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MOVABLE-WALL COKE OVEN TESTS AND RELATED ANALYSES OF  
TWO SAMPLES FROM THE SUKUNKA MINE SUBMITTED BY  
BP EXPLORATION CANADA LIMITED

Project No. 03-5-1/6-17  
Job No. 3364R

J. G. Jorgensen, T. A. Lloyd and A. B. Fung  
Combustion and Carbonization Research Laboratory  
Western Research Laboratory

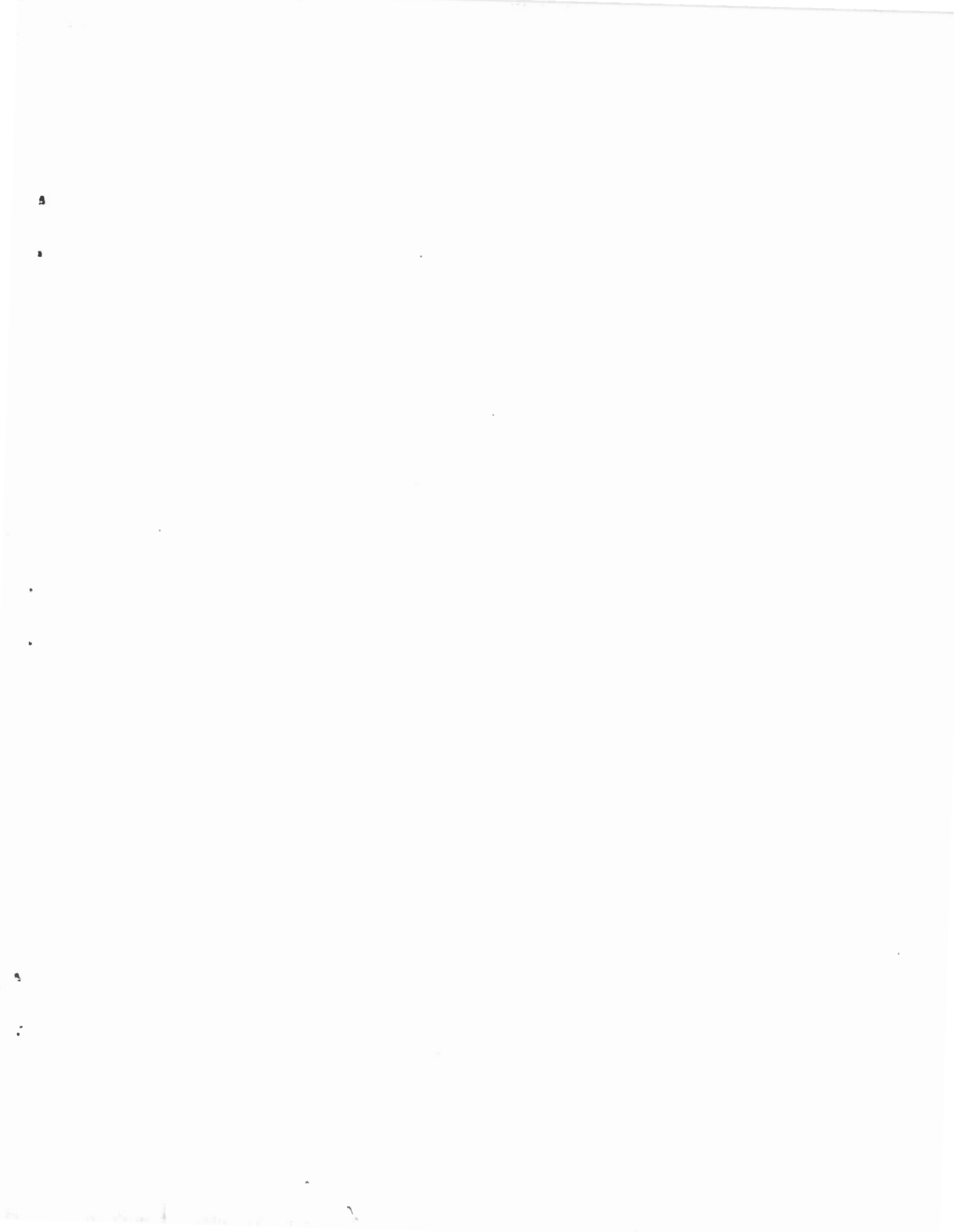
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Two Coal Samples from the Sukunka Mine Submitted by  
BP Exploration Canada Limited

