogen[a]	1.65	1.64
	100.00	100.00	Sulphur	.50	.67
Sulphur	.48	.63	Ash	3.94	4.20
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 81, Kentucky No. 5.

Size as shipped, run of mine. Size as used, over 1 inch, 71 per cent; ½ inch to 1 inch, 10 per cent; ¼ inch to ½ inch, 8 per cent; under ¼ inch, 11 per cent. Duration of test, 50 hours.

Average electrical horsepower	198.2
Average B. T. U. gas, per cubic foot	163.2
Total coal fired.....pounds..	12,900

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 81.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.38	1.33	1.28
Developed at switch board	1.30	1.25	1.20
Per brake horsepower:			
Available for outside purposes	1.18	1.13	1.08
Developed at engine	1.11	1.07	1.02
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.47	1.42	1.36
Developed at switch board	1.39	1.33	1.28
Per brake horsepower:			
Available for outside purposes	1.25	1.20	1.15
Developed at engine	1.18	1.13	1.08

ANALYSES.

	Test 81.		Test 81.
Coal.		*Gas by volume.*	
Moisture	3.75	Carbon dioxide (CO_2)	8.8
Volatile matter	36.05	Carbon monoxide (CO)	21.0
Fixed carbon	56.17	Hydrogen (H_2)	14.9
Ash	4.03	Methane (CH_4)	3.4
	100.00	Nitrogen (N_2)	51.9
Sulphur	0.47		100.0

COKING TEST.

Test 75, Kentucky No. 5.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 49 hours.

Coal charged	pounds	12,000
Coke produced	do	7,993
Breeze produced	do	256
Coke produced	per cent	66.61
Breeze produced	do	2.13
Total percentage yield		68.74

Remarks.—Light gray and silvery. Fine heavy coke. High yield due to deposited carbon.

ANALYSES.

	Test 75.	
	Coal.	Coke.
Moisture	4.67	0.30
Volatile matter	35.33	1.21
Fixed carbon	56.30	93.26
Ash	3.70	5.23
Sulphur	.45	.41

KENTUCKY NO. 6.

Bituminous coal furnished by Justus Collins, of Charleston, W. Va., from Miller Creek country bank, 5 miles southeast of Paintsville, Johnson County, Ky., 7 miles from the Chesapeake and Ohio Railway.

This sample consisted of run-of-mine coal, which was loaded in wagons and hauled to the railroad under the supervision of Inspector W. J. Von Borries. It was used in making coking tests Nos. 86 and 90, steaming tests Nos. 270 and 271, and producer-gas test No. 85.

Two mine samples were taken from this country bank for chemical analysis. No. 2405 was from the first right entry, 100 feet west of the drift mouth; No. 2406 was taken on the main entry, 140 feet west of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2405	2406	2592
Air-drying loss		4.50	4.20	2.20
Proximate.	Moisture	6.95	6.52	5.12
	Volatile matter	35.03	34.42	36.49
	Fixed carbon	55.99	56.80	55.63
	Ash	2.03	2.26	2.76
Ultimate.	Sulphur	.48	.45	.57
	Hydrogen			5.47
	Carbon			77.20
	Nitrogen			1.45
	Oxygen			12.55
Calorific value determined:				
	Calories	7,604		7,635
	British thermal units	13,687		13,743

STEAMING TESTS.

Test 270, Kentucky No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 62.6 per cent; ½ inch to 1 inch, 16.5 per cent; ¼ inch to ½ inch, 9.4 per cent; under ¼ inch, 11.5 per cent. Duration of test, 10.02 hours. Kind of grate, plain.

Test 271, Kentucky No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 62.2 per cent; ½ inch to 1 inch, 14.1 per cent; ¼ inch to ½ inch, 7.6 per cent; under ¼ inch, 16.1 per cent. Duration of test, 10.02 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 270.	Test 271.
Heating value of coal.....B. T. U. per pound dry coal..	14,445	14,512
Force of draft:		
Under stack damper.....inch water..	0.37	0.35
Above fire.....do....	.08	.05
Furnace temperature.....°F..	2,412	2,426
Dry coal used per square foot of grate surface per hour.....pounds..	16.03	15.86
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.19	3.12
Percentage of rated horsepower of boiler developed	89.4	87.6
Water apparently evaporated per pound of coal as fired.....pounds..	7.91	7.83
Water evaporated from and at 212°-F.:		
Per pound of coal as fired.....do....	9.50	9.37
Per pound of dry coal.....do....	9.96	9.86
Per pound of combustible.....do....	10.42	10.33
Efficiency of boiler, including grate.....per cent..	66.59	65.61

MISCELLANEOUS ITEMS—continued.

	Test 270.	Test 271.
Coal as fired:		
Per indicated horsepower hour.....pounds..	2.98	3.02
Per electrical horsepower hour.....do....	3.68	3.73
Dry coal:		
Per indicated horsepower hour.....do....	2.84	2.87
Per electrical horsepower hour.....do....	3.51	3.54

ANALYSES.

	Test 270.	Test 271.		Test 270.	Test 271.
Proximate.			*Ultimate.*		
Moisture	4.69	5.01	Carbon[a]	81.18	81.53
Volatile matter	35.63	36.23	Hydrogen[a]	5.16	5.19
Fixed carbon	56.56	56.09	Oxygen[a]	8.41	8.43
Ash	3.12	2.67	Nitrogen[a]	1.52	1.53
	100.00	100.00	Sulphur	.46	.51
Sulphur	.44	.48	Ash	3.27	2.81
				100.09	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 85, Kentucky No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 73 per cent; ½ inch to 1 inch, 11 per cent; ¼ inch to ½ inch, 5 per cent; under ¼ inch, 11 per cent. Duration of test, 50 hours.

Average electrical horsepower	199.5
Average B. T. U. gas, per cubic foot	176.0
Total coal fired.....pounds..	12,600

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 85.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.34	1.28	1.24
Developed at switch board	1.26	1.21	1.16
Per brake horsepower:			
Available for outside purposes	1.14	1.09	1.05
Developed at engine	1.07	1.03	.99
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.42	1.35	1.30
Developed at switch board	1.33	1.27	1.23
Per brake horsepower:			
Available for outside purposes	1.20	1.15	1.11
Developed at engine	1.13	1.08	1.04

ANALYSES.

	Test 85.		Test 85.
Coal.		*Gas by volume.*	
Moisture	4.49	Carbon dioxide (CO_2)	7.7
Volatile matter	36.82	Carbon monoxide (CO)	23.6
Fixed carbon	55.28	Hydrogen (H_2)	16.6
Ash	3.41	Methane (CH_4)	2.9
	100.00	Nitrogen (N_2)	49.2
Sulphur	.51		100.0

COKING TESTS.

Test 86, Kentucky No. 6.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 56 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,780
Breeze produced	do....	587
Coke produced	per cent..	56.50
Breeze produced	do....	4.89
Total percentage yield		61.39

Remarks.—Light gray and silvery, with ½-inch black butts. Fine-fingered coke. Could not burn coal to coke without butts. Very hard to burn.

Test 90, Kentucky No. 6.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 55 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,659
Breeze produced	do....	447
Coke produced	per cent..	55.49
Breeze produced	do....	3.73
Total percentage yield		59.22

Remarks.—Light gray and silvery. One-half inch black butts could not be remedied, though this test is better than No. 86. Fine-fingered coke.

ANALYSES.

	Test 86.		Test 90.	
	Coal.	Coke.	Coal.	Coke.
Moisture	5.21	2.81	5.42	1.64
Volatile matter	36.82	1.27	36.82	1.69
Fixed carbon	55.62	91.93	55.30	92.26
Ash	2.35	3.99	2.46	4.41
Sulphur	.51	.40	.48	.37

KENTUCKY NO. 7.

Bituminous coal from Central mine, Central Coal and Iron Company, Central City, Muhlenberg County, Ky., on the Illinois Central Railroad.

This sample was shipped under the supervision of Inspector J. W. Groves, and consisted of "standard lump" coal over 1½-inch bar screen. The sample was used for making coking test No. 85, steaming tests Nos. 278 and 279, and producer-gas test No. 84.

Mine samples taken for chemical analysis were as follows: No. 2453 was taken from the face of room 43 off the fourteenth north entry, 1¼ miles northeast of the shaft; No. 2454 was taken from room 9 off the fourteenth south entry, 1¼ miles south of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2453	2454	2595
Air-drying loss		5.70	3.90	3.00
Proximate.	Moisture	8.76	8.75	8.47
	Volatile matter	35.02	34.00	35.24
	Fixed carbon	46.80	46.48	46.81
	Ash	9.42	10.77	9.48
Ultimate.	Sulphur	4.07	3.69	3.60
	Hydrogen	.....	.....	5.24
	Carbon	.....	.....	65.77
	Nitrogen	.....	.....	1.29
	Oxygen	.....	.....	14.63
Calorific value determined:				
	Calories	6,647	.....	6,659
	British thermal units	11,965	.....	11,986

STEAMING TESTS.

Test 278, Kentucky No. 7.

Size as shipped, standard lump. Size as used, over 1 inch, 26.8 per cent; ½ inch to 1 inch, 24.7 per cent; ¼ inch to ½ inch, 20.6 per cent; under ¼ inch, 27.9 per cent. Duration of test, 9.60 hours. Kind of grate, rocking.

Test 279, Kentucky No. 7.

Size as shipped, standard lump. Size as used, over 1 inch, 36.1 per cent; ½ inch to 1 inch, 24.1 per cent; ¼ inch to ½ inch, 7.4 per cent; under ¼ inch, 32.4 per cent. Duration of test, 9.22 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 278.	Test 279.
Heating value of coal.....B. T. U. per pound dry coal..	12,564	12,505
Force of draft:		
Under stack damper.....inch water..	0.37	0.41
Above fire.....do....	.12	.14
Furnace temperature.....°F..	.....	1,983
Dry coal used per square foot of grate surface per hour.....pounds..	16.95	14.60
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.69	2.44
Percentage of rated horsepower of boiler developed.....	75.3	68.4
Water apparently evaporated per pound of coal as fired.....pounds..	6.67	6.45
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	8.01	7.63
Per pound of dry coal.....do....	8.84	8.38
Per pound of combustible.....do....	10.44	10.05
Efficiency of boiler, including grate.....per cent..	67.95	64.71
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.53	3.71
Per electrical horsepower hour.....do....	4.36	4.58
Dry coal:		
Per indicated horsepower hour.....do....	3.20	3.37
Per electrical horsepower hour.....do....	3.95	4.17

ANALYSES.

	Test 278.	Test 279.		Test 278.	Test 279.
Proximate.			*Ultimate.*		
Moisture	9.39	9.01	Carbon[a]	68.66	68.36
Volatile matter	33.27	33.72	Hydrogen[a]	4.49	4.47
Fixed carbon	45.49	44.92	Oxygen[a]	7.42	7.39
Ash	11.85	12.35	Nitrogen[a]	1.34	1.33
	100.00	100.00	Sulphur	5.01	4.88
Sulphur	4.54	4.44	Ash	13.08	13.57
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 84, Kentucky No. 7.

Size as shipped, "standard lump." Size as used, over 1 inch, 73 per cent; ½ inch to 1 inch, 14 per cent; ¼ inch to ½ inch, 6 per cent; under ¼ inch, 7 per cent. Duration of test, 50 hours.

Average electrical horsepower	195.5
Average B. T. U. gas, per cubic foot	153.7
Total coal fired, pounds	15,300

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 84.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.66	1.52	1.36
Developed at switch board	1.57	1.43	1.28
Per brake horsepower:			
Available for outside purposes	1.41	1.29	1.16
Developed at engine	1.33	1.22	1.09
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.75	1.60	1.44
Developed at switch board	1.65	1.51	1.35
Per brake horsepower:			
Available for outside purposes	1.49	1.36	1.22
Developed at engine	1.40	1.29	1.15

ANALYSES.

	Test 84.		Test 84.
Coal.		*Gas by volume.*	
Moisture	8.47	Carbon dioxide (CO_2)	9.6
Volatile matter	35.24	Carbon monoxide (CO)	19.2
Fixed carbon	46.81	Hydrogen (H_2)	13.1
Ash	9.48	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	55.0
Sulphur	3.60		100.0

COKING TEST.

Test 85, Kentucky No. 7.

Size as shipped, "standard lump." Size as used, finely crushed. Raw. Duration of test, 40 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,865
Breeze produced	do....	342
Coke produced	per cent..	57.21
Breeze produced	do....	2.85
Total percentage yield		60.06

Remarks.—Light gray silvery. Good weight coke. Contains large amount of hard clinker on top and through cracks. Ash and sulphur both high; might be improved by washing.

ANALYSES.

	Test 85.	
	Coal.	Coke.
Moisture	8.82	0.23
Volatile matter	35.03	2.16
Fixed carbon	46.78	82.97
Ash	9.37	14.64
Sulphur	3.56	3.16

MARYLAND NO. 1.

Bituminous coal from Washington No. 3 mine, Piedmont and Georges Creek Coal Company, 2 miles north of Westernport, Garrett County, Md., on the Cumberland and Pennsylvania Railroad.

This sample of coal was loaded under the supervision of Inspector J. W. Groves, and consisted of run of mine. It was used in making washing test No. 130, coking tests Nos. 50, 54, and 58, steaming test No. 222, and steaming tests on washed coal Nos. 231 and 232.

Two mine samples were taken for chemical analysis, as follows: No. 2018 was cut from the face of room 2, sixth right entry, 1,600 feet west of the drift mouth; No. 2019 was cut from the face of room 3, off the eighth left entry, 1,900 feet southwest of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2018	2019	2274
Air-drying loss		1.80	2.50	1.40
Proximate.	Moisture	2.47	3.45	2.33
	Volatile matter	14.03	13.73	16.11
	Fixed carbon	73.95	71.97	68.43
	Ash	9.55	10.85	13.13
Ultimate.	Sulphur	1.23	1.60	1.49
	Hydrogen	.....	.....	3.99
	Carbon	.....	.....	75.21
	Nitrogen	.....	.....	1.29
	Oxygen	.....	.....	4.89
Calorific value determined:				
	Calories	7,696	.....	7,364
	British thermal units	13,853	.....	13,255

STEAMING TESTS.

Test 222, Maryland No. 1.

Size as shipped, run of mine. Size as used, over 1 inch, 5.2 per cent; ½ inch to 1 inch, 6.9 per cent; ¼ inch to ½ inch, 14.5 per cent; under ¼ inch 73.4 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 231, Maryland No. 1, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 17.2 per cent; ½ inch to 1 inch, 21.2 per cent; ¼ inch to ½ inch, 22.2 per cent; under ¼ inch, 39.4 per cent. Duration of test, 9.95 hours. Kind of grate, rocking.

Test 232, Maryland No. 1, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 15.7 per cent; ½ inch to 1 inch, 14.7 per cent; ¼ inch to ½ inch, 17.3 per cent; under ¼ inch, 52.3 per cent. Duration of test, 9.97 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 222.	Test 231.	Test 232.
Heating value of coal ..... B. T. U. per pound dry coal..	13,680	13,946	14,033
Force of draft:			
Under stack damper ..... inch water..	0.49	0.46	0.41
Above fire ..... do....	.16	.11	.12
Furnace temperature ..... °F..	2,129	2,398	2,350
Dry coal used per square foot of grate surface per hour ..... pounds..	15.81	19.67	19.42
Equivalent water evaporated per square foot of water-heating surface per hour ..... pounds..	2.86	3.42	3.32
Percentage of rated horsepower of boiler developed	80.1	95.9	93.2
Water apparently evaporated per pound of coal as fired ..... pounds..	7.59	7.86	7.75
Water evaporated from and at 212° F.:			
Per pound of coal as fired ..... do....	8.90	9.34	9.22
Per pound of dry coal ..... do....	9.06	9.70	9.55
Per pound of combustible ..... do....	10.60	11.14	10.98
Efficiency of boiler, including grate ..... per cent..	63.96	67.17	65.72
Coal as fired:			
Per indicated horsepower hour ..... pounds..	3.18	3.03	3.07
Per electrical horsepower hour ..... do....	3.92	3.74	3.79
Dry coal:			
Per indicated horsepower hour ..... do....	3.12	2.91	2.96
Per electrical horsepower hour ..... do....	3.85	3.60	3.66

ANALYSES.

	Test 222.	Test 231.	Test 232.		Test 222.	Test 231.	Test 232.
Proximate.				*Ultimate.*			
Moisture	1.84	3.70	3.43	Carbon[a]	77.60	79.52	80.02
Volatile matter	14.03	13.96	14.08	Hydrogen[a]	3.85	3.95	3.97
Fixed carbon	71.61	71.63	72.36	Oxygen[a]	2.90	2.97	3.01
Ash	12.52	10.71	10.13	Nitrogen[a]	1.34	1.36	1.38
	100.00	100.00	100.00	Sulphur	1.55	1.08	1.14
Sulphur	1.52	1.04	1.10	Ash	12.76	11.12	10.48
					100.00	100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 130, Maryland No. 1.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	45,500
Washed coal	do....	37,450
Refuse	do....	8,050

ANALYSES.

	Test 130.	
	Raw coal.	Washed coal.
Moisture	2.33	3.67
Volatile matter	16.11	.....
Fixed carbon	68.43	.....
Ash	13.13	10.61
Sulphur	1.49	1.09

COKING TESTS.

Test 50, Maryland No. 1.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 36 hours.

Remarks.—No coke produced.

Test 54, Maryland No. 1, washed.

Size as shipped, run of mine. Size as used not crushed. Duration of test, 48 hours.

Remarks.—No coke produced.

Test 58, Maryland No. 1, washed.

Size as shipped, run of mine. Size as used, finely crushed. 10 per cent pitch added. Duration of test, 54 hours.

Coal charged	pounds..	8,000
Coke produced	do....	4,650
Breeze produced	do....	565
Coke produced	per cent..	58.13
Breeze produced	do....	7.06
Total percentage yield		65.19

Remarks.—Dull-gray color. Very poor coke. Soft and dense. Breaks in large and small chunks.

ANALYSES.

	Test 58.	
	Coal.	Coke.
Moisture	4.35	0.27
Volatile matter	17.81	.88
Fixed carbon	68.86	87.47
Ash	8.98	11.38
Sulphur	1.09	.95

MASSACHUSETTS NO. 1.

Peat briquettes from bog near Halifax, Plymouth County, Mass. They were furnished by Prof. C. L. Norton, of the Massachusetts Institute of Technology, Boston, Mass., and shipped under the supervision of J. S. Burrows.

This sample consisted of a small amount (less than 5 tons) of peat which had been macerated and pressed into bricks and then dried, and it was impossible to run a test of sufficient length to eliminate the factor of uncertainty. It was demonstrated, however, that a satisfactory gas could be obtained, and no trouble was experienced in manipulating the fuel bed or in maintaining the load, but owing to the small supply of peat it was necessary to make the foundation of the fuel bed out of another fuel—Illinois coal. Considering this fact and that the amount of peat furnished made it possible to conduct a test of only nine hours' duration, it is possible that the results as given below are somewhat erroneous.

The figures are given, however, for what they are worth, as they furnish an approximate idea of the possibilities of peat fuel in the gas producer, although they can not be regarded as official results. It is impossible to tell exactly what portion of the gas was due to the Illinois coal and what portion to the peat alone.

The results of the tests of the Massachusetts peat were as follows:

PRODUCER-GAS TEST.

Test 97. Massachusetts No. 1.

Average electrical horsepower	200.0
Average B. T. U. gas, per cubic foot	166.6
Total peat fired.....pounds..	6,480

PEAT CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 97.		
	Peat as fired.	Dry peat.	Combustible.
Per electrical horsepower:			
Available for outside purposes	3.77	1.89	1.44
Developed at switch board	3.60	1.81	1.38
Per brake horsepower:			
Available for outside purposes	3.20	1.61	1.22
Developed at engine	3.06	1.54	1.17

ANALYSES.

	Test 97.		Test 97.
Peat.		*Gas by volume.*	
Moisture	49.80	Carbon dioxide (CO_2)	10.5
Volatile matter	27.27	Carbon monoxide (CO)	22.5
Fixed carbon	10.88	Hydrogen (H_2)	13.9
Ash	12.05	Methane (CH_4)	2.1
	100.00	Nitrogen (N_2)	51.0
Sulphur	0.34		100.0

In connection with this test of a small quantity of Massachusetts peat it is deemed advisable to refer briefly to a more elaborate test of peat bricks obtained from Florida, the results of which test have been obtained in time to be mentioned here, although the test was run subsequent to the date covered by the body of the report. In the producer-gas test of the Florida peat the producer was maintained in operation for fifty hours, and no difficulty whatever was experienced either in maintaining the load or in handling the fuel bed. The peat was furnished by the Orlando Water and Light Company and was secured from a bog near the city of Orlando, Orange County, Fla.

In starting the producer test the fuel bed was built up entirely of the Florida peat, and the usual preliminary run was conducted before the official test began. The total amount of peat consumed in the producer in the fifty-hour run was 29,250 pounds, or 585 pounds per hour. The average calorific value of the gas produced was 175 British thermal units per cubic foot. During the entire run the average electrical horsepower developed at the switch board was 205. The amount of peat used per electrical horsepower per hour available for outside purposes, including the estimated quantity required for the generation of the steam used in the operation of the producer, was 3.16 pounds, while 2.69 pounds were required per brake horsepower hour at the gas engine, available for outside purposes.

It should be stated that the peat bricks had been dried and that the moisture content of those used averaged 21 per cent. The gas was particularly rich in hydrogen, running 18.5 per cent, and comparatively low in nitrogen (45.5 per cent).

As there was a small supply of peat bricks left after the completion of the gas-producer tests, a short run of a little over four hours was made in the boilers. This was not sufficiently long to make any definite conclusions possible, but the results obtained were exceedingly satisfactory so far as they went. No difficulty was encountered in keeping the boiler up to its rated capacity, and, in fact, during the four hours' run the percentage of rated horsepower of the boiler developed was 113.2. The amount of peat burned per indicated horsepower hour at the steam engine was 5.66 pounds, and per electrical horsepower hour at the switch board was 6.98 pounds. The calorific value of the peat as used was 10,082 British thermal units per pound. The principal difficulty in the utilization of peat under boilers appears to be the frequency with which it is necessary to fire. On account of the lightness of the material and also on account of its rapid combustion the fireman was kept at work almost constantly during the test.

NORTH DAKOTA NO. 1 B.

Brown lignite from Lehigh mine, Consolidated Coal Company, Lehigh, Stark County N. Dak., on the Northern Pacific Railway.

This sample consisted of run of mine, and was shipped under the supervision of M. R. Campbell, of the United States Geological Survey. Producer-gas test No. 68 was run on this sample.[a]

Two mine samples (Nos. 1971 and 1972) were taken at widely separated points in the mine for chemical analysis.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1971	1972	2289
Air-drying loss		35.60	33.90	10.40
Proximate.	Moisture	42.06	42.81	32.64
	Volatile matter	24.55	26.84	29.19
	Fixed carbon	25.73	23.93	26.75
	Ash	7.66	6.42	11.42
Ultimate.	Sulphur	1.13	.96	3.54
	Hydrogen	.....	.....	6.15
	Carbon	.....	.....	39.53
	Nitrogen	.....	.....	.49
	Oxygen	.....	.....	38.87
Calorific value determined:				
	Calories	3,421	.....	3,872
	British thermal units	6,158	.....	6,970

[a] For tests of sample furnished in 1904, see Bull. U. S. Geol. Survey No. 261, 1905, pp. 82, 162.

PRODUCER-GAS TEST.

Test 68, North Dakota No. 1 B.

Size as shipped, run of mine. Size as used, over 1 inch, 79 per cent; ½ inch to 1 inch, 9 per cent; ¼ inch to ½ inch, 5 per cent; under ¼ inch, 7 per cent. Duration of test, 49 hours.

Average electrical horsepower	198.4
Average B. T. U. gas, per cubic foot	160.6
Total coal fired.....pounds..	26,000

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 68.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	2.88	1.94	1.61
Developed at switch board	2.67	1.80	1.50
Per brake horsepower:			
Available for outside purposes	2.45	1.65	1.37
Developed at engine	2.27	1.53	1.27
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	3.04	2.05	1.70
Developed at switch board	2.82	1.90	1.58
Per brake horsepower:			
Available for outside purposes	2.58	1.74	1.45
Developed at engine	2.40	1.61	1.34

ANALYSES.

	Test 68.		Test 68.
Coal.		*Gas by volume.*	
Moisture	32.64	Carbon dioxide (CO_2)	8.2
Volatile matter	29.19	Carbon monoxide (CO)	25.2
Fixed carbon	26.75	Hydrogen (H_2)	15.3
Ash	11.42	Methane (CH_4)	2.6
	100.00	Nitrogen (N_2)	48.7
Sulphur	3.54		100.0

NORTH DAKOTA NO. 2 B.

Brown lignite from mouth of Cedar Coulee, 4 miles southeast of Williston, Williams County, N. Dak., furnished by the engineers of the United States Reclamation Service.

This sample consisted of run-of-mine coal, and was used in making producer-gas test No. 72.[a]

Mine sample No. 1730 was taken in this mine for chemical analysis.

[a] For tests of sample shipped during 1904, see Bull. U. S. Geol. Survey No. 261, 1905, p. 104.

CHEMICAL ANALYSES.

		Mine sample.	Car sample.
	Laboratory number	1730	2365
	Air-drying loss	33.10	17.30
Proximate.	Moisture	41.13	36.13
Proximate.	Volatile matter	27.17	29.28
Proximate.	Fixed carbon	26.34	29.55
Proximate.	Ash	5.36	5.04
Ultimate.	Sulphur	.72	.59
Ultimate.	Hydrogen	.....	6.60
Ultimate.	Carbon	.....	42.00
Ultimate.	Nitrogen	.....	.73
Ultimate.	Oxygen	.....	45.04
	Calorific value determined:		
	Calories	3,603	4,070
	British thermal units	6,485	7,326

PRODUCER-GAS TEST.

Test 72, North Dakota No. 2 B.

Size as shipped, run of mine. Size as used, over 1 inch, 82 per cent; ½ inch to 1 inch, 7 per cent; ¼ inch to ½ inch, 5 per cent; under ¼ inch, 6 per cent. Duration of test, 50 hours.

Average electrical horsepower	195.5
Average B. T. U. gas, per cubic foot	164.1
Total coal fired, pounds	26,000

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 72.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	2.80	1.79	1.65
Developed at switch board	2.66	1.70	1.57
Per brake horsepower:			
Available for outside purposes	2.38	1.52	1.40
Developed at engine	2.26	1.44	1.33
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	2.97	1.90	1.75
Developed at switch board	2.83	1.80	1.66
Per brake horsepower:			
Available for outside purposes	2.53	1.61	1.49
Developed at engine	2.40	1.53	1.41

ANALYSES.

	Test 72.		Test 72.
Coal.		*Gas by volume.*	
Moisture	36.13	Carbon dioxide (CO_2)	9.3
Volatile matter	29.28	Carbon monoxide (CO)	22.9
Fixed carbon	29.55	Hydrogen (H_2)	15.6
Ash	5.04	Methane (CH_4)	2.7
	100.00	Nitrogen (N_2)	49.5
Sulphur	.59		100.0

NORTH DAKOTA NO. 3.

Brown lignite from Wilton mine, Washburn Lignite Coal Company, 1 mile east of Wilton, McLean County, N. Dak., on the Minneapolis, St. Paul and Sault Ste. Marie Railway.

This sample was made up of lump lignite and was shipped under the supervision of M. R. Campbell, of the United States Geological Survey. It was used in making steaming test No. 206 and producer-gas test No. 67.

Mine samples Nos. 1935 and 1938 were taken at widely separated points in the mine for chemical analysis.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1935	1938	2243
Air-drying loss		32.30	33.50	12.70
Proximate.	Moisture	40.53	41.88	35.96
	Volatile matter	27.05	26.11	31.92
	Fixed carbon	27.37	26.73	24.37
	Ash	5.05	5.28	7.75
Ultimate.	Sulphur	.76	.96	1.15
	Hydrogen	.....	.....	6.54
	Carbon	.....	.....	41.43
	Nitrogen	.....	.....	1.21
	Oxygen	.....	.....	41.92
Calorific value determined:				
	Calories	3,691	.....	3,927
	British thermal units	6,644	.....	7,069

STEAMING TEST.

Test 206, North Dakota No. 3.

Size as shipped, lump. Size as used, average diameter, three inches, 76.5 per cent; ½ inch to 1 inch, 10.6 per cent; ¼ inch to ½ inch, 4.9 per cent; under ¼ inch, 8 per cent. Duration of test, 5.72 hours. Kind of gate, rocking.

MISCELLANEOUS ITEMS.

	Test 206.
Heating value of coal, B. T. U. per pound dry coal	11,036
Force of draft:	
Under stack damper, inch water	0.65
Above fire, do	a.10
Furnace temperature, °F.	2,093
Dry coal used per square foot of grate surface per hour, pounds	27.99
Equivalent water evaporated per square foot of water-heating surface per hour, do	3.24
Percentage of rated horsepower of boiler developed	90.7
Water apparently evaporated per pound of coal as fired, pounds	3.52
Water evaporated from and at 212° F.:	
Per pound of coal as fired, do	4.13
Per pound of dry coal, do	6.45
Per pound of combustible, do	7.47
Efficiency of boiler, including grate, per cent	56.44
Coal as fired:	
Per indicated horsepower hour, pounds	6.85
Per electrical horsepower hour, do	8.46
Dry coal:	
Per indicated horsepower hour, do	4.38
Per electrical horsepower hour, do	5.41

a Forced draft.

ANALYSES.

	Test 206.		Test 206.
Proximate.		*Ultimate.*	
Moisture	35.96	Carbon [a]	64.69
Volatile matter	31.92	Hydrogen [a]	3.97
Fixed carbon	24.37	Oxygen [a]	15.55
Ash	7.75	Nitrogen [a]	1.89
	100.00	Sulphur	1.80
Sulphur	1.15	Ash	12.10
			100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 67, North Dakota No. 3.

