PROVINCE OF BRITISH COLUMBIA

REPORT OF TESTS

ON

Hasler Creek Coal

CONDUCTED BY

DEPARTMENT OF RAILWAYS
IN
LOCOMOTIVES AND STEAM PLANTS

VICTORIA, B.C.:
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1949.

CANADIAN PACIFIC RAILWAY LOCOMOTIVE, MAY, 1949.

ABSTRACT.

Tests were made on C.P.R. locomotive to determine the usability of Hasler Creek coal as a locomotive fuel and to compare its efficiency with that of coals regularly used.

The tests prove that Hasler Creek coal is a good locomotive fuel, and savings as high as 15 per cent. may be obtained by its use. This is attributable to its exceptionally high calorific value and low ash and moisture content.

No trouble was experienced in firing or handling the locomotive while using this coal.

Through the courtesy of Mr. N. R. Crump, vice-president, and Mr. G. H. Baillie, vice-president, Pacific Region, Canadian Pacific Railway Company, it was made possible to carry out tests with Hasler Creek coal in comparison with coal regularly used in locomotives by the Canadian Pacific Railway. The arrangements were made by Mr. J. M. Stewart, Department of Railways, Victoria, B.C., and Dr. T. B. Williams, Coal Controller, B.C. Department of Lands and Forests. Acting in accordance with the above, four tests were conducted on the Brooks and Strathmore Subdivisions of the Canadian Pacific Railway between Calgary and Medicine Hat on May 10th to 13th, 1949, inclusive, a distance of approximately 175 miles for each test trip.

A class P_2 j C.P.R. locomotive, road number 5442, was assigned to the test, the specifications of which are shown later in this report.

Mr. N. R. Crump kindly arranged that the C.P.R. dynamometer car No. 62 with operating crew be placed at our disposal.

The personnel conducting and witnessing these tests was as follows:—

R. E. Swanson, chief inspector, B.C. Department of Railways.
J. W. Millar, chief mechanical officer, Ontario Northland Railway, and representing B.C. Department of Railways.
K. C. Gilbart, chief chemist, B.C. Coal Control, Victoria, B.C.
A. E. Mimms, mechanical engineer, C.P.R., Montreal, Que.
J. Hewitson, dynamometer engineer, C.P.R., Montreal, Que.
W. B. Patterson, dynamometer car operator, C.P.R., Montreal, Que.
Alexis Faulkerson, road foreman of engines, C.P.R., Medicine Hat, Alta.
J. Smart, machinist apprentice, Ogden, Alta.
R. Graham, machinist apprentice, Vancouver, B.C.

THE COAL.

The coal under test was mined in April, 1949, from the Hasler mine, situated on Hasler Creek at latitude 55° 30′ N. and longitude 122° W. in the Peace River area of British Columbia. The coal was mined and sacked under the supervision of Mr. N. D. McKechnie, B.C. Coal Control, and transported over land to rail-head, where 50 tons were shipped in closed freight-cars to the Canadian Pacific Railway at Calgary, Alta., for test purposes.

The mine-run coal used in these tests is a 20-per-cent. volatile short-flame bituminous coal, with the following analysis as mined:—

ANALYSIS, SAMPLE NO. 3A-49.

	As received.	Cap. Moist.	Dry.
Moisture ..... Per Cent.	2.6	2.2	.....
Ash ..... Per Cent.	3.5	3.5	3.6
Volatile matter ..... Per Cent.	19.8	19.9	20.3
Fixed carbon ..... Per Cent.	74.1	74.4	76.1
Sulphur ..... Per Cent.	0.5	0.5	0.5
Gross calorific value ..... B.t.u.	14,710	14,780	15,110
Fuel ratio		3.8	
Coking properties		Good coking.	
Mineral matter—free dry F.C.		79.2	
Mineral matter—free dry B.t.u.		15,730	
Mineral matter—free moist B.t.u.		15,380	
Classification, A.S.T.M.		Low volatile bituminous.	

THE TEST LOCOMOTIVE.

The locomotive assigned for test was a Class P_2 j C.P.R. locomotive, No. 5442, with the following specifications:—

Type, 2-8-2.
Boiler pressure, 275 lb.
Cylinders (2), 22" x 32".
Driver, 63".
Tractive effort, 57,500 lb.
Fire-box: Inside width, 84¼"; inside length, 120 1/16".
Grate area, 70.3 sq. ft.
Arch tubes, 4 only, 3½" diameter.
Tubes:—
32 only, 2", 17' 10⅞" long.
158 only, 2¼", 17' 10⅞" long.
45 only, 5½", 17' 10⅞" long.
Heating surfaces:—

Tubes and flues	3,126 sq. ft.
Fire-box	274 „ „
Arch tubes	36 „ „
Total heating surface	3,436 „ „
Superheater	970 „ „
Combined total	4,406 „ „

Weight on drivers, 248,500 lb.
Loaded weight, engine, 339,000 lb.
Light weight, engine, 310,000 lb.
Loaded weight, tender, 238,000 lb.
Light weight, tender, 98,000 lb.
Fuel capacity, 18 tons of coal.
Water capacity, 10,000 imperial gallons.
Built, June, 1944.
Montreal Locomotive Works.
Equipped with:—
Elesco feed-water heater.
Elesco feed-water pump.

HT standard stoker.
Multiple throttle.
Type A superheaters.
Screw air reverse.

PREPARATION OF LOCOMOTIVE FOR TEST.

Through the courtesy of Mr. G. Grant, master mechanic, and Mr. F. Booth, locomotive foreman, Canadian Pacific Railway, Calgary, it was arranged that Mr. J. W. Millar and Mr. R. E. Swanson draught the test locomotive suitably to burn Hasler Creek coal and to be redraughted again to burn the regular coal. Consequently, exhaust nozzle-tips were fitted as follows:—

For Hasler Creek coal, 6½" diameter with ½" "X" bar.
For regular coal, 6¼" diameter with ½" "X" bar.

No other changes to the draught arrangement were made. This engine was regularly equipped with rosebud grates, 9/16-inch openings, and side wind-baffles to the ash-pan, to which no changes were made.

The condensate from the feed-water heater was arranged to spill on the track. This was done to avoid complications in metering feed-water.

The water space and the coal space on the tender were both calibrated and checked with standard charts kept on car 62.

METHOD OF TEST.

Each bag of the test coal was weighed. After weighing, each bag was tagged and set aside for subsequent loading on the tender either at Calgary or Medicine Hat. Before each test the hopper was cleaned out and a known weight of coal loaded into the hopper as required. About 2 tons of reserve coal, weighed and tagged, was carried on the back of the tender. At the end of each test run the hopper was put back in the condition as at the beginning and the weight of the coal-bags deducted.

In making the tests with regular C.P.R. coal, the calibration chart for the tender was used. This calibration was checked by measuring and calculation of the cubical contents of the hopper, also by weighing a 2-cubic-foot sample of coal each time coal was loaded on to the tender at various coal-docks along the railway. A sample of coal for analysis was taken each time the tender was loaded.

The coal necessary for steaming up and getting the engine to the train was loaded in bags and placed in the cab so that calibrated or weighed coal from the tender was not used until the official start of the test run.

Immediately before the test and at each water-stop the level of the water in the tender and also its temperature was logged. The level of the water in the boiler and the condition of the fire were noted at the beginning of each test, and the water and fire brought back to this condition at the end of the test.

With respect to ash measurements on Hasler Creek coal, the pan was dumped at Medicine Hat and ashes weighed, while the entire fire was dumped and weighed on the completion of the round trip at Calgary. On the tests using regular C.P.R. coal, it was found necessary to dump the pan several times on the road; consequently, the ash could not be weighed, but the piles of ash were levelled and measured and the weight calculated from weighed samples measuring 2 cubic feet each. Samples of the ash from each test were forwarded to the laboratory for analysis.