Project No. 03-5-1/6-17  
Job No. 3364R

by

J. G. Jorgensen\*, T. A. Lloyd\*\* and A. B. Fung\*\*\*

INTRODUCTION

The evaluation of coals for BP Exploration Canada Limited is a continuing divisional project in which periodic investigations are undertaken as requested by the company.

This investigation includes evaluation data on coals specified in a letter dated 3 September 1981 from Mr. W. Irwin, Coal Preparation Engineer, BP Exploration Canada Limited. A copy of the letter appears in Appendix 1.

The coking quality of two coal samples from Sukunka were compared. One sample described as BP Regular coal from Sukunka No. 1 Mine was cleaned at Birtley Coal and Mineral Testing, Calgary and the other sample described as BP Coarse (Adit D-4) which was hand cleaned at the mine site. Before coking, preliminary samples of these coals were analyzed to assess chemical, thermal rheological and petrographical properties. These coals were then crushed, mixed and carbonized individually in the 18-inch width Carbolite movable-wall coke oven.

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In addition, 25% of each of these coals were blended with 75% Kanawha high volatile coal and carbonized in the Koppers oven located at the Western Research Laboratory at Edmonton. Representative samples of all coke oven tests were taken for chemical, thermal rheological and petrographical analyses which were carried out at the Energy Research Laboratories located at the CANMET Bells Corners Complex near Ottawa. The results of the testing program are tabulated in Tables 1 to 8.



Table 1 - Chemical Analyses of Component Coals

<u>Identification</u>		3373-81	3374-81	3375-81	3528-81	3529-81
Laboratory Number.....		BP	BP	Kanawha	BP	BP
Description.....		Regular Coal (Preliminary Sample)	Coarse Coal (Preliminary Sample)		Regular Coal Birtley Coal Cleaned	Coarse Coal
<u>Classification</u>						
Rank (ASTM).....						
International System.....						
Specific Volatile Index....						
Carbon (dmmfb).....%						
<u>Proximate Analysis (db)</u>						
Ash.....%		3.7	6.8	6.4	4.1	7.2
Volatile Matter.....%		22.9	21.7	34.0	23.3	21.6
Fixed Carbon.....%		73.4	71.5	59.6	72.6	71.2
<u>Gross Calorific Value (db)</u>						
Btu/per pound.....						
<u>Ultimate Analysis (db)</u>						
Carbon.....%						
Hydrogen.....%						
Sulphur.....%		0.45	0.50	0.76	0.43	0.46
Nitrogen.....%						
Ash.....%						
Oxygen (by difference)....%						
<u>Ash Analysis (db)</u>						
SiO <sub>2</sub> .....%						
Al <sub>2</sub> O <sub>3</sub> .....%						
Fe <sub>2</sub> O <sub>3</sub> .....%						
TiO <sub>2</sub> .....%						
P <sub>2</sub> O <sub>5</sub> .....%						
CaO.....%						
MgO.....%						
SO <sub>3</sub> .....%						
Na <sub>2</sub> O.....%						
K <sub>2</sub> O.....%						

Table 2 - Physical Tests and Fusibility of Ash of Component Coals

Identification

Laboratory Number.....	C-103	C-104	C-105	C-106
Description.....	BP	BP	BP 25%	BP 25%
	Regular Coal	Coarse Coal	Fine Coal	Coarse Coal
			Kanawha 75%	Kanawha 75%

Coal Pulverization

Sieve Analysis

<u>Passing</u>	<u>Retained On</u>				
	1/4 in. %	4.0	1.6	2.3	1.7
1/4 in.	1/8 in. %	13.2	14.5	9.5	9.8
1/8 in.	1/16 in. %	23.2	24.3	21.7	22.0
1/16 in.	1/32 in. %	20.3	22.7	21.9	22.5
1/32 in.	.....%	39.3	36.9	44.6	44.0
Total Passing	1/8 in. %	82.8	83.9	88.2	88.5

Grindability

Hardgrove Index .....