Size as shipped, lump. Size as used, over 1 inch, 85 per cent; ½ inch to 1 inch, 6 per cent; ¼ inch to ½ inch, 3 per cent; under ¼ inch, 6 per cent. Duration of test 50 hours.

Average electrical horsepower	195.5
Average B. T. U. gas, per cubic foot	158.9
Total coal fired, pounds	30,250

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 67.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	3.27	2.10	1.89
Developed at switch board	3.10	1.99	1.79
Per brake horsepower:			
Available for outside purposes	2.78	1.78	1.61
Developed at engine	2.63	1.69	1.52
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	3.42	2.20	1.98
Developed at switch board	3.24	2.08	1.87
Per brake horsepower:			
Available for outside purposes	2.92	1.87	1.68
Developed at engine	2.75	1.77	1.59

ANALYSES.

	Test 67.		Test 67.
Coal.		*Gas by volume.*	
Moisture	35.78	Carbon dioxide (CO_2)	9.0
Volatile matter	28.76	Carbon monoxide (CO)	23.2
Fixed carbon	29.01	Hydrogen (H_2)	15.5
Ash	6.45	Methane (CH_4)	2.7
	100.00	Nitrogen (N_2)	49.6
Sulphur	.90		100.0

OHIO NO. 1.

Bituminous coal from mine No. 10, Superior Coal Company, 9 miles southeast of Wellston, Jackson County, Ohio, on the Baltimore and Ohio Railroad.

This sample consisted of run-of-mine coal from No. 4 bed and was loaded under the supervision of Inspector J. W. Groves. Both No. 4 and No. 5 seams are worked in this mine.[a]

The following tests were made on this coal: Washing test No. 119, coking test No. 24, steaming test No. 191, and steaming test on washed coal No. 192.

Two mine samples were taken in this mine for chemical analysis. No. 1896 was cut from a point 1,400 feet southwest of the entrance to the mine, in room 16, off the fourth right entry. No. 1897 was taken at a point 1,400 feet northeast of the entrance to the mine, at the face of room 17, off the fourth right entry.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1896	1897	2071
Air-drying loss		4.90	3.70	4.90
Proximate.	Moisture	8.45	7.50	7.71
	Volatile matter	41.27	39.25	38.32
	Fixed carbon	43.55	42.74	42.02
	Ash	6.73	10.51	11.95
Ultimate.	Sulphur	3.10	5.44	4.61
	Hydrogen	.....	.....	5.41
	Carbon	.....	.....	62.49
	Nitrogen	.....	.....	1.11
	Oxygen	.....	.....	14.43
Calorific value determined:				
	Calories	6,805	.....	6,397
	British thermal units	12,249	.....	11,515

STEAMING TESTS.

Test 191, Ohio No. 1.

Size as shipped, run of mine. Size as used, over 1 inch, 19.3 per cent; ½ inch to 1 inch, 22.4 per cent; ¼ inch to ½ inch, 19.4 per cent; under ¼ inch, 38.9 per cent. Duration of test, 9.92 hours. Kind of grate, rocking.

Test 192, Ohio No. 1, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 37.9 per cent; ½ inch to 1 inch, 27.8 per cent; ¼ inch to ½ inch, 18.1 per cent; under ¼ inch, 16.2 per cent. Duration of test, 10.07 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 191.	Test 192.
Heating value of coal ..... B. T. U. per pound dry coal	11,704	13,041
Force of draft:		
Under stack damper ..... inch water	0.52	0.53
Above fire ..... do	.15	.18
Furnace temperature ..... °F.	2,194	2,384
Dry coal used per square foot of grate surface per hour ..... pounds	20.66	21.57
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.98	3.21
Percentage of rated horsepower of boiler developed	83.6	90.1
Water apparently evaporated per pound of coal as fired ..... pounds	6.36	6.48

[a] For tests of No. 5 coal see Ohio No. 2 (p. 142).

MISCELLANEOUS ITEMS—continued.

	Test 191.	Test 192.
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	7.44	7.58
Per pound of dry coal.....do....	8.05	8.31
Per pound of combustible.....do....	10.04	9.42
Efficiency of boiler, including grate.....per cent..	66.42	61.54
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.80	3.73
Per electrical horsepower hour.....do....	4.69	4.61
Dry coal:		
Per indicated horsepower hour.....do....	3.51	3.40
Per electrical horsepower hour.....do....	4.34	4.20

ANALYSES.

	Test 191.	Test 192.		Test 191.	Test 192.
Proximate.			*Ultimate.*		
Moisture	7.59	8.80	Carbon[a]	63.31	71.08
Volatile matter	35.43	40.26	Hydrogen[a]	4.61	5.17
Fixed carbon	40.64	42.12	Oxygen[a]	7.70	8.63
Ash	16.34	8.82	Nitrogen[a]	1.12	1.26
	100.00	100.00	Sulphur	5.58	4.19
Sulphur	5.16	3.82	Ash	17.68	9.67
				100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 119, Ohio No. 1.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	26,900
Washed coal	do....	23,750
Refuse	do....	3,150

ANALYSES.

	Test 119.	
	Raw coal.	Washed coal.
Moisture	7.71	9.25
Volatile matter	38.32	.....
Fixed carbon	42.02	.....
Ash	11.95	8.57
Sulphur	4.61	3.72

COKING TEST.

Test 24, Ohio No. 1, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 48 hours.

Coal charged	pounds..	10,000
Coke produced	do....	5,708
Breeze produced	do....	5.89
Coke produced	per cent..	57.08
Breeze produced	do....	5.89
Total percentage yield		62.97

Remarks.—Light gray and silvery. Fingered coke. High ash and sulphur.

ANALYSES.

	Test 24.	
	Coal.	Coke.
Moisture	8.67	1.30
Volatile matter	38.81	1.95
Fixed carbon	44.02	82.98
Ash	8.50	13.77
Sulphur	3.70	3.30

OHIO NO. 2.

Bituminous coal from mine No. 10, Superior Coal Company, 9 miles southeast of Wellston, Jackson County, Ohio, on the Baltimore and Ohio Railroad.

This sample consisted of run-of-mine coal from bed No. 5, both No. 4 and No. 5 seams being worked in this mine.[a] The sample was shipped under the supervision of Inspector W. J. Von Borries, and was used in making washing test No. 121, coking test No. 27, steaming test No. 193, and steaming test on washed coal No. 197.

Two mine samples were taken in this mine for chemical analysis. No. 1898 was cut from room 5, off the second right entry on the south side of the mine, 800 feet southwest of the opening on No. 5 seam. No. 1899 was taken in room 7, off the fourth right entry on the north side of the mine, 800 feet northeast of the opening on seam No. 5.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1898	1899	2109
Air-drying loss		5.60	5.30	3.60
Proximate.	Moisture	9.38	8.95	9.01
	Volatile matter	36.74	37.82	35.85
	Fixed carbon	46.26	43.89	43.80
	Ash	7.62	9.34	11.34
Ultimate.	Sulphur	4.08	4.41	4.02
	Hydrogen	.....	.....	5.38
	Carbon	.....	.....	62.79
	Nitrogen	.....	.....	1.20
	Oxygen	.....	.....	15.27
Calorific value determined:				
	Calories	6,610	.....	6,386
	British thermal units	11,898	.....	11,495

[a] For tests of No. 4 coal, see Ohio No. 1 (p. 140).

STEAMING TESTS.

Test 193, Ohio No. 2.

Size as shipped, run of mine. Size as used, over 1 inch, 30.2 per cent; ½ inch to 1 inch, 25 per cent; ¼ inch to ½ inch, 16.6 per cent; under ¼ inch, 28.2 per cent. Duration of test, 9.95 hours. Kind of grate, rocking.

Test 197, Ohio No. 2, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 34 per cent; ½ inch to 1 inch, 23.3 per cent; ¼ inch to ½ inch, 17.4 per cent; under ¼ inch, 25.3 per cent. Duration of test, 9.87 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 193.	Test 197.
Heating value of coal.....B. T. U. per pound dry coal..	12,190	13,113
Force of draft:		
Under stack damper.....inch water..	0.51	0.45
Above fire.....do....	.18	.20
Furnace temperature.....°F..	2,293	2,294
Dry coal used per square foot of grate surface per hour.....pounds..	20.60	18.47
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	2.86	3.01
Percentage of rated horsepower of boiler developed.....	80.3	84.4
Water apparently evaporated per pound of coal as fired.....pounds..	6.03	6.32
Water evaporated from and at 212° F:		
Per pound of coal as fired.....do....	7.06	7.43
Per pound of dry coal.....do....	7.75	8.16
Per pound of combustible.....do....	9.57	9.28
Efficiency of boiler, including grate.....per cent..	61.40	60.09
Coal as fired:		
Per indicated horsepower hour.....pounds..	4.01	3.81
Per electrical horsepower hour.....do....	4.95	4.70
Dry coal:		
Per indicated horsepower hour.....do....	3.65	3.47
Per electrical horsepower hour.....do....	4.51	4.28

ANALYSES.

	Test 193.	Test 197.		Test 193.	Test 197.
Proximate.			*Ultimate.*		
Moisture	8.86	8.99	Carbon[a]	66.46	73.09
Volatile matter	35.01	37.71	Hydrogen[a]	4.64	5.11
Fixed carbon	42.32	45.56	Oxygen[a]	7.69	8.43
Ash	13.81	7.74	Nitrogen[a]	1.27	1.41
	100.00	100.00	Sulphur	4.79	3.46
Sulphur	4.37	3.15	Ash	15.15	8.50
				100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 121, Ohio No. 2.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	32,420
Washed coal	do....	25,625
Refuse	do....	6,795

ANALYSES.

	Test 121.	
	Raw coal.	Washed coal.
Moisture	9.01	10.77
Volatile matter	35.85	.....
Fixed carbon	43.80	.....
Ash	11.34	7.42
Sulphur	4.02	2.95

COKING TEST.

Test 27, Ohio No. 2, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 59 hours.

Coal charged	pounds..	10,000
Coke produced	do....	4,980
Breeze produced	do....	690
Coke produced	per cent..	49.80
Breeze produced	do....	6.90
Total percentage yield		56.70

Remarks.—Dull-gray color. Soft coke. High sulphur.

ANALYSES.

	Test 27.	
	Coal.	Coke.
Moisture	10.38	3.55
Volatile matter	37.30	2.27
Fixed carbon	45.04	82.52
Ash	7.28	11.66
Sulphur	3.07	2.84

OHIO NO. 3.

Bituminous coal from Gosline & Barbour mine, Ohio Mining and Manufacturing Company, Shawnee, Perry County, Ohio, on the Zanesville and Western Railway.

This sample was shipped under the supervision of Inspector J. W. Groves and consisted of run-of-mine coal. The following tests were made: Washing test No. 122, coking test No. 31, steaming test No. 203, and producer-gas test No. 64.

Two mine samples were taken for chemical analysis. No. 1900 was taken in the main entry, 500 feet northeast of the drift mouth, and No. 1901 was cut in the face of entry No. 7, 300 feet northeast of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1900	1901	2144
Air-drying loss		6.60	5.20	3.90
Proximate.	Moisture	10.78	9.79	9.90
	Volatile matter	34.86	35.74	33.66
	Fixed carbon	48.23	48.46	44.86
	Ash	6.13	6.01	11.58
Ultimate.	Sulphur	1.11	1.43	1.81
	Hydrogen	.....	.....	5.28
	Carbon	.....	.....	63.06
	Nitrogen	.....	.....	1.23
	Oxygen	.....	.....	17.04
Calorific value determined:				
	Calories	6,663	.....	6,265
	British thermal units	11,993	.....	11,77

STEAMING TEST.

Test 203, Ohio No. 3, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 36.2 per cent; ½ inch to 1 inch, 23.8 per cent; ¼ inch to ½ inch, 17.5 per cent; under ¼ inch, 22.5 per cent. Duration of test, 9.78 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 203.
Heating value of coal.....B. T. U. per pound dry coal..	13,237
Force of draft:	
Under stack damper.....inch water..	0.47
Above fire.....do....	.12
Furnace temperature.....°F..	2,434
Dry coal used per square foot of grate surface per hour.....pounds..	23.30
Equivalent water evaporated per square foot of water-heating surface per hour.....do....	3.75
Percentage of rated horsepower of boiler developed.....	105.0
Water apparently evaporated per pound of coal as fired.....pounds..	6.95
Water evaporated from and at 212° F:	
Per pound of coal as fired.....do....	8.17
Per pound of dry coal.....do....	8.97
Per pound of combustible.....do....	10.01
Efficiency of boiler, including grate.....per cent..	65.44
Coal as fired:	
Per indicated horsepower hour.....pounds..	3.46
Per electrical horsepower hour.....do....	4.27
Dry coal:	
Per indicated horsepower hour.....do....	3.15
Per electrical horsepower hour.....do....	3.89

ANALYSES.

	Test 203.		Test 203.
Proximate.		*Ultimate.*	
Moisture	8.88	Carbon [a]	73.77
Volatile matter	34.52	Hydrogen [a]	4.89
Fixed carbon	48.70	Oxygen [a]	9.65
Ash	7.90	Nitrogen [a]	1.44
	100.00	Sulphur	1.58
Sulphur	1.44	Ash	8.67
			100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 64, Ohio No. 3.

Size as shipped, run of mine. Size as used, over 1 inch, 47 per cent; ½ inch to 1 inch, 38 per cent; ¼ inch to ½ inch, 9 per cent; under ¼ inch, 6 per cent. Duration of test, 50 hours.

Average electrical horsepower	200.8
Average B. T. U. gas, per cubic foot	156.1
Total coal fired, pounds	14,250

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 64.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.52	1.39	1.28
Developed at switch board	1.42	1.30	1.19
Per brake horsepower:			
Available for oustide purposes	1.29	1.18	1.08
Developed at engine	1.21	1.11	1.01
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.62	1.48	1.36
Developed at switch board	1.51	1.39	1.27
Per brake horsepower:			
Available for outside purposes	1.37	1.26	1.16
Developed at engine	1.28	1.18	1.08

ANALYSES.

	Test 64.		Test 64.
Coal.		*Gas by volume.*	
Moisture	8.13	Carbon dioxide (CO_2)	8.2
Volatile matter	34.64	Carbon monoxide (CO)	22.7
Fixed carbon	49.45	Hydrogen (H_2)	15.1
Ash	7.78	Methane (CH_4)	2.5
	100.00	Nitrogen (N_2)	51.5
Sulphur	1.40		100.0

WASHING TEST.

Test 122, Ohio No. 3.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds	47,125
Washed coal	do	34,800
Refuse	do	12,325

ANALYSES.

	Test 122.	
	Raw coal.	Washed coal.
Moisture	9.90	9.96
Volatile matter	33.66	.....
Fixed carbon	44.86	.....
Ash	11.58	7.74
Sulphur	1.81	1.36

COKING TEST.

Test 31, Ohio No. 3, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 60 hours.
Remarks.—No coke produced.

OHIO NO. 4.

Bituminous coal from Crow Hollow mine, United States Coal Company, Bradley, Jefferson County, Ohio, on the Baltimore and Ohio Railroad.

This sample consisted of "three-fourths inch coal," having been passed over a three-fourths inch bar screen, and was shipped under the supervision of Inspector J. W. Groves. The following tests were made on it: Washing test No. 125, coking test No. 28, steaming tests Nos. 188, 201, and 202, steaming tests on washed coal Nos. 219, 220, and 221, and producer-gas test No. 60.

Two mine samples were taken for chemical analysis, as follows: No. 1910 from room 9 off the fourth left entry in district No. 9, 3,000 feet northwest of the tipple; No. 1911 from room 17 off main entry No. 2 in district No. 2.

CHEMICAL ANALYSES.

		Mine samples.		Car samples.
Laboratory number		1910	1911	2083
Air-drying loss		1.70	2.00	1.40
Proximate.	Moisture	4.06	4.20	3.53
	Volatile matter	38.49	37.16	37.45
	Fixed carbon	49.70	51.13	49.90
	Ash	7.75	7.51	9.12
Ultimate.	Sulphur	3.67	3.22	3.47
	Hydrogen	.....	.....	5.15
	Carbon	.....	.....	71.66
	Nitrogen	.....	.....	1.31
	Oxygen	.....	.....	9.29
Calorific value determined:				
	Calories	7,304	.....	7,262
	British thermal units	13,147	.....	13,072

STEAMING TESTS.

Test 188, Ohio No. 4.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 33.3 per cent; ½ inch to 1 inch, 23.5 per cent; ¼ inch to ½ inch, 14.4 per cent; under ¼ inch, 28.8 per cent. Duration of test, 10.13 hours. Kind of grate, plain.

Test 201, Ohio No. 4.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 38.5 per cent; ½ inch to 1 inch, 20.9 per cent; ¼ inch to ½ inch, 13.8 per cent; under ¼ inch, 26.8 per cent. Duration of test, 9.98 hours. Kind of grate, rocking.

Test 202, Ohio No. 4.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 48.2 per cent; ½ inch to 1 inch, 20.8 per cent; ¼ inch to ½ inch, 12.2 per cent; under ¼ inch, 18.8 per cent. Duration of test, 9.38 hours. Kind of grate, rocking.

Test 219, Ohio No. 4, washed.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 30.6 per cent; ½ inch to 1 inch, 23.6 per cent; ¼ inch to ½ inch, 17.8 per cent; under ¼ inch, 28 per cent. Duration of test, 9.92 hours. Kind of grate, plain.

Test 220, Ohio No. 4, washed.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 34.4 per cent; ½ inch to 1 inch, 22.9 per cent; ¼ inch to ½ inch, 15.2 per cent; under ¼ inch, 27.5 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 221, Ohio No. 4, washed.

Size as shipped, over ¾ inch. Size as used, not determined. Duration of test, 6.30 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 188.	Test 201.	Test 202.	Test 219.	Test 220.	Test 221.
Heating value of coal, B. T. U. per pound dry coal	13,370	13,545	13,374	13,889	13,986	13,986
Force of draft:						
Under stack damper....inch water..	0.47	0.47	0.55	0.42	0.43	0.42
Above fire .....do....	.14	.18	.21	.17	.09	.08
Furnace temperature.....°F..	2,426	2,196	2,289	2,525	2,359	2,312
Dry coal used per square foot of grate surface per hour.....pounds..	19.70	20.60	21.76	17.56	18.60	18.30
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.39	3.32	3.55	3.21	3.32	3.29
Percentage of rated horsepower of boiler developed	95.0	93.2	99.5	89.90	93.20	92.1
Water apparently evaporated per pound of coal as fired.....pounds..	7.08	7.37	7.46	7.44	7.26	7.32
Water evaporated from and at 212°F.:						
Per pound of coal as fired..pounds..	8.31	8.66	8.78	8.77	8.56	8.61
Per pound of dry coal.....do....	8.62	9.00	9.10	9.14	8.95	9.00
Per pound of combustible.....do....	9.89	10 32	10.48	10.17	9.84	.....
Efficiency of boiler, including grate, per cent	62.26	64.17	65.71	63.55	61.80	62.14
Coal as fired:						
Per indicated horsepower hour, pounds	3.40	3.27	3.22	3.22	3.30	3.28
Per electrical horsepower hour, pounds	4.20	4.03	3.98	3.98	4.08	4.06
Dry coal:						
Per indicated horsepower hour, pounds	3.28	3.14	3.11	3.09	3.16	3.14
Per electrical horsepower hour, pounds	4.05	3.88	3.84	3.82	3.90	3.88

ANALYSES.

	Test 188.	Test 201.	Test 202.	Test 219.	Test 220.	Test 221.
Proximate.						
Moisture	3.61	3.73	3.60	4.04	4.30	4.30
Volatile matter	37.00	36.73	35.85	38.40	38.86	38.86
Fixed carbon	49.31	49.81	50.54	50.15	50.15	50.15
Ash	10.08	9.73	10.01	7.41	6.69	6.69
	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	3.66	2.65	3.71	3.04	2.97	2.97
Ultimate.						
Carbon[a]	73.26	74.44	73.27	76.13	76.80	76.80
Hydrogen[a]	4.85	4.93	4.87	5.05	5.10	5.10
Oxygen[a]	6.30	6.41	6.29	6.53	6.61	6.61
Nitrogen[a]	1.34	1.36	1.34	1.40	1.40	1.40
Sulphur	3.80	2.75	3.85	3.17	3.10	3.10
Ash	10.45	10.11	10.38	7.72	6.99	6.99
	100.00	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 60, Ohio No. 4.

Size as shipped, over ¾ inch. Size as used, not determined. Duration of test, 25 hours.

Average electrical horsepower		202.4
Average B. T. U. gas per cubic foot		148.8
Total coal fired	pounds..	6,300

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 60.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.31	1.24	1.14
Developed at switch board	1.25	1.18	1.09
Per brake horsepower:			
Available for outside purposes	1.11	1.06	.97
Developed at engine	1.06	1.01	.92
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.41	1.33	1.23
Developed at switch board	1.34	1.27	1.17
Per brake horsepower:			
Available for outside purposes	1.20	1.13	1.04
Developed at engine	1.14	1.08	.99

ANALYSES.

	Test 60.		Test 60.
Coal.		*Gas by volume.*	
Moisture	5.03	Carbon dioxide (CO_2)	9.6
Volatile matter	36.68	Carbon monoxide (CO)	20.0
Fixed carbon	50.70	Hydrogen (H_2)	13.0
Ash	7.59	Methane (CH_4)	2.7
	100.00	Nitrogen (N_2)	54.7
Sulphur	2.77		100.0

WASHING TEST.

Test 125, Ohio No. 4.

Size as shipped, over ¾ inch. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	29,120
Washed coal	do....	26,000
Refuse	do....	3,120

ANALYSES.

	Test 125.	
	Raw coal.	Washed coal.
Moisture	3.53	3.33
Volatile matter	37.45	.....
Fixed carbon	49.90	.....
Ash	9.12	7.48
Sulphur	3.47	3.27

COKING TEST.

Test 28, Ohio No. 4.

Size as shipped, over ¾ inch. Size as used, finely crushed. Raw. Duration of test, 45 hours.

Coal charged	pounds..	10,000
Coke produced	do....	6,770
Breeze produced	do....	332
Coke produced	per cent..	67.70
Breeze produced	do....	3.32
Total percentage yield		71.02

Remarks.—Light-gray and silvery color. Good, heavy coke. High yield due to deposited carbon. High ash and sulphur.

ANALYSES.

	Test 28.	
	Coal.	Coke.
Moisture	3.86	5.33
Volatile matter	37.09	1.28
Fixed carbon	49.38	79.79
Ash	9.67	13.60
Sulphur	3.60	2.87

OHIO NO. 5.

Bituminous coal from Rush Run No. 1 mine, Glens Run Coal Company, Rush Run, Jefferson County, Ohio, on the Pennsylvania Railroad.

This sample consisted of "three-fourths inch coal" which had been passed over a three-fourths inch bar screen. It was shipped under the supervision of Inspector J. W. Groves, and was used in making coking test No. 22, steaming tests Nos. 186, 187, 189, and 190, and producer-gas test No. 58.

Two mine samples were taken for chemical analysis. No. 1944 was cut from a point off the first left entry, 2,400 feet southeast of the drift mouth; No. 1945 was cut from the face of room 17 off the third entry, 2,600 feet south of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1944	1945	2062
Air-drying loss		2.40	2.20	2.40
Proximate.	Moisture	4.69	4.99	4.34
	Volatile matter	35.57	35.33	35.53
	Fixed Carbon	53.73	53.98	52.83
	Ash	6.01	5.70	7.30
Ultimate.	Sulphur	1.54	.95	1.72
	Hydrogen			5.21
	Carbon			72.65
	Nitrogen			1.42
	Oxygen			11.70
Calorific value determined:				
	Calories	7,403		7,321
	British thermal units	13,325		13,178

STEAMING TESTS.

Test 186, Ohio No. 5.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 49.2 per cent; ½ inch to 1 inch, 23.6 per cent; ¼ inch to ½ inch, 11.8 per cent; under ¼ inch, 15.4 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 187, Ohio No. 5.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 44 per cent; ½ inch to 1 inch, 20.2 per cent; ¼ inch to ½ inch, 12 per cent; under ¼ inch, 23.8 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 189, Ohio No. 5.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 28.3 per cent; ½ inch to 1 inch, 19.7 per cent; ¼ inch to ½ inch, 15.6 per cent; under ¼ inch, 36.4 per cent. Duration of test, 10.05 hours. Kind of grate, plain.

Test 190, Ohio No. 5.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 35.1 per cent; ½ inch to 1 inch, 22.7 per cent; ¼ inch to ½ inch, 15.6 per cent; under ¼ inch, 26.6 per cent. Duration of test, 10.07 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 186.	Test 187.	Test 189.	Test 190.
Heating value of coal.....B. T. U. per pound dry coal..	13,684	13,469	13,532	13,450
Force of draft:				
Under stack damper.....inch water..	0.41	0.31	0.42	0.40
Above fire.....do....	.12	.16	.13	.10
Furnace temperature.....°F..	2,673	2,441	2,440	2,503
Dry coal used per square foot of grate surface per hour, pounds	21.49	22.91	19.48	20.44
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.80	4.06	3.60	3.70
Percentage of rated horsepower of boiler developed	106.4	113.7	100.9	103.7
Water apparently evaporated per pound of coal as fired, pounds	7.25	7.20	7.52	7.39

MISCELLANEOUS ITEMS—continued.

	Test 186.	Test 187.	Test 189.	Test 190.
Water evaporated from and at 212° F.:				
Per pound of coal as fired....pounds..	8.47	8.45	8.81	8.67
Per pound of dry coal....do....	8.85	8.87	9.25	9.07
Per pound of combustible....do....	9.84	9.96	10.34	10.24
Efficiency of boiler, including grate....per cent..	62.45	63.60	66.01	65.12
Coal as fired:				
Per indicated horsepower hour....pounds..	3.34	3.35	3.21	3.26
Per electrical horsepower hour....do....	4.12	4.13	3.96	4.03
Dry coal:				
Per indicated horsepower hour....do....	3.20	3.19	3.06	3.12
Per electrical horsepower hour....do....	3.95	3.94	3.77	3.85

ANALYSES.

	Test 186.	Test 187.	Test 189.	Test 190.
Proximate.				
Moisture	4.25	4.74	4.74	4.43
Volatile matter	34.40	33.04	34.37	34.52
Fixed carbon	53.41	52.97	52.21	51.73
Ash	7.94	9.25	8.68	9.32
	100.00	100.00	100.00	100.00
Sulphur	1.63	1.63	1.86	1.76
Ultimate.				
Carbon [a]	75.47	74.27	74.57	74.14
Hydrogen [a]	4.91	4.83	4.85	4.82
Oxygen [a]	8.16	8.03	8.07	8.01
Nitrogen [a]	1.47	1.45	1.45	1.44
Sulphur	1.70	1.71	1.95	1.84
Ash	8.29	9.71	9.11	9.75
	100.00	100.00	100.00	100.0

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 58, Ohio No. 5.

Size as shipped, over ¾ inch. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	202.2
Average B. T. U. gas, per cubic foot	152.3
Total coal fired....pounds..	11,850

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 58.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.25	1.19	1.12
Developed at switch board	1.17	1.12	1.05
Per brake horsepower:			
Available for outside purposes	1.06	1.01	.95
Developed at engine	1.00	0.95	.89

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR)—continued.

	Test 58.		
	Coal as fired.	Dry coal.	Combustible.
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.34	1.28	1.20
Developed at switch board	1.26	1.20	1.13
Per brake horsepower:			
Available for outside purposes	1.13	1.09	1.02
Developed at engine	1.07	1.02	.96

ANALYSES.

	Test 58.		Test 58.
Coal.		*Gas by volume.*	
Moisture	4.39	Carbon dioxide (CO_2)	8.9
Volatile matter	35.91	Carbon monoxide (CO)	20.7
Fixed carbon	53.77	Hydrogen (H_2)	12.7
Ash	5.93	Methane (CH_4)	3.0
	100.00	Nitrogen (N_2)	54.7
Sulphur	1.42		100.0

COKING TEST.

Test 22, Ohio No. 5.

Size as shipped, over ¾ inch. Size as used, finely crushed. Raw. Duration of test, 55 hours.

Coal charged	pounds..	10,000
Coke produced	do....	6,383
Breeze produced	do....	358
Coke produced	per cent..	63.83
Breeze produced	do....	3.58
Total percentage yield		67.41

Remarks: Light-gray and silvery color. Good, strong coke. Should make good furnace coke. Washing would probably reduce ash and sulphur and make good foundry coke. High yield due to deposited carbon.

ANALYSES.

	Test 22.	
	Coal.	Coke.
Moisture	4.49	0.87
Volatile matter	34.57	.98
Fixed carbon	52.85	86.15
Ash	8.09	12.00
Sulphur	1.77	1.64

OHIO NO. 6.

Bituminous coal from mine No. 1, Neff Coal Mining Company, Neffs, Belmont County, Ohio, on the Baltimore and Ohio Railroad.

This sample, which consisted of run-of-mine coal, was shipped under the supervision of Inspector W. J. Von Borries and was used in making washing test No. 133, coking tests Nos. 59 and 66, steaming test No. 284, steaming test on washed coal No. 253, and producer-gas test No. 76.

Two mine samples were taken for chemical analysis as follows: No. 2095 from room 12 off the fourth east entry, 2,000 feet southeast of the drift mouth; No. 2096 in room 3 off the second west entry, 1,000 feet southwest of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2095	2096	2392
Air-drying loss		1.80	1.80	3.90
Proximate.	Moisture	3.99	4.06	5.31
	Volatile matter	38.77	39.45	36.72
	Fixed carbon	49.17	50.05	49.45
	Ash	8.07	6.44	8.52
Ultimate.	Sulphur	3.49	3.35	3.33
	Hydrogen	.....	.....	5.39
	Carbon	.....	.....	70.71
	Nitrogen	.....	.....	1.12
	Oxygen	.....	.....	10.93
Calorific value determined:				
	Calories	7,279	.....	7,135
	British thermal units	13,102	.....	12,843

STEAMING TESTS.