Pyrometers were fitted to the locomotive to indicate the temperature of the feed-water entering the boiler and also the total temperature (superheat) of the steam in the header. These instruments were checked for accuracy before application to the locomotive. The throttle and reverse quadrants were graduated, and a tested steam gauge and back-pressure gauge fitted. A draught gauge was fitted to the front end of the locomotive in the first pass behind the diaphragm plate and piped back to the cab.

Readings were taken every five minutes and telephoned back to the dynamometer car, where a log was kept.

Dynamometer car No. 62 was placed immediately behind the test locomotive during the tests, where all records, drawbar horsepower-hours, mileage, and other data were recorded.

Two tests were made using Hasler Creek coal, one from Calgary to Medicine Hat on May 10th and a return trip from Medicine Hat to Calgary on May 11th. For comparison purposes, two trips were made using regular C.P.R. coal from the coal-docks, one from Calgary to Medicine Hat on May 12th and a return trip from Medicine Hat to Calgary on May 13th. The tonnage on each trip was as near as possible full freight tonnage for each subdivision, tonnage being set out or filled out as required. Most of the mileage was run with trains of approximately eighty-five cars.

OBSERVATIONS AND RESULTS.

It was noted that due to the friable nature of this coal there was about 40 per cent. fines which would pass a ¼-inch screen. After passing through the stoker screw, it is estimated the fines would amount to about 60 per cent. No difficulty was experienced in a stoker operation with Hasler Creek coal. It was noticed that due to the dryness of Hasler Creek coal the dust or pulverized coal flashed into flame immediately on leaving the stoker. This appeared to cause a 20 to 30 per cent. Ringleman chart number smoke from the stack as the stoker was started. Immediately the stoker was stopped, the stack cleared up. Excess air from an open fire-door or wetting the coal immediately brought the result of a clear stack. After the fireman had learned to handle the coal, the smoke condition was considered satisfactory. The coal was fired dry during the tests.

Previous tests of Hasler Creek coal suggested that a lessened draught would be an advantage, as there would be less carry-over and stack losses. This opinion was confirmed by the use of a 6½-inch nozzle-tip (opened one-quarter inch) on these tests when using Hasler Creek coal, as there was a remarkable lack of cinders during the Hasler tests, while there was evidence of considerable cinder emission during the tests of regular C.P.R. coals. No sparks from the stack were observed during the tests of Hasler Creek coal; in fact, no sparks were observed on either coal while a portion of the Hasler tests were run after dark.

It was further observed the average total temperature of the steam (including superheat) when using Hasler Creek coal was 633° F., against 672° F. on regular coal. This is attributed to Hasler Creek coal burning with a shorter flame, and it is recommended that a shorter arch would be an advantage on Hasler Creek coal and would allow more radiant heat to reach the superheater flues.

During the tests, results show that Hasler Creek coal steamed more freely than regular coal, the average steam pressures being 265 as against 261 in favour of Hasler Creek coal. The fire was light and uniform throughout and burned with a bright flame. It was noted Hasler Creek coal seems to be self-regulating, in that when the throttle was shut, the fire burned dully but immediately came up to a white heat when the throttle was again opened.

No clinkers were formed during the test trips with Hasler Creek coal, and it was not necessary at any time to dump the ash-pan on the road, nor was it necessary to shake grates or use the clinker bar and poker at any time; in fact, the fire built in the engine at Calgary made entire round trip (350 miles) back to Calgary without shaking the grates or dumping the fire. The fire remained banked overnight at Medicine Hat, and the same fire from the day before made the return trip to Calgary. At the conclusion of the 350-mile round trip with Hasler Creek coal, the fire was dumped, and the total ash for the round trip was 3,076 lb. On the other hand, on test round trips using regular coal, the pan was dumped seven times, the total ash being 11,739 lb. On the basis of coal fired, the ash removed was 2.7 per cent., as against 12.8 per cent. in favour

of Hasler Creek coal, while actual laboratory analyses showed Hasler Creek coal to have 3.3 per cent. for the round trip where the regular coal had 16 per cent. The actual calorific value of Hasler Creek coal as fired was 14,880 B.t.u., while the actual analysis of regular coal as fired was 12.300 B.t.u. No slagging was in evidence on the back tube-sheet on either coal, also the front end was found to be clean after all test trips.

During the round-trip tests, 40.13 tons of Hasler Creek coal were burned to produce 10,982 drawbar horsepower-hours, as against 45.75 tons of regular coal to produce 10,598 drawbar horsepower-hours. Coal burned per drawbar horsepower-hour on Hasler Creek coal amounted to 7.3, as against 8.6 on regular coal. This amounts to a saving of 15 per cent. of the coal regularly used.

The results of the four tests are summarized in a table appended to this report. It will be noticed the tonnage, mileage, and horsepower-hours developed are approximately the same for all comparative tests. It will also be seen the weather, rail conditions, running time, and detentions are nearly alike, which taken in all leads to the conclusion the tests were fair and comparable in all respects.

Analyses of all coals and ash refuse are tabulated and included in the appendix of this report. These analyses were made in the laboratory of the Coal Control, Department of Lands and Forests, Victoria, B.C.

CONCLUSIONS.

The tests prove that Hasler Creek coal is a good locomotive coal, and savings as high as 15 per cent. may be obtained by its use.

No trouble was experienced in firing or handling Hasler Creek coal.

Due to the dryness of Hasler Creek coal as delivered, no trouble is anticipated by freezing in tender-hoppers and coal-docks.

The low ash content of Hasler Creek coal will eliminate much cinder-handling on a railway, also detentions for cleaning fires on the road will be minimized.

Hasler Creek coal showed no evidence of slagging on tube-sheet or clinkering on grates.

The test proves that in order to take advantage of the high calorific value of Hasler Creek coal, a larger nozzle-tip than normal is advisable, thus reducing back pressure and raising efficiency. No undue carry-over or stack emission was noticed during the tests. This is attributed to the use of a larger exhaust tip.

ACKNOWLEDGMENTS.

The courtesy and assistance of Canadian Pacific Railway Company, its officials, dynamometer car operators, shop personnel, and engine crews is gratefully acknowledged.

Respectfully submitted.

ROBERT E. SWANSON,
Chief Inspector, Department of Railways, Vancouver, B.C.

J. W. MILLAR,
Chief Mechanical Officer, Ontario Northern Railway, representing B.C. Department of Railways.

K. C. GILBART,
Chief Chemist, B.C. Coal Control, Victoria, B.C.

Vancouver, B.C.,
June 13th, 1949.