Fusibility of Ash

Initial Deformation Temp .....°F  
 Softening Temp. Spherical.....°F  
 Softening Temp. Hemispherical...°F  
 Fluid Temp .....°F

Table 3 - Thermal Rheological Properties of Component Coals

Identification

Laboratory Number.....	3373-81	3374-81	3375-81
Description	BP Regular Coal (Preliminary Sample)	BP Coarse Coal (Preliminary Sample)	BP Kanawha

Linear Expansion

Bd. 52 lb/ft<sup>3</sup> at 2% moisture

Gieseler Plasticity

Start.....°C	436	428	400
Fusion Temp .....°C	449	444	411
Max Fluid Temp .....°C	465	468	438
Final Fluid Temp .....°C	490	497	471
Solidification Temp .....°C	494	500	475
Melting Range .....°C	54	69	71
Max Fluidity.....dd/m	42	255	5500
Torque .....g/in.	40	40	40

Dilatation

Ti - Softening Temp .....°C	
Tii - Max Contraction Temp...°C	
Tiii - Max Dilatation Temp....°C	
Contraction.....%	
Dilatation .....%	

Free Swelling Index

F.S.I. ....

Table 4 - Thermal Rheological Properties of Component Coals

Identification

Laboratory Number.....	3528-81	3529-81	3530-81	3531-81
Description	BP Regular Coal	BP Coarse Coal Adit B-4	BP 25% Fine Coal Kanawha 75%	BP 25% Coarse Coal Kanawha 75%
	C-104	C-104	C-105	C-106

Linear Expansion

Bd. 52 lb/ft<sup>3</sup> at 2% moisture.....%

Gieseler Plasticity

Start.....°C	436	433	407	408
Fusion Temp .....°C	452	445	419	419
Max Fluid Temp .....°C	467	469	444	445
Final Fluid Temp .....°C	491	497	474	476
Solidification Temp .....°C	495	501	479	481
Melting Range .....°C	55	64	67	68
Max Fluidity.....dd/m	36	180	1085	1285
Torque .....g/in.	40	40	40	40

Dilatation

T<sub>i</sub> - Softening Temp .....°C  
 T<sub>ii</sub> - Max Contraction Temp...°C  
 T<sub>iii</sub> - Max Dilatation Temp....°C

Contraction.....%  
 Dilatation .....%

Free Swelling Index

F.S.I. ....