Test 284, Ohio No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 49 per cent; ½ inch to 1 inch, 14.3 per cent; ¼ inch to ½ inch, 10.9 per cent; under ¼ inch, 25.8 per cent. Duration of test, 9.93 hours. Kind of grate, rocking.

Test 253, Ohio No. 6, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 40 per cent; ½ inch to 1 inch, 24.1 per cent; ¼ inch to ½ inch, 13.7 per cent; under ¼ inch, 22.2 per cent. Duration of test, 8.2 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 284.	Test 253.
Heating value of coal.....B. T. U. per pound dry coal..	12,974	13,901
Force of draft:		
Under stack damper.....inch water..	0.41	0.45
Above fire.....do....	.12	.18
Furnace temperature.....°F..	2,334	2,332
Dry coal used per square foot of grate surface per hour.....pounds..	17.88	15.73
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	2.90	2.83
Percentage of rated horsepower of boiler developed.....	81.3	79.4
Water apparently evaporated per pound of coal as fired.....pounds..	7.27	7.32
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	8.71	8.73
Per pound of dry coal.....do....	9.04	9.02
Per pound of combustible.....do....	10.60	9.93
Efficiency of boiler, including grate.....per cent..	67.29	62.66
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.25	3.24
Per electrical horsepower hour.....do....	4.01	4.00
Dry coal:		
Per indicated horsepower hour.....do....	3.13	3.13
Per electrical horsepower hour.....do....	3.86	3.87

ANALYSES.

	Test 284.	Test 253.		Test 284.	Test 253.
Proximate.			*Ultimate.*		
Moisture	3.71	3.26	Carbon[a]	71.32	76.63
Volatile matter	36.58	38.74	Hydrogen[a]	4.84	5.21
Fixed carbon	47.64	51.12	Oxygen[a]	6.26	6.72
Ash	12.07	6.88	Nitrogen[a]	1.13	1.22
	100.00	100.00	Sulphur	3.91	3.11
Sulphur	3.77	3.01	Ash	12.54	7.11
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 76, Ohio No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 61 per cent; ½ inch to 1 inch, 14 per cent; ¼ inch to ½ inch, 10 per cent; under ¼ inch, 15 per cent. Duration of test, 50 hours.

Average electrical horsepower	195.6
Average B. T. U. gas, per cubic foot	163.4
Total coal fired, pounds	11,850

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 76.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.27	1.23	1.12
Developed at switch board	1.21	1.17	1.06
Per brake horsepower:			
Available for outside purposes	1.08	1.04	.95
Developed at engine	1.03	.99	.90
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.36	1.31	1.20
Developed at switch board	1.30	1.25	1.14
Per brake horsepower:			
Available for outside purposes	1.16	1.12	1.02
Developed at engine	1.10	1.06	.97

ANALYSES.

	Test 76.		Test 76.
Coal.		*Gas by volume.*	
Moisture	3.61	Carbon dioxide (CO_2)	10.4
Volatile matter	38.05	Carbon monoxide (CO)	19.1
Fixed carbon	49.68	Hydrogen (H_2)	14.1
Ash	8.66	Methane (CH_4)	3.6
	100.00	Nitrogen (N_2)	52.8
Sulphur	3.76		100.0

WASHING TEST.

Test 133, Ohio No. 6.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	24,000
Washed coal	do....	20,400
Refuse	do....	3,600

ANALYSES.

	Test 133.	
	Raw coal.	Washed coal.
Moisture	5.31	6.16
Volatile matter	36.72	.....
Fixed carbon	49.45	.....
Ash	8.52	6.38
Sulphur	3.33	2.94

COKING TESTS.

Test 59, Ohio No. 6.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 46 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,200
Breeze produced	do....	370
Coke produced	per cent..	60.00
Breeze produced	do....	3.08
Total percentage yield		63.08

Remarks.—Light gray and silvery. Large, long, heavy pieces. Ash and sulphur high. Would make very good coke if these impurities could be removed by washing.

Test 66, Ohio No. 6, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 60 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,166
Breeze produced	do....	369
Coke produced	per cent..	59.72
Breeze produced	do....	3.08
Total percentage yield		62.80

Remarks.—Light gray and silvery. Washing does not materially reduce ash and sulphur, and coke from washed coal not as good physically as that from raw charge.

ANALYSES.

	Test 59.		Test 66.	
	Coal.	Coke.	Coal.	Coke.
Moisture	5.26	0.77	5.53	0.42
Volatile matter	37.36	1.26	36.95	1.20
Fixed carbon	47.53	83.71	50.96	88.35
Ash	9.85	14.26	6.56	10.03
Sulphur	3.49	2.96	2.96	2.51

OHIO NO. 7.

Bituminous coal from Forsythe mine, Forsythe Coal Company, Danford, Guernsey County, Ohio, on the Baltimore and Ohio Railroad.

This sample was shipped as "lump coal," having been passed over a 1¼-inch bar screen. It was loaded under the supervision of Inspector J. W. Groves and was used in making washing test No. 138, coking tests Nos. 89 and 94, steaming tests Nos. 268 and 269, and producer-gas test No. 87.

Two mine samples were taken for chemical analysis. No. 2090 was cut from the face of room 1 off the sixteenth east entry, 2,600 feet northwest of the bottom of the slope. No. 2091 was taken in room 22 off the fourteenth east entry, 3,700 feet north from the bottom of the slope.

CHEMICAL ANALYSES.

		Mine samples.		Boiler test sample.
Laboratory number		2090	2091	2656
Air-drying loss		2.60	2.20	2.60
Proximate.	Moisture	6.28	5.80	6.65
	Volatile matter	35.81	36.89	33.94
	Fixed carbon	50.61	50.73	48.86
	Ash	7.30	6.58	10.55
Ultimate.	Sulphur	3.55	2.62	3.13
	Hydrogen	.....	.....	5.30
	Carbon	.....	.....	67.38
	Nitrogen	.....	.....	1.20
	Oxygen	.....	.....	12.44
Calorific value determined:				
	Calories	7,056	.....	6,766
	British thermal units	12,701	.....	12,179

STEAMING TESTS.

Test 268, Ohio No. 7.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 41.1 per cent; ½ inch to 1 inch, 18.5 per cent; ¼ inch to ½ inch, 14.1 per cent; under ¼ inch, 26.3 per cent. Duration of test, 9.92 hours. Kind of grate, plain.

Test 269, Ohio No. 7.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 50.7 per cent; ½ inch to 1 inch, 19.9 per cent; ¼ inch to ½ inch, 11.5 per cent; under ¼ inch, 17.9 per cent. Duration of test, 8.27 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 268.	Test 269.
Heating value of coal.....B. T. U. per pound dry coal..	13,046	13,079
Force of draft:		
Under stack damper.....inch water..	0.40	0.55
Above fire.....do....	.13	.18
Furnace temperature.....°F..	2,280	2,453
Dry coal used per square foot of grate surface per hour.....pounds..	15.96	18.55
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.87	3.24
Percentage of rated horsepower of boiler developed	80.3	90.9
Water apparently evaporated per pound of coal as fired.....pounds..	7.03	6.85
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	8.40	8.20
Per pound of dry coal.....do....	9.00	8.76
Per pound of combustible.....do....	10.37	10.06
Efficiency of boiler, including grate.....per cent..	66.62	64.68
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.37	3.45
Per electrical horsepower hour.....do....	4.16	4.26
Dry coal:		
Per indicated horsepower hour.....do....	3.14	3.23
Per electrical horsepower hour.....do....	3.88	3.99

ANALYSES.

	Test 268.	Test 269.		Test 268.	Test 269.
Proximate.			*Ultimate.*		
Moisture	6.65	6.42	Carbon [a]	72.19	72.34
Volatile matter	33.94	34.20	Hydrogen [a]	4.89	4.90
Fixed carbon	48.86	49.14	Oxygen [a]	6.98	7.00
Ash	10.55	10.24	Nitrogen [a]	1.29	1.29
	100.00	100.00	Sulphur	3.35	3.53
Sulphur	3.13	3.30	Ash	11.30	10.94
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 87, Ohio No. 7.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 72 per cent; ½ inch to 1 inch, 12 per cent; ¼ to ½ inch, 6 per cent; under ¼ inch, 10 per cent. Duration of test, 41 hours.

Average electrical horsepower 198.0
Average B. T. U. gas, per cubic foot 156.2
Total coal fired ..... pounds.. 12,850

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 87.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.67	1.58	1.44
Developed at switch board	1.58	1.50	1.37
Per brake horsepower:			
Available for outside purposes	1.42	1.34	1.23
Developed at engine	1.35	1.27	1.16
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.76	1.67	1.52
Developed at switch board	1.67	1.58	1.45
Per brake horsepower:			
Available for outside purposes	1.50	1.41	1.30
Developed at engine	1.42	1.35	1.23

ANALYSES.

	Test 87.		Test 87.
Coal.		*Gas by volume.*	
Moisture	5.29	Carbon dioxide (CO_2)	9.5
Volatile matter	35.86	Carbon monoxide (CO)	20.4
Fixed carbon	50.73	Hydrogen H_2)	12.3
Ash	8.12	Methune (CH_4)	3.1
	100.00	Nitrogen (N_2)	54.7
Sulphur	2.34		100.0

WASHING TEST.

Test 138, Ohio No. 7.

Size as shipped, over 1¼ inches. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	16,000
Washed coal	do....	14,000
Refuse	do....	2,000

ANALYSES.

	Test 138.	
	Raw coal.	Washed coal.
Moisture	6.65	7.47
Volatile matter	33.94	.....
Fixed carbon	48.86	.....
Ash	10.55	6.37
Sulphur	3.13	2.16

COKING TESTS.

Test 89, Ohio No. 7.

Size as shipped, over 1¼ inches. Size as used, finely crushed. Raw. Duration of test, 45 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,117
Breeze produced	do....	374
Coke produced	per cent..	59.31
Breeze produced	do....	3.12
Total percentage yield		62.43

Remarks.—Light gray and silvery. Large-fingered coke. Ash and sulphur high.

Test 94, Ohio No. 7, washed.

Size as shipped, over 1¼ inches. Size as used, finely crushed. Duration of test, 60 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,898
Breeze produced	do....	303
Coke produced	per cent..	57.49
Breeze produced	do....	2.53
Total percentage yield		60.02

Remarks.—Light gray and silvery. Fine-fingered coke. Lighter than coke from raw coal. Washing does not improve; sulphur high.

ANALYSES.

	Test 89.		Test 94.	
	Coal.	Coke.	Coal.	Coke.
Moisture	5.77	0.75	7.37	0.57
Volatile matter	35.43	.98	36.36	1.58
Fixed carbon	49.82	85.33	49.72	88.08
Ash	8.98	12.94	6.55	9.77
Sulphur	2.88	2.32	2.23	1.90

OHIO NO. 8.

Bituminous coal from Dixie mine, Upson Coal and Mining Company, Dixie, Perry County Ohio, on the Baltimore and Ohio Railroad.

This sample consisted of run-of-mine coal. It was loaded under the supervision of Inspector J. W. Groves and was used in making washing test No. 137, coking tests Nos. 81 and 93, steaming test No. 287, and producer-gas test No. 83.

Two mine samples were taken in the mine for chemical analysis—No. 2119 from the first pair of east entries, 1,000 feet southeast of the drift mouth, and No. 2120 from the first pair of west entries, 1,000 feet southwest of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2119	2120	2559
Air-drying loss		3.80	3.70	4.50
Proximate.	Moisture	8.92	8.87	7.55
	Volatile matter	38.58	39.32	38.00
	Fixed carbon	46.65	47.81	46.08
	Ash	5.85	4.00	8.37
Ultimate.	Sulphur	3.00	1.74	2.84
	Hydrogen	.....	.....	5.48
	Carbon	.....	.....	67.02
	Nitrogen	.....	.....	1.29
	Oxygen	.....	.....	15.00
Calorific value determined:				
	Calories	6,849	.....	6,738
	British thermal units	12,328	.....	12,128

STEAMING TEST.

Test 287, Ohio No. 8.

Size as shipped, run of mine. Size as used, over 1 inch, 50.2 per cent; ½ inch to 1 inch, 20.4 per cent; ¼ inch to ½ inch, 11.8 per cent; under ¼ inch, 17.6 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 287.
Heating value of coal ..... B. T. U. per pound dry coal	13,136
Force of draft:	
Under stack damper ..... inch water	0.50
Above fire ..... do	.21
Furnace temperature ..... °F.	2,596
Dry coal used per square foot of grate surface per hour ..... pounds	21.29
Equivalent water evaporated per square foot of water heating surface per hour ..... do	3.44
Percentage of rated horsepower of boiler developed	96.3
Water apparently evaporated per pound of coal as fired ..... pounds	6.86
Water evaporated from and at 212° F.:	
Per pound of coal as fired ..... do	8.22
Per pound of dry coal ..... do	9.01
Per pound of combustible ..... do	10.08
Efficiency of boiler, including grate ..... per cent	66.24
Coal as fired:	
Per indicated horsepower hour ..... pounds	3.44
Per electrical horsepower hour ..... do	4.25
Dry coal:	
Per indicated horsepower hour ..... do	3.14
Per electrical horsepower hour ..... do	3.88

ANALYSES.

	Test 287.		Test 287.
Proximate.		*Ultimate.*	
Moisture	8.70	Carbon[a]	72.70
Volatile matter	35.76	Hydrogen[a]	5.04
Fixed carbon	47.10	Oxygen[a]	8.98
Ash	8.44	Nitrogen[a]	1.40
	100.00	Sulphur	2.64
Sulphur	2.41	Ash	9.24
			100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 83, Ohio No. 8.

Size as shipped, run of mine. Size as used, over 1 inch, 58 per cent; ½ inch to 1 inch, 14 per cent; ¼ inch to ½ inch, 9 per cent; under ¼ inch, 19 per cent. Duration of test, 50 hours.

Average electrical horsepower	198.6
Average B. T. U. gas, per cubic foot	170.2
Total coal fired, pounds	14,850

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 83.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.60	1.47	1.27
Developed at switch board	1.50	1.37	1.19
Per brake horsepower:			
Available for outside purposes	1.36	1.25	1.08
Developed at engine	1.27	1.17	1.01
Equivalent-used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.67	1.53	1.32
Developed at switch board	1.56	1.42	1.23
Per brake horsepower:			
Available for outside purposes	1.42	1.30	1.12
Developed at engine	1.32	1.21	1.05

ANALYSES.

	Test 83.		Test 83.
Coal.		*Gas by volume.*	
Moisture	8.70	Carbon dioxide (CO_2)	6.5
Volatile matter	35.58	Carbon monoxide (CO)	24.5
Fixed carbon	43.63	Hydrogen (H_2)	12.3
Ash	12.09	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	53.6
Sulphur	3.82		100.00

WASHING TEST.

Test 137, Ohio No. 8.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	17,200
Washed coal	do....	15,560
Refuse	do....	1,640

ANALYSES.

	Test 137.	
	Raw coal.	Washed coal.
Moisture	7.55	11.77
Volatile matter	38.00	.....
Fixed carbon	46.08	.....
Ash	8.37	6.03
Sulphur	2.84	2.07

COKING TESTS.

Test 81, Ohio No. 8.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 52 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,526
Breeze produced	do....	454
Coke produced	per cent..	54.38
Breeze produced	do....	3.78
Total percentage yield		58.16

Remarks.—Light gray and silvery. Fine-fingered coke. High ash and sulphur.

Test 93, Ohio No. 8, washed.

Size as shipped, run of mine. Size as used finely crushed. Duration of test, 69 hours.

Coal charged	pounds..	12,000
Coke produced	do....	6,281
Breeze produced	do....	433
Coke produced	per cent..	52.34
Breeze produced	do....	3.61
Total percentage yield		55.95

Remarks.—Light gray, with some little silvery deposit. About three-fourths of oven seemed to coke up about 8 inches and upper 16 inches coked down, showing clear demarcation. Upper part fingered, lower in chunks. Washing does not improve.

ANALYSES.

	Test 81.		Test 93.	
	Coal.	Coke.	Coal.	Coke.
Moisture	8.43	0.66	11.43	2.46
Volatile matter	37.25	.93	37.90	1.76
Fixed carbon	44.56	82.81	44.64	86.05
Ash	9.76	15.60	6.03	9.73
Sulphur	2.90	2.59	2.10	1.88

OHIO NO. 9.

Bituminous coal from Clarion mine, Gallia Mining Company, Clarion, Vinton County, Ohio, on the Hocking Valley Railway.

Two samples were shipped under the supervision of Inspector J. W. Groves, as follows: Ohio No. 9 A, lump coal over 1¼-inch screen, used in making coking test No. 72, steaming tests Nos. 246, 249, 250, and 252, and producer-gas test No. 73; Ohio No. 9 B, nut and slack coal through 1¼-inch screen, used in making washing test No. 131, coking tests Nos. 55 and 57, steaming test No. 224, and steaming tests on washed coal Nos. 241, 243, and 244.

Two mine samples were taken in this mine for chemical analysis—No. 2208 from room 6 off the fourth east entry, 900 feet northeast of the drift mouth, and No. 2209 from No. 5 butt entry off the main entry, 800 feet west of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample A.	Car sample B.
Laboratory number		2208	2209	2310	2311
Air-drying loss		2.80	3.40	3.20	5.60
Proximate.	Moisture	6.79	7.38	5.59	8.40
	Volatile matter	40.01	41.60	36.86	36.87
	Fixed carbon	45.54	44.86	49.26	43.10
	Ash	7.66	6.16	8.29	11.93
Ultimate.	Sulphur	3.34	2.77	3.15	3.35
	Hydrogen	.....	.....	4.88	5.15
	Carbon	.....	.....	69.76	63.54
	Nitrogen	.....	.....	1.18	1.06
	Oxygen	.....	.....	12.74	14.97
Calorific value determined:					
Calories		6,952	.....	7,096	6,424
British thermal units		12,514	.....	12,773	11,563

STEAMING TESTS.

Test 246, Ohio No. 9 A.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 48.5 per cent; ½ inch to 1 inch, 17.7 per cent; ¼ inch to ½ inch, 11.2 per cent; under ¼ inch, 22.6 per cent. Duration of test, 8 hours. Kind of grate, plain.

Test 249, Ohio No. 9 A.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 58 per cent; ½ inch to 1 inch, 14.5 per cent; ¼ inch to ½ inch, 8.7 per cent; under ¼ inch, 18.8 per cent. Duration of test, 9.80 hours. Kind of grate, plain.

Test 250, Ohio No. 9 A.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 45.8 per cent; ½ inch to 1 inch, 17.6 per cent; ¼ inch to ½ inch, 14.1 per cent; under ¼ inch, 22.5 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 252, Ohio No. 9 A.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 35.4 per cent; ½ inch to 1 inch, 16.5 per cent; ¼ inch to ½ inch, 16 per cent; under ¼ inch, 32.1 per cent. Duration of test, 6.63 hours. Kind of grate, plain.

Test 224, Ohio No. 9 B.

Size as shipped, nut and slack. Size as used, over 1 inch, 20.6 per cent; ½ inch to 1 inch, 20.7 per cent; ¼ inch to ½ inch, 16.8 per cent; under ¼ inch, 41.9 per cent. Duration of test, 9.88 hours. Kind of grate, rocking.

Test 241, Ohio No. 9 B, washed.

Size as shipped, nut and slack. Size as used, over 1 inch, 28.1 per cent; ½ inch to 1 inch, 26.9 per cent; ¼ inch to ½ inch, 19 per cent; under ¼ inch, 26 per cent. Duration of test, 8.08 hours. Kind of grate, plain.

Test 243, Ohio No. 9 B, washed and dried.

Size as shipped, nut and slack. Size as used, over 1 inch, 11.7 per cent; ½ inch to 1 inch, 22.8 per cent; ¼ inch to ½ inch, 23.8 per cent; under ¼ inch, 41.7 per cent. Duration of test, 9.45 hours. Kind of grate, plain.

Test 244, Ohio No. 9 B, washed and dried.

Size as shipped, nut and slack. Size as used, over 1 inch, 16.6 per cent; ½ inch to 1 inch, 29.8 per cent; ¼ inch to ½ inch, 22.6 per cent; under ¼ inch, 31 per cent. Duration of test, 6.07 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 246.	Test 249.	Test 250.	Test 252.	Test 224.	Test 241.	Test 243.	Test 244.
Heating value of coal, B. T. U. per pound dry coal	13,507	13,390	13,369	13,406	12,119	13,504	13,374	13,421
Force of draft:								
Under stack damper, inch water	0.48	0.38	0.37	0.42	0.59	0.47	0.49	0.44
Above fire.....do....	.15	.13	.11	.14	.18	.11	.13	.11
Furnace temperature.....°F..	2,400	2,411	2,322	2,436	.....	2,349	2,487	2,532
Dry coal used per square foot of grate surface per hour...pounds..	18.30	16.50	15.64	17.39	21.51	17.81	18.22	18.08
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.32	2.93	2.88	3.13	3.13	3.31	3.31	3.26
Percentage of rated horsepower of boiler developed	93.1	82.1	80.7	87.9	87.8	92.7	92.8	91.5
Water apparently evaporated per pound of coal as fired...pounds..	7.20	7.00	7.26	7.11	6.32	7.18	7.48	7.41
Water evaporated from and at 212° F.:								
Per pound of coal as fired, pounds	8.57	8.33	8.66	8.49	7.48	8.56	8.93	8.82
Per pound of dry coal.pounds..	9.10	8.90	9.22	9.03	8.12	9.30	9.11	9.04
Per pound of combustible, pounds	10.06	9.96	10.31	10.10	9.97	10.17	9.98	9.86
Efficiency of boiler, including grate, per cent	65.06	64.19	66.60	65.05	64.70	66.51	65.78	65.05
Coal as fired:								
Per indicated horsepower hour, pounds	3.30	3.40	3.26	3.33	3.78	3.30	3.17	3.21
Per electrical horsepower hour, pounds	4.08	4.19	4.03	4.11	4.67	4.08	3.91	3.96
Dry coal:								
Per indicated horsepower hour, pounds	3.11	3.18	3.07	3.13	3.48	3.04	3.10	3.13
Per electrical horsepower hour, pounds	3.84	3.92	3.79	3.87	4.30	3.75	3.83	3.86

ANALYSES.

	Test 246.	Test 249.	Test 250.	Test 252.	Test 224.	Test 241.	Test 243.	Test 244.
Proximate.								
Moisture	5.83	6.40	6.06	5.99	7.84	7.92	1.92	2.47
Volatile matter	40.02	37.82	38.44	38.99	35.24	38.58	41.68	41.33
Fixed carbon	46.23	47.06	46.66	46.31	42.03	46.42	48.99	49.15
Ash	7.92	8.72	8.84	8.71	14.89	7.08	7.41	7.05
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	3.76	3.60	3.66	3.50	3.27	2.86	3.06	3.02
Ultimate.								
Carbon[a]	73.64	73.00	72.89	73.15	66.59	73.97	73.18	73.45
Hydrogen[a]	4.50	4.45	4.45	4.47	4.46	4.95	5.05	5.06
Oxygen[a]	8.22	8.14	8.12	8.17	8.13	9.04	9.86	9.91
Nitrogen[a]	1.24	1.24	1.23	1.23	1.11	1.24	1.24	1.25
Sulphur	3.99	3.85	3.90	3.72	3.55	3.11	3.12	3.10
Ash	8.41	9.32	9.41	9.26	16.16	7.69	7.55	7.23
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 73, Ohio No. 9 A.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 62 per cent; ½ inch to 1 inch, 14 per cent; ¼ inch to ½ inch, 11 per cent; under ¼ inch, 13 per cent. Duration of test, 50 hours.

Average electrical horsepower		194.5
Average B. T. U. gas, per cubic foot		154.6
Total coal fired	pounds..	12,800

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 73.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.39	1.29	1.17
Developed at switch board	1.32	1.22	1.11
Per brake horsepower:			
Available for outside purposes	1.18	1.10	1.00
Developed at engine	1.12	1.04	.95
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.51	1.40	1.27
Developed at switch board	1.43	1.32	1.21
Per brake horsepower:			
Available for outside purposes	1.28	1.19	1.08
Developed at engine	1.21	1.13	1.03

ANALYSES.

	Test 73.		Test 73.
Coal.		*Gas by volume.*	
Moisture	7.22	Carbon dioxide (CO_2)	14.5
Volatile matter	38.32	Carbon monoxide (CO)	13.8
Fixed carbon	46.23	Hydrogen (H_2)	18.1
Ash	8.23	Methane (CH_4)	3.0
	100.00	Nitrogen (N_2)	50.6
Sulphur	3.52		100.0

WASHING TEST.

Test 131, Ohio No. 9 B.

Size as shipped, nut and slack. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	46,530
Washed coal	do....	37,830
Refuse	do....	8,700

ANALYSES.

	Test 131.	
	Raw coal.	Washed coal.
Moisture	8.10	9.49
Volatile matter	36.87	.....
Fixed carbon	43.10	.....
Ash	11.93	7.45
Sulphur	3.35	2.88

COKING TESTS.

Test 72, Ohio No. 9 A.

Size as shipped, over 1¼ inches. Size as used, finely crushed. Raw. Duration of test, 71 hours.

Coal charged	pounds	12,000
Coke produced	do	5,596
Breeze produced	do	452
Coke produced	per cent	54.97
Breeze produced	do	3.77
Total percentage yield		58.74

Remarks.—Light gray and silvery. Fine-fingered coke. Sulphur too high. Good coke can be produced if sulphur can be lowered by washing. Somewhat brittle.

Test 55, Ohio No. 9 B.

Size as shipped, nut and slack. Size as used, finely crushed. Raw. Duration of test, 53 hours.

Coal charged	pounds	12,000
Coke produced	do	6,647
Breeze produced	do	593
Coke produced	per cent	55.39
Breeze produced	do	4.96
Total percentage yield		60.35

Remarks.—Dull-gray color. Some little deposited carbon. Good weight coke. Breaks in about equal proportions of fingered coke and chunks. High ash and sulphur.

Test 57, Ohio No. 9 B, washed.

Size as shipped, nut and slack. Size as used, finely crushed. Duration of test, 57 hours.

Coal charged	pounds	12,000
Coke produced	do	6,300
Breeze produced	do	441
Coke produced	per cent	52.50
Breeze produced	do	3.68
Total percentage yield		56.18

Remarks.—Light-gray color. Fine-fingered coke. Somewhat brittle. Washing reduces ash very materially, but does not remove sufficient sulphur.

ANALYSES.

	Test 72.		Test 55.		Test 57.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	5.58	1.80	9.03	0.70	9.73	0.68
Volatile matter	39.80	1.08	33.56	1.35	37.27	.89
Fixed carbon	46.44	84.43	41.10	78.63	46.02	86.93
Ash	8.18	12.69	16.31	19.32	6.98	11.50
Sulphur	3.63	3.06	3.40	2.94	2.84	2.40

PENNSYLVANIA NO. 4.

Bituminous coal from Jamison mine, Jamison Coal and Coke Company, 4 miles north of Greensburg, Westmoreland County, Pa., on the Pennsylvania Railroad.

This sample consisted of lump coal (over 1¼-inch bar screen) and was shipped under the supervision of Inspector J. W. Groves. The following tests were made: Steaming tests Nos. 207, 208, and 209, and producer-gas test No. 65.

Two mine samples for chemical analysis were taken from this mine—No. 1942 from the face of room 19 off the tenth butt entry, 3,500 feet north of the shaft, and No. 1943 in the main west entry, 2,000 feet northwest of the shaft.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1942	1943	2187
Air-drying loss		1.60	1.70	2.20
Proximate.	Moisture	2.73	2.80	3.15
	Volatile matter	30.34	30.92	30.27
	Fixed carbon	57.80	58.21	56.17
	Ash	9.13	8.07	10.41
Ultimate.	Sulphur	1.33	.83	1.26
	Hydrogen	.....	.....	4.96
	Carbon	.....	.....	74.33
	Nitrogen	.....	.....	1.43
	Oxygen	.....	.....	7.61
Calorific value determined:				
	Calories	7,563	.....	7,448
	British thermal units	13,613	.....	13,406

STEAMING TESTS.

Test 207, Pennsylvania No. 4.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 30.4 per cent; ½ inch to 1 inch, 21 per cent; ¼ inch to ½ inch, 16.9 per cent; under ¼ inch, 31.7 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 208, Pennsylvania No. 4.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 25.8 per cent; ½ inch to 1 inch, 20.3 per cent; ¼ inch to ½ inch, 16.4 per cent; under ¼ inch, 37.5 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 209, Pennsylvania No. 4.

Size as shipped, over 1¼ inches. Size as used, over 1 inch, 30.7 per cent; ½ inch to 1 inch, 22.7 per cent; ¼ inch to ½ inch, 16.7 per cent; under ¼ inch, 29.9 per cent. Duration of test, 10.05 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 207.	Test 208.	Test 209.
Heating value of coal.....B. T. U. per pound dry coal..	13,979	13,921	13,952
Force of draft:			
Under stack damper.....inch water..	0.44	0.44	0.49
Above fire.....do....	.14	.13	.15
Furnace temperature.....°F..	2,363	2,223	2,200
Dry coal used per square foot of grate surface per hour.....pounds..	19.61	17.45	17.83
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.41	3.08	3.07
Percentage of rated horsepower of boiler developed.....	95.6	86.2	86.0
Water apparently evaporated per pound of coal as fired.....pounds..	8.10	8.23	8.02
Water evaporated from and at 212° F.:			
Per pound of coal as fired.....do....	9.47	9.62	9.38
Per pound of dry coal.....do....	9.70	9.84	9.61
Per pound of combustible.....do....	11.09	11.36	10.98
Efficiency of boiler, including grate.....per cent..	67.01	68.26	66.52
Coal as fired:			
Per indicated horsepower hour.....pounds..	2.99	2.94	3.01
Per electrical horsepower hour.....do....	3.69	3.63	3.72
Dry coal:			
Per indicated horsepower hour.....do....	2.92	2.87	2.94
Per electrical horsepower hour.....do....	3.60	3.55	3.63

ANALYSES.