TABLE I.—SUMMARY OF COAL TEST TRIPS.*

Item.	Eastbound.		Westbound.	
	49–12–1. May 10, Hasler Creek.	49–12–3. May 12, C.P.R.	49–12–2. May 11, Hasler Creek.	49–12–4. May 13, C.P.R.
Weather	Clear	Clear	Clear	Clear
Rail condition	Good	Good	Good	Good
Average air temperature ....deg. F.	69°	73°	74°	75°
Test mileage	172.3	173.1	177.5	176.1
Total time on road	8 hr. 14 min.	7 hr. 39 min.	8 hr. 53 min.	8 hr. 59 min.
Detention	2 hr. 14 min.	1 hr. 57 min.	2 hr. 25 min.	2 hr. 15 min.
Total running time	6 hr. 0 min.	5 hr. 42 min.	6 hr. 28 min.	6 hr. 44 min.
Number of stops	11	9	12	13
Average speed—total time ....m.p.h.	20.9	22.6	20.0	19.6
Average speed—running time ....m.p.h.	28.7	30.4	27.4	26.2
Average drawbar pull ....lb.	10,904	10,327	12,638	12,390
Average drawbar horse-power per hour	835.0	837.0	923.0	865.6
Average drawbar horsepower-hours	5,007	4,772	5,975	5,826
Total coal used ....lb.	35,555	39,090	44,714	52,400
Coal per square foot of grate area per hour (total time) ....lb.	61.3	72.8	71.6	83.2
Coal per drawbar horse-power ....hr.	7.1	8.2	7.48	9.0
Total water used ....lb.	196,760	158,490	213,400	242,240
Evaporation—pounds of water/pounds of coal	5.53	4.06	4.73	4.62
Water per drawbar horse-power-hour ....lb.	39.2	33.2	35.0	41.6
Coal per square foot of grate area per hour (running time) ....lb.	84.2	97.6	93.2	110.3
Over-all boiler and superheater efficiency ....per cent.	44.3	38.3	38.5	42.8
Over-all thermal efficiency ....per cent.	2.42	2.39	2.30	2.17
Equated ton-miles	835,070	842,982	485,285	479,142
Coal per 1,000 equated ton-miles	42.6	46.3	91.8	109.5
Integrations	62	59	74	72
Safety-valves open	13' 15"	20"	10'	30"
Average temperature of feed-water in tender ....deg. F.	56	55.2	56.7	58.5
Average temperature of feed-water from heater ....deg. F.	157.6	144.2	150.8	161.0
Average temperature of steam to steam-pipe ....deg. F.	633.2	662.6	632.0	680.4
Average boiler pressure ....lb. p.s.i.-gauge	263	260	267	261.6
Average back pressure ....lb. p.s.i.-gauge	12.4	14.0	13.7	16.6
Average draught ....inches of water	4.14	5.4	5.0	5.6

* The above table is subject to certain corrections on receipt of corrected analysis.

P_2j class locomotive 2-8-2, No. 5442, Canadian Pacific Railway; grate area, 70.3 sq. ft.; pressure, 275 lb.; driving wheels, 63" diameter.

REPORT OF J. W. MILLAR, ONTARIO NORTHERN RAILWAYS.

A test of Hasler Creek coal was conducted on the Canadian Pacific Railway between Alyth and Medicine Hat, Alta., on May 10th and 11th, 1949, using engine No. 5442 as the test locomotive. The test was made in freight service, and for purposes of comparison a test was run on the same locomotive on May 12th and 13th, using the regular run of coal from the railway's coal-chutes.

The tests were conducted by R. E. Swanson, chief inspector, B.C. Department of Railways, and J. W. Millar, chief mechanical officer, Ontario Northland Railways; and assisted by A. E. Mimms, mechanical engineer, C.P.R.; K. C. Gilbart, chemist, B.C. Department of Lands and Forests; J. Hewitson and staff of C.P.R. dynamometer car No. 62; A. Faulkerson, road foreman of engines, C.P.R.

CONCLUSIONS.

1. As compared with the usual run of coal used on the Canadian Pacific Railway, the sample of Hasler Creek coal rated 119 per cent. in comparing the equivalent evaporation, but did not rate any higher than on the C.N.R. tests.

2. The coal did smoke more than was anticipated, but not more than C.P.R. coal. There was no serious sparking.

3. There was very little carry-over of cinders on the Hasler Creek coal as compared to the test run with C.P.R. regular coal.

4. Stoker jet pressures were reduced from 5 to 10 lb. under that normally used.

5. There was no slagging of the tube-sheet; front-end netting was clean; there were practically no cinders in the smoke-box, and very little ash in the ash-pan.

6. The fire-bed was still in fairly good condition after complete round trip of 349.8 miles without shaking the grates at any time.

METHOD.

The C.P.R. dynamometer car No. 62, in charge of A. E. Mimms, mechanical engineer, and J. Hewitson, dynamometer car operator, was placed behind the locomotive, and continuous record made of drawbar pull, speed, horse-power etc.

The water in the tender was measured by a calibrated rod reading in inches and converted to gallons from a chart available on the dynamometer car. The condensate from the feed-water heater was spilled to the track, as there was no meter available to measure this condensate.

The Hasler Creek coal was in bags, which were individually weighed and tagged. In computing the coal used, the weight of the bags was deducted. At the start of each test of the Hasler Creek coal, the tender was swept clean and the coal was loaded into the tender each time by an overhead crane. A reserve supply in sacks was loaded over the water space and used as required during the trip when the coal in the hopper was depleted. On the eastward trip the hopper was empty at the end of the run, but on the westward trip it was necessary to sack and weigh the coal remaining in the hopper.

With the C.P.R. coal, the hopper was first cleaned and then filled directly from the coal-chutes. Each time the measurement of the coal was required, the coal was levelled off and distance measured from the top of the hopper. Charts available in the dynamometer car indicated the quantity of coal remaining in the hopper. The coal was fired dry with Standard Stoker Company's H.T. stoker.

In all cases the coal under test was used in building up the fire and steaming up before each run, but this coal is not included in the coal consumed on the test trips.

Feed-water temperature was recorded by installing a thermocouple in the discharge quarter of the feed-water heater, and the steam temperature was recorded by installing a thermocouple in the main auxiliary steam-pipe which supplies superheated steam to the auxiliaries. This location was used rather than the main steam-pipe to the cylinders in order to avoid the throttling action of the main throttle.

A draught gauge was applied to the smoke-box, with the open end of the pipe directly behind the back plates and in the approximate centre of the circumference of the smoke-box. Back pressure was read from a back-pressure gauge already in the locomotive.

Readings were taken every 5 miles and averaged for the trip. The readings were communicated from the locomotive cab to the dynamometer car by telephone.

Samples of both coals as fired were taken for analysis, as also were samples of the ashes in the ash-pan and the ash dumped from the grates at the end of the Hasler Creek tests.

During the Hasler Creek tests the exhaust tip was 6½ inches with bridge, and during the C.P.R. coal tests 6¼ inches with bridge, being the standard size used in this particular territory.

OBSERVATIONS.

The Hasler Creek coal was very dry and dusty and contained a high percentage of slack, although the lumps were somewhat larger than supplied for the tests on the Canadian National Railway.

Some difficulty was experienced in firing at first, as the fire-bed was too light, and it was some time until the fire-bed was built up satisfactorily. At first the coal became banked against the tube-sheet, but this later burned out. The fire burned with a fairly short flame and was light and clean throughout. With the C.P.R. coal it was necessary to shake the grates and clean the pans en route, as well as before the return trip, whereas with Hasler Creek coal the grates were not moved for the entire round trip.

It is noted that the superheat with Hasler Creek coal was lower than with the C.P.R. coal, which would be expected on account of the shorter flame.

On tests with Hasler Creek coal, the draught and back pressure were much lower than with C.P.R. coal, due to the larger size of exhaust tip. This probably accounts for the fact that considerable smoke was experienced, but on the other hand the engine steamed freely and the cinders emitted from the stack were negligible. It should be noted that the safety-valves on the Hasler tests were open a total of 23 minutes 15 seconds, as against 50 seconds on the C.P.R. coal tests. This is explained by the fact that the Hasler Creek coal is very hot, and the fireman on that trip, being very anxious to keep the steam pressure up at all times, did not make allowance for the additional heat in the coal. It is possible also that with more experience with Hasler Creek coal, there would have been less smoke and less loss at the safety-valves.

With the Hasler Creek coal, there was no difficulty for steam at any time, and on the whole it provides a much better operating condition than the regular coal, as there is no necessity for cleaning the fire and dumping the pans en route.