Table 5 - Petrographic Analysis of Component Coals

<u>Identification</u>	3373-81	3374-81	3375-81	3528-81	3529-81
Laboratory Number.....	BP	BP	Kanawha	BP	BP
Description .....	Regular	Coarse	HV	Regular	Coarse
	Coal	Coal	Coal	Coal	Coal
<u>Distribution of Vitrinite Types</u>		Hand Cleaned		Birtley	
V-6.....%	(Preliminary	(Preliminary	1.2	Cleaned	
V-7.....%	Sample)	Sample)	18.0		
V-8.....%			39.7		
V-9.....%			1.2		
V-10.....%					
V-11.....%					
V-12.....%	14.0	4.9		20.5	5.2
V-13.....%	43.7	42.0		34.2	41.4
V-14.....%	3.0	14.8		2.3	10.9
V-15.....%					
V-16.....%					
V-17.....%					
V-18.....%					
<u>Reactive Components</u>					
Total Vitrinite.....%	60.7	61.8	60.1	56.9	57.5
Reactive Semi-fusinite (1/3)....%	14.7*	12.0*	3.9	15.5*	12.9*
Exinite.....%	0.1	0.0	8.7	0.2	0.1
Total.....%	75.5	73.8	72.7	72.6	70.5
<u>Inert Components</u>					
Inert Semi-fusinite (2/3).....%	14.6**	12.0**	7.9	15.5**	13.0**
Micrinite.....%	3.7	2.8	10.9	4.4	5.3
Fusinite.....%	4.1	7.6	4.8	5.2	7.4
Mineral Matter.....%	2.1	3.8	3.7	2.3	3.8
Total.....%	24.5	26.2	27.3	27.4	29.5
<u>Petrographic Indices</u>					
Mean Reflectance.....%	1.33	1.36	0.91	1.32	1.35
Balance Index.....	1.67	1.99	1.00	1.85	2.31
Strength Index.....	5.69	6.05	3.43	5.50	5.93
Stability Index.....	60.9	59.8	44.4	58.2	57.2

\*Reactive Semi-fusinite (1/2)\*\* Inert Semi-fusinite (1/2)

Table 6 - Carbonization Conditions  
Project No. 03-5-1/6-17 (BP)

Test Identification Number.....	C-103	C-104	C-105	C-106
Date of Test.....	June 30/81	July 7/81	July 16/81	July 16/81
Coke Oven Identification .....				
Description.....	BP Sukunka #1 Birtley Clean Regular Coal	BP Coarse Adit D-4 Coarse Coal	BP (Birtley) Regular 25% Kanawha 75%	BP Coarse 25% Kanawha 75%

CHARGE PROPERTIES

Proximate Analysis (db) Ash.....%	4.1	7.2	5.8	6.6
Volatile Matter....%	23.3	21.6	32.8	32.5
Fixed Carbon.....%	72.6	71.2	61.4	60.9
Moisture in Charge.....%	2.5	2.2	1.9	1.6
Minus 1/8 in. (6 mesh).....%	82.8	83.9	88.2	88.5
Other.....				
.....				

CARBONIZATION CONDITIONS

Net Weight of Charge (wet).....lb	657.1	658.5	655.5	659.0
ASTM Cne Bulk Density (wet).....lb/ft <sup>3</sup>	49.5	49.5	49.3	49.1
Calc Charge Dry Bulk Density in Oven...lb/ft <sup>3</sup>	51.7	51.9	51.9	51.9
Flue Temp Control.....				
Charge Push (Centre Temp:Soak Time).....°C:hr	950:3	960:3	950:3	950:3
Quenched Coke Conditioning Drop.....ft	10	10	10	10

CARBONIZATION RESULTS

Gross Coking Time (at Push).....hr:min	18:04	18:42	17:55	18:05
Final Centre Temp.....°C	1055	1050	1052	1046
Time to 900°C Centre Temp.....hr:min	14:33	15:15	14:26	14:37
Time to 950°C Centre Temp.....hr:min	15:04	15:42	14:55	15:05
Time to 1000°C Centre Temp.....hr:min	15:57	16:48	16:00	15:55
Maximum Wall Pressure.....lb/in <sup>2</sup>	1:32	2.49	0.24	0.26
Coke Yield Actual.....%	75.0	76.3	71.9	70.0