	Test 207.	Test 208.	Test 209.		Test 207.	Test 208.	Test 209.
Proximate.				*Ultimate.*			
Moisture	2.32	2.22	2.34	Carbon [a]	77.48	77.21	77.40
Volatile matter	30.28	30.46	30.56	Hydrogen [a]	4.81	4.80	4.80
Fixed carbon	57.71	57.18	57.18	Oxygen [a]	5.03	4.98	5.02
Ash	9.69	10.14	9.92	Nitrogen [a]	1.48	1.48	1.49
	100.00	100.00	100.00	Sulphur	1.28	1.16	1.15
Sulphur	1.25	1.13	1.12	Ash	9.92	10.37	10.14
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 65, Pennsylvania No. 4.

Size as shipped, over 1¼ inches. Size as used, over 1¼ inches, 75 per cent; ½ inch to 1 inch, 9 per cent; ¼ inch to ½ inch, 6 per cent; under ¼ inch, 10 per cent. Duration of test, 50 hours.

Average electrical horsepower	195.1
Average B. T. U. gas, per cubic foot	140.6
Total coal fired, pounds	13,200

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR.)

	Test 65.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.42	1.40	1.24
Developed at switch board	1.35	1.33	1.18
Per brake horsepower:			
Available for outside purposes	1.21	1.19	1.05
Developed at engine	1.15	1.13	1.00
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.49	1.46	1.30
Developed at switch board	1.42	1.39	1.24
Per brake horsepower:			
Available for outside purposes	1.27	1.24	1.10
Developed at engine	1.21	1.18	1.05

ANALYSES.

	Test 65.		Test 65.
Coal.		*Gas by volume.*	
Moisture	1.79	Carbon dioxide (CO_2)	8.7
Volatile matter	30.17	Carbon monoxide (CO)	20.7
Fixed carbon	57.04	Hydrogen (H_2)	12.5
Ash	11.00	Methane (CH_4)	2.5
	100.00	Nitrogen (N_2)	55.6
Sulphur	1.35		100.0

PENNSYLVANIA NO. 5.

Bituminous coal from Nos. 1 and 2 mines, James W. Ellsworth & Co., Ellsworth, Washington County, Pa., on the Pennsylvania Railroad.

This sample consisted of "three-fourths inch coal" over a three-fourths inch bar screen. It was loaded under the supervision of Inspector W. J. Von Borries, and was used in making washing test No. 120, coking tests Nos. 25 and 26, steaming test No. 286, steaming tests on washed coal Nos. 194 and 195, and producer-gas test No. 59.

Two mine samples were taken for chemical analysis—No. 1966 from room 10 off the first butt entry, 3,000 feet southeast of the shaft in mine No. 2, and No. 1967 from room 17 off the fifth butt north entry, 3,000 feet north of the shaft in mine No. 1.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1966	1967	2068
Air-drying loss		1.50	1.50	1.00
Proximate.	Moisture	3.01	2.91	2.46
	Volatile matter	33.46	33.70	34.48
	Fixed carbon	58.70	57.99	57.01
	Ash	4.83	5.40	6.05
Ultimate.	Sulphur	.73	1.08	.88
	Hydrogen	.....	.....	5.26
	Carbon	.....	.....	77.99
	Nitrogen	.....	.....	1.53
	Oxygen	.....	.....	8.29
Calorific value determined:				
	Calories	7,887	.....	7,785
	British thermal units	14,197	.....	14,013

STEAMING TESTS.

Test 286, Pennsylvania No. 5.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 55.3 per cent; ½ inch to 1 inch, 14.5 per cent; ¼ inch to ½ inch, 9.8 per cent; ¼ inch, 20.4 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 194, Pennsylvania No. 5, washed.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 53.4 per cent; ½ inch to 1 inch, 22.2 per cent; ¼ inch to ½ inch, 11.8 per cent; under ¼ inch, 12.6 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 195, Pennsylvania No. 5, washed.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 55.2 per cent; ½ inch to 1 inch, 18.7 per cent; ¼ inch to ½ inch, 11.8 per cent; under ¼ inch, 14.3 per cent. Duration of test, 10.02 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 286.	Test 194.	Test 195.
Heating value of coal.....B. T. U. per pound dry coal..	14,029	14,526	14,567
Force of draft:			
Under stack damper.....inch water..	0.36	0.51	0.47
Above fire.....do....	.12	.14	.16
Furnace temperature.....°F..	2,628	2,478	2,532
Dry coal used per square foot of grate surface per hour.....pounds..	18.43	20.52	19.97
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.42	3.53	3.46
Percentage of rated horsepower of boiler developed.....	95.9	98.8	96.9
Water apparently evaporated per pound of coal as fired.....pounds..	8.29	7.93	7.97

MISCELLANEOUS ITEMS—continued.

	Test 286.	Test 194.	Test 195.
Water evaporated from and at 212° F.:			
Per pound of coal as fired.....pounds..	9.92	9.30	9.36
Per pound of dry coal.....do....	10.35	9.59	9.65
Per pound of combustible.....do....	11.40	10.21	10.36
Efficiency of boiler, including grate.....per cent..	71.25	63.76	63.97
Coal as fired:			
Per indicated horsepower hour.....pounds..	2.85	3.04	3.02
Per electrical horsepower hour.....do....	3.52	3.75	3.73
Dry coal:			
Per indicated horsepower hour.....do....	2.73	2.95	2.93
Per electrical horsepower hour.....do....	3.37	3.64	3.62

ANALYSES.

	Test 286.	Test 194.	Test 195.		Test 286.	Test 194.	Test 195.
Proximate.				*Ultimate.*			
Moisture.....	4.11	3.03	2.97	Carbon[a].....	78.03	80.86	81.04
Volatile matter....	32.51	35.23	35.11	Hydrogen[a].....	4.99	5.18	5.18
Fixed carbon.....	55.43	56.85	57.19	Oxygen[a].....	6.11	6.34	6.34
Ash.....	7.95	4.89	4.73	Nitrogen[a].....	1.53	1.59	1.59
	100.00	100.00	100.00	Sulphur.....	1.05	.99	.97
Sulphur.....	1.01	.96	.94	Ash.....	8.29	5.04	4.88
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 59, Pennsylvania No. 5.

Size as shipped, over ¾ inch. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower..... 203.0
Average B. T. U. gas, per cubic foot..... 149.3
Total coal fired.....pounds.. 12,150

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 59.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes.....	1.28	1.24	1.14
Developed at switch board.....	1.20	1.16	1.06
Per brake horsepower:			
Available for outside purposes.....	1.09	1.05	.97
Developed at engine.....	1.02	.98	.90
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes.....	1.37	1.32	1.21
Developed at switch board.....	1.28	1.24	1.14
Per brake horsepower:			
Available for outside purposes.....	1.16	1.12	1.03
Developed at engine.....	1.09	1.05	.97

ANALYSES.

	Test 59.		Test 59.
Coal.		*Gas by volume.*	
Moisture	3.42	Carbon dioxide (CO_2)	9.6
Volatile matter	32.73	Carbon monoxide (CO)	19.4
Fixed carbon	56.13	Hydrogen (H_2)	12.7
Ash	7.72	Methane (CH_4)	3.3
	100.00	Nitrogen (N_2)	55.0
Sulphur	.81		100.0

WASHING TEST.

Test 120, Pennsylvania No. 5.

Size as shipped, over ¾ inch. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	30,920
Washed coal	do....	29,000
Refuse	do....	1,920

ANALYSES.

	Test 120.	
	Raw coal.	Washed coal.
Moisture	2.46	4.91
Volatile matter	34.48	.....
Fixed carbon	57.01	.....
Ash	6.05	4.57
Sulphur	.88	.90

COKING TESTS.

Test 25, Pennsylvania No. 5.

Size as shipped, over ¾ inch. Size as used, finely crushed. Raw. Duration of test, 62 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,433
Breeze produced	do....	319
Coke produced	per cent..	61.94
Breeze produced	do....	2.66
Total percentage yield		64.60

Remarks.—Light-gray and silvery color. Foundry coke. Good, strong coke. High yield due to deposited carbon.

Test 26, Pennsylvania No. 5, washed.

Size as shipped, over ¾ inch. Size as used, finely crushed. Duration of test, 92 hours.

Coal charged	pounds..	13,000
Coke produced	do....	8,598
Breeze produced	do....	242
Coke produced	per cent..	66.14
Breeze produced	do....	1.86
Total percentage yield		68.00

Remarks.—Good, strong coke. Foundry coke Physical appearance not as good as coke from raw coal. Ash reduced by washing.

ANALYSES.

	Test 25.		Test 26.	
	Coal.	Coke.	Coal.	Coke.
Moisture	2.44	0.49	4.73	0.23
Volatile matter	34.28	.90	34.29	1.19
Fixed carbon	56.76	88.03	56.27	91.63
Ash	6.52	10.58	4.71	6.95
Sulphur	.97	.79	.94	.81

PENNSYLVANIA NO. 6.

Bituminous coal from Hustead-Seamens mine, Hustead-Seamens Coal and Coke Company East Millsboro, Westmoreland County, Pa., on the Pennsylvania Railroad.

This sample was run-of-mine coal and was loaded under the supervision of Inspector J. W. Groves. It was used in making washing test No. 124, coking tests Nos. 32, 34, 35, 38, and 41, steaming tests Nos. 217 and 218, and producer-gas tests Nos. 66 and 70.

Two mine samples were taken for chemical analysis. No. 1968 was cut from No. 5 butt entry, 900 feet from the bottom of the slope; No. 1970 was taken in No. 1 butt entry, 1,300 feet north of the bottom of the slope.

CHEMICAL ANALYSES.

		Mine samples.		Car samples.	
Laboratory number		1968	1970	2161	2176
Air-drying loss		2.90	1.50	2.00	2.40
Proximate.	Moisture	4.08	2.81	3.24	3.46
	Volatile matter	32.44	33.88	31.78	31.80
	Fixed carbon	53.98	54.68	52.46	51.74
	Ash	9.50	8.63	12.52	13.00
Ultimate.	Sulphur	1.64	2.00	1.94	1.95
	Hydrogen	.....	.....	4.80	.....
	Carbon	.....	.....	71.41	.....
	Nitrogen	.....	.....	1.24	1.20
	Oxygen	.....	.....	8.09	.....
Calorific value determined:					
	Calories	7,371	.....	7,155	.....
	British thermal units	13,268	.....	12,879	.....

STEAMING TESTS.

Test 217, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 35.4 per cent; ½ inch to 1 inch, 21.8 per cent; ¼ inch to ½ inch, 15 per cent; under ¼ inch, 27.8 per cent. Duration of test, 9.9 hours. Kind of grate, plain.

Test 218, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 26.4 per cent; ½ inch to 1 inch, 22.5 per cent; ¼ inch to ½ inch, 16.6 per cent; under ¼ inch, 34.5 per cent. Duration of test, 9.95 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 217.	Test 218.
Heating value of coal.....B. T. U. per pound dry coal..	13,405	13,271
Force of draft:		
Under stack damper.....inch water..	0.46	0.49
Above fire.....do....	.13	.17
Furnace temperature.....°F..	2,425	2,251
Dry coal used per square foot of grate surface per hour.....pounds..	19.26	16.65
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	3.46	3.12
Percentage of rated horsepower of boiler developed.....	97.10	87.4
Water apparently evaporated per pound of coal as fired.....pounds..	7.46	7.74
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	8.79	9.11
Per pound of dry coal.....do....	9.01	9.37
Per pound of combustible.....do....	10.52	10.94
Efficiency of boiler, including grate.....per cent..	64.91	68.18

MISCELLANEOUS ITEMS—continued.

	Test 217.	Test 218.
Coal as fired:		
Per indicated horsepower hour....pounds..	3.22	3.10
Per electrical horsepower hour....do....	3.97	3.83
Dry coal:		
Per indicated horsepower hour....do....	3.14	3.02
Per electrical horsepower hour....do....	3.88	3.72

ANALYSES.

	Test 217.	Test 218.		Test 217.	Test 218.
Proximate.			*Ultimate.*		
Moisture	2.44	2.81	Carbon[a]	74.35	73.57
Volatile matter	32.98	32.80	Hydrogen[a]	4.62	4.58
Fixed carbon	52.48	51.72	Oxygen[a]	5.41	5.37
Ash	12.10	12.67	Nitrogen[a]	1.29	1.28
	100.00	100.00	Sulphur	1.93	2.16
Sulphur	1.88	2.10	Ash	12.40	13.04
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TESTS.

Test 66, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 45 per cent; ½ inch to 1 inch, 20 per cent; ¼ inch to ½ inch, 15 per cent; under ¼ inch, 20 per cent.
Duration of test, 47 hours.

Average electrical horsepower	195.3
Average B. T. U. gas, per cubic foot	126.6
Total coal fired....pounds..	13,000

Test 70, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, over 1 inch, 65 per cent; ½ inch to 1 inch, 16 per cent; ¼ inch to ½ inch, 7 per cent; under ¼ inch, 12 per cent.
Duration of test, 50 hours.

Average electrical horsepower	194.2
Average B. T. U. gas, per cubic foot	146.4
Total coal fired....pounds..	11,250

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 66.			Test 70.		
	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:						
Available for outside purposes	1.53	1.50	1.38	1.23	1.19	1.05
Developed at switch board	1.42	1.39	1.28	1.16	1.13	.99
Per brake horsepower:						
Available for outside purposes	1.30	1.27	1.17	1.04	1.01	.89
Developed at engine	1.20	1.18	1.09	.99	.96	.84
Equivalent used by producer plant.						
Per electrical horsepower:						
Available for outside purposes	1.63	1.59	1.47	1.30	1.26	1.11
Developed at switch board	1.51	1.48	1.36	1.23	1.19	1.05
Per brake horsepower:						
Available for outside purposes	1.38	1.35	1.25	1.10	1.07	.94
Developed at engine	1.28	1.26	1.16	1.04	1.01	.89

ANALYSES.

	Test 66.	Test 70.		Test 66.	Test 70.
Coal.			*Gas by volume.*		
Moisture	2.15	2.86	Carbon dioxide (CO_2)	10.0	9.6
Volatile matter	35.01	31.88	Carbon monoxide (CO)	18.5	19.2
Fixed carbon	55.18	53.35	Hydrogen (H_2)	12.1	11.5
Ash	7.66	11.91	Methane (CH_4)	2.4	3.0
	100.00	100.00	Nitrogen (N_2)	57.0	56.7
Sulphur	1.60	2.04		100.00	100.00

WASHING TEST.

Test 124, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	50,000
Washed coal	do....	43,300
Refuse	do....	6,700

ANALYSES.

	Test 124.	
	Raw coal.	Washed coal.
Moisture	3.24	4.31
Volatile matter	31.78	.....
Fixed carbon	52.46	.....
Ash	12.52	7.26
Sulphur	1.94	1.47

COKING TESTS.

Test 32, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 46 hours.

Coal charged	pounds..	10,000
Coke produced	do....	7,330
Breeze produced	do....	315
Coke produced	per cent..	73.30
Breeze produced	do....	3.15
Total percentage yield		76.45

Remarks.—Very heavy coke. Silvery color. Much deposited carbon. Conditions of oven must have been practically perfect to attain these results.

Test 34, Pennsylvania No. 6, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 45 hours.

Coal charged	pounds..	10,000
Coke produced	do....	6,905
Breeze produced	do....	246
Coke produced	per cent..	69.05
Breeze produced	do....	2.46
Total percentage yield		71.51

Remarks.—Light-gray and silvery color. Heavy coke, but physically not as good as coke from raw coal. Ash and sulphur reduced by washing.

Test 35, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 88 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,646
Breeze produced	do....	295
Coke produced	per cent..	72.05
Breeze produced	do....	2.46
Total percentage yield		74.51

Remarks.—Light-gray and silvery color. Good heavy coke. Sulphur and ash high.

Test 38, Pennsylvania No. 6, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 86 hours.

Coal charged	pounds..	13,000
Coke produced	do....	8,927
Breeze produced	do....	373
Coke produced	per cent..	68.67
Breeze produced	do....	2.87
Total percentage yield		71.54

Remarks.—Light gray and silvery. Not so good as coke from unwashed coal in physical appearance. Ash and sulphur reduced by washing.

Test 41, Pennsylvania No. 6.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 72 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,743
Breeze produced	do....	364
Coke produced	per cent..	72.86
Breeze produced	do....	3.03
Total percentage yield		75.89

Remarks.—Silvery color. Very heavy coke, but not dense. Breakage practically perfect, large pieces. Sulphur and ash high. High yield due to deposited carbon.

ANALYSES.

	Test 32.		Test 34.		Test 35.		Test 38.		Test 41.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	3.22	0.34	6.58	0.24	3.64	0.48	4.21	0.89	2.53	0.27
Volatile matter	31.52	.71	33.00	.66	32.01	1.62	33.40	2.26	32.09	1.26
Fixed carbon	51.87	82.31	52.96	88.61	51.03	81.20	55.21	86.77	53.21	82.66
Ash	13.39	16.64	7.46	10.49	13.32	16.70	7.18	10.08	12.17	15.81
Sulphur	2.10	1.59	1.46	1.21	1.93	1.70	1.51	1.24	1.78	1.52

PENNSYLVANIA NO. 7.

Bituminous coal from Ligonier mine, Old Colony Coal and Coke Company, 3 miles north of Ligonier, Westmoreland County, Pa., on the Ligonier Valley Railroad.

This sample consisted of run-of-mine coal and was loaded under the supervision of Inspector J. S. Burrows. The following tests were made on it: Washing test No. 123, coking tests Nos. 30 and 33, steaming test No. 198, steaming test on washed coal No. 199, and producer-gas test No. 88.

Two mine samples were taken for chemical analysis—No. 1994 from room 3 off the fourth left head entry, 800 feet from drift mouth, and No. 1995 from room 3 off sixth right entry, 950 feet from drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1994	1995	2154
Air-drying loss		2.40	1.90	3.20
Proximate.	Moisture	3.30	2.78	4.09
	Volatile matter	23.03	22.91	20.62
	Fixed carbon	62.49	61.58	62.82
	Ash	11.18	12.73	12.47
Ultimate.	Sulphur	1.79	1.88	2.08
	Hydrogen	.....	.....	4.73
	Carbon	.....	.....	72.78
	Nitrogen	.....	.....	1.50
	Oxygen	.....	.....	6.44
Calorific value determined:				
	Calories	7,432	.....	7,307
	British thermal units	13,378	.....	13,153

STEAMING TESTS.

Test 198, Pennsylvania No. 7.

Size as shipped, run of mine. Size as used, over 1 inch, 13.4 per cent; ½ inch to 1 inch, 16.7 per cent; ¼ inch to ½ inch, 18.9 per cent; under ¼ inch, 51.0 per cent. Duration of test, 10.03 hours. Kind of grate, plain.

Test 199, Pennsylvania No. 7, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 19.2 per cent; ½ inch to 1 inch, 22.0 per cent; ¼ inch to ½ inch, 20.4 per cent; under ¼ inch, 38.4 per cent. Duration of test, 10.03 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 198.	Test 199.
Heating value of coal.....B. T. U. per pound dry coal..	13,648	13,828
Force of draft:		
Under stack damper.....inch water..	0.48	0.39
Above fire.....do....	.16	.12
Furnace temperature.....°F..	2,091	2,330
Dry coal used per square foot of grate surface per hour.....pounds..	17.04	16.74
Equivalent water evaporated per square foot of water-heating surface per hour pounds.....	3.12	3.16
Percentage of rated horsepower of boiler developed.....	87.5	88.6
Water apparently evaporated per pound of coal as fired.....pounds..	7.55	7.64
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	8.87	8.99
Per pound of dry coal.....do....	9.18	9.44
Per pound of combustible.....do....	10.85	10.88
Efficiency of boiler, including grate.....per cent..	64.96	65.93
Coal as fired:		
Per indicated horsepower hour.....pounds..	3.19	3.15
Per electrical horsepower hour.....do....	3.94	3.88
Dry coal:		
Per indicated horsepower hour.....do....	3.08	3.00
Per electrical horsepower hour.....do....	3.80	3.70

ANALYSES.

	Test 198.	Test 199.		Test 198.	Test 199.
Proximate.			*Ultimate.*		
Moisture	3.45	4.80	Carbon[a]	75.36	77.64
Volatile matter	21.79	22.64	Hydrogen[a]	4.42	4.56
Fixed carbon	62.20	61.62	Oxygen[a]	2.93	3.00
Ash	12.56	10.94	Nitrogen[a]	1.55	1.60
	100.00	100.00	Sulphur	2.73	1.70
Sulphur	2.63	1.62	Ash	13.01	11.50
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 88, Pennsylvania No. 7.

Size as shipped, run of mine. Size as used, over 1 inch, 41 per cent; ½ inch to 1 inch, 16 per cent; ¼ inch to ½ inch, 15 per cent; under ¼ inch, 28 per cent. Duration of test, 50 hours.

Average electrical horsepower	169.9
Average B. T. U. gas, per cubic foot	139.4
Total coal fired, pounds	13,350

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 88.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.68	1.62	1.41
Developed at switch board	1.57	1.52	1.32
Per brake horsepower:			
Available for outside purposes	1.42	1.37	1.19
Developed at engine	1.34	1.29	1.12
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.79	1.72	1.50
Developed at switch board	1.68	1.62	1.41
Per brake horsepower:			
Available for outside purposes	1.52	1.47	1.27
Developed at engine	1.42	1.37	1.19

ANALYSES.

	Test 88.		Test 88.
Coal.		*Gas by volume.*	
Moisture	3.52	Carbon dioxide (CO_2)	10.2
Volatile matter	22.25	Carbon monoxide (CO)	17.5
Fixed carbon	61.57	Hydrogen (H_2)	11.3
Ash	12.66	Methane (CH_4)	2.5
	100.00	Nitrogen (N_2)	58.5
Sulphur	1.99		100.00

WASHING TEST.

Test 123, Pennsylvania No. 7.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	32,000
Washed coal	do....	27,180
Refuse	do....	4,820

ANALYSES.

	Test 123.	
	Raw coal.	Washed coal.
Moisture	4.09	5.67
Volatile matter	20.62	.....
Fixed carbon	62.82	.....
Ash	12.47	10.08
Sulphur	2.08	1.55

COKING TESTS.

Test 30, Pennsylvania No. 7.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 90 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,750
Breeze produced	do....	325
Coke produced	per cent..	72.92
Breeze produced	do....	2.71
Total percentage yield		75.63

Remarks.—Gray color. Heavy coke. High ash and sulphur.

Test 33, Pennsylvania No. 7, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 93 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,400
Breeze produced	do....	509
Coke produced	per cent..	70.00
Breeze produced	do....	4.24
Total percentage yield		74.24

Remarks.—Gray color. Heavy coke. Very little improved by washing.

ANALYSES.

	Test 30.		Test 33.	
	Coal.	Coke.	Coal.	Coke.
Moisture	3.75	0.46	3.98	0.43
Volatile matter	21.89	1.16	23.32	1.84
Fixed carbon	62.04	82.39	60.75	83.40
Ash	12.32	15.99	11.95	14.33
Sulphur	2.33	1.87	1.64	1.42

PENNSYLVANIA NO. 8.

Bituminous coal from mine No. 3, Pennsylvania Coal and Coke Company, Ehrenfeld, Cambria County, Pa., on the Pennsylvania Railroad.

This sample consisted of run-of-mine coal and was loaded under the supervision of Inspector J. S. Burrows. The following tests were made on it: Coking test No. 29, steaming test Nos. 236, 237, 238, and 239, steaming test on dried coal No. 242, and producer-gas test No. 63. A steaming test (No. 245) was also made on this sample, mixed with Virginia No. 4.

Two samples for chemical analysis were taken from this mine—No. 2014 from the twenty-third head entry, 2¼ miles from the drift mouth, and No. 2015 from the face of the main entry, 2¾ miles from the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2014	2015	2152
Air-drying loss		2.80	2.20	2.90
Proximate.	Moisture	3.49	3.09	3.51
	Volatile matter	16.12	16.66	16.82
	Fixed carbon	74.68	74.79	73.04
	Ash	5.71	5.46	6.63
Ultimate.	Sulphur	.95	1.18	.94
	Hydrogen	.....	.....	4.56
	Carbon	.....	.....	80.70
	Nitrogen	.....	.....	1.26
	Oxygen	.....	.....	5.91
Calorific value determined:				
	Calories	8,064	.....	7,933
	British thermal units	14,515	.....	14,279

STEAMING TESTS.

Test 236, Pennsylvania No. 8.

Size as shipped, run of mine. Size as used, over 1 inch, 6.5 per cent; ½ inch to 1 inch, 13.6 per cent; ¼ inch to ½ inch, 22.4 per cent; under ¼ inch, 57.5 per cent. Duration of test, 9.88 hours. Kind of grate, rocking.

Test 237, Pennsylvania No. 8.

Size as shipped, run of mine. Size as used, over 1 inch, 5.8 per cent; ½ inch to 1 inch, 12.3 per cent; ¼ inch to ½ inch, 19.5 per cent; under ¼ inch, 62.4 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 238, Pennsylvania No. 8.

Size as shipped, run of mine. Size as used, over 1 inch, 5.4 per cent; ½ inch to 1 inch, 9.1 per cent; ¼ inch to ½ inch, 14.9 per cent; under ¼ inch, 70.6 per cent. Duration of test, 10.02 hours. Kind of grate, rocking.

Test 239, Pennsylvania No. 8.

Size as shipped, run of mine Size as used, over 1 inch, 4.4 per cent; ½ inch to 1 inch, 8.8 per cent; ¼ inch to ½ inch, 16.2 per cent; under ¼ inch, 70.6 per cent. Duration of test, 9.92 hours. Kind of grate, rocking.

Test 242, Pennsylvania No. 8.

Size as shipped, run of mine. Size as used, over 1 inch, 2.0 per cent; ½ inch to 1 inch, 7.0 per cent; ¼ inch to ½ inch, 14.5 per cent; under ¼ inch, 76.5 per cent. Dried coal. Duration of test, 7.88 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 236.	Test 237.	Test 238.	Test 239.	Test 242.
Heating value of coal B. T. U. per pound dry coal	14,886	14,868	14,828	14,690	14,659
Force of draft:					
Under stack damper, inch water	0.43	0.45	0.50	0.63	0.47
Above fire, do	.15	.16	.17	.19	.16
Furnace temperature, °F.	2,317	2,266	2,212	.....	2,059
Dry coal used per square foot of grate surface per hour, pounds	15.74	16.23	15.69	17.64	14.33
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	2.93	2.96	2.93	3.08	2.92
Percentage of rated horsepower of boiler developed	82.0	83.0	82.1	86.5	81.9
Water apparently evaporated per pound of coal as fired, pounds	8.51	8.27	8.44	7.98	8.52
Water evaporated from and at 212° F.:					
Per pound of coal as fired, do	10.12	9.85	10.05	9.52	10.17
Per pound of dry coal, do	10.37	10.17	10.42	9.75	10.22
Per pound of combustible, do	11.20	11.02	11.29	10.71	11.15
Efficiency of boiler, including grate, per cent	67.27	66.06	67.86	64.10	67.19

MISCELLANEOUS ITEMS—continued.

	Test 236.	Test 237.	Test 238.	Test 239.	Test 242.
Coal as fired:					
Per indicated horsepower hour.....pounds.	2.79	2.87	2.81	2.97	2.78
Per electrical horsepower hour.....do....	3.45	3.54	3.47	3.67	3.43
Dry coal:					
Per indicated horsepower hour.....do....	2.73	2.78	2.71	2.90	2.77
Per electrical horsepower hour.....do....	3.37	3.43	3.35	3.58	3.41

ANALYSES.

	Test 236.	Test 237.	Test 238.	Test 239.	Test 242.
Proximate.					
Moisture	2.37	3.11	3.56	2.44	0.42
Volatile matter	16.74	15.68	16.09	16.64	17.51
Fixed carbon	74.66	74.93	73.85	73.69	75.20
Ash	6.23	6.28	6.50	7.23	6.87
	100.00	100.00	100.00	100.00	100.00
Sulphur	.88	.89	.87	1.12	1.01
Ultimate.					
Carbon[a]	84.14	84.03	83.81	82.98	83.35
Hydrogen[a]	4.34	4.35	4.33	4.28	4.15
Oxygen[a]	2.93	2.91	2.91	2.89	3.27
Nitrogen[a]	1.31	1.31	1.31	1.29	1.32
Sulphur	.90	.92	.90	1.15	1.01
Ash	6.38	6.48	6.74	7.41	6.90
	100.00	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 63, Pennsylvania No. 8.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	187.9
Average B. T. U. gas, per cubic foot	133.0
Total coal fired.....pounds..	11,100

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 63.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.25	1.22	1.13
Developed at switch board	1.18	1.15	1.07
Per brake horsepower:			
Available for outside purposes	1.06	1.04	.96
Developed at engine	1.00	.98	.91
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.35	1.32	1.22
Developed at switch board	1.28	1.25	1.15
Per brake horsepower:			
Available for outside purposes	1.15	1.12	1.04
Developed at engine	1.09	1.06	.98

ANALYSES.

	Test 63.		Test 63.
Coal.		*Gas by volume.*	
Moisture	2.49	Carbon dioxide (CO_2)	9.9
Volatile matter	16.61	Carbon monoxide (CO)	18.7
Fixed carbon	73.70	Hydrogen (H_2)	14.1
Ash	7.20	Methane (CH_4)	2.2
	100.00	Nitrogen (N_2)	55.1
Sulphur	.91		100.0

COKING TEST.

Test 29, Pennsylvania No. 8.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 51 hours.