COMMENTS.

Table I attached showing the test results indicates that the Hasler Creek coal consumed per 1,000 equated ton-miles was 86.5 per cent. of the C.P.R. coal required, although the total time on the road and the loss through the safety-valves were greater. The equivalent evaporation of Hasler Creek coal is also 19 per cent. higher.

Hasler Creek coal has been found to be an excellent locomotive coal, providing the draught is adjusted to suit.

J. W. MILLAR,
Chief Mechanical Officer,
Ontario Northland Railway.

UNIVERSITY OF BRITISH COLUMBIA STEAM PLANT, MAY, 1949.

ABSTRACT.

Tests were made in the University of British Columbia power plant to determine the usability of Hasler Creek coal on chain-grate stoker in a modern steam plant.

The tests prove that Hasler Creek coal is a suitable fuel to be burned in this type of plant and that savings as high as 20 per cent. may be obtained by its use.

No trouble was experienced in firing this coal when the coal was suitably prepared.

Through the courtesy and co-operation of Dr. H. J. McLeod, Department of Mechanical and Electrical Engineering, and Mr. W. E. Dale, chief engineer, power plant of the University of British Columbia, a series of tests were made in the power plant of the University of British Columbia to determine the usability of Hasler Creek coal in a stoker-fed modern steam plant. These tests were arranged by Dr. T. B. Williams, Coal Controller, Department of Lands and Forests, and Mr. J. M. Stewart, Department of Railways, Victoria, B.C.

The following persons were present to conduct and witness the tests:—

Dr. H. J. McLeod, University of British Columbia.
Professor Wolfe, University of British Columbia.
W. E. Dale, chief engineer, power plant of the University of British Columbia.
R. E. Swanson, chief inspector, Department of Railways.
K. C. Gilbart, chief chemist, B.C. Coal Control.
W. E. Tyler, inspector, Department of Railways.
T. A. Wood, inspector of boilers and machinery.
J. E. Weston, manager, Diethers, Ltd.

PURPOSE OF TEST.

The purpose of these tests was to prove that Hasler Creek coal can be successfully burned on a chain-grate stoker in a modern steam plant, designed and installed to burn other coals now on the market, and to make a comparison as to efficiencies and evaporation between Hasler Creek coal and the lower-grade coals now normally used for fuel in the same plant.

THE TEST COAL.

The coal under test was mined in April, 1949, from the Hasler mine, situated on Hasler Creek at latitude 55° 30′ N. and longitude 122° W. in the Peace River area of British Columbia. The coal was mined and sacked under the supervision of Mr. N. D. McKechnie, of the B.C. Coal Control, and transported overland to rail-head, when 40 tons of the sacked mine-run coal was consigned in closed freight-cars to Diethers, Ltd., Vancouver, B.C.

The coal as mined was a 20-per-cent. volatile coal, with the following analysis:—

ANALYSIS, SAMPLE NO. 13-49.

	As received.	Cap. Moist.	Dry.
Moisture ..... per cent.	2.1	2.1	.....
Ash ..... per cent.	4.5	4.5	4.6
Volatile matter ..... per cent.	19.6	19.6	20.0
Fixed carbon ..... per cent.	73.8	73.8	75.4
Sulphur ..... per cent.	0.4	0.4	0.5
Gross calorific value ..... B.t.u.	14,620	14,620	14,930
Fuel ratio		3.8	
Coking properties		Good coking.	
Mineral matter-free dry F.C.		79.4	
Mineral matter-free dry B.t.u.		15,730	
Mineral matter-free moist B.t.u.		15,400	
Classification, A.S.T.M.		Low volatile bituminous.	

On arrival at Vancouver, B.C., the coal was trucked to North Vancouver, where it was put through a jaw and roll rock-crusher, where it was reduced in size to pass a ¾-inch screen. In this operation the entire shipment of coal was put through the crusher, thus further crushing coal that would have passed through a ¼-inch screen down to almost the point of pulverization. At the completion of this preparation it is estimated that the test coal contained 60 per cent. fines which would pass a ¼-inch screen. Of this percentage, a considerable amount of coal was almost dust. The coal was then transported and placed in the coal-bunkers at the University power plant.

After two tests on the above prepared coal it was found that due to the excessive amount of fines the coal could not be properly handled and burned on a travelling grate. Therefore, it was decided to screen the coal remaining in the bunker over a ¼-inch screen so that it would be in the same prepared condition as the coal normally used in this plant. After this was done, only sufficient coal was left for a one-day test. Therefore, a few tons remaining from the C.P.R. test was transported to Diethers, Ltd., Vancouver, B.C., where it was crushed by hand-hammers and passed over a ¼-inch screen. Lumps over 1 inch in size were hand-picked and recrushed. This coal was then placed in the bunkers of the University power plant and used for a further one-day test.

It might be mentioned that due to the large amount of dust in this coal it was found necessary while placing the coal in the bunkers to apply a water spray in order to keep down the dust. This tended to raise the moisture content of the coal as fired. The analysis of the coal as fired in the various tests will be found appended to this report.

THE REGULAR POWER-PLANT COAL.

The coal regularly used in the University power plant is supplied to them by Diethers, Ltd. It is a mixture of 80 per cent. McLeod River coal and 20 per cent. Comox coal. The preparation of this coal is such that it will all pass through a ¾-inch screen and remain on a ¼-inch screen. In other words, there is practically no slack in the coal as normally burned in this plant.

THE TEST BOILER.

This plant is designed and equipped to burn pea coal on stoker chain grates. The coal is delivered to the plant in motor-trucks and conveyed to the coal-bunkers by an adequate conveyer system. The coal-bunker is located directly above the firing deck, and the coal is loaded into a travelling hopper as required, where it is weighed before being transferred to the hoppers of the various stokers.

No. 3 boiler was chosen for test, the specifications being as follows:—

Combustion Engineering Company boiler.

Stirling type.

Nominal horse-power, 261.

Square feet of heating surface, 2,610.
Grate area, 46.8 square feet.
Cone chain-grate stoker, steam driven.
Forced and induced draught.
Equipped with Bailey flow meter system.
CO_2 recorder connected.
Deaërating feed-water heater.

The steam generated in this plant is used mainly for heating purposes, it being passed through reducing valves and distributed as required.

The ash refuse, after combustion has taken place, falls from the end of the travelling grate into the ash-pit, from which it is removed by hand and can be weighed before it is put through the ash-disposal system.

THE TESTS.

Four tests were made on Hasler Creek coal, and for comparison purposes one test was made on the regular coal used in this plant. As a matter of record, tests Nos. 1 and 2 will be discussed as one phase of the testing while tests Nos. 4 and 5 are another phase of testing of Hasler coal, all compared with test No. 3 run on regular plant coal. Each test was of approximately seven hours' duration. The first two tests were made on the coal which contained a very large amount of fines, and, as mentioned before, during preliminary tests it had been found that the fire tended to burn through in spots, with consequent excessive amount of air getting through. The engineers at the plant felt that this could be overcome by spraying the dry fine coal with water before it went on to the grate. During the first two tests the practice followed was to weigh the coal as it came from the hopper and transfer it to the hopper of the stoker, but while the coal was falling into this hopper, a fine spray of water was directed on it, thus wetting the coal. The water sprayed on was metered, but a considerable amount of the water ran through and did not remain on the coal. The wetted coal was, however, sampled, and the amount of excess moisture on the coal was then calculated. During the tests the depth of fire on the grate and the rate of travel of the grate were adjusted to give the required evaporation, but without carry-over of unburned coal from the end of the grate. A fire-depth of 4 inches and a grate-travel of 0.33 foot per minute were maintained throughout most of the tests. During the first two tests the average rate of steam production was 8,711.2 lb. per hour, which is 109 per cent. of the boiler rating.