Table 7 - Coke Properties

Test Identification Number.....	C-103	C-104	C-105	C-106
<u>SCREEN ANALYSIS OF COKE</u>				
(cum % retained on)				
4 inch sieve.....	1.1	3.2	2.8	1.8
3 inch sieve.....	9.6	14.7	26.0	19.2
2 inch sieve.....	57.5	64.8	75.8	67.5
1 inch sieve.....	84.2	85.9	86.9	85.5
1 inch sieve.....	95.2	94.7	94.7	94.7
3/4 inch sieve.....	96.2	96.4	96.2	96.4
1/2 inch sieve.....	97.0	97.3	97.2	97.3
Percentage -1/2 inch (breeze).....	3.0	2.7	2.8	2.7
Mean Coke Size.....in.	2.17	2.31	2.50	2.35
<u>COKE CHEMICAL ANALYSIS</u>				
<u>Proximate Analysis (db)</u>				
Ash.....%	4.9	8.6	7.9	9.3
Volatile Matter.....%	1.1	1.7	0.9	1.2
Fixed Carbon.....%	94.0	89.7	91.2	89.5
Sulphur (db).....%	0.44	0.41	0.51	0.54
<u>COKE APPARENT SPECIFIC GRAVITY.....</u>				
<u>ASTM COKE TUMBLER TEST</u>				
Stability Factor (cum % + 1 in.)....	58.6	56.7	50.7	49.9
Hardness Factor (cum % + 1/4 in.)...	70.7	69.5	67.6	65.2
<u>JIS COKE TUMBLER TEST</u>				
(cum % retained on)				
30 revs: 50 mm sieve.....	19.2	29.4	12.1	16.8
25 mm sieve.....	89.5	88.0	84.4	84.5
15 mm sieve.....	94.1	92.8	91.9	91.9
150 revs: 50 mm sieve.....	8.4	5.1	0.9	3.7
25 mm sieve.....	77.4	70.9	66.5	65.8
15 mm sieve.....	84.6	81.0	80.4	79.7
<u>OTHER</u>				

Table 8 - Analyses of Coke Oven Charges and Resultant Cokes

Identification

Test Number.....	C103	C-104	C-105	C-106
Date Charged.....	1981-06-30	1981-07-07	1981-07-16	1981-08-21
Description.....	BP Regular Coal	BP Coarse Coal	BP 25% Regular Coal Kanawha 75%	BP 25% Coarse Coal Kanawha 75%

Coke Oven Charge

Laboratory Number.....	3528-81	3529-81	3530-81	3531-81
------------------------	---------	---------	---------	---------

Proximate Analysis (db)

Ash.....%	4.1	7.2	5.8	6.6
Volatile Matter....%	23.3	21.6	32.8	32.5
Fixed Carbon.....%	72.6	71.2	61.4	60.9
Sulphur (db) .....%	0.44	0.46	0.68	0.66

Resultant Coke

Laboratory Number.....	3803-81	3804-81	3805-81	3806-81
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Proximate Analysis (db)

Ash.....%	4.9	8.6	7.9	9.3
Volatile Matter....%	1.1	1.7	0.9	1.2
Fixed Carbon.....%	94.0	89.7	91.2	89.5
Sulphur (db).....%	0.44	0.41	0.51	0.54



APPENDIX 1

Letter dated September 3, 1981 from  
W. Irwin, Coal Preparation Engineer  
BP Exploration Canada Limited

BP Exploration Canada Limited

333 Fifth Avenue S.W., Calgary, Alberta T2P 3B6 • Telephone (403) 237-1234

September 3, 1981

Mr. J.G. Jorgensen,  
Head, Petrography Section,  
Can-Met Laboratories,  
Dept. of Energy, Mines & Resources,  
555 Booth Street,  
Ottawa, Ontario

Dear John,

Re: Test on Sukunka Coal

Further to our telephone conversation of yesterday in connection with the test work you have carried out for us recently, we confirm the following.

Due to the recent postal strike we were unable to forward the usual documentation authorizing you to proceed with the test work agreed with you during that period. Will you please take this letter as your authorization for covering the testing of our coal, namely, carbonization test of Sukunka hand cleaned coarse coal and associated test as a component of a blend with Algoma H.V. Coal. In addition, we also requested you to include proximate analysis, fluidity, dilation, etc.

In recording our appreciation for the assistance you have given us, may we thank you for your understanding in this particularly unusual set of circumstances.

Yours sincerely,

  
W. Irwin,  
Coal Preparation Engineer

WI/af

c.c. R. Leeder  
R.T. Marshall  
W.S. Wilson

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