Coal charged	pounds..	10,000
Coke produced	do....	5,223
Breeze produced	do....	1,600
Coke produced	per cent..	52.23
Breeze produced	do....	16.00
Total percentage yield		68.23

Remarks.—Soft, dense coke. Dull-gray color. Large and small chunks. Heavy black butt on coke. Hard to burn.

ANALYSES.

	Test 29.	
	Coal.	Coke.
Moisture	3.32	0.91
Volatile matter	15.56	2.16
Fixed carbon	74.29	88.99
Ash	6.83	7.94
Sulphur	1.12	.91

PENNSYLVANIA NO. 9.

Bituminous coal from Kimmelton mine, Reading Iron Company, Kimmelton, Somerset County, Pa., on the Baltimore and Ohio Railroad.

This sample, which was loaded under the supervision of Inspector W. J. Von Borries, consisted of run-of-mine coal, and was used in making washing test No. 126 and coking tests Nos. 37, 39, 42, and 56.

Two mine samples were taken for chemical analysis, as follows: No. 2016 from the second head entry off the sixth right entry, 3,200 feet south of the drift mouth, and No. 2017 from the eighth left entry, 3,000 feet southeast of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2016	2017	2199
Air-drying loss		1.80	3.20	2.60
Proximate.	Moisture	2.63	3.90	3.09
	Volatile matter	16.22	14.64	17.29
	Fixed carbon	70.94	73.13	68.29
	Ash	10.21	8.33	11.33
Ultimate.	Sulphur	2.05	1.76	2.04
	Hydrogen	.....	.....	4.19
	Carbon	.....	.....	75.40
	Nitrogen	.....	.....	1.25
	Oxygen	.....	.....	5.79
Calorific value determined:				
	Calories	7,614	.....	7,458
	British thermal units	13,705	.....	13,424

WASHING TEST.

Test 126, Pennsylvania No. 9.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	12,000
Washed coal	do....	9,700
Refuse	do....	2,300

ANALYSES.

	Test 126.	
	Raw coal.	Washed coal.
Moisture	3.09	4.58
Volatile matter	17.29	.....
Fixed carbon	68.29	.....
Ash	11.33	8.75
Sulphur	2.04	1.24

COKING TESTS.

Test 37, Pennsylvania No. 9.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 45 hours.

Coal charged	pounds..	7,000

Coke produced, few pieces.

Remarks.—Few pieces of dull coke obtained, and analysis was made from these. The amount was too small to calculate as percentage yield of coke.

Test 39, Pennsylvania No. 9.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 66 hours.

Coal charged	pounds..	8,000

Coke produced, few pieces.

Remarks.—This was the second test on this coal and a few pieces were obtained. Result warranted another trial after washing.

Test 42, Pennsylvania No. 9, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 51 hours.

Coal charged	pounds..	8,000
Coke produced	do....	5,600
Breeze produced	do....	801
Coke produced	per cent..	70.00
Breeze produced	do....	10.01
Total percentage yield		80.01

Remarks.—This was the third trial on this coal. The other two charges were raw, and succeeded in getting only a few pieces of coke. Washing reduced sulphur and ash. Coke was dull-gray in color. Breaks badly into small pieces, and breeze content very large.

Test 56, Pennsylvania No. 9.

Size as shipped, run of mine. Size as used, finely crushed. Raw, with 5 per cent pitch. Duration of test, 38 hours.

Coal charged	pounds..	8,000
Coke produced	do....	5,300
Breeze produced	do....	495
Coke produced	per cent..	66.25
Breeze produced	do....	6.19
Total percentage yield		72.44

Remarks.—Dull-gray color. Poor soft coke. Quality not so good as coke from washed coal. Ash and sulphur higher.

ANALYSES.

	Test 37.		Test 39.	Test 42.		Test 56.	
	Coal.	Coke.	Coal.	Coal.	Coke.	Coal.	Coke.
Moisture	3.26	0.70	2.86	4.55	0.54	2.60	0.72
Volatile matter	16.18	1.05	16.24	17.59	1.21	17.92	.61
Fixed carbon	69.44	84.92	68.60	68.80	86.84	69.36	86.02
Ash	11.12	13.33	12.30	9.06	11.41	10.12	12.65
Sulphur	1.90	1.53	2.14	1.39	1.06	1.80	1.53

PENNSYLVANIA NO. 10.

Bituminous coal from Bertha mine, Pittsburg-Buffalo Coal Company, Bruce, Allegheny County, Pa., on the Baltimore and Ohio Railroad.

This sample consisted of "three-fourths inch coal." It was loaded under the supervision of Inspector W. J. Von Borries, and was used in making coking tests Nos. 47 and 53, steaming tests Nos. 227, 228, and 229, and producer-gas test No. 71.

Two mine samples were taken for chemical analysis, as follows: No. 2080 from No 1 face entry off No. 1 butt entry, 5,000 feet from the drift mouth, and No. 2081 from the third face entry, 300 feet from the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2080	2081	2229
Air-drying loss		1.80	2.20	1.30
Proximate.	Moisture	3.67	4.08	2.61
	Volatile matter	34.03	34.41	34.92
	Fixed carbon	56.84	56.19	56.30
	Ash	5.46	5.32	6.17
	Sulphur	1.37	1.31	1.26
Ultimate.	Hydrogen			5.21
	Carbon			77.14
	Nitrogen			1.57
	Oxygen			8.65
Calorific value determined:				
	Calories	7,708		7,776
	British thermal units	13,874		13,997

STEAMING TESTS.

Test 227, Pennsylvania No. 10.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 22.8 per cent; ½ inch to 1 inch, 23.2 per cent; ¼ inch to ½ inch, 18.5 per cent; under ¼ inch, 35.5 per cent. Duration of test, 10.0 hours. Kind of grate, rocking.

Test 228, Pennsylvania No. 10.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 23.9 per cent; ½ inch to 1 inch, 18.7 per cent; ¼ inch to ½ inch, 15.8 per cent; under ¼ inch, 41.6 per cent. Duration of test, 9.97 hours. Kind of grate, rocking.

Test 229, Pennsylvania No. 10.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 27.4 per cent; ½ inch to 1 inch, 21.7 per cent; ¼ inch to ½ inch, 16.7 per cent; under ¼ inch, 34.2 per cent. Duration of test, 10.0 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 227.	Test 228.	Test 229.
Heating value of coal.....B. T. U. per pound dry coal..	14,341	14,324	14,431
Force of draft:			
Under stack damper.....inch water..	0.52	0.48	0.56
Above fire.....do....	.16	.16	.15
Furnace temperature.....°F.		2,329	2,445
Dry coal used per square foot of grate surface per hour.....pounds..	19.07	17.80	21.73
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.46	3.23	3.78
Percentage of rated horsepower of boiler developed	97.0	90.7	105.9
Water apparently evaporated per pound of coal as fired.....pounds..	8.28	8.35	7.94
Water evaporated from and at 212° F.:			
Per pound of coal as fired.....do....	9.80	9.85	9.47
Per pound of dry coal.....do....	10.12	10.14	9.69
Per pound of combustible.....do....	11.03	11.09	10.49
Efficiency of boiler, including grate.....per cent..	68.15	68.36	64.84
Coal as fired:			
Per indicated horsepower hour.....pounds..	2.89	2.87	2.99
Per electrical horsepower hour.....do....	3.56	3.55	3.69
Dry coal:			
Per indicated horsepower hour.....do....	2.79	2.79	2.92
Per electrical horsepower hour.....do....	3.45	3.44	3.61

ANALYSES.

	Test 227.	Test 228.	Test 229.		Test 227.	Test 228.	Test 229.
Proximate.				*Ultimate.*			
Moisture	3.13	2.88	2.29	Carbon [a]	79.03	78.92	79.53
Volatile matter	34.84	34.76	35.93	Hydrogen [a]	5.05	5.04	5.08
Fixed carbon	55.75	55.98	55.87	Oxygen [a]	6.46	6.47	6.51
Ash	6.28	6.38	5.91	Nitrogen [a]	1.61	1.61	1.62
	100.00	100.00	100.00	Sulphur	1.37	1.39	1.21
Sulphur	1.33	1.35	1.18	Ash	6.48	6.57	6.05
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 71, Pennsylvania No. 10.

Size as shipped, over ¾ inch. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	196.3
Average B. T. U. gas, per cubic foot	159.5
Total coal fired, pounds	12,300

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 71.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.32	1.28	1.17
Developed at switch board	1.25	1.22	1.11
Per brake horsepower:			
Available for outside purposes	1.12	1.09	0.99
Developed at engine	1.07	1.04	0.95
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.38	1.35	1.23
Developed at switch board	1.32	1.28	1.17
Per brake horsepower:			
Available for outside purposes	1.18	1.14	1.04
Developed at engine	1.12	1.09	0.99

ANALYSES.

	Test 71.		Test 71.
Coal.		*Gas by volume.*	
Moisture	2.77	Carbon dioxide (CO_2)	9.2
Volatile matter	33.94	Carbon monoxide (CO)	20.4
Fixed carbon	54.84	Hydrogen (H_2)	13.8
Ash	8.45	Methane (CH_4)	3.4
	100.00	Nitrogen (N_2)	53.2
Sulphur	1.37		100.0

COKING TESTS.

Test 47, Pennsylvania No. 10.

Size as shipped, ¾ inch. Size as used, not crushed. Raw. Duration of test, 49 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,400
Breeze produced	do....	340
Coke produced	per cent..	61.67
Breeze produced	do....	2.83
Total percentage yield		64.50

Remarks.—Light-gray and silvery color. Somewhat brittle. Large-cell structure. Good furnace coke.

Test 53, Pennsylvania No. 10.

Size as shipped, over ¾ inch. Size as used, finely crushed. Raw. Duration of test, 47 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,322
Breeze produced	do....	268
Coke produced	per cent..	69.35
Breeze produced	do....	2.23
Total percentage yield		71.58

Remarks.—Light gray and silvery. Breakage poor; small pieces. Good furnace coke. High yield due to deposited carbon.

ANALYSES.

	Test 47.		Test 53.	
	Coal.	Coke.	Coal.	Coke.
Moisture	2.56	0.39	2.73	0.36
Volatile matter	34.80	1.14	35.41	1.14
Fixed carbon	56.81	90.40	55.58	89.93
Ash	5.83	8.07	6.28	8.57
Sulphur	1.25	1.00	1.36	1.05

VIRGINIA NO. 1.

Bituminous coal from H. C. Morris prospect, Interstate Investment Company, Crab Orchard, Lee County, Va., about 7 miles from the Louisville and Nashville Railroad.

This sample, which might be designated run-of-mine coal, was taken from a small prospect hole or country bank and was hauled in wagons, under the supervision of Inspector J. S. Burrows, to the railroad. It was used in making coking tests Nos. 64, 65, 67, 68, and 77, steaming tests Nos. 281 and 282, and producer-gas test No. 77.

Three mine samples were taken for chemical analysis at this point. No. 2246 was cut from the entire seam of the left rib of the drift, 29 feet from the outcrop; No. 2268 was cut from the lower bench at the face of the drift; No. 2269 was cut from the upper bench at the face of the drift.

CHEMICAL ANALYSES.

		Mine samples.			Car sample.
Laboratory number		2246	2268	2269	2420
Air-drying loss		2.60	4.20	4.40	2.40
Proximate.	Moisture	4.72	5.69	6.55	4.06
	Volatile matter	34.21	34.43	33.51	34.93
	Fixed carbon	56.44	51.77	55.54	56.28
	Ash	4.63	8.11	4.40	4.73
Ultimate.	Sulphur	2.55	2.31	.80	1.20
	Hydrogen				5.32
	Carbon				76.59
	Nitrogen				1.24
	Oxygen				10.92
Calorific value determined:					
	Calories		7,287		7,681
	British thermal units		13,117		13,826

STEAMING TESTS.

Test 281, Virginia No. 1.

Size as shipped, run of mine. Size as used, over 1 inch, 30 per cent; ½ inch to 1 inch, 21.3 per cent; ¼ inch to ½ inch, 17.5 per cent; under ¼ inch, 31.2 per cent. Duration of test, 9.75 hours. Kind of grate, rocking.

Test 282, Virginia No. 1.

Size as shipped, run of mine. Size as used, over 1 inch, 25.4 per cent; ½ inch to 1 inch, 21.6 per cent; ¼ inch to ½ inch, 19.4 per cent; under ¼ inch, 33.6 per cent. Duration of test, 9.83 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 281.	Test 282.
Heating value of coal.....B. T. U. per pound dry coal..	14,281	14,198
Force of draft:		
Under stack damper.....inch water..	0.41	0.38
Above fire.....do....	.14	.11
Furnace temperature.....°F..	2,637	2,542
Dry coal used per square foot of grate surface per hour.....pounds..	18.35	18.57
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	3.29	3.29
Percentage of rated horsepower of boiler developed.....	92.2	92.3
Water apparently evaporated per pound of coal as fired.....pounds..	7.95	7.82
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	9.54	9.39
Per pound of dry coal.....do....	10.01	9.89
Per pound of combustible.....do....	10.78	10.72
Efficiency of boiler, including grate.....per cent..	67.69	67.27
Coal as fired:		
Per indicated horsepower hour.....pounds..	2.96	3.01
Per electrical horsepower hour.....do....	3.66	3.72
Dry coal:		
Per indicated horsepower hour.....do....	2.82	2.86
Per electrical horsepower hour.....do....	3.49	3.53

ANALYSES.

	Test 281.	Test 282.		Test 281.	Test 282.
Proximate.			*Ultimate.*		
Moisture	4.62	5.05	Carbon[a]	79.12	78.67
Volatile matter	33.85	32.82	Hydrogen[a]	5.03	5.00
Fixed carbon	55.92	56.05	Oxygen[a]	7.56	7.50
Ash	5.61	6.08	Nitrogen[a]	1.28	1.28
	100.00	100.00	Sulphur	1.13	1.15
Sulphur	1.08	1.09	Ash	5.88	6.40
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 77, Virginia No. 1.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	196.2
Average B. T. U. gas, per cubic foot	164.4
Total coal fired, pounds	14,100

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 77.		
	Coal as fired.	Drycoal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.51	1.43	1.33
Developed at switch board	1.44	1.35	1.26
Per brake horsepower:			
Available for outside purposes	1.29	1.21	1.13
Developed at engine	1.22	1.15	1.07
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.61	1.52	1.42
Developed at switch board	1.53	1.44	1.34
Per brake horsepower:			
Available for outside purposes	1.37	1.29	1.20
Developed at engine	1.30	1.23	1.14

ANALYSES.

	Test 77.		Test 77.
Coal.		*Gas by volume.*	
Moisture	5.72	Carbon dioxide (CO_2)	10.0
Volatile matter	31.93	Carbon monoxide (CO)	19.7
Fixed carbon	55.91	Hydrogen (H_2)	14.9
Ash	6.44	Methane (CH_4)	3.6
	100.00	Nitrogen (N_2)	51.8
Sulphur	1.08		100.0

COKING TESTS.

Test 64, Virginia No. 1.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 71 hours.

Coal charged.....pounds..	14,000
Coke produced.....do....	9,079
Breeze produced.....do....	415
Coke produced.....per cent..	64.85
Breeze produced.....do....	2.96
Total percentage yield.....	67.81

Remarks.—Light gray. Hard heavy coke. High yield due to deposited carbon.

Test 65, Virginia No. 1.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 36 hours.

Coal charged.....pounds..	10,000
Coke produced.....do....	6,811
Breeze produced.....do....	258
Coke produced.....per cent..	68.11
Breeze produced.....do....	2.58
Total percentage yield.....	70.69

Remarks.—Light gray and silvery. Good heavy coke. High yield due to deposited carbon.

Test 67, Virginia No. 1.

Size as shipped, run of mine. Size as used, not crushed. Raw. Duration of test, 36 hours.

Coal charged.....pounds..	10,000
Coke produced.....do....	5,879
Breeze produced.....do....	424
Coke produced.....per cent..	58.79
Breeze produced.....do....	4.24
Total percentage yield.....	63.03

Remarks.—Light gray and silvery. Coke not so good as that from ground charge. Cross breakage increased and breeze much larger, but good coke. Results would justify installation of disintegrating machinery. High yield due to deposited carbon.

Test 68, Virginia No. 1.

Size as shipped, run of mine. Size as used not crushed. Raw. Duration of test, 67 hours.

Coal charged.....pounds..	14,000
Coke produced.....do....	8,596
Breeze produced.....do....	590
Coke produced.....per cent..	61.40
Breeze produced.....do....	4.21
Total percentage yield.....	65.61

Remarks.—Light gray and silvery. Large percentage of breeze due to not grinding coal before charging. Loss by breakage also increased from same cause. Good hard heavy coke. High yield due to deposited carbon.

Test 77, Virginia No. 1.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 65 hours.

Coal charged.....pounds..	14,000
Coke produced.....do....	9,506
Breeze produced.....do....	314
Coke produced.....per cent..	67.90
Breeze produced.....do....	2.24
Total percentage yield.....	70.14

Remarks.—Light gray and silvery. Good hard heavy coke. High yield due to deposited carbon.

ANALYSES.

	Test 64.		Test 65.		Test 67.		Test 68.		Test 77.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	5.70	1.52	4.44	1.23	4.95	0.21	4.82	0.30	4.40	0.20
Volatile matter	32.52	.99	33.44	1.67	34.21	.89	33.21	1.16	35.09	.80
Fixed carbon	56.15	89.20	56.27	89.24	55.86	90.99	56.95	90.85	55.24	91.52
Ash	5.63	8.29	5.85	7.86	4.98	7.91	5.02	7.69	5.27	7.48
Sulphur	.98	.88	1.13	.94	1.12	1.01	1.10	.97	1.05	1.02

VIRGINIA NO. 2.

Bituminous coal from the "big opening" on Wilson farm, Interstate Investment Company, near Crab Orchard, Lee County, Va., about 7 miles from the Louisville and Nashville Railroad.

This sample, which was run of mine, was loaded in wagons and hauled to the railroad under the supervision of Inspector J. S. Burrows. It was used for washing test No. 134, coking tests Nos. 63, 69, and 70; steaming tests Nos. 247, 251, 256, and 258, steaming test on washed coal No. 260, and producer-gas test No. 78.

Two mine samples were taken in this opening for chemical analysis. No. 2248 was taken from the upper bench at the face of the opening, 75 feet from the outcrop; No. 2249 was taken from the lower bench at the same location.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2248	2249	2476
Air-drying loss		1.90	5.00	1.90
Proximate.	Moisture	3.90	6.80	3.35
	Volatile matter	34.08	33.01	35.13
	Fixed carbon	56.96	58.26	55.94
	Ash	5.06	1.93	5.58
Ultimate.	Sulphur	.90	.68	.92
	Hydrogen			5.19
	Carbon			77.02
	Nitrogen			1.42
	Oxygen			9.87
Calorific value determined:				
	Calories			7,740
	British thermal units			13,932

STEAMING TESTS.

Test 247, Virginia No. 2.

Size as shipped, run of mine. Size as used, over 1 inch, 49.6 per cent; ½ inch to 1 inch, 23 per cent; ¼ inch to ½ inch, 12.4 per cent; under ¼ inch, 15 per cent. Duration of test, 8 hours. Kind of grate, plain.

Test 251, Virginia No. 2.

Size as shipped, run of mine. Size as used, over 1 inch, 45 per cent; ½ inch to 1 inch, 18 per cent; ¼ inch to ½ inch, 13.4 per cent; under ¼ inch 23.6 per cent. Duration of test, 8 hours. Kind of grate, plain.

Test 256, Virginia No. 2.

Size as shipped, run of mine. Size as used, over 1 inch, 28.9 per cent; ½ inch to 1 inch, 18.9 per cent; ¼ inch to ½ inch, 15 per cent, under ¼ inch, 37.2 per cent. Duration of test, 8.43 hours. Kind of grate, rocking.

Test 258, Virginia No. 2.

Size as shipped, run of mine. Size as used, over 1 inch, 31.8 per cent; ½ inch to 1 inch, 19 per cent; ¼ inch to ½ inch, 16.9 per cent; under ¼ inch, 32.3 per cent. Test run on an ordinary Frost fire-tube boiler. Duration of test, 7 hours. Kind of grate, rocking.

Test 260, Virginia No. 2, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 49.5 per cent; ½ inch to 1 inch, 23.3 per cent; ¼ inch to ½ inch, 12.6 per cent; under ¼ inch, 14.6 per cent. Duration of test, 9.87 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 247.	Test 251.	Test 256.	Test 258.	Test 260.
Heating value of coal..B. T. U. per pound dry coal..	14,443	14,285	14,317	14,254	14,497
Force of draft:					
Under stack damper.....inch water..	0.44	0.41	0.44	0.23	0.34
Above fire.....do....	.10	.10	.15	.20	.13
Furnace temperature.....°F..	2,548	2,515	2,673	(a)	2,671
Dry coal used per square foot of grate surface per hour.....pounds..	18.52	17.71	18.24	.....	18.02
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.71	3.41	3.13	.....	3.13
Percentage of rated horsepower of boiler developed.	104.0	95.60	87.6	b 110.0	87.7
Water apparently evaporated per pound of coal as fired.....pounds..	8.21	7.82	7.67	6.96	7.79
Water evaporated from and at 212° F.:					
Per pound of coal as fired.....do....	9.76	9.32	9.16	8.26	9.35
Per pound of dry coal.....do....	10.02	9.65	9.56	8.57	9.68
Per pound of combustible.....do....	10.74	10.45	10.45	9.45	10.38
Efficiency of boiler, including grate.....per cent..	67.00	65.24	64.48	58.06	64.48
Coal as fired:					
Per indicated horsepower hour.....pounds...	2.90	3.03	3.09	3.42	3.02
Per electrical horsepower hour.....do....	3.58	3.75	3.81	4.23	3.73
Dry coal:					
Per indicated horsepower hour.....do....	2.82	2.93	2.96	3.30	2.92
Per electrical horsepower hour.....do....	3.48	3.62	3.65	4.07	3.61

a Too low for pyrometer. b Approximately.

ANALYSES.

	Test 247.	Test 251.	Test 256.	Test 258.	Test 260.
Proximate.					
Moisture	2.56	3.37	4.22	3.60	3.34
Volatile matter	35.34	33.75	33.48	33.56	36.14
Fixed carbon	56.72	56.41	56.11	56.23	56.04
Ash	5.38	6.47	6.19	6.61	4.48
	100.00	100.00	100.00	100.00	100.00
Sulphur	.98	.82	.82	.85	.85
Ultimate.					
Carbon a	79.86	79.00	79.18	78.82	80.74
Hydrogen a	5.01	4.95	4.96	4.94	5.05
Oxygen a	7.12	7.04	7.08	7.05	7.21
Nitrogen a	1.48	1.46	1.46	1.45	1.49
Sulphur	1.01	.85	.86	.88	.88
Ash	5.52	6.70	6.46	6.86	4.63
	100.00	100.00	100.00	100.00	100.00

a Figured from car sample.

PRODUCER-GAS TEST.

Test 78, Virginia No. 2.

Size as shipped, run of mine. Size as used, over 1 inch, 74 per cent; ½ inch to 1 inch 11 per cent; ¼ inch to ½ inch, 6 per cent; under ¼ inch, 9 per cent. Duration of test, 50 hours.

Average electrical horsepower	197.5
Average B. T. U. gas, per cubic foot	169.0
Total coal fired, pounds	12,950

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 78.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.39	1.36	1.28
Developed at switch board	1.31	1.28	1.20
Per brake horsepower:			
Available for outside purposes	1.18	1.15	1.09
Developed at engine	1.11	1.09	1.02
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.47	1.43	1.35
Developed at switch board	1.38	1.35	1.27
Per brake horsepower:			
Available for outside purposes	1.25	1.22	1.14
Developed at engine	1.17	1.15	1.08

ANALYSES.

	Test 78.		Test 78.
Coal.		*Gas by volume.*	
Moisture	2.36	Carbon dioxide (CO_2)	8.2
Volatile matter	36.40	Carbon monoxide (CO)	22.3
Fixed carbon	55.44	Hydrogen (H_2)	13.0
Ash	5.80	Methane (CH_4)	3.5
	100.00	Nitrogen (N_2)	53.0
Sulphur	.67		100.0

WASHING TEST.

Test 134, Virginia No. 2.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds	28,000
Washed coal	do	24,550
Refuse	do	3,450

ANALYSES.

	Test 134.	
	Raw coal.	Washed coal.
Moisture	3.35	6.39
Volatile matter	35.13	.....
Fixed carbon	55.94	.....
Ash	5.58	3.95
Sulphur	.92	.88

COKING TESTS.

Test 63, Virginia No. 2.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 51 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,518
Breeze produced	do....	291
Coke produced	per cent..	62.65
Breeze produced	do....	2.43
Total percentage yield		65.08

Remarks.—Light gray and silvery. Good foundry coke. Large draft, giving more intense heat, would probably give better coke. Used small draft at first to hold charge as long as possible.

Test 69, Virginia No. 2.

Size as shipped, run of mine. Size as used, not crushed. Raw. Duration of test, 48 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,314
Breeze produced	do....	433
Coke produced	per cent..	60.95
Breeze produced	do....	3.61
Total percentage yield		64.56

Test 69, Virginia No. 2—Continued.

Remarks.—Light gray and silvery. Good heavy coke. Breeze content large, due to not grinding coal. Not as good as coke from ground charge. High yield due to deposited carbon.

Test 70, Virginia No. 2, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of est, 40 hours.

Coal charged	pounds..	10,000
Coke produced	do....	6,096
Breeze produced	do....	294
Coke produced	per cent..	60.96
Breeze produced	do....	2.94
Total percentage yield		63.90

Remarks.—Light gray and silvery. Good hard coke. Washing does not improve coke enough to warrant the expense. High yield due to deposited carbon.

ANALYSES.

	Test 63.		Test 69.		Test 70.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	3.88	0.25	3.86	0.69	5.96	0.45
Volatile matter	34.11	1.08	34.13	.93	34.17	1.23
Fixed carbon	57.01	91.25	56.39	90.33	56.03	92.25
Ash	5.00	7.42	5.62	8.05	3.84	6.07
Sulphur	1.02	.68	.79	.65	.91	.69

VIRGINIA NO. 3.

Bituminous coal from Coburn mine, Virginia Iron, Coal and Coke Company, Toms Creek, Wise County, Va., on the Norfolk and Western Railway.

This sample, which was loaded under the supervision of Inspector W. J. Von Borries, consisted of lump coal (over 3½-inch bar screen). It was used in making coking tests Nos. 61 and 88, steaming tests Nos. 280 and 283, and producer-gas test No. 75.

Two mine samples were taken for chemical analysis. No. 2281 is from the seventeenth east heading, 3,000 feet northeast of the drift mouth; No. 2282 is from room 3 off the eleventh west heading, 2,000 feet northeast of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2281	2282	2382
Air-drying loss		1.60	1.70	2.20
Proximate.	Moisture	2.70	2.91	3.05
	Volatile matter	32.45	31.99	31.65
	Fixed carbon	60.36	60.97	60.82
	Ash	4.49	4.13	4.48
Ultimate.	Sulphur	.52	.55	.67
	Hydrogen			5.17
	Carbon			80.35
	Nitrogen			1.59
	Oxygen			7.74
Calorific value determined:				
	Calories			8,039
	British thermal units			14,470

STEAMING TESTS.

Test 280, Virginia No. 3.

Size as shipped, over 3½ inches. Size as used, over 1 inch, 44.7 per cent; ½ inch to 1 inch, 20.2 per cent; ¼ inch to ½ inch, 15.7 per cent; under ¼ inch, 19.4 per cent. Duration of test, 9.88 hours. Kind of grate, rocking.

Test 283, Virginia No. 3.

Size as shipped, over 3½ inches. Size as used, over 1 inch, 32.8 per cent; ½ inch to 1 inch, 16.5 per cent; ¼ inch to ½ inch, 15.6 per cent; under ¼ inch, 35.1 per cent. Duration of test, 10 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 280.	Test 283.
Heating value of coal.....B. T. U. per pound dry coal..	14,908	14,936
Force of draft:		
Under stack damper.....inch water..	0.42	0.37
Above fire.....do....	.15	.16
Furnace temperature.....°F..	2,452	2,537
Dry coal used per square foot of grate surface per hour.....pounds..	16.40	16.47
Equivalent water evaporated per square foot of water-heating surface per hour, pounds.....	2.91	2.99
Percentage of rated horsepower of boiler developed.....	81.6	83.8
Water apparently evaporated per pound of coal as fired.....pounds..	8.14	8.18
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	9.74	9.79
Per pound of dry coal.....do....	9.91	10.12
Per pound of combustible.....do....	10.66	10.84
Efficiency of boiler, including grate.....per cent..	64.19	65.43
Coal as fired:		
Per indicated horsepower hour.....pounds..	2.90	2.89
Per electrical horsepower hour.....do....	3.59	3.57
Dry coal:		
Per indicated horsepower hour.....do....	2.85	2.79
Per electrical horsepower hour.....do....	3.52	3.45

ANALYSES.

	Test 280.	Test 283.		Test 280.	Test 283.
Proximate.			*Ultimate.*		
Moisture	1.73	3.29	Carbon [a]	82.80	82.95
Volatile matter	33.25	32.00	Hydrogen [a]	4.98	4.98
Fixed carbon	60.35	60.20	Oxygen [a]	5.18	5.19
Ash	4.67	4.51	Nitrogen [a]	1.64	1.64
	100.00	100.00	Sulphur	.65	.58
Sulphur	.64	.56	Ash	4.75	4.66
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 75, Virginia No. 3.

Size as shipped, over 3½ inches. Size as used, over 1 inch, 51 per cent; ½ inch to 1 inch, 14 per cent; ¼ inch to ½ inch, 13 per cent; under ¼ inch, 22 per cent. Duration of test, 50 hours.

Average electrical horsepower	194.8
Average B. T. U. gas, per cubic foot	156.4
Total coal fired, pounds	11,050

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 75.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.21	1.18	1.13
Developed at switch board	1.13	1.11	1.06
Per brake horsepower:			
Available for outside purposes	1.03	1.01	.96
Developed at engine	.96	.95	.90
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.29	1.27	1.21
Developed at switch board	1.21	1.19	1.13
Per brake horsepower:			
Available for outside purposes	1.10	1.08	1.03
Developed at engine	1.03	1.01	.96

ANALYSES.