Due to the adverse conditions encountered on the first two tests when the excessive amount of slack coal had to be wetted, it was considered advisable to discontinue the tests on Hasler coal until it could be prepared to resemble in size the coal normally used in this plant. During the interim period while this was being done, a test was run for comparison purposes on the regular coal normally used in this plant.

After the fines had been screened out of the remainder of the Hasler coal, another eight hours' test was run on May 19th, this test being recorded as No. 4 test. The results were highly gratifying, and it was felt advisable to continue the tests for one more day, using the Hasler coal left over from the C.P.R. tests and properly prepared for the test at Diethers' plant in Vancouver. Consequently, this test was run on May 20th, 1949, for a duration of seven and one-half hours and is recorded as test No. 5.

TEST PROCEDURE.

One hour prior to the beginning of each test, the test coal was started through the stoker to ensure that the boiler was operating on test coal at the official start of each test, at which time the level of the water in the boiler and the height of the coal in the hopper were noted and all readings taken. Readings of all instruments were taken at 30-minute intervals during the test, and observations made continuously. The fire temperature was measured with an optical pyrometer, and flue-gas analyses were made

with an Orsat apparatus. The Orsat readings were used to check the recording CO_2 meter.

Steam-flow, feed-water temperature, flue-gas temperature and air-flow were recorded on recording instruments, and the charts preserved for reference. The speed of the stoker engine was regulated by the governor set to tachometer readings. Carry-over of unburned fuel was maintained at a minimum consistent with a good fuel-bed and CO_2 reading by controlling the speed of the stoker.

Coal was weighed each time it was transferred from the bunker to the stoker hopper and the weights logged. A portion of coal was taken for analysis each time the weighing was done.

Immediately prior to the termination of each test, the level of the coal in the hopper, the height of the water in the boiler, and condition of the fire, and other pertinent factors were adjusted to the same conditions as existed at the official beginning of the test, and all readings and observations taken accordingly at the finish time. Immediately this was done the ash-pit was cleaned and the ashes weighed, and a sample preserved for analysis. The fly ash was treated in a like manner.

OBSERVATIONS AND RESULTS.

Although the tests on Hasler Creek coal appear to be divided into two groups, the inference should not be made that the first two tests are unsatisfactory. The coal, even with the fines in it, gave a performance more than comparable with the fuel normally used in this plant. That is to say, the evaporation rate was higher than normal in this plant. It was felt, however, that if Hasler Creek coal were properly prepared for burning in this particular stoker and boiler setting, better advantage could be taken of its exceptionally high calorific value. The two latter tests confirmed this opinion. The evaporation rate in the first test using Hasler Creek coal amounted to 7.48 lb. of steam per pound of coal, and with the experience gained in handling this coal, the second day's test showed an evaporation of 8.1 lb. of steam per pound of coal. This compares with 7.2 lb. of steam per pound of coal in test No. 3 using regular coal normally burned in this plant. The evaporation rate was somewhat lower in the first two tests than it should have been because of the water added to induce coking and prevent holes forming in the fire. For example, in the first test this added water raised the moisture content to 7 per cent., thus reducing the calorific value to 14,290 B.t.u. per pound of coal fired.

After the coal had been properly prepared for burning in this plant, test No. 4 showed an evaporation of 8.3 lb. of steam per pound of coal and test No. 5 showed the exceptionally high evaporation rate for this plant of 9.1 lb. of steam per pound of coal. This is to be compared as before with 7.2 lb. of steam per pound of coal on test No. 3 using the regular coal as normally burned in this plant.

During No. 1 test of Hasler Creek coal it was observed there appeared to be considerable carry-over of coke into the ash refuse. This was considered to be due to the extreme amount of fines in the coal as fired and may be explained as follows: The coal being dry in spots on the grate; holes burned in the fire and as the grate carried the fire-bed forward sufficient air did not get through the remaining part of the fire-bed to give complete combustion. Consequently, lumps were at times carried over into the ash refuse. In order to alleviate this condition, various stoker speeds were tried, but it was found the most satisfactory result when burning coal with an excessive amount of fines in it was to uniformly moisten the coal so that the fuel-bed would uniformly coke. This tended to eliminate holes and carry-over. On the other hand, however, on tests Nos. 4 and 5, after the coal had been properly prepared and the fines removed, it could be burned dry with a faster rate of speed, with no carry-over and a resultant high evaporation rate.

In spite of the carry-over of unburned fuel the average total ash on all Hasler tests amounted to 9.57 per cent. of the total weight of coal burned, as against 12.85 per cent. on the regular coal.

In keeping with what has already been said, it was observed that CO_2 readings were low when holes existed in the fire, but in tests Nos. 4 and 5, with the coal properly prepared, the CO_2 reading averaged approximately 12.8 per cent.

Optical pyrometer readings indicated an average fire temperature of 2650° F. while burning Hasler Creek coal, as against 2420° F. when burning the regular coal. In spite of this high temperature when burning Hasler Creek coal, no slagging was observed. This is due to the low ash content and high fusion temperature of the ash inherent in Hasler Creek coal. At no time was there evidence of any smoke whatsoever from the chimney.

The complete data for all tests, including the analysis of all coals and ash refuse, are shown in the table attached to this report.

CONCLUSIONS.

These tests prove that Hasler Creek coal is a suitable fuel to be burned on chain-grate stokers in modern steam plants designed and installed to burn other coals now on the market.

Higher evaporation rates per pound of coal were obtained when burning Hasler Creek coal than with other lower-grade coals now on the market.

The normal ash refuse of the plant was considerably reduced by burning Hasler Creek coal. Fly ash was negligible.

No slagging or clinkering was in evidence when burning this coal.

This coal burns smokelessly and is free from soot.

It is recommended that for use on this type of stoker the coal be properly prepared, screened, and classified.

As this coal is of a friable nature, the general consensus of opinion seemed to be that if this coal were properly screened and classified at the mine it would probably ship without undue breakage.

ACKNOWLEDGMENTS.

The courtesy and assistance of the University of British Columbia, its executive personnel, chief engineer of the power plant and power plant staff is gratefully acknowledged.

Respectfully submitted.

ROBERT E. SWANSON,
Chief Inspector, Department of Railways,
Vancouver, B.C.

K. C. GILBART,
Chief Chemist, B.C. Coal Control,
Victoria, B.C.

WM. EDW. TYLER,
Inspector, Department of Railways,
Vancouver, B.C.

Vancouver, B.C., June 17th, 1949.

SUMMARY OF TEST OF HASLER CREEK COAL AT UNIVERSITY OF BRITISH COLUMBIA.

