



Energy, Mines and  
Resources Canada

Énergie, Mines et  
Ressources Canada

## CANMET

Canada Centre  
for Mineral  
and Energy  
Technology

Centre canadien  
de la technologie  
des minéraux  
et de l'énergie


MOVABLE-WALL COKE OVEN TESTS AND RELATED ANALYSES OF  
COMPONENT COALS AND BLEND B FROM THE LINE CREEK EXTENSION  
PROJECT SUBMITTED BY CROWS NEST RESOURCES LIMITED

Project No. 03-3-1/11-11  
Job No. 3394-R

J.G. JORGENSEN AND T.A. LLOYD  
COMBUSTION AND CARBONIZATION  
RESEARCH LABORATORY