	Test 75.		Test 75.
Coal.		*Gas by volume.*	
Moisture	1.66	Carbon dioxide (CO_2)	9.7
Volatile matter	31.68	Carbon monoxide (CO)	19.3
Fixed carbon	61.76	Hydrogen (H_2)	13.8
Ash	4.90	Methane (CH_4)	3.1
	100.00	Nitrogen (N_2)	54.1
Sulphur	.49		100.0

COKING TESTS.

Test 61, Virginia No. 3.

Size as shipped, over 3½ inches. Size as used, finely crushed. Raw. Duration of test, 45 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,160
Breeze produced	do....	240
Coke produced	per cent..	68.00
Breeze produced	do....	2.00
Total percentage yield		70.00

Remarks.—Light gray and silvery. Very heavy coke. Breaks in long, large, heavy pieces. Fine coke. High yield due to deposited carbon.

Test 88, Virginia No. 3.

Size as shipped, over 3½ inches. Size as used, same. Duration of test, 50 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,907
Breeze produced	do....	336
Coke produced	per cent..	65.89
Breeze produced	do....	2.80
Total percentage yield		68.69

Remarks.—Fine coke. Light gray and silvery. Very heavy. Breakage good; long, large pieces. Yield not so high and breeze higher than in coke from crushed coal.

ANALYSES.

	Test 61.		Test 88.	
	Coal.	Coke.	Coal.	Coke.
Moisture	2.87	0.29	2.49	0.16
Volatile matter	31.58	1.21	31.90	1.26
Fixed carbon	61.43	92.60	61.16	91.85
Ash	4.12	5.90	4.45	6.73
Sulphur	.56	.61	.57	.55

VIRGINIA NO. 4.

Bituminous coal from Darby mine, Darby Coal and Coke Company, Darby, Lee County, Va., on the Louisville and Nashville Railroad.

This sample was loaded under the supervision of Inspector J. W. Groves, and consisted of lump coal over 1½-inch bar screen. The following tests were made: Coking test No. 62, steaming tests Nos. 240, 248, 254, and 245, and producer-gas test No. 74.

Two mine samples were taken for chemical analysis. No. 2323 was cut in room 18 off the first butt entry, 1,423 feet from the drift mouth; No. 2324 was taken in room 1 off the third butt entry, 900 feet from the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2323	2324	2358
Air-drying loss		1.90	1.50	2.00
Proximate.	Moisture	3.89	3.55	4.35
	Volatile matter	34.89	37.06	36.89
	Fixed carbon	58.16	56.88	54.43
	Ash	3.06	2.51	4.33
Ultimate.	Sulphur	.34	.50	.79
	Hydrogen	.....	.....	5.25
	Carbon	.....	.....	76.99
	Nitrogen	.....	.....	1.32
	Oxygen	.....	.....	11.32
Calorific value determined:				
	Calories	7,858	.....	7,744
	British thermal units	14,144	.....	13,939

STEAMING TESTS.

Test 240, Virginia No. 4.

Size as shipped, over 1½ inches. Size as used, over 1 inch, 46.5 per cent; ½ inch to 1 inch, 21.9 per cent; ¼ inch to 1 inch, 12.9 per cent; under ¼ inch, 18.7 per cent. Duration of test, 9.70 hours. Kind of grate, plain.

Test 248, Virginia No. 4.

Size as shipped, over 1½ inches. Size as used, over 1 inch, 46.1 per cent; ½ inch to 1 inch, 20.4 per cent; ¼ inch to ½ inch, 12.5 per cent; under ¼ inch, 21.0 per cent. Duration of test, 8.02 hours. Kind of grate, plain. Limestone spread over grate at start.

Test 254, Virginia No. 4.

Size as shipped, over 1½ inches. Size as used, over 1 inch, 62.6 per cent; ½ inch to 1 inch, 15.4 per cent; ¼ inch to ½ inch, 7.9 per cent; under ¼ inch, 14.1 per cent. Duration of test, 10 hours. Kind of grate, plain. Limestone spread over grate at start.

Test 245, 2-3 Virginia No. 4 and 1-3 Pennsylvania No. 8 (dried).

Size as shipped, ovet 1½ inches and run of mine. Size as used, over 1 inch, 44.8 per cent; ½ inch to 1 inch, 13.6 per cent; ¼ inch to ½ inch, 9.3 per cent; under ¼ inch, 32.3 per cent. Coals mixed. Duration of test, 7.82 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 240.	Test 248.	Test 254.	Test 245.
Heating value of coal.....B. T. U. per pound dry coal..	14,558	14,677	14,414	14,476
Force of draft:				
Under stack damper.....inch water..	0.53	0.46	0.44	0.45
Above fire.....do....	.22	.11	.13	.12
Furnace temperature.....°F..	2,224	2,483	2,582	2,338
Dry coal used per square foot of grate surface per hour pounds.....	15.73	17.14	18.0	17.14
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.04	3.48	3.46	3.06
Percentage of rated horsepower of boiler developed.....	85.10	97.50	96.9	85.7
Water apparently evaporated per pound of coal as fired, pounds.....	7.83	8.23	7.76	7.27
Water evaporated from and at 212° F.:				
Per pound of coal as fired.....pounds..	9.33	9.81	9.22	8.66
Per pound of dry coal.....do....	9.66	10.18	9.62	8.93
Per pound of combustible.....do....	10.39	10.86	10.20	9.81
Efficiency of boiler, including grate.....per cent..	64.08	66.98	64.45	59.57
Coal as fired:				
Per indicated horsepower hour.....pounds..	3.03	2.88	3.07	3.27
Per electrical horsepower hour.....do....	3.74	3.56	3.79	4.03
Dry coal:				
Per indicated horsepower hour.....do....	2.93	2.78	2.94	3.17
Per electrical horsepower hour.....do....	3.61	3.43	3.63	3.91

ANALYSES.

	Test 240.	Test 248.	Test 254.	Test 245.
Proximate.				
Moisture.....	3.40	3.62	4.13	2.99
Volatile matter.....	36.01	35.84	36.18	28.16
Fixed carbon.....	55.87	56.58	56.09	63.30
Ash.....	4.72	3.96	3.60	5.55
	100.00	100.00	100.00	100.00
Sulphur.....	.49	.44	.44	.70

ANALYSES—continued.

	Test 240.	Test 248.	Test 254.	Test 245.
Ultimate.				
Carbon[a]	80.44	81.15	81.44	81.24
Hydrogen[a]	4.99	5.03	5.05	4.46
Oxygen[a]	7.79	7.86	7.89	6.45
Nitrogen[a]	1.38	1.39	1.40	1.41
Sulphur	.51	.46	.46	.72
Ash	4.89	4.11	3.76	5.72
	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 74, Virginia No. 4.

Size as shipped, over 1½ inches. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower	196.3
Average B. T. U. gas, per cubic foot	167.2
Total coal fired, pounds	12,200

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 74.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.31	1.28	1.24
Developed at switch board	1.24	1.21	1.18
Per brake horsepower:			
Available for outside purposes	1.12	1.09	1.05
Developed at engine	1.06	1.03	1.00
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.38	1.35	1.31
Developed at switch board	1.31	1.27	1.24
Per brake horsepower:			
Available for outside purposes	1.17	1.14	1.11
Developed at engine	1.11	1.08	1.05

ANALYSES.

	Test 74.		Test 74.
Coal.		*Gas by volume.*	
Moisture	2.72	Carbon dioxide (CO_2)	7.5
Volatile matter	36.79	Carbon monoxide (CO)	23.5
Fixed carbon	57.72	Hydrogen (H_2)	13.8
Ash	2.77	Methane (CH_4)	3.3
	100.00	Nitrogen (N_2)	51.9
Sulphur	.42		100.0

COKING TEST.

Test 62, Virginia No. 4.

Size as shipped, over 1½ inches. Size as used, finely crushed. Raw. Duration of test, 36 hours.

Coal charged	pounds..	10,000
Coke produced	do....	6,272
Breeze produced	do....	241
Coke produced	per cent..	62.72
Breeze produced	do....	2.41
Total percentage yield		65.13

Remarks.—Light gray and silvery. Fine-fingered coke. Breaks in long, thin pieces. Light-weight coke.

ANALYSES.

	Test 62.	
	Coal.	Coke.
Moisture	3.87	0.16
Volatile matter	36.39	1.14
Fixed carbon	55.60	92.90
Ash	4.14	5.80
Sulphur	.39	.42

WEST VIRGINIA NO. 4.

Bituminous coal from No. 2 mine, Elkins Coal Company, Bretz, Preston County, W. Va., on the Morgantown and Kingwood Railroad.

This sample, designated West Virginia No. 4 B in this report, consisted of run-of-mine coal. It was loaded under the supervision of Inspector J. W. Groves, and was used in making washing test No. 127 and coking tests Nos. 40, 44, and 46.[a]

Two mine samples were taken for chemical analysis, as follows: No. 2054 from the second left heading off the main entry, 1,300 feet from the drift mouth, and No. 2055 from the third right entry off the main entry, 800 feet southeast of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2054	2055	2250
Air-drying loss		2.40	2.30	2.60
Proximate.	Moisture	3.57	3.47	3.91
	Volatile matter	27.38	28.65	26.68
	Fixed carbon	62.84	62.70	59.30
	Ash	6.21	5.18	10.11
Ultimate.	Sulphur	.85	.80	1.07
	Hydrogen			4.69
	Carbon			74.73
	Nitrogen			1.56
	Oxygen			7.84
Calorific value determined:				
	Calories	7,899		7,428
	British thermal units	14,218		13,370

[a] For tests made during 1904 on the same coal see Bull. U. S. Geol. Survey No. 261, 1905, pp. 71, 82, 111, and 127.

WASHING TEST.

Test 127, West Virginia No. 4 B.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	26,600
Washed coal	do....	21,000
Refuse	do....	5,600

ANALYSES.

	Test 127.	
	Raw coal.	Washed coal.
Moisture	3.91	4.47
Volatile matter	26.68	.....
Fixed carbon	59.30	.....
Ash	10.11	7.76
Sulphur	1.07	.81

COKING TESTS.

Test 40, West Virginia No. 4 B.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 57 hours.

Coal charged	pounds..	10,000
Coke produced	do...	7,553
Breeze produced	do...	286
Coke produced	per cent..	75.53
Breeze produced	do...	2.86
Total percentage yield		78.39

Remarks.—Light gray and silvery. High yield due to deposited carbon. Breakage somewhat crosswise, but in good-sized pieces. Very good coke.

Test 44, West Virginia No. 4 B, washed.

Size as shipped, run of mine. Size as used, not crushed. Duration of test, 72 hours.

Coal charged	pounds..	12,000
Coke produced	do...	8,129
Breeze produced	do...	337
Coke produced	per cent..	67.74
Breeze produced	do...	2.81
Total percentage yield		70.55

Remarks.—Fine coke. Silvery color. Much deposited carbon. Heavy, good foundry coke. Breakage, practically perfect. Coal not ground. These tests would seem to indicate better coke physically from coal not ground, but per cent yield is lower, and the difference in yield would seem to warrant grinding.

Test 46, West Virginia No. 4 B, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 74 hours.

Coal charged	pounds..	9,760
Coke produced	do...	7,220
Breeze produced	do...	268
Coke produced	per cent..	73.98
Breeze produced	do...	2.75
Total percentage yield		76.73

Remarks.—Fine coke. Heavy, good-sized pieces, though breakage is not so good as coke from charge not ground. Unfortunate that charges were not same size, so as to make better comparison, but there were only 9,760 pounds of coal left. Yield better than coke from coal not ground. Washing does not improve enough to warrant this expense.

ANALYSES.

	Test 40.		Test 44.		Test 46.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	4.24	.35	5.40	.60	3.87	.27
Volatile matter	26.57	.68	26.83	1.20	27.72	1.37
Fixed carbon	58.89	86.01	59.90	87.04	59.67	86.98
Ash	10.30	12.96	7.87	11.16	8.74	11.38
Sulphur	.97	.82	.93	.72	.87	.78

WEST VIRGINIA NO. 13.

Bituminous coal from Page No. 2 mine, Loup Creek Colliery Company, Page, Fayette County, W. Va., on the Deep Water Railway and the Chesapeake and Ohio Railway.

This sample, which consisted of run-of-mine coal, was loaded under the supervision of E. W. Parker, of the United States Geological Survey. It was used in making coking test No. 21, steaming tests Nos. 179 and 180, and producer-gas test No. 56. It was also used, mixed with West Virginia No. 14, in making coking test No. 23.

Mine samples Nos. 1867 and 1868 were taken from the two distinct benches in the mine.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		[a] 1867	[b] 1868	2028
Air-drying loss		4.50	1.90	2.60
Proximate.	Moisture	5.48	2.93	3.74
	Volatile matter	29.70	31.95	31.04
	Fixed carbon	62.53	60.17	61.31
	Ash	2.29	4.95	3.91
Ultimate.	Sulphur	.79	1.22	.89
	Hydrogen	.....	.....	5.31
	Carbon	.....	.....	80.50
	Nitrogen	.....	.....	1.32
	Oxygen	.....	.....	8.07
Calorific value determined:				
	Calories	8,030	.....	8,020
	British thermal units	14,454	.....	14,436

[a] Lower bench. [b] Upper bench.

STEAMING TESTS.

Test 179, West Virginia No. 13.

Size as shipped, run of mine. Size as used, over 1 inch, 15.4 per cent; ½ inch to 1 inch, 19.7 per cent; ¼ inch to ½ inch, 22.4 per cent; under ¼ inch, 42.5 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 180, West Virginia No. 13.

Size as shipped, run of mine. Size as used, over 1 inch, 12.7 per cent; ½ inch to 1 inch, 13.3 per cent; ¼ inch to ½ inch, 19.6 per cent; under ¼ inch, 54.4 per cent. Duration of test, 9.95 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 179.	Test 180.
Heating value of coal ..... B. T. U. per pound dry coal	14,999	14,933
Force of draft:		
Under stack damper ..... inch water	0.37	0.37
Above fire ..... do	.08	.10
Furnace temperature ..... °F.	2,428	2,312
Dry coal used per square foot of grate surface per hour ..... pounds	16.47	15.19
Equivalent water evaporated per square foot of water-heating surface per hour ..... pounds	3.45	3.22
Percentage of rated horsepower of boiler developed	96.8	90.1
Water apparently evaporated per pound of coal as fired ..... pounds	8.71	8.69
Water evaporated from and at 212° F.:		
Per pound of coal as fired ..... do	10.12	10.11
Per pound of dry coal ..... do	10.50	10.59
Per pound of combustible ..... do	11.11	11.29
Efficiency of boiler, including grate ..... per cent	67.60	68.48

MISCELLANEOUS ITEMS—continued.

	Test 179.	Test 180.
Coal as fired:		
Per indicated horsepower hour....pounds..	2.79	2.80
Per electrical horsepower hour....do....	3.45	3.45
Dry coal:		
Per indicated horsepower hour....do....	2.69	2.67
Per electrical horsepower hour....do....	3.32	3.30

ANALYSES.

	Test 179.	Test 180.		Test 179.	Test 180
Proximate.			*Ultimate.*		
Moisture	3.59	4.53	Carbon[a]	83.64	83.30
Volatile matter	30.88	29.82	Hydrogen[a]	5.09	5.07
Fixed carbon	61.69	61.38	Oxygen[a]	4.93	4.90
Ash	3.84	4.27	Nitrogen[a]	1.38	1.37
	100.00	100.00	Sulphur	.98	.89
Sulphur	.94	.85	Ash	3.98	4.47
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 56, West Virginia No. 13.

Size as shipped, run of mine. Size as used, over 1 inch, 25 per cent; ½ inch to 1 inch, 42 per cent; ¼ inch to ½ inch, 20 per cent; under ¼ inch, 13 per cent. Duration of test, 50 hours.

Average electrical horsepower.... 200.5
Average B. T. U. gas, per cubic foot.... 139.2
Total coal fired....pounds.. 9,750

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 56.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.03	1.00	0.96
Developed at switch board	.97	.95	.91
Per brake horsepower:			
Available for outside purposes	.87	.85	.82
Developed at engine	.83	.80	.78
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.10	1.07	1.03
Developed at switch board	1.04	1.01	.97
Per brake horsepower:			
Available for outside purposes	.93	.91	.87
Developed at engine	.88	.86	.83

ANALYSES.

	Test 56.		Test 56.
Coal.		*Gas by volume.*	
Moisture	2.65	Carbon dioxide (CO_2)	9.8
Volatile matter	31.00	Carbon monoxide (CO)	18.4
Fixed carbon	62.82	Hydrogen (H_2)	13.7
Ash	3.53	Methane (CH_4)	2.3
	100.00	Nitrogen (N_2)	55.8
Sulphur	.82		100.0

COKING TESTS.

Test 21, West Virginia No. 13.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 84 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,955
Breeze produced	do....	413
Coke produced	per cent..	66.29
Breeze produced	do....	3.44
Total percentage yield		69.73

Remarks.—Good, hard coke. Foundry coke. Light-gray and silvery color. High yield due to deposited carbon.

Test 23, West Virginia No. 13 and 14 mixed in equal proportions.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 77 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,093
Breeze produced	do....	215
Coke produced	per cent..	67.44
Breeze produced	do....	1.79
Total percentage yield		69.23

Remarks.—Good, hard coke. Foundry coke. Light-gray and silvery color. High yield due to deposited carbon.

ANALYSES.

	Test 21.		Test 23.	
	Coal.	Coke.	Coal.	Coke.
Moisture	3.23	0.75	4.81	0.43
Volatile matter	31.12	1.05	29.28	1.37
Fixed carbon	61.98	93.36	62.84	94.20
Ash	3.67	4.84	3.07	4.00
Sulphur	.86	.77	.89	.84

WEST VIRGINIA NO. 14.

Bituminous coal from Page No. 1 mine, Loup Creek Colliery Company, Page, Fayette County, W. Va., on the Deep Water Railway and the Chesapeake and Ohio Railway.

This sample consisted of run-of-mine coal and was shipped under the supervision of E. W. Parker, of the United States Geological Survey. The following tests were made: Coking test No. 20, steaming tests Nos. 178 and 181, and producer-gas test No. 54. It was also used mixed with West Virginia No. 13 in making coking test No. 23.

Three mine samples were taken in this mine. No. 1869 was cut from the lower bench, No. 1870 from the middle bench, and No. 2178 was a sample of the entire seam.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number	[a] 1869	[b] 1870	2178	2004
Air-drying loss	2.30	1.80	3.20	3.10
Proximate. Moisture	3.53	2.96	4.11	5.09
Proximate. Volatile matter	29.36	30.23	29.08	29.07
Proximate. Fixed carbon	64.77	59.37	59.36	62.57
Proximate. Ash	2.34	7.44	7.45	3.27
Ultimate. Sulphur	.92	1.04	.80	1.03
Ultimate. Hydrogen	.....	.....	.....	5.33
Ultimate. Carbon	.....	.....	.....	78.23
Ultimate. Nitrogen	.....	.....	.....	1.51
Ultimate. Oxygen	.....	.....	.....	10.63
Calorific value determined:				
Calories	.....	7,762	.....	7,839
British thermal units	.....	13,972	.....	14,110

[a] Lower bench. [b] Middle bench.

STEAMING TESTS.

Test 178, West Virginia No. 14.

Size as shipped, run of mine. Size as used, over 1 inch, 26.8 per cent; ½ inch to 1 inch, 14.5 per cent; ¼ inch to ½ inch, 16.7 per cent; under ¼ inch, 42 per cent. Duration of test, 10 hours. Kind of grate, plain.

Test 181, West Virginia No. 14.

Size as shipped, run of mine. Size as used, over 1 inch, 23.1 per cent; ½ inch to 1 inch, 15.5 per cent; ¼ inch to ½ inch, 16.4 per cent; under ¼ inch, 45 per cent. Duration of test, 7.60 hours. Kind of grate, plain. Limestone spread over grate at start.

MISCELLANEOUS ITEMS.

	Test 178.	Test 181.
Heating value of coal ..... B. T. U. per pound dry coal..	15,048	15,003
Force of draft:		
Under stack damper ..... inch water..	0.42	0.50
Above fire ..... do....	.16	.13
Furnace temperature ..... °F..	2,337	2,459
Dry coal used per square foot of grate surface per hour ..... pounds..	14.38	19.31
Equivalent water evaporated per square foot of water-heating surface per hour, pounds	3.02	3.70
Percentage of rated horsepower of boiler developed	84.6	103.8
Water apparently evaporated per pound of coal as fired ..... pounds..	8.80	7.84
Water evaporated from and at 212°F.:		
Per pound of coal as fired ..... do....	10.22	9.11
Per pound of dry coal ..... do....	10.52	9.60
Per pound of combustible ..... do....	10.88	10.14
Efficiency of boiler, including grate ..... per cent..	67.51	61.79
Coal as fired:		
Per indicated horsepower hour ..... pounds..	2.77	3.10
Per electrical horsepower hour ..... do....	3.41	3.83
Dry coal:		
Per indicated horsepower hour ..... do....	2.69	2.95
Per electrical horsepower hour ..... do....	3.32	3.64

ANALYSES.

	Test 178.	Test 181.		Test 178.	Test 181.
Proximate.			*Ultimate.*		
Moisture	2.85	5.15	Carbon [a]	83.41	83.16
Volatile matter	30.13	28.38	Hydrogen [a]	5.07	5.06
Fixed carbon	64.78	64.09	Oxygen [a]	6.51	6.50
Ash	2.24	2.38	Nitrogen [a]	1.61	1.60
	100.00	100.00	Sulphur	1.09	1.17
Sulphur	1.06	1.11	Ash	2.31	2.51
				100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 54, West Virginia No. 14.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 47 hours.

Average electrical horsepower 201.3
Average B. T. U. gas, per cubic foot 147.0
Total coal fired, pounds 9,750

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 54.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.08	1.05	1.02
Developed at switch board	1.03	1.00	.97
Per brake horsepower:			
Available for outside purposes	.92	.89	.87
Developed at engine	.87	.85	.82
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.15	1.12	1.08
Developed at switch board	1.10	1.06	1.03
Per brake horsepower:			
Available for outside purposes	.98	.95	.92
Developed at engine	.93	.90	.88

ANALYSES.

	Test 54.		Test 54.
Coal.		*Gas by volume.*	
Moisture	3.12	Carbon dioxide (CO_2)	8.6
Volatile matter	28.99	Carbon monoxide (CO)	20.7
Fixed carbon	65.22	Hydrogen (H_2)	13.3
Ash	2.67	Methane (CH_4)	2.3
	100.00	Nitrogen (N_2)	55.1
Sulphur	1.21		100.0

COKING TEST.

Test 20, West Virginia No. 14.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 71 hours.

Coal charged	pounds..	11,000
Coke produced	do....	7,154
Breeze produced	do....	364
Coke produced	per cent..	65.04
Breeze produced	do....	3.31
Total percentage yield		68.35

Remarks.—Good hard coke. Foundry coke. Light-gray and silvery color. High yield due to deposited carbon.

ANALYSES.

	Test 20.	
	Coal.	Coke.
Moisture	1.04	0.38
Volatile matter	29.28	.96
Fixed carbon	66.80	95.19
Ash	2.88	3.47
Sulphur	1.04	.94

WEST VIRGINIA NO. 15.

Bituminous coal from Ocean mine, Fairmont Coal Company, 3 miles east of Clarksburg, Harrison County, W. Va., on the Baltimore and Ohio Railroad.

This sample consisted of run-of-mine coal and was loaded under the supervision of Inspector J. S. Burrows. It was used in making coking tests Nos. 36 and 43 and steaming tests Nos. 214, 215, and 216.

Two mine samples were taken for chemical analysis. No. 2039 was cut from the second butt entry off the third face entry, 2,750 feet northwest of the drift mouth. No. 2040 was cut in room 7 off the third butt entry, 2,025 feet northeast of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2039	2040	2195
Air-drying loss		1.50	1.90	0.90
Proximate.	Moisture	2.80	3.27	2.01
	Volatile matter	38.51	37.72	37.31
	Fixed carbon	53.14	53.27	52.13
	Ash	5.55	5.74	8.55
Ultimate.	Sulphur	2.40	2.41	2.54
	Hydrogen			5.08
	Carbon			75.83
	Nitrogen			1.43
	Oxygen			6.57
Calorific value determined:				
	Calories	7,836		7,673
	British thermal units	14,105		13,811

STEAMING TESTS.

Test 214, West Virginia No. 15.

Size as shipped, run of mine. Size as used, over 1 inch, 33.1 per cent; ½ inch to 1 inch, 24.4 per cent; ¼ inch to ½ inch, 15 per cent; under ¼ inch, 27.5 per cent. Duration of test, 8.78 hours. Kind of grate, rocking.

Test 215, West Virginia No. 15.

Size as shipped, run of mine. Size as used, over 1 inch, 32.6 per cent; ½ inch to 1 inch, 24.2 per cent; ¼ inch to ½ inch, 15.8 per cent; under ¼ inch, 27.4 per cent. Duration of test, 9.75 hours. Kind of grate, plain.

Test 216, West Virginia No. 15.

Size as shipped run of mine. Size as used, over 1 inch, 43.5 per cent; ½ inch to 1 inch, 20.3 per cent; ½ inch to ¼ inch, 14.5 per cent; under ¼ inch, 21.7 per cent. Duration of test, 5.80 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 214.	Test 215.	Test 216.
Heating value of coal.....B. T. U. per pound dry coal..	14,126	14,202	14,197
Force of draft:			
Under stack damper.....inch water..	0.53	0.40	0.41
Above fire .....do....	.22	.12	a.04
Furnace temperature.....°F..	2,247	2,269	2,365
Dry coal used per square foot of grate surface per hour.....pounds..	16.32	16.77	21.28
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.68	3.01	3.67
Percentage of rated horsepower of boiler developed.....	75.2	84.4	103.0
Water apparently evaporated per pound of coal as fired.....pounds..	7.65	7.44	7.14
Water evaporated from and at 212 °F.:			
Per pound of coal as fired .....do....	9.00	8.77	8.41
Per pound of dry coal .....do....	9.18	8.99	8.65
Per pound of combustible .....do....	10.92	10.04	9.63
Efficiency of boiler, including grate.....per cent..	62.76	61.13	58.84
Coal as fired:			
Per indicated horsepower hour.....pounds..	3.14	3.22	3.36
Per electrical horsepower hour .....do....	3.88	3.98	4.15
Dry coal:			
Per indicated horsepower hour .....do....	3.08	3.15	3.27
Per electrical horsepower hour .....do....	3.80	3.88	4.04

a Forced draft.

ANALYSES.

	Test 214.	Test 215.	Test 216.		Test 214.	Test 215.	Test 216.
Proximate.				*Ultimate.*			
Moisture.....	1.90	2.47	2.73	Carbon a.....	77.45	77.93	77.90
Volatile matter....	38.18	38.38	38.43	Hydrogen a.....	4.97	5.00	5.00
Fixed carbon.....	51.90	51.48	51.11	Oxygen a.....	4.87	4.90	4.89
Ash.....	8.02	7.67	7.73	Nitrogen a.....	1.46	1.47	1.47
	100.00	100.00	100.00	Sulphur.....	3.07	2.84	2.79
Sulphur.....	3.01	2.77	2.71	Ash.....	8.18	7.86	7.95
					100.00	100.00	100.00

a Figured from car sample.

COKING TESTS.

Test 36, West Virginia No. 15.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 46 hours.

Coal charged	pounds	10,000
Coke produced	do	6,867
Breeze produced	do	267
Coke produced	per cent	68.67
Breeze produced	do	2.76
Total percentage yield		71.43

Remarks.—Light gray and silvery. Good, heavy coke. High yield due to deposited carbon. Sulphur high.

Test 43, West Virginia No. 15.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 73 hours.

Coal charged	pounds	12,000
Coke produced	do	8,404
Breeze produced	do	269
Coke produced	per cent	70.03
Breeze produced	do	2.24
Total percentage yield		72.27

Remarks.—Fine heavy coke. Silvery color. Breakage practically perfect; large pieces. Sulphur high. High yield due to deposited carbon.

ANALYSES.

	Test 36.		Test 43.	
	Coal.	Coke.	Coal.	Coke.
Moisture	1.79	0.45	2.33	0.26
Volatile matter	37.90	.78	38.33	1.89
Fixed carbon	53.00	88.70	51.72	87.30
Ash	7.31	10.07	7.62	10.55
Sulphur	2.73	2.09	2.72	2.26

WEST VIRGINIA NO. 16.

Bituminous coal from Monongha mine No. 6, Fairmont Coal Company, Monongha, Marion County, W. Va., on the Baltimore and Ohio Railroad.

Two samples of coal were shipped from this mine under the supervision of Inspector J. S. Burrows. West Virginia No. 16 A consisted of three-fourths inch lump coal over a three-fourths inch screen. It was used in making coking test No. 73 and producer-gas test No. 86. West Virginia No. 16 B consisted of slack coal which had passed through a three-fourths inch screen. It was used in making washing test No. 128 and coking tests Nos. 45, 48, and 49.

Two mine samples were taken from this mine for chemical analysis as follows: No. 2041 from room 2 on the third right entry, 5,000 feet southwest of the drift mouth; No. 2042 from room 1 off the third left entry, 5,000 feet northwest of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
	Laboratory number	2041	2042	2264
	Air-drying loss	1.30	1.40	4.40
Proximate.	Moisture	2.89	2.68	5.57
Proximate.	Volatile matter	34.54	35.97	31.61
Proximate.	Fixed carbon	56.86	55.78	54.45
Proximate.	Ash	5.71	5.57	8.37
Ultimate.	Sulphur	.69	1.06	1.20
Ultimate.	Hydrogen	.....	.....	5.08
Ultimate.	Carbon	.....	.....	72.74
Ultimate.	Nitrogen	.....	.....	1.46
Ultimate.	Oxygen	.....	.....	11.15
	Calorific value determined:			
	Calories	7,800	.....	7,274
	British thermal units	14,540	.....	13,093

PRODUCER-GAS TEST.