Item.	Test No. 1.	Test No. 2.	Test No. 3.	Test No. 4.	Test No. 5.
Date of test	May 4/49	May 5/49	May 6/49	May 19/49	May 20/49
Duration of test ....hr.	7	7	7	8	7½
Total coal burned during test ....lb.	8,290	7,420	10,940	10,830	8,810
Coal burned per hour (average) ....lb.	1,184.3	1,060.0	1,561.4	1,353.75	1,174.6
Coal burned per hour per square foot of grate ....lb.	25.3	22.6	33.4	28.9	25.0
Calorific value of coal as fired in B.t.u./lb.	14,290	14,290	11,000	14,620	14,620
Moisture content of coal as fired ....per cent.	7	7	.....	2.1	2.1
Total steam generated during test ....lb.	62,000	60,000	79,000	90,000	80,000
Steam generated per hour ....lb.	8,851.4	8,571.4	11,143	11,111	10,666
Rating of boiler based on 8,000 lb. per hour ....per cent.	110.6	107.1	139.3	126.4	133.3
Average steam pressure, gauge, during test ....lb.	143.6	142	150	141.8	142
Average total temperature of steam during test	334.86° F.	361° F.	365.99° F.	361.0° F.	361.52° F.
Average feed-water temperature during test	230.00° F.	231° F.	229.00° F.	210.4° F.	228.00° F.
Total B.t.u. in 1 lb. of steam as generated	1,194.9	1,194.8	1,196.6	1,194.6	1,194.7
B.t.u. added to water per pound of steam generated	996.9	995.8	999.6	1,016.2	998.7
Factor of evaporation	1.027	1.026	1.03	1.047	1.029
Water evaporated per pound of coal (actual)	7.48	8.1	7.2	8.3	9.1
Equivalent evaporation from and at 212° F.	7.68	8.31	7.41	8.69	9.364
Boiler and furnace efficiency (not including feed-water heater) ....per cent.	52.1	56.4	65.5	57.7	62.3
Average CO_2 in flue gas during tests ....per cent.	8.33	9.0	12.0	13.0	12.8
Average O_2 by analysis during test ....per cent.	14.07	19.36	18.9	18.8	.....
Average temperature, flue gas to chimney ....deg. F.	587.5	577.5	597	639	614
Average fire temperature, front of grate ....deg. F.	2,650	2,650	2,420	2,650	2,650
Total refuse in ash-pit ....lb.	742	968	1,400	786	806
Per cent. of ash to total weight of coal as fired	8.95	16.28	12.85	7.6	9.3
Fly ash in first pass ....lb.	*	240	35	35	18

* Not collected.

Boiler: Combustion Engineering Company, Stirling type without superheater or economizer; capacity, 8,000 lb. steam per hour at 100 per cent. rating; Stoker-Coxe chain grate, area 46.859 square feet.

PULVERIZED BURNING AT PRINCETON.

Acting in accordance with instructions from Mr. J. M. Stewart, Department of Railways, Victoria, B.C., a test was arranged and conducted so that a sample of Hasler Creek coal could be burned in the modern pulverized-coal-burning steam plant of the Granby Consolidated Mining, Smelting and Power Company, Limited, at Princeton, B.C. The test was conducted on June 7th, 1949. The following personnel were present to conduct and witness the test:—

A. R. Eastcott, chief engineer of plant, Princeton, B.C.
A. C. R. Yuill, consulting engineer, Vancouver, B.C.
K. C. Gilbart, chief chemist, B.C. Coal Control, Victoria, B.C.
R. E. Swanson, chief inspector, Department of Railways, Vancouver, B.C.

PURPOSE OF TEST.

The purpose of this test was to prove whether or not Hasler Creek coal could be successfully burned in a pulverized-coal-burning steam plant primarily designed to burn low-rank coals; and, provided Hasler Creek coal could be successfully burned and ignition maintained in the above type of plant, to observe its performance as to evaporation rate and boiler efficiency.

THE COAL.

Forty of the two hundred tons of Hasler Creek coal mined in April, 1949, for test purposes was assigned to the Granby plant test. The mine-run coal was shipped in bags and was crushed, prepared, and placed in the coal-bunkers of this plant by this company's plant machinery normally used for other coals. The coal was pulverized in the regular bowl pulverizer as it was being fed to the firing burners.

This coal is a 20-per-cent. volatile short-flame bituminous coal, with the following analysis as mined:—

ANALYSIS, SAMPLE NO. 8A-49.

	As received.	Cap. Moist.	Dry.
Moisture ..... per cent.	2.4	2.1	.....
Ash ..... per cent.	3.4	3.4	3.4
Volatile matter ..... per cent.	20.2	20.3	20.7
Fixed carbon ..... per cent.	74.0	74.2	75.9
Sulphur ..... per cent.	0.4	0.4	0.4
Gross calorific value ..... B.t.u.	14,770	14,810	15,130
Fuel ratio		3.7	
Coking properties		Good coking.	
Mineral matter-free dry F.C.		78.9	
Mineral matter-free dry B.t.u.		15,730	
Mineral matter-free moist B.t.u.		15,400	
Classification, A.S.T.M.		Low volatile bituminous.	

Prior to the test there seemed some doubt if a coal of this analysis could be successfully burned in this plant.

THE STEAM PLANT.

This plant was designed to burn low-rank coals in suspension by pulverizing the coal as it is fed to the horizontal-type burners on the boilers. The steam produced is fed to steam turbines and electric power generated. The total output of this plant at 100 per cent. capacity is 17,500 kilowatts. Steam is generated in three boilers, namely: One stoker grate and two boilers equipped for pulverized burning.

No. 3 boiler on which the test was conducted is a Combustion Engineering Company steam generator; capacity, 80,000 lb. of steam per hour at 250 lb. pressure, with a total temperature of 600° F. The boiler is equipped with two bowl-mill pulverizers feeding four horizontal pulverized-coal burners. The plant is arranged with air pre-heaters and heat exchanges feeding heated primary air along with the pulverized coal to the burners. The purpose of this arrangement is to dry the high-moisture low-grade coal normally used in this plant.

As the test coal is low in moisture, pre-heated primary air for drying was not required, consequently this air had to be cut down or otherwise diverted. For this reason it was not considered good policy to force the boiler under test beyond 80 per cent. capacity, as the pre-heater tubes might be damaged, and to accomplish this end only two burners were used during the test. The two burners were fed by one bowl-mill pulverizer. The burners are designed to operate on finely pulverized coal, of which at least 65 per cent. must pass a 200-mesh sieve.

The coal was metered as it passed from the hopper to the pulverizing-mill. The accuracy of this apparatus was checked by weighing a metered sample of the test coal.

In this type of plant the ash is in suspension and is precipitated by sprays in the final uptake and carried away in a water steam; consequently, the ash cannot be weighed.

THE TEST.

Immediately prior to the start of the test the test boiler was operating on low-grade coal in one mill feeding the two upper burners and Hasler in the other mill feeding the two lower burners. At the starting time of the test the mill feeding the two upper burners was shut down, leaving the mill feeding the two lower burners with Hasler coal for the duration of the test. At the starting time (8.45 a.m.) all readings were taken and the water-height observed. Readings were then taken every fifteen minutes during the test, and recording-instrument charts preserved for reference.

Flue-gas analyses and fire-temperature readings were made at regular intervals during the test. A composite sample of the coal fed to the pulverizer for the entire test has been sent to the laboratory for analysis. Samples of the pulverized coal were also taken for screen analysis.

During the test it was observed that Hasler Creek coal pulverized easily, and it was possible to lessen the tension on the mill, which tends to cut down maintenance and save in power required to drive the mill.

Stack observations revealed little smoke, there being the normal stack emission inherent in this type of plant.

Normal operating procedure was carried on during the test, there being no flash-backs, black-outs, or other difficulties experienced. It was observed the boiler responded well to change of controls and could be termed very free steaming.

When the test coal became low in the hopper, the test was terminated at 4.30 p.m. after a 7¾-hour run. This was accomplished by starting the mill to the upper burners and feeding regular coal and at the same time taking the readings. By this procedure there was no interruption in the plant's operation.

RESULTS OF TEST.

During the test no difficulties were experienced in pulverizing and firing Hasler coal; 49,392 lb. of coal were fired during test, at the rate of 6,373 lb. per hour. The steam generated during the 7¾-hour test was 447,304 lb., which is at the rate of 57,700 lb. per hour. This is 72 per cent. of rating based on 80,000 lb. per hour. The actual evaporation per pound of coal amounted to 9.06 lb. of steam per pound of coal, and the equivalent evaporation from and at 212° F. would amount to 10.12 lb. of steam per pound of coal. It might be mentioned as a basis for comparison that the normal evaporation on this boiler with low-grade coals normally used is 6.48 lb. per pound of coal, or the evaporation ratio of 9.06 to 6.48 in favour of Hasler Creek coal.

It was observed the flame remained stable and appeared normal during the entire test. No black-outs or flash-backs were experienced. The flame temperature by optical pyrometer averaged 2,650° F. at 3 feet from burner and 2,400° F. at approximately 10 feet. There was no slagging of coal ash on the water tubes. Flue-gas analyses made during the test showed an average of 12.7 per cent. carbon dioxide, which was considered to be normal for good operating conditions in this unit. The boiler and furnace efficiency calculated to 70 per cent. during the test.

CONCLUSIONS.

The test proves Hasler Creek coal can be burned successfully in boilers equipped to burn pulverized low-grade coals. If certain changes were made to such a plant to accommodate this high-grade coal, increased efficiency would result.

Due to the dryness of Hasler Creek coal, pre-heated air to dry the coal is not necessary.

A stable flame can be maintained burning Hasler Creek coal in a pulverized plant designed for low-grade coals.

This coal appears to respond very satisfactorily to varying demands and changing loads imposed on the plant.

Slagging on boiler tubes is eliminated when burning Hasler Creek coal due to low ash content and high ash fusion temperatures.

The grindability of Hasler Creek coal makes it very suitable for pulverized-coal units, also the maintenance of pulverizing equipment will be lowered due to its excellent grindability.

It would appear Hasler Creek coal would make a very suitable fuel for large pulverized-coal-burning steam plants.

Summary of test results is appended.

Respectfully submitted.

ROBERT E. SWANSON,
Chief Inspector, Department of Railways.

K. C. GILBART,
Chief Chemist, B.C. Coal Control, Victoria, B.C.

Vancouver, B.C., June 9th, 1949.

SUMMARY OF TEST.

Date of test		June 7, 1949
Boiler: Combustion Engineering Co., 80,000 lb. capacity at 250 lb., 600° F. tt.		
Number of burners		4
Number of burners used during test		2
Type of pulverizing-mills		Bowl
Number of pulverizing-mills		2
Number of mills used during test		1
Duration of test in hours		7¾
Total coal burned during test	lb.	49,392
Coal burned per hour	lb.	6,373
Calorific value of coal as fired	B.t.u.	14,800
Moisture content of coal as delivered to mill	per cent.	1.0
Total steam generated during test	lb.	447,304
Steam generated per hour		57,700
Per cent. rating of boiler based on 80,000 lb. per hr.		72
Average steam pressure, gauge, during test		242
Average total temperature of steam during test	deg. F.	560
Average feed-water temperature during test	deg. F.	207

Total B.t.u. in 1 lb of steam as generated		1,313
B.t.u. added to water from firing per pound		1,138
Factor of evaporation		1.1175
Water evaporated per pound of coal during test (actual)		9.06
Equivalent evaporation from and at 212° F.		10.12
Boiler and furnace efficiency (not including feed-water heater)	per cent.	70
Average CO_2 in flue gas during test	per cent.	12.7
Average O_2 by analyses during test	per cent.	6.6
Average temperature of flue gas leaving first uptake	deg. F.	610
Average temperature of flue gas leaving second uptake	deg. F.	390
Average temperature of flue gas to chimney	deg. F.	370
Average fire temperature at 3 feet	deg. F.	2,650
Average fire temperature at 10 feet	deg. F.	2,400
Number of back-flashes during test		0

REPORT OF A. C. R. YUILL, CONSULTING ENGINEER.

675 HASTINGS STREET WEST,
VANCOUVER, CANADA, June 8th, 1949.

Mr. C. E. Hopper,
Acting Deputy Minister of Lands,
Parliament Buildings,
Victoria, B.C.

Re *Commercial Trial, Hasler Creek Coal.*

DEAR SIR,—Pursuant to instructions contained in your letter of April 23rd and acknowledged in ours of April 29th, the writer attended at the Princeton Steam Power Plant of the Granby Consolidated Mining, Smelting and Power Company, Limited, during a trial run of Hasler Creek coal supplied by the Province of British Columbia through Dr. T. B. Williams, Coal Controller.

The trial was arranged through the Company's general manager, Mr. W. I. Nelson, and was carried out under the direct supervision of Mr. A. R. Eastcott, power plant superintendent, who holds a first-class British Columbia stationary engineer's certificate.

The actual trial operations were conducted by the power plant staff under Mr. J. E. Ray, acting assistant chief engineer.

In addition to the above, the following were present as observers and assisted as requisite:—

R. E. Swanson, Chief Provincial Inspector of Railways.
K. C. Gilbart, chief chemist, Provincial Coal Controller's Office.
And the writer.

Individual reports will be submitted by Messrs. Swanson, Gilbart, and Eastcott, each covering different detailed aspects of the trial.

The coal shipment had been received some time previously, in sacks, and had been transferred over the company's cable tramway and through the power-plant coal-handling system to a bin above No. 3 boiler.

This boiler, which is more correctly described as a steam generator, having a rated capacity of 80,000 lb. of steam per hour at 250 lb. per square inch working pressure and 600° F. temperature, was manufactured by Combustion Engineering Corporation, Limited, of Montreal, in 1940. It is fired by powdered coal produced in two Raymond Brothers bowl-mill pulverizers, each having a grinding capacity of 9,000 lb. of coal per hour, and each supplying two burners located symmetrically in the front wall of the boiler, one mill supplying the two lower burners and the other the two upper burners.

The furnace is fitted with water walls on front and sides and with ceiling and floor water-tube screens.

The pulverizing and grinding equipment, also the boiler furnace, were designed for burning coals of much lower grade and greatly higher moisture content than the Hasler Creek coal; consequently, there was some apprehension as to the performance of the trial coal, but this was found to be unwarranted. No difficulty was experienced in pulverizing the coal nor in burning it satisfactorily. The grindability, that is the ease with which the coal pulverized, is of a high order.

It should be understood that coal being burned in pulverized form responds to load changes immediately in the same manner as fuel-oil.

During the trial only the mill supplying the lower burners was used, the other mill being kept in readiness in the event of the fires from the trial mill being extinguished, either inadvertently or due to the natural characteristics of the trial coal.

The trial coal mill was placed in service and the companion mill stopped at 8.45 o'clock and the trial continued until 16.28 o'clock.

During this period 49,392 lb. of coal were burned (the remainder of the car-load shipment being accounted for in preliminary operations and final adjustments to restore normal plant operation).

The quantity of water evaporated during the trial was 447,304 lb, being 9.06 lb. of steam per pound of coal fired. This is a creditable performance, but which could be materially improved by the use of equipment especially designed for such high-grade coal.

Finally, the Hasler Creek coal is eminently suitable for firing in powdered form, particularly in large boilers being continuously operated.

A tabulation of records taken during the trial is attached.

Yours very truly,
A. C. R. YUILL.

After preliminary adjustments to pulverizers and burners, the trial run was started at 8.45, June 7th, 1949, and continued until 16.28.

Time.	Coal-feeder Counter.	Steam-flow Meter (Lb. per Hr.).	Steam Production Meter (Lb.).
08.45	17,120	———	442,169
09.05	17,244	72,000	442,188
10.05	17,591	58,000	442,242
11.05	17,925	43,000	442,290
16.05	19,734	52,000	442,542
16.28	19,864	Finish	442,560
Less	17,120	*Less*	442,169
	2,744	Meter	391
At	18 lb.	Multiplier	1,144
Total coal recorded	49,392 lb.	Total steam production	447,304 lb.