Test 86, West Virginia No. 16 A.

Size as shipped, over ¾ inch. Size as used, over 1 inch, 86 per cent; ½ inch to 1 inch, 5 per cent; ¼ inch to ½ inch, 4 per cent; under ¼ inch, 5 per cent. Duration of test, 50 hours.

Average electrical horsepower		198.5
Average B. T. U. gas, per cubic foot		156.1
Total coal fired	pounds..	13,150

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 86.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.41	1.38	1.28
Developed at switch board	1.33	1.30	1.20
Per brake horsepower:			
Available for outside purposes	1.20	1.17	1.09
Developed at engine	1.13	1.10	1.02
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.49	1.45	1.35
Developed at switch board	1.40	1.37	1.27
Per brake horsepower:			
Available for outside purposes	1.26	1.24	1.15
Developed at engine	1.19	1.16	1.08

ANALYSES.

	Test 86.		Test 86.
Coal.		*Gas by volume.*	
Moisture	2.28	Carbon dioxide (CO_2)	8.4
Volatile matter	35.54	Carbon monoxide (CO)	21.2
Fixed carbon	55.29	Hydrogen (H_2)	14.0
Ash	6.89	Methane (CH_4)	2.5
	100.00	Nitrogen (N_2)	53.9
Sulphur	0.95		100.0

WASHING TEST.

Test 128, West Virginia No. 16 B.

Size as shipped, slack. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	22,825
Washed coal	do....	19,800
Refuse	do....	3,025

ANALYSES.

	Test 128.	
	Raw coal.	Washed coal.
Moisture	5.57	5.41
Volatile matter	31.61	.....
Fixed carbon	54.45	.....
Ash	8.37	5.91
Sulphur	1.20	.92

COKING TESTS.

Test 73, West Virginia No. 16 A.

Size as shipped, over ¾ inch. Size as used, finely crushed. Raw. Duration of test, 60 hours.

Coal charged	pounds..	14,000
Coke produced	do....	9,700
Breeze produced	do....	384
Coke produced	per cent..	69.29
Breeze produced	do....	2.74
Total percentage yield		72.03

Remarks.—Light gray and silvery; much deposited carbon to which high yield is due. Fine hard, heavy coke.

Test 45, West Virginia No. 16 B.

Size as shipped, slack. Size as used, finely crushed. Raw. Duration of test, 72 hours.

Coal charged	pounds..	21,000
Coke produced	do....	8,124
Breeze produced	do....	276
Coke produced	per cent..	67.70
Breeze produced	do....	2.30
Total percentage yield		70.00

Remarks.—Fine heavy coke. Silvery color. Breakage practically perfect; large pieces. Good foundry coke if sulphur was reduced a little. High yield due to deposited carbon.

Test 48, West Virginia No. 16 B, washed.

Size as shipped, slack. Size as used, finely crushed. Duration of test, 47 hours.

Test 48, West Virginia No. 16 B.—Continued.

Coal charged	pounds..	12,000
Coke produced	do....	7,984
Breeze produced	do....	289
Coke produced	per cent..	66.53
Breeze produced	do....	2.41
Total percentage yield		68.94

Remarks.—Light gray and silvery. Light coke. Brittle. Ash and sulphur reduced by washing, but physical properties not so good as coke from raw charge. High yield due to deposited carbon.

Test 49, West Virginia No. 16 B, washed.

Size as shipped, slack. Size as used, finely crushed. Duration of tests, 25 hours.

Coal charged	pounds..	7,800
Coke produced	do....	5,207
Breeze produced	do....	175
Coke produced	per cent..	66.76
Breeze produced	do....	2.24
Total percentage yield		69.00

Remarks.—Light gray and silvery. Light coke. Brittle. Ash and sulphur reduced by washing, but physical properties not so good as coke from raw charge. High yield due to deposited carbon.

ANALYSES.

	Test 73.		Test 45.		Test 48.		Test 49.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	2.93	0.54	5.70	0.40	5.31	0.37	4.59	0.38
Volatile matter	35.20	1.31	32.52	1.55	32.83	1.18	33.90	2.35
Fixed carbon	55.26	89.07	53.44	85.61	55.89	89.87	55.71	88.91
Ash	6.61	9.08	8.34	12.44	5.97	8.58	5.80	8.36
Sulphur	0.92	0.81	1.20	1.23	0.97	0.91	0.95	0.89

WEST VIRGINIA NO. 17.

Bituminous coal from a country bank 2½ miles above Bretz, Preston County, W. Va., on the Morgantown and Kingwood Railroad. This coal was furnished by the Elkins Coal Company, of Bretz, W. Va.

This sample, which consisted of run-of-mine coal, was loaded under the supervision of Inspector J. W. Groves and hauled to the Morgantown and Kingwood Railroad. It was used in making washing test No. 132, coking test No. 60, steaming tests Nos. 225 and 226, and steaming test on washed coal No. 230.

Two mine samples (Nos. 2056 and 2057) were taken from a prospect hole about one-fourth mile below the country bank from which the coal was shipped.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2056	2057	2332
Air-drying loss		2.30	3.10	2.50
Proximate.	Moisture	3.22	4.05	3.46
	Volatile matter	29.54	28.70	27.29
	Fixed carbon	59.91	61.65	61.13
	Ash	7.33	5.60	8.12
Ultimate.	Sulphur	1.73	1.16	1.45
	Hydrogen	.....	.....	4.68
	Carbon	.....	.....	76.98
	Nitrogen	.....	.....	1.37
	Oxygen	.....	.....	7.40
Calorific value determined:				
	Calories	7,775	.....	7,705
	British thermal units	13,995	.....	13,869

STEAMING TESTS.

Test 225, West Virginia No. 17.

Size as shipped, run of mine. Size as used, over 1 inch, 11 per cent; ½ inch to 1 inch, 11 per cent; ¼ inch to ½ inch, 16.2 per cent; under ¼ inch, 61.8 per cent. Duration of test, 9.92 hours. Kind of grate, rocking.

Test 226, West Virginia No. 17.

Size as shipped, run of mine. Size as used, over 1 inch, 16.5 per cent; ½ inch to 1 inch, 14 per cent; ¼ inch to ½ inch, 15.3 per cent; under ¼ inch, 54.2 per cent. Duration of test, 9.97 hours. Kind of grate, rocking.

Test 230, West Virginia No. 17, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 29.6 per cent; ½ inch to 1 inch, 20.2 per cent; ¼ inch to ½ inch, 15.7 per cent; under ¼ inch, 34.5 per cent. Duration of test, 10.07 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 225.	Test 226.	Test 230.
Heating value of coal.....B. T. U. per pound dry coal..	14,546	14,508	14,641
Force of draft:			
Under stack damper.....inch water..	0.53	0.61	0.48
Above fire.....do....	.16	.17	.19
Furnace temperature.....°F..	2,165	.....	2,392
Dry coal used per square foot of grate surface per hour.....pounds..	16.37	17.56	17.64
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.00	3.13	3.17
Percentage of rated horsepower of boiler developed	84.1	87.6	89.0
Water apparently evaporated per pound of coal as fired.....pounds..	8.30	8.06	8.03
Water evaporated from and at 212 °F.:			
Per pound of coal as fired.....do....	9.79	9.53	9.61
Per pound of dry coal.....do....	10.22	9.94	10.05
Per pound of combustible.....do....	11.32	11.04	11.01
Efficiency of boiler, including grate.....per cent..	67.85	66.16	66.29
Coal as fired:			
Per indicated horsepower hour.....pounds..	2.89	2.97	2.94
Per electrical horsepower hour.....do....	3.57	3.66	3.63
Dry coal:			
Per indicated horsepower hour.....do....	2.77	2.84	2.81
Per electrical horsepower hour.....do....	3.42	3.51	3.47

ANALYSES.

	Test 225.	Test 226.	Test 230.		Test 225.	Test 226.	Test 230.
Proximate.				*Ultimate.*			
Moisture	4.14	4.10	4.35	Carbon[a]	80.79	80.59	81.56
Volatile matter	27.89	27.92	28.35	Hydrogen[a]	4.51	4.49	4.55
Fixed carbon	60.87	60.58	61.13	Oxygen[a]	4.51	4.50	4.57
Ash	7.10	7.40	6.17	Nitrogen[a]	1.44	1.44	1.45
	100.00	100.00	100.00	Sulphur	1.34	1.26	1.42
Sulphur	1.28	1.21	1.36	Ash	7.41	7.72	6.45
					100.00	100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 132, West Virginia No. 17.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	29,530
Washed coal	do....	24,765
Refuse	do....	4,765

ANALYSES.

	Test 132.	
	Raw coal.	Washed coal.
Moisture	3.46	5.33
Volatile matter	27.29	.....
Fixed carbon	61.13	.....
Ash	8.12	5.50
Sulphur	1.45	1.14

COKING TEST.

Test 60, West Virginia No. 17, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 42 hours.

Coal charged	pounds..	10,000
Coke produced	do....	6,675
Breeze produced	do....	293
Coke produced	per cent..	66.75
Breeze produced	do....	2.93
Total percentage yield		69.68

Remarks.—Light gray and silvery. Good weight coke. Brittle and breaks badly. High yield due to deposited carbon. This was outcrop coal, and results are exceedingly good under these circumstances.

ANALYSES.

	Test 60.	
	Coal.	Coke.
Moisture	4.84	0.07
Volatile matter	28.63	.63
Fixed carbon	60.49	91.36
Ash	6.04	7.94
Sulphur	1.25	1.04

WEST VIRGINIA NO. 18.

Bituminous coal from Glen Alum mine, Glen Alum Fuel Company, Glen Alum, Mingo County, W. Va., on the Norfolk and Western Railway.

This sample consisted of run-of-mine coal, and was loaded under the supervision of Inspector J. W. Groves. It was used in making coking tests Nos. 74 and 78, steaming tests Nos. 259, 261, and 262, and producer-gas test No. 80.

Two mine samples were taken from this mine for chemical analysis, as follows: No. 2348 from a crosscut 900 feet from the drift mouth, and No. 2349 from room 19, off the twentieth entry, 3,000 feet from the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2348	2349	2527
Air-drying loss		1.50	2.40	1.60
Proximate.	Moisture	2.81	4.04	2.86
	Volatile matter	31.67	31.25	33.23
	Fixed carbon	59.02	59.55	58.08
	Ash	6.50	5.16	5.83
Ultimate.	Sulphur	0.66	.64	.67
	Hydrogen	.....	.....	5.01
	Carbon	.....	.....	78.38
	Nitrogen	.....	.....	1.43
	Oxygen	.....	.....	8.68
Calorific value determined:				
	Calories	7,754	.....	7,836
	British thermal units	13,957	.....	14,106

STEAMING TESTS.

Test 259, West Virginia No. 18.

Size as shipped, run of mine. Size as used, over 1 inch, 44.8 per cent; ½ inch to 1 inch, 18.1 per cent; ¼ inch to ½ inch, 12 per cent; under ¼ inch, 25.1 per cent. Test run on an ordinary Frost fire-tube boiler. Duration of test, 9.95 hours. Kind of grate, rocking.

Test 261, West Virginia No. 18.

Size as shipped, run of mine. Size as used, over 1 inch, 22.4 per cent; ½ inch to 1 inch, 20 per cent; ¼ inch to ½ inch, 17.1 per cent; under ¼ inch, 40.5 per cent. Duration of test, 10 hours. Kind of grate, rocking.

Test 262, West Virginia No. 18.

Size as shipped, run of mine. Size as used, over 1 inch, 47.7 per cent; ½ inch to 1 inch, 17.2 per cent; ¼ inch to ½ inch, 11.9 per cent; under ¼ inch, 23.2 per cent. Duration of test, 10.07 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 259.	Test 261.	Test 262.
Heating value of coal.....B. T. U. per pound dry coal..	14,476	14,414	14,384
Force of draft:			
Under stack damper.....inch water..	0.18	0.39	0.50
Above fire.....do....	.15	.13	.18
Furnace temperature.....°F..	(a)	2,590	2,600
Dry coal used per square foot of grate surface per hour .....pounds..	.....	17.80	20.44
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	.....	3.35	3.77
Percentage of rated horsepower of boiler developed.....	b100.0	93.8	105.6
Water apparently evaporated per pound of coal as fired.....pounds..	7.38	8.46	8.31
Water evaporated from and at 212° F.:			
Per pound of coal as fired.....do....	8.73	10.17	10.0
Per pound of dry coal.....do....	9.00	10.49	10.29
Per pound of combustible.....do....	9.71	11.41	11.19
Efficiency of boiler, including grate.....per cent..	60.04	70.28	69.08
Coal as fired:			
Per indicated horsepower hour.....pounds..	3.24	2.78	2.83
Per electrical horsepower hour.....do....	4.00	3.43	3.49
Dry coal:			
Per indicated horsepower hour.....do....	3.14	2.69	2.75
Per electrical horsepower hour.....do....	3.88	3.33	3.39

a Too low to read with pyrometer. b Approximated.

ANALYSES.

	Test 259.	Test 261.	Test 262.		Test 259.	Test 261.	Test 262.
Proximate.				*Ultimate.*			
Moisture.....	3.07	3.02	2.74	Carbon a.....	80.45	80.08	79.91
Volatile matter....	32.71	32.79	32.52	Hydrogen a.....	4.82	4.79	4.78
Fixed carbon.....	58.12	57.66	58.02	Oxygen a.....	6.30	6.26	6.24
Ash.....	6.10	6.53	6.72	Nitrogen a.....	1.46	1.46	1.45
	100.00	100.00	100.00	Sulphur.....	0.68	0.68	0.71
Sulphur.....	0.66	0.66	0.69	Ash.....	6.29	6.73	6.91
					100.00	100.00	100.00

a Figured from car sample.

PRODUCER-GAS TEST.

Test 80, West Virginia No. 18.

Size as shipped, run of mine. Size as used, over 1 inch, 69 per cent; ½ inch to 1 inch, 13 per cent; ¼ inch to ½ inch, 7 per cent; under ¼ inch, 11 per cent. Duration of test, 50 hours.

Average electrical horsepower.....	197.9
Average B. T. U. gas, per cubic foot	158.9
Total coal fired.....pounds..	11,250

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 80.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.20	1.17	1.10
Developed at switch board	1.14	1.11	1.04
Per brake horsepower:			
Available for outside purposes	1.02	1.00	0.94
Developed at engine	0.97	0.94	.88
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.27	1.24	1.17
Developed at switch board	1.20	1.17	1.10
Per brake horsepower:			
Available for outside purposes	1.08	1.05	0.99
Developed at engine	1.02	0.99	.94

ANALYSES.

	Test 80.		Test 80.
Coal.		*Gas by volume.*	
Moisture	2.66	Carbon dioxide (CO_2)	8.6
Volatile matter	32.71	Carbon monoxide (CO)	21.5
Fixed carbon	58.89	Hydrogen (H_2)	12.9
Ash	5.74	Methane (CH_4)	3.7
	100.00	Nitrogen (N_2)	53.3
Sulphur	0.65		100.0

COKING TESTS.

Test 74, West Virginia No. 18.

Size as shipped, run of mine. Size as used, not crushed Raw. Duration of test, 43 hours.

Coal charged	pounds	12,000
Coke produced	do	8,444
Breeze produced	do	309
Coke produced	per cent	70.37
Breeze produced	do	2.58
Total percentage yield		72.95

Remarks.—Light gray and silvery. Good, hard, heavy coke. High yield due to deposited carbon.

Test 78, West Virginia No. 18.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 48 hours.

Coal charged	pounds	12,000
Coke produced	do	8,422
Breeze produced	do	340
Coke produced	per cent	70.18
Breeze produced	do	2.83
Total percentage yield		73.01

Remarks.—Light gray and silvery. Good, hard, heavy coke. High yield due to deposited carbon.

ANALYSES.

	Test 74.		Test 78.	
	Coal.	Coke.	Coal.	Coke.
Moisture	3.42	0.63	4.18	0.69
Volatile matter	32.82	.97	32.08	1.19
Fixed carbon	57.02	89.54	57.69	89.47
Ash	6.74	8.86	6.05	8.65
Sulphur	0.70	0.54	0.61	0.53

WEST VIRGINIA NO. 19.

Bituminous coal from McDonald mine, White Oak Coal Company, McDonald, Fayette County, W. Va., on the Chesapeake and Ohio Railway.

This sample consisted of run-of-mine coal and was loaded under the supervision of Inspector J. W. Groves. It was used in making coking tests Nos. 79 and 83 and steaming tests Nos. 285 and 289.

Two mine samples were taken from this mine for chemical analysis, as follows: No. 2359 from room 11 off the eighteenth left entry, 7,720 feet from the drift mouth; No. 2360 from room 16 on the sixteenth right entry, 7,600 feet southwest of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2359	2360	2549
Air-drying loss		2.50	2.80	2.30
Proximate.	Moisture	3.26	3.51	2.96
	Volatile matter	21.57	21.11	22.74
	Fixed carbon	72.71	72.83	69.29
	Ash	2.46	2.55	5.01
Ultimate.	Sulphur	.78	.53	.89
	Hydrogen	.....	.....	4.81
	Carbon	.....	.....	81.64
	Nitrogen	.....	.....	1.57
	Oxygen	.....	.....	6.08
Calorific value determined:				
	Calories	8,207	.....	8,014
	British thermal units	14,773	.....	14,425

STEAMING TESTS.

Test 285, West Virginia No. 19.

Size as shipped, run of mine. Size as used, over 1 inch, 14.8 per cent; ½ inch to 1 inch, 11.6 per cent; ¼ inch to ½ inch, 15.3 per cent; under ¼ inch, 58.3 per cent. Duration of test, 9.97 hours. Kind of grate, rocking.

Test 289, West Virginia No. 19.

Size as shipped, run of mine. Size as used, over 1 inch, 13.4 per cent; ½ inch to 1 inch, 11.7 per cent; ¼ inch to ½ inch, 16.2 per cent; under ¼ inch, 58.7 per cent. Duration of test, 8 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

		Test 285.	Test 289.
Heating value of coal	B. T. U. per pound dry coal	14,618	14,571
Force of draft:			
Under stack damper	inch water	0.45	0.56
Above fire	do	.22	.12
Furnace temperature	°F	2,419	2,065
Dry coal used per square foot of grate surface per hour	pounds	15.55	13.86
Equivalent water evaporated per square foot of water-heating surface per hour, pounds		2.92	2.84
Percentage of rated horsepower of boiler developed		81.8	79.6
Water apparently evaporated per pound of coal as fired	pounds	8.53	8.25
Water evaporated from and at 212° F.:			
Per pound of coal as fired	do	10.20	9.94
Per pound of dry coal	do	10.45	10.26
Per pound of combustible	do	11.48	11.45
Efficiency of boiler, including grate	per cent	69.04	68.00

MISCELLANEOUS ITEMS—continued.

	Test 285.	Test 289.
Coal as fired:		
Per indicated horsepower hour.....pounds..	2.77	2.84
Per electrical horsepower hour.....do....	3.42	3.51
Dry coal:		
Per indicated horsepower hour.....do....	2.71	2.76
Per electrical horsepower hour.....do....	3.34	3.40

ANALYSES.

	Test 285.	Test 289.		Test 285.	Test 289.
Proximate.			*Ultimate.*		
Moisture	2.44	3.07	Carbon [a]	82.72	82.43
Volatile matter	20.59	20.58	Hydrogen [a]	4.54	4.52
Fixed carbon	70.43	69.66	Oxygen [a]	3.51	3.49
Ash	6.54	6.69	Nitrogen [a]	1.59	1.59
	100.00	100.00	Sulphur	.94	1.07
Sulphur	0.92	1.04	Ash	6.70	6.90
				100.00	100.00

[a] Figured from car sample.

COKING TESTS.

Test 79, West Virginia No. 19.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 49 hours.

Coal charged.....pounds..	12,000
Coke produced.....do....	7,692
Breeze produced.....do....	258
Coke produced.....per cent..	64.10
Breeze produced.....do....	2.15
Total percentage yield.....	66.25

Remarks.—Dull-gray color; slightly silvery. Light weight. Poor, dense coke.

Test 83, West Virginia No. 19.

Size as shipped, run of mine. Size as used finely crushed. Raw. Duration of test, 53 hours.

Coal charged.....pounds..	12,000
Coke produced.....do....	7,914
Breeze produced.....do....	283
Coke produced.....per cent..	65.95
Breeze produced.....do....	2.36
Total percentage yield.....	68.31

Remarks.—Dull-gray color, with slight silvery luster; cell structure small. Much heavier and better than in test 79.

ANALYSES.

	Test 79.		Test 83.	
	Coal.	Coke.	Coal.	Coke.
Moisture	2.82	0.38	2.43	0.45
Volatile matter	20.63	1.68	21.34	.55
Fixed carbon	70.30	89.96	70.50	91.57
Ash	6.25	7.98	5.73	7.43
Sulphur	1.00	.77	.96	.82

WEST VIRGINIA NO. 20.

Bituminous coal from Keystone mine, Stevens Coal Company, Acme, Kanawha County, W. Va., on the Chesapeake and Ohio Railway.

This sample consisted of run-of-mine coal and was loaded under the supervision of Inspector J. W. Groves. It was used in making washing test No. 135, coking tests Nos. 80, 84, 87, and 92, steaming tests Nos. 272 and 273, steaming tests on washed coal Nos. 264 and 266, and producer-gas test No. 82.

Two mine samples were taken in this mine for chemical analysis, as follows: No. 2375 from a point in the left entry 4,600 feet east of the drift mouth; No. 2376 from room 16 off the fifth right entry, 3,500 feet east of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car samples.	
Laboratory number		2375	2376	2556	2626
Air-drying loss		1.40	1.60	2.10	1.90
Proximate.	Moisture	2.66	2.84	2.82	2.89
	Volatile matter	33.30	33.18	32.20	32.53
	Fixed carbon	59.60	58.75	56.95	56.95
	Ash	4.44	5.23	8.03	7.63
Ultimate.	Sulphur	1.14	1.35	1.38	1.50
	Hydrogen	.....	.....	5.16	.....
	Carbon	.....	.....	76.74	.....
	Nitrogen	.....	.....	1.34	.....
	Oxygen	.....	.....	7.35	.....
Calorific value determined:					
	Calories	7,982	.....	7,648	.....
	British thermal units	14,368	.....	13,766	.....

STEAMING TESTS.

Test 272, West Virginia No. 20.

Size as shipped, run of mine. Size as used, over 1 inch, 31.1 per cent; ½ inch to 1 inch, 22.3 per cent; ¼ inch to ½ inch, 19.4 per cent; under ¼ inch, 27.2 per cent. Duration of test, 9.92 hours. Kind of grate, rocking.

Test 273, West Virginia No. 20.

Size as shipped, run of mine. Size as used, over 1 inch, 27.7 per cent; ½ inch to 1 inch, 20 per cent; ¼ inch to ½ inch, 18.5 per cent; under ¼ inch, 33.8 per cent. Duration of test, 9.87 hours. Kind of grate, rocking.

Test 264, West Virginia No. 20, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 23 per cent; ½ inch to 1 inch, 23.7 per cent; ¼ inch to ½ inch, 25.4 per cent; under ¼ inch, 27.9 per cent. Duration of test, 9.97 hours. Kind of grate, rocking.

Test 266, West Virginia No. 20, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 30.9 per cent; ½ inch to 1 inch, 24.4 per cent; ¼ inch to ½ inch, 21.2 per cent; under ¼ inch, 23.5 per cent. Duration of test, 10 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 272.	Test 273.	Test 264.	Test 266.
Heating value of coal.....B. T. U. per pound dry coal..	14,202	14,083	14,584	14,530
Force of draft:				
Under stack damper.....inch water..	0.31	0.40	0.38	0.35
Above fire.....do....	.09	.10	.16	.10
Furnace temperature.....°F..	.....	2,274	2,520	2,392
Dry coal used per square foot of grate surface per hour, pounds.....	15.44	16.57	17.23	15.73
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.80	2.98	3.23	3.09
Percentage of rated horsepower of boiler developed.....	78.5	83.6	90.5	86.7
Water apparently evaporated per pound of coal as fired, pounds.....	8.24	8.13	8.41	7.97
Water evaporated from and at 212° F.:				
Per pound of coal as fired.....pounds..	9.89	9.75	10.09	9.54
Per pound of dry coal.....do....	10.11	10.04	10.46	9.85
Per pound of combustible.....do....	11.21	11.19	11.21	10.56
Efficiency of boiler, including grate.....per cent..	68.75	68.85	69.26	65.47
Coal as fired:				
Per indicated horsepower hour .....pounds..	2.86	2.90	2.80	2.96
Per electrical horsepower hour.....do....	3.53	3.58	3.46	3.66
Dry coal:				
Per indicated horsepower hour .....do....	2.80	2.82	2.70	2.87
Per electrical horsepower hour .....do....	3.45	3.48	3.34	3.55

ANALYSES.

	Test 272.	Test 273.	Test 264.	Test 266.
Proximate.				
Moisture.....	2.21	2.89	3.49	3.14
Volatile matter.....	32.55	31.75	32.94	33.40
Fixed carbon.....	57.31	56.93	58.37	57.93
Ash.....	7.93	8.43	5.20	5.53
	100.00	100.00	100.00	100.00
Sulphur.....	1.28	1.50	1.06	1.10
Ultimate.				
Carbon[a].....	79.20	78.49	81.75	81.45
Hydrogen[a].....	5.00	4.95	5.17	5.15
Oxygen[a].....	5.00	4.97	5.16	5.13
Nitrogen[a].....	1.38	1.37	1.43	1.42
Sulphur.....	1.31	1.54	1.10	1.14
Ash.....	8.11	8.68	5.39	5.71
	100.00	100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 82, West Virginia No. 20.

Size as shipped, run of mine. Size as used, not determined. Duration of test, 50 hours.

Average electrical horsepower		196.3
Average B. T. U. gas, per cubic foot		156.3
Total coal fired	pounds	12,150

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 82.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	1.31	1.29	1.19
Developed at switch board	1.24	1.22	1.12
Per brake horsepower:			
Available for outside purposes	1.12	1.09	1.01
Developed at engine	1.05	1.03	0.95
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	1.39	1.36	1.26
Developed at switch board	1.31	1.29	1.19
Per brake horsepower:			
Available for outside purposes	1.18	1.16	1.07
Developed at engine	1.11	1.09	1.01

ANALYSES.

	Test 82.		Test 82.
Coal.		*Gas by volume.*	
Moisture	1.83	Carbon dioxide (CO_2)	8.3
Volatile matter	32.94	Carbon monoxide (CO)	21.0
Fixed carbon	57.63	Hydrogen (H_2)	13.1
Ash	7.60	Methane (CH_4)	2.6
	100.00	Nitrogen (N_2)	55.0
Sulphur	1.71		100.0

WASHING TEST.

Test 135, West Virginia No. 20.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds	49,150
Washed coal	do	42,590
Refuse	do	6,560

ANALYSES.

	Test 135.	
	Raw coal.	Washed coal.
Moisture	2.82	5.70
Volatile matter	32.20	.....
Fixed carbon	56.95	.....
Ash	8.03	4.64
Sulphur	1.38	1.07

COKING TESTS.

Test 80, West Virginia No. 20.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 42 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,385
Breeze produced	do....	262
Coke produced	per cent..	69.88
Breeze produced	do....	2.18
Total percentage yield		72.06

Remarks.—Light gray and silvery. Fine coke. Very heavy. High yield due to deposited carbon.

Test 84, West Virginia No. 20, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 50 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,037
Breeze produced	do....	208
Coke produced	per cent	66.98
Breeze produced	do....	1.73
Total percentage yield		68.71

Remarks.—Light gray and silvery. Breakage badly cross-fractured and irregular, but coke of good foundry size. Results do not warrant washing. Sulphur and ash in coke from raw coal are both low, and coke from washed coal not as good, physically, as that from raw coal.

Test 87, West Virginia No. 20, washed.

Size as shipped, run of mine. Size as used, not crushed. Duration of test, 53 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,893
Breeze produced	do....	302
Coke produced	per cent..	65.78
Breeze produced	do....	2.52
Total percentage yield		68.30

Remarks.—Light gray and silvery. Results, same as in test 84. Do not warrant washing.

Test 92, West Virginia No. 20.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test, 46 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,292
Breeze produced	do....	264
Coke produced	per cent..	69.10
Breeze produced	do....	2.20
Total percentage yield		71.30

Remarks.—Light gray and silvery. Fine coke. Very heavy. High yield due to deposited carbon. Breakage not so good as test 80. Sulphur a little high.

ANALYSES.

	Test 80.		Test 84.		Test 87.		Test 92.	
	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.	Coal.	Coke.
Moisture	3.79	0.17	5.34	0.29	4.47	0.17	3.01	0.18
Volatile matter	32.24	1.08	32.56	0.46	32.79	0.81	32.40	0.57
Fixed carbon	56.49	89.01	57.00	91.73	57.87	92.29	56.60	87.95
Ash	7.48	9.74	5.10	7.52	4.87	6.73	7.99	11.30
Sulphur	1.44	1.10	1.09	0.90	1.02	0.85	1.62	1.30

WEST VIRGINIA NO. 21.

Bituminous coal from Gas mine, Winifrede Coal Company, Winifrede, Kanawha County, W. Va., on the Chesapeake and Ohio Railroad.

This sample consisted of run-of-mine coal, and was loaded under the supervision of Inspector J. W. Groves. The following tests were made: Washing test No. 136, coking tests Nos. 82 and 91, steaming tests Nos. 274, 275, and 296, and steaming test on washed coal No. 267.