Evaporation per pound of coal: $\frac{447,304}{49,392} = 9.06$ lb.

Average furnace temperature, 2,650° F.

No slagging on boiler tubes.

REPORT OF THE GRANBY CONSOLIDATED MINING, SMELTING AND POWER COMPANY, LIMITED.

POWER PLANT,
PRINCETON, B.C., June 9th, 1949.

Mr. R. E. Swanson, Chief Inspector,
Department of Railways,
602 Hastings Street West,
Vancouver, B.C.

DEAR SIR,—The following is my report on the Hasler Creek coal tested in our Princeton power plant on June 7th, 1949:—

A sample of Hasler Creek coal was tested in our 30,000-lb. per hour Combustion VU boiler. The boiler is of 982 B.H.P. operating at 250 p.s.i. gauge and 550° F., equipped with water walls, plate-type pre-heater, tubular heater for primary air, two Raymond bowl-mill pulverizers, and four combustion type R burners.

Due to the small amount of coal provided for the test, no attempt was made to vary the fineness of the pulverized coal; or to vary the steam flow-air flow ratio. Bowl-mill and classifier settings and the steam-air flow ratio were maintained as when burning local high-volatile low-B.t.u. lignites, or Alberta sub-bituminous coals.

In order to avoid the possibility of flame failure with an unknown coal, it was fired by No. 2 mill, serving Nos. 3 and 4 burners. For some time it was fired thus, in conjunction with Alberta coal fired by No. 1 mill and Nos. 1 and 2 burners. When it became apparent that the Hasler coal would maintain ignition by itself, No. 1 mill and Nos. 1 and 2 burners were shut down. For the remainder of the test the boiler was operated on Hasler coal only, fired through No. 2 mill and Nos. 3 and 4 burners, with No. 1 mill and Nos. 1 and 2 burners held as stand-by to take up the boiler load in case of flame failure.

Needless to say, maximum efficiency could not be obtained with two idle burners, since some unwanted secondary air would escape to the furnace through the secondary air vanes on the idle burners. The excess oxygen in the flue-gas analysis bears this out. For the same reason the average CO_2 reading was somewhat below the optimum of 14 per cent.

The test run commenced at 0845 hours, when Hasler coal was burned alone, and ended at 1628 hours, when a mixture of Hasler and Alberta coal was again fired. During this run 24.6 tons of Hasler coal were burned, with an evaporation of 9.06 lb. of steam per pound of coal, for a boiler efficiency of 72 per cent.

The thermal efficiency was calculated as follows:—

Data: Average steam pressure, 255 p.s.i. absolute.
Average steam temperature, 556° F.
Average feed-water temperature, 214° F.
Calorific fuel value, 14,000 B.t.u. as received (estimated).

B.t.u. put into 1 lb. of steam at working condition:—

$$H = h - (t - 32)$$

Where h=total heat at 255 p.s.i. absolute and 556° F.= 1,294.3 (from Keenan's tables)
t=feed-water temperature=214° F.

Then H=1,294.3—(214—32)=1,294.3—182=1,112.3 B.t.u.

$$\text{Efficiency} = \frac{H \times \text{evap.} \times 100}{\text{calorific fuel value}} = \frac{1{,}112.3 \times 9.06 \times 100}{14{,}000} = 72.0\%$$

With poorest of local coals the boiler consistently maintains efficiencies over 80 per cent. This naturally comes down somewhat with higher-grade coals. With all burners operating on Hasler coal and with more time available to vary operating procedure, efficiencies of over 77 per cent. could be expected.

For comparison, the following table has been submitted:—

BOILER No. 3.

Make: Combustion Engineering.
Type: VU, pulverized-coal fired.
Capacity: 80,000 lb. per hour at 250 p.s.i. grate area and 600° F.

Coal Name.	Type.	Calorific Value B.T.U. as received.	Hours run.	Steam evaporated (Lb.).	Coal burned (Tons).	Evaporation per Lb. of Coal.	Efficiency (Per Cent.).
Mannix	Lignite	7,100	24	1,446,000	148.0	5.25	82.4
North West	Sub-bituminous	8,900	24	1,335,000	105.0	6.36	79.5
Hasler	Bituminous	14,000 est.	7¾	447,304	24.6	9.06	72.0

The short test proves conclusively that Hasler Creek coal lends itself to pulverized-coal firing. That it is low in ash, and that it has no objectionable slagging qualities. It is quite friable and pulverizes easily. In spite of the fact that steam production went to as high as 60,000 lb. per hour with one mill and half the burners in operation, the mill motor amperage did not exceed 91 amps. as against 156 full-load amps.

Two copies of boiler log sheet and shift record are enclosed herewith. If you desire any further information please do not hesitate in writing us.

Very truly yours,

GRANBY CONSOLIDATED M.S. & P. CO., LTD.
A. R. EASTCOTT,
Power Plant Superintendent.

THE GRANBY CONSOLIDATED MINING, SMELTING AND POWER COMPANY, LIMITED.

SHIFT RECORD.

Power Plant.
Engineer: J. Huey.
Fireman: H. McGowan.

Date: June 7, 1949.
Shift: 8-16.

Steam Production: Hasler Creek Coal.

Boilers No.	Hours Steam.	Integrators. Start.	Integrators. Stop.	Production.	Press. Temp. Factor.	Steam 1,000 Lb.	Coal 1,000 Lb.	Lb. Steam Per Lb. Coal.	Remarks.
1									
2									
3	7¾	442,169	442,560	391	1,144	447,304	49,392	9.06	

Coal Consumption.

Feeder No.	Start.	Stop.	Revs.	Multiplier.	Coal 1,000 Lb.	Slack.	Pea.	Lump.	Other.
1									
2									
3									
4									
5	17,120	19,864	2,744	18	49,392				

Pounds steam per pound of coal: 9.06.

Boiler thermal efficiency $= \frac{1,112.3 \times 9.06 \times 100}{14,000} = 72.0\%$

Checked by: A. R. EASTCOTT.

POWER PLANT,
PRINCETON, B.C., June 11th, 1949.

Mr. R. E. Swanson, Chief Inspector,
Department of Railways,
602 Hastings Street West,
Vancouver, B.C.

DEAR SIR,—I have received the following proximate analysis on Hasler Creek coal from the Assay Office at Allenby:—

Moisture	7.38%
Ash	5.18%
B.t.u. (as received)	12,830
B.t.u. (dry)	13,850

If this assay is correct the efficiency would have to be amended as follows:—

$$\text{Efficiency} = \frac{1{,}112.3 \times 9.06 \times 100}{12{,}830} = 78.5\%$$

The Assay Office also reports the following screen test:—

Weight taken, 359.2 grams.

Mesh.	Weight (Grams).	Weight (%).	Cumulative Weight (%).
65	3.4	0.9	0.9
100	2.8	0.8	1.7
150	6.5	1.8	3.5
200	63.0	17.8	21.3
270	232.5	64.6	85.9
325	43.9	12.1	98.0
—325	7.1	2.0	100.0
Totals	359.2	100.0	

From the above, we find that the amount passing through a 200-mesh screen is:—

232.5
43.9
7.1

283.5 grams

$$\text{Then, per cent. through 200 mesh} = \frac{283.5 \times 100}{359.2} = 78.9\%$$

Combustion Engineering Corporation recommends not less than 60 per cent. through a 200-mesh screen for best results. If our figures are correct, it would indicate that your Hasler coal pulverizes readily as 78.9 per cent. passed the 200-mesh screen with mill classifiers set at maximum coarseness.

I would be very pleased to have your coal analysis and screen test figures as a check against our Assay Office.

Very truly yours,

A. R. EASTCOTT,
Power Plant Superintendent.

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