Two mine samples were taken from this mine for chemical analysis, as follows: No. 2377 from room 12 off the third left entry, 1,400 feet southeast of the drift mouth; No. 2378 from room 10 off the first left entry, 800 feet southeast of the drift mouth.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		2377	2378	2572
Air-drying loss		2.00	2.30	2.10
Proximate.	Moisture	3.57	3.72	3.57
	Volatile matter	36.76	35.95	36.38
	Fixed carbon	56.05	56.21	55.20
	Ash	3.62	4.12	4.85
Ultimate.	Sulphur	1.14	1.16	1.32
	Hydrogen	.....	.....	5.33
	Carbon	.....	.....	77.49
	Nitrogen	.....	.....	1.49
	Oxygen	.....	.....	9.52
Calorific value determined:				
	Calories	7,874	.....	7,749
	British thermal units	14,173	.....	13,948

STEAMING TESTS.

Test 274, West Virginia No. 21.

Size as shipped, run of mine. Size as used, over 1 inch, 66.3 per cent; ½ inch to 1 inch, 15.7 per cent; ¼ inch to ½ inch, 10.8 per cent; under ¼ inch, 7.2 per cent. Duration of test, 7.30 hours. Kind of grate, rocking.

Test 275, West Virginia No. 21.

Size as shipped, run of mine. Size as used, over 1 inch, 44 per cent; ½ inch to 1 inch, 15.3 per cent; ¼ inch to ½ inch, 11.5 per cent; under ¼ inch, 29.2 per cent. Duration of test, 9.05 hours. Kind of grate, plain.

Test 267, West Virginia No. 21, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 36.2 per cent; ½ inch to 1 inch, 26.6 per cent; ¼ inch to ½ inch, 17.7 per cent; under ¼ inch, 19.5 per cent. Duration of test, 10.02 hours. Kind of grate, plain.

Test 296, West Virginia No. 21.

Size as shipped, run of mine. Size as used, over 1 inch, 40 per cent; ½ inch to 1 inch, 20 per cent; ¼ inch to ½ inch, 14.7 per cent; under ¼ inch, 25.3 per cent. Duration of test, 7.15 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 274.	Test 275.	Test 267.	Test 296.
Heating value of coal.....B. T. U. per pound dry coal..	14,528	14,292	14,791	14,274
Force of draft:				
Under stack damper.....inch water..	0.49	0.54	0.40	0.55
Above fire.....do....	.13	.11	.10	.10
Furnace temperature.....° F..	2,776	2,279	2,476	2,561
Dry coal used per square foot of grate surface per hour, pounds.....	21.59	16.50	16.87	18.13
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	3.99	3.36	3.40	3.63
Percentage of rated horsepower of boiler developed.....	111.9	94.1	95.4	101.8
Water apparently evaporated per pound of coal as fired, pounds.....	8.27	8.23	8.06	8.11
Water evaporated from and at 212 ° F.:				
Per pound of coal as fired.....pounds..	9.94	9.80	9.67	9.69
Per pound of dry coal.....do....	10.31	10.20	10.10	10.03
Per pound of combustible.....do....	10.87	11.05	10.64	10.96
Efficiency of boiler, including grate.....per cent..	68.53	68.92	65.94	67.86
Coal as fired:				
Per indicated horsepower hour.....pounds..	2.85	2.88	2.92	2.92
Per electrical horsepower hour.....do....	3.51	3.56	3.61	3.60
Dry coal:				
Per indicated horsepower hour.....do....	2.74	2.77	2.80	2.82
Per electrical horsepower hour.....do....	3.39	3.42	3.46	3.48

ANALYSES.

	Test 274.	Test 275.	Test 267.	Test 296.
Proximate.				
Moisture.....	3.60	3.90	4.24	3.42
Volatile matter.....	36.30	34.31	36.46	34.26
Fixed carbon.....	55.44	55.75	55.63	56.20
Ash.....	4.66	6.04	3.67	6.12
	100.00	100.00	100.00	100.00
Sulphur.....	1.03	1.13	1.07	1.22
Ultimate.				
Carbon [a].....	80.77	79.43	81.58	79.33
Hydrogen [a].....	5.15	5.06	5.19	5.04
Oxygen [a].....	6.62	6.52	6.72	6.51
Nitrogen [a].....	1.56	1.53	1.56	1.52
Sulphur.....	1.07	1.18	1.12	1.26
Ash.....	4.83	6.28	3.83	6.34
	100.00	100.00	100.00	100.00

[a] Figured from car sample.

WASHING TEST.

Test 136, West Virginia No. 21.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	24,000
Washed coal	do....	22,000
Refuse	do....	2,000

ANALYSES.

	Test 136.	
	Raw coal.	Washed coal.
Moisture	3.57	6.35
Volatile matter	36.38	.....
Fixed carbon	55.20	.....
Ash	4.85	3.47
Sulphur	1.32	1.00

COKING TESTS.

Test 82, West Virginia No. 21.

Size as shipped, run of mine. Size as used, finely crushed. Raw. Duration of test 52 hours.

Coal charged	pounds..	12,000
Coke produced	do....	8,106
Breeze produced	do....	242
Coke produced	per cent..	67.55
Breeze produced	do....	2.02
Total percentage yield		69.57

Remarks.—Fine coke. Light gray and silvery. Very heavy. High yield due to deposited carbon. Good foundry coke.

Test 91, West Virginia No. 21, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 44 hours.

Coal charged	pounds..	12,000
Coke produced	do....	7,816
Breeze produced	do....	249
Coke produced	per cent..	65.13
Breeze produced	do....	2.08
Total percentage yield		67.21

Remarks.—Light gray and silvery. High yield due to deposited carbon. Breakage very irregular, but pieces of good foundry size. Somewhat brittle. Not so good as coke from raw coal. The raw coal and resultant coke are both low in sulphur and ash and washing is of no commercial value.

ANALYSES.

	Test 82.		Test 91.	
	Coal.	Coke.	Coal.	Coke.
Moisture	3.55	0.24	5.72	0.55
Volatile matter	36.32	.81	36.54	1.03
Fixed carbon	55.18	91.23	54.35	93.16
Ash	4.95	7.72	3.39	5.26
Sulphur	1.23	.98	1.01	.76

WYOMING NO. 2.

Bituminous coal from Antelope Nos. 1 and 2 and Jumbo mines, Cambria Fuel Company, Cambria, Weston County, Wyo., on the Burlington system.

This sample consisted of run-of-mine coal and was loaded under the supervision of M. R. Campbell, of the United States Geological Survey. It is designated as Wyoming No. 2 B in the following tests: Steaming tests Nos. 196, 210, and 213, and producer-gas test No. 62.[a]

Two mine samples (Nos. 1376 and 1377) were taken at working faces at widely separated points in the mine.

[a] For tests of same coal received during 1904 see Bull. U. S. Geol. Survey No. 261, 1905, pp. 83, 115.

CHEMICAL ANALYSES.

		Mine samples.		Car sample.
Laboratory number		1376	1377	2131
Air-drying loss		4.70	3.80	4.50
Proximate.	Moisture	8.60	9.23	8.93
	Volatile matter	37.13	36.08	36.52
	Fixed carbon	32.37	33.72	33.76
	Ash	21.90	20.97	20.79
	Sulphur	4.94	4.33	4.03
Ultimate.	Hydrogen			4.88
	Carbon			53.33
	Nitrogen			.81
	Oxygen			16.16
Calorific value determined:				
	Calories	5,394		5,556
	British thermal units	9,709		10,001

STEAMING TESTS.

Test 196, Wyoming No. 2 B.

Size as shipped, run of mine. Size as used, over 1 inch, 54.3 per cent; ½ inch to 1 inch, 18.4 per cent; ¼ inch to ½ inch, 14.5 per cent; under ¼ inch, 12 8 per cent. Duration of test, 9.88 hours. Kind of grate, plain.

Test 210, Wyoming No. 2 B.

Size as shipped, run of mine. Size as used, over 1 inch, 34.8 per cent; ½ inch to 1 inch, 21.5 per cent; ¼ inch to ½ inch, 20.4 per cent; under ¼ inch, 23.3 per cent. Duration of test, 10.08 hours. Kind of grate, rocking.

Test 213, Wyoming No. 2 B.

Size as shipped, run of mine. Size as used, over 1 inch, 40.4 per cent; ½ inch to 1 inch, 26.7 per cent; ¼ inch to ½ inch, 15.2 per cent; under ¼ inch, 17.7 per cent. Duration of test, 10.03 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 196.	Test 210.	Test 213.
Heating value of coal....B. T. U. per pound dry coal..	10,888	11,261	10,751
Force of draft:			
Under stack damper....inch water..	0.59	0.68	0.63
Above fire....do....	.19	.20	[a].08
Furnace temperature....°F..	1,950	2,067	2,228
Dry coal used per square foot of grate surface per hour....pounds..	22.61	25.66	32.58
Equivalent water evaporated per square foot of water-heating surface per hour....pounds..	2.83	3.15	3.56
Percentage of rated horsepower of boiler developed	79.3	88.3	99.86
Water apparently evaporated per pound of coal as fired....pounds..	4.83	5.30	4.72
Water evaporated from and at 212 °F.:			
Per pound of coal as fired....do....	5.66	6.19	5.56
Per pound of dry coal....do....	6.27	6.84	6.10
Per pound of combustible....do....	8.54	9.01	8.30
Efficiency of boiler, including grate....per cent..	55.61	58.66	54.79
Coal as fired:			
Per indicated horsepower hour....pounds..	5.00	4.57	5.09
Per electrical horsepower hour....do....	6.17	5.64	6.28
Dry coal:			
Per indicated horsepower hour....do....	4.51	4.13	4.64
Per electrical horsepower hour....do....	5.57	5.10	5.72

[a] Forced draft.

ANALYSES.

	Test 196.	Test 210.	Test 213.		Test 196.	Test 210.	Test 213.
Proximate.				*Ultimate.*			
Moisture	9.64	9.55	8.94	Carbon [a]	58.01	60.09	57.08
Volatile matter	34.75	35.75	35.90	Hydrogen [a]	4.23	4.39	4.16
Fixed carbon	34.68	35.73	33.70	Oxygen [a]	8.93	9.25	8.80
Ash	20.93	18.97	21.46	Nitrogen [a]	0.89	0.92	0.87
	100.00	100.00	100.00	Sulphur	4.78	4.37	5.52
Sulphur	4.32	3.95	5.03	Ash	23.16	20.98	23.57
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST

Test 62, Wyoming No. 2 B.

Size as shipped, run of mine. Size as used, over 1 inch, 59 per cent; ½ inch to 1 inch, 18 per cent; ¼ inch to ½ inch, 13 per cent; under ¼ inch, 10 per cent. Duration of test, 49 hours.

Average electrical horsepower	192.9
Average B. T. U. gas, per cubic foot	146.6
Total coal fired, pounds	20,400

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 62.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	2.28	2.08	1.59
Developed at switch board	2.16	1.97	1.50
Per brake horsepower:			
Available for outside purposes	1.93	1.77	1.35
Developed at engine	1.83	1.68	1.28
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	2.40	2.20	1.68
Developed at switch board	2.28	2.09	1.59
Per brake horsepower:			
Available for outside purposes	2.05	1.87	1.43
Developed at engine	1.94	1.77	1.35

ANALYSES.

	Test 62.		Test 62.
Coal.		*Gas by volume.*	
Moisture	8.63	Carbon dioxide (CO_2)	10.8
Volatile matter	36.81	Carbon monoxide (CO)	18.2
Fixed carbon	32.83	Hydrogen (H_2)	10.7
Ash	21.73	Methane (CH_4)	3.3
	100.00	Nitrogen (N_2)	57.0
Sulphur	4.47		100.0

WYOMING NO. 3.

Bituminous coal from mine of Stilwell Coal Company, Aladdin, Crook County, Wyo., on the Wyoming and Missouri Railroad.

This sample consisted of run-of-mine coal and was shipped under the direction of M. R. Campbell, of the United States Geological Survey. The following tests were made: Washing test No. 129, coking test No. 52, steaming tests Nos. 211 and 212, steaming test on washed coal No. 223, and producer-gas test No. 69.

Two mine samples (Nos. 1976 and 1977) for chemical analysis were taken at working faces in the mine.

CHEMICAL ANALYSES.

		Mine samples.		Boiler test sample.
Laboratory number		1976	1977	2278
Air-drying loss		11.80	12.00	2.90
Proximate.	Moisture	17.74	18.42	15.12
	Volatile matter	37.64	36.53	34.36
	Fixed carbon	33.07	34.95	33.82
	Ash	11.55	10.10	16.70
Ultimate.	Sulphur	7.03	6.73	6.66
	Hydrogen	.....	.....	5.20
	Carbon	.....	.....	48.16
	Nitrogen	.....	.....	.70
	Oxygen	.....	.....	22.58
Calorific value determined:				
	Calories	5,293	.....	4,960
	British thermal units	9,527	.....	8,928

STEAMING TESTS.

Test 211, Wyoming No. 3.

Size as shipped, run of mine. Size as used, over 1 inch, 58.7 per cent; ½ inch to 1 inch, 17.3 per cent; ¼ inch to ½ inch, 11.6 per cent; under ¼ inch, 12.4 per cent. Duration of test, 10.05 hours. Kind of grate, rocking.

Test 212, Wyoming No. 3.

Size as shipped, run of mine. Size as used, over 1 inch, 51 per cent; ½ inch to 1 inch, 20.6 per cent; ¼ inch to ½ inch, 12.6 per cent; under ¼ inch, 15.8 per cent. Duration of test, 9.8 hours. Kind of grate, rocking.

Test 223, Wyoming No. 3, washed.

Size as shipped, run of mine. Size as used, over 1 inch, 27.9 per cent; ½ inch to 1 inch, 21.3 per cent; ¼ inch to ½ inch, 20.5 per cent; under ¼ inch, 30.3 per cent. Duration of test, 8.95 hours. Kind of grate, rocking.

MISCELLANEOUS ITEMS.

	Test 211.	Test 212.	Test 223.
Heating value of coal.....B. T. U. per pound dry coal..	10,519	10,517	12,641
Force of draft:			
Under stack damper.....inch water..	0.63	0.45	0.59
Above fire.....do....	.28	a.01	.23
Furnace temperature.....° F..	1,917	2,142	.....
Dry coal used per square foot of grate surface per hour.....pounds..	18.96	26.07	20.0
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.39	3.15	2.89
Percentage of rated horsepower of boiler developed.....	67.0	88.2	81.0
Water apparently evaporated per pound of coal as fired .....pounds..	5.12	4.95	5.54
Water evaporated from and at 212° F.:			
Per pound of coal as fired.....do....	5.98	5.81	6.53
Per pound of dry coal.....do....	7.04	6.73	8.07
Per pound of combustible.....do....	9.17	8.59	9.05

[a] Natural and forced draft.

MISCELLANEOUS ITEMS—continued.

	Test 211.	Test 212.	Test 223.
Efficiency of boiler, including grate.....per cent..	64.63	61.80	61.65
Coal as fired:			
Per indicated horsepower hour.....pounds..	4.73	4.87	4.33
Per electrical horsepower hour.....do....	5.84	6.01	5.35
Dry coal:			
Per indicated horsepower hour.....do....	4.02	4.20	3.50
Per electrical horsepower hour.....do....	4.96	5.19	4.33

ANALYSES.

	Test 211.	Test 212.	Test 223.		Test 211.	Test 212.	Test 223.
Proximate.				*Ultimate.*			
Moisture.....	15.12	13.60	19.08	Carbon [a].....	56.73	56.44	67.60
Volatile matter....	34.36	36.12	36.58	Hydrogen [a].....	4.15	4.12	4.94
Fixed carbon.....	33.82	34.07	37.56	Oxygen [a].....	10.77	10.72	12.83
Ash.....	16.70	16.21	6.78	Nitrogen [a].....	0.83	0.82	0.99
	100.00	100.00	100.00	Sulphur.....	7.85	9.14	5.26
Sulphur.....	6.66	7.90	4.26	Ash.....	19.67	18.76	8.38
					100.00	100.00	100.00

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 69, Wyoming No. 3.

Size as shipped, run of mine. Size as used, over 1 inch, 59 per cent; ½ inch to 1 inch, 15 per cent; ¼ inch to ½ inch, 12 per cent; under ¼ inch, 14 per cent. Duration of test, 47 hours.

Average electrical horsepower	193.1
Average B. T. U. gas, per cubic foot	160.9
Total coal fired.....pounds..	17,400

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 69.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes.....	2.05	1.78	1.47
Developed at switch board.....	1.92	1.67	1.37
Per brake horsepower:			
Available for outside purposes.....	1.74	1.52	1.25
Developed at engine.....	1.63	1.42	1.17
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes.....	2.19	1.90	1.57
Developed at switch board.....	2.04	1.78	1.46
Per brake horsepower:			
Available for outside purposes.....	1.86	1.62	1.33
Developed at engine.....	1.74	1.51	1.24

ANALYSES.

	Test 69.		Test 69.
Coal.		*Gas by volume.*	
Moisture	13.02	Carbon dioxide (CO_2)	11.1
Volatile matter	37.56	Carbon monoxide (CO)	19.8
Fixed carbon	34.05	Hydrogen (H_2)	13.3
Ash	15.37	Methane (CH_4)	3.5
	100.00	Nitrogen (N_2)	52.3
Sulphur	7.36		100.0

WASHING TEST.

Test 129, Wyoming, No. 3.

Size as shipped, run of mine. Size as used, crushed to 2 inches. Jig used, Stewart modified.

Raw coal	pounds..	24,120
Washed coal	do....	20,060
Refuse	do....	4,060

ANALYSES.

	Test 129.	
	Raw coal.	Washed coal.
Moisture	15.12	19.16
Volatile matter	34.36	.....
Fixed carbon	33.82	.....
Ash	16.70	6.52
Sulphur	6.66	4.16

COKING TEST.

Test 52, Wyoming No. 3, washed.

Size as shipped, run of mine. Size as used, finely crushed. Duration of test, 27 hours.
Remarks.—No coke produced.

ALASKA COAL.[a]

Coal from Bering River field.—The Bering River coal field [b] is located near Controller Bay, on the Pacific coast of Alaska, in latitude 60° 20′ to 60° 30′ N. and longitude 143° 15′ to 144° 45′ W., and covers an area of about 70 square miles, including 25 square miles of anthracite and 45 miles of semibituminous coking coal. The seams are numerous and very large (several exceeding 20 feet in thickness). The average quality of the Bering River coal is excellent, several of the seams being remarkably low in both ash and sulphur.

This coal is not now available for sale in any market, but there are prospects of transportation soon being provided to tide water on Controller Bay, Katalla Bay, or Prince William Sound.

Coal from Matanuska River field.—The Matanuska coal field [c] is located about 30 to 75 miles northeast of Cook Inlet, Alaska, in latitude 61° 40′ to 62° N. and longitude 148° to 149° 10′ W., and covers an area of at least 70 and possibly several hundred square miles of coal in the Matanuska Valley. The deposits include anthracite, semibituminous coking coal, and a lower grade of bituminous coal. The seams are of good thickness and well situated for mining. Transportation to Resurrection Bay on the Pacific coast and into the interior may soon be provided by the Alaska Central Railway, now under construction.

[a] The analyses given herein are all of field samples collected by Mr. G. C. Martin.
[b] See Martin, G. C., Bull. U. S. Geol. Survey No. 225, 1904, pp. 365-382; No. 250, 1905, pp. 11-36; No. 259, 1905, pp. 140-150; No. 284, 1906, pp. 65-77.
[c] See Martin, G. C., Bull. U. S. Geol. Survey No. 284, 1906, pp. 88-100; No. 289, 1906.

CHEMICAL ANALYSES.

BERING RIVER COALS.

Laboratory number	2490	2488	2493	2495	2486	2492	2491
Thickness of coal seam, feet	6.7	10	8.6	31	27	11	19.6
Air-drying loss, per cent	3.70	5.20	5.10	4.60	3.00	3.70	5.40
Moisture, do	4.35	6.03	5.84	5.66	4.23	4.22	5.95
Volatile matter, do	11.97	12.98	11.74	13.65	14.03	13.37	13.01
Fixed carbon, do	73.34	78.40	60.21	76.81	79.75	78.80	76.12
Ash, do	10.34	2.59	22.21	3.88	1.99	3.61	4.92
Sulphur, do	1.13	.70	3.36	.77	.96	1.56	.61

Laboratory number	2494	2497	2489	2496	2487	2485	2478
Thickness of coal seam, feet	17	18	8	15	4.7	2.17	2.67
Air-drying loss, per cent	3.90	1.90	1.30	5.20	6.20	1.90	4.70
Moisture, do	4.94	2.68	2.11	5.93	7.26	3.74	7.67
Volatile matter, do	13.34	11.06	16.58	6.76	6.64	5.41	5.78
Fixed carbon, do	77.29	73.31	79.68	81.47	75.89	85.92	66.03
Ash, do	4.43	12.95	1.63	5.84	10.21	4.93	20.52
Sulphur, do	.83	5.27	.78	.82	1.27	1.10	2.90

No. 2490. Opening at lower end of gorge on Tokun Creek.
No. 2488. Christopher's opening on branch of Dick Creek.
No. 2493. Christopher's lower tunnel, Dick Creek.
No. 2495. Opening on lower seam, Queen Creek.
No. 2486. Opening on upper seam, Queen Creek.
No. 2492. Carbon Creek tunnel.
No. 2491. Tunnel near mouth of Carbon Creek.
No. 2494. South branch of Queen Creek.
No. 2497. Kushtaka River, tunnel 710 feet above Lake Kushtaka.

Laboratory number	2479	2480	2481	2482	2483	2484
Thickness, feet	2.85	15+	5.25	10	10.5	33
Air-drying loss, per cent	1.50	6.10	5.00	7.00	13.20	5.40
Moisture, do	4.43	8.33	7.94	8.31	13.89	6.34
Volatile matter, do	10.14	6.36	9.20	7.12	5.01	14.29
Fixed carbon, do	80.78	82.00	78.53	82.43	73.87	69.55
Ash, do	4.65	3.31	4.33	2.14	7.23	9.82
Sulphur, do	.51	1.11	.79	1.05	.82	.64
Calories	7,578	.....	.....	.....	6,743	.....
British thermal units	.....	.....	.....	.....	12,137	.....

No. 2489. Cunningham's upper tunnel, Trout Creek; tunnel across from house.
No. 2496. Opening at north end of Hunt's hillside trail, Carbon Mountain.
No. 2487. Lower seam east side Carbon Mountain.
No. 2485. Gulch at head of First Berg Lake, Carbon Mountain.
No. 2478. Gulch at head of Fourth Berg Lake, Carbon Mountain.
No. 2479. Near crest (west side) of Carbon Mountain, between trails.
No. 2480. Eastern opening, hillside trail, east side of Carbon Mountain.
No. 2481. Crest of Carbon Mountain, 50 feet above sample No. 2479, between Hunt's and Green's trails.
No. 2482. South end of hillside trail, west side of Carbon Mountain.
No. 2483. Western opening, hillside trail, east side of Carbon Mountain.
No. 2484. Trout Creek tunnel, one-fourth mile below house.

MATANUSKA COALS.

Laboratory number	2217	2221	2225	2226	2223	2214	2216
Thickness of coal seam ....feet..	5	11.7	6	2.6	1	7	7
Air-drying loss....per cent..	0.80	4.60	(a)	(a)	(a)	1.60	1.00
Moisture....do....	2.24	10.05	4.03	5.56	2.50	4.36	2.46
Volatile matter....do....	23.08	36.05	34.84	36.52	28.32	18.92	17.01
Fixed carbon....do....	70.21	48.90	49.31	51.32	58.82	61.19	53.23
Ash....do....	4.47	5.00	11.82	6.60	10.36	15.53	27.30
Sulphur....do....	.50	.25	.38	.42	.58	.37	.84

Laboratory number	2215	2218	2219	2220	2222	2224	2227
Thickness of coal seam ....feet..	12.3	9.9	8.6	7.9	38	3.3	5.2
Air-drying loss....per cent..	1.60	1.80	4.10	1.90	(a)	(a)	(a)
Moisture....do....	2.58	2.93	6.74	2.90	2.55	6.60	0.90
Volatile matter....do....	19.14	21.85	14.96	17.47	7.08	34.30	19.60
Fixed carbon....do....	67.46	63.09	65.83	56.15	84.32	48.23	74.60
Ash....do....	10.82	12.13	12.47	23.48	6.05	10.87	4.90
Sulphur....do....	.57	.59	.44	.46	.57	.41	.60
Calories....	.....	.....	6,649	.....	7,617	6,299	8,260

a Sample too small to be air dried accurately.

No. 2217. Coal Creek, three-fourths mile above Matanuska River.
No. 2221. Tsadaka Creek, 4½ miles above trail.
No. 2225. Tsadaka Creek, 4 miles above trail.
No. 2226. West bank of Eska Creek, 3 miles above trail.
No. 2223. West bank of Young Creek, 3 miles above trail.
No. 2214. South bank of Matanuska River, 3 miles above mouth of Chickaloon Creek.
No. 2216. Watson's tunnel No. 3, Chickaloon Creek.
No. 2215. Watson's tunnel No. 2, Chickaloon Creek.
No. 2218. West bank of Kings Creek, at upper bridge.
No. 2219. Coal Creek, three-fifths mile above Matanuska River. Sample package not sealed.
No. 2220. Watson's tunnel No. 5, Chickaloon Creek.
No. 2222. Matanuska Valley (north side) between Boulder and Hicks creeks, about 18 miles from Chickaloon Creek. Small sample.
No. 2224. Eska Creek, 3 miles above trail.
No. 2227. Watson's tunnel No. 2, Chickaloon Creek.

BRAZIL NO. 1.

Run-of-mine coal from mines near Sao Jeronymo, about 30 miles west of Porto Alegre, in the state of Rio Grande do Sul, Brazil. The bed has a thickness of nearly 6 feet and is usually separated into two nearly equal portions by a stratum of black clay or slate, which varies from 4 inches to 2 feet or more in thickness. The rocks which hold the Brazil coal consist of alternate layers of gray sandstones and shales having a thickness of 300 to 400 feet. The flora found in connection with them appears to place them at the very top of the Carboniferous beds, either in the Permian or "Permo-Carboniferous." The bed from which this sample was taken occurs near the summit of the coal-bearing series. It is found over a wide area in the state of Rio Grande do Sul and appears to extend northward through the state of Santa Catharina, where it has been mined in the Tubarao district.

This sample was supplied by the Brazilian Government through Dr. I. C. White, State geologist of West Virginia, and was tested to furnish data that will serve as a basis for an investigation of coals now undeveloped in West Virginia and other States, which are similar in character and geologic age.

STEAMING TESTS.

Test 172, Brazil No. 1.

Size as used (average diameter), 1.42 inches. Duration of test, 5.35 hours. Kind of grate, plain.

Test 173, Brazil No. 1.

Size as used (average diameter), 1.26 inches. Duration of test, 5.60 hours. Kind of grate, plain.

MISCELLANEOUS ITEMS.

	Test 172.	Test 173.
Heating value of coal.....B. T. U. per pound dry coal..	10,028	9,830
Force of draft:		
Under stack damper.....inch water..	0.65	0.59
Above fire.....do....	.16	[a].03
Furnace temperature.....°F..	1,900	1,858
Dry coal used per square foot of grate surface per hour.....pounds..	22.61	24.93
Equivalent water evaporated per square foot of water-heating surface per hour.....pounds..	2.62	3.03
Percentage of rated horsepower of boiler developed.....	73.38	85.0
Water apparently evaporated per pound of coal as fired.....pounds..	4.48	4.67
Water evaporated from and at 212° F.:		
Per pound of coal as fired.....do....	5.16	5.43
Per pound of dry coal.....do....	5.80	6.09
Per pound of combustible.....do....	8.43	8.94
Efficiency of boiler, including grate.....per cent..	55.85	59.02
Coal as fired:		
Per indicated horsepower hour.....pounds..	5.48	5.21
Per electrical horsepower hour.....do....	6.77	6.43
Dry coal:		
Per indicated horsepower hour.....do....	4.88	4.64
Per electrical horsepower hour.....do....	6.02	5.73

[a] Forced.

ANALYSES.

	Test 172.	Test 173.		Test 172.	Test 173.
Proximate.			*Ultimate.*[a]		
Moisture	10.92	10.87	Carbon	56.70	55.23
Volatile matter	27.06	26.00	Hydrogen	3.71	3.61
Fixed carbon	37.49	38.32	Oxygen	8.08	7.86
Ash	24.53	24.81	Nitrogen	.95	.93
	100.00	100.00	Sulphur	3.02	4.53
Sulphur	2.69	4.04	Ash	27.54	27.84

[a] Figured from car sample.

PRODUCER-GAS TEST.

Test 44, Brazil No. 1.

Duration of test, 24 hours.

Average electrical horsepower 141.8
Average B. T. U. gas, per cubic foot 130.9
Total coal fired ..... pounds.. 8,100

COAL CONSUMED IN PRODUCER (POUNDS PER HORSEPOWER PER HOUR).

	Test 44.		
	Coal as fired.	Dry coal.	Combustible.
Per electrical horsepower:			
Available for outside purposes	2.63	2.35	1.73
Developed at switch board	2.38	2.12	1.56
Per brake horsepower:			
Available for outside purposes	2.24	1.99	1.47
Developed at engine	2.02	1.80	1.33
Equivalent used by producer plant.			
Per electrical horsepower:			
Available for outside purposes	2.88	2.56	1.89
Developed at switch board	2.60	2.32	1.71
Per brake horsepower:			
Available for outside purposes	2.45	2.18	1.61
Developed at engine	2.21	1.97	1.45

ANALYSES.

	Test 44.		Test 44.
Coal.		*Gas by volume.*	
Moisture	10.96	Carbon dioxide (CO_2)	11.5
Volatile matter	26.78	Carbon monoxide (CO)	15.9
Fixed carbon	38.82	Hydrogen (H_2)	10.8
Ash	23.44	Methane (CH_4)	2.9
	100.00	Nitrogen (N_2)	58.8
Sulphur	2.94	Oxygen (O_2)	.1
			100.0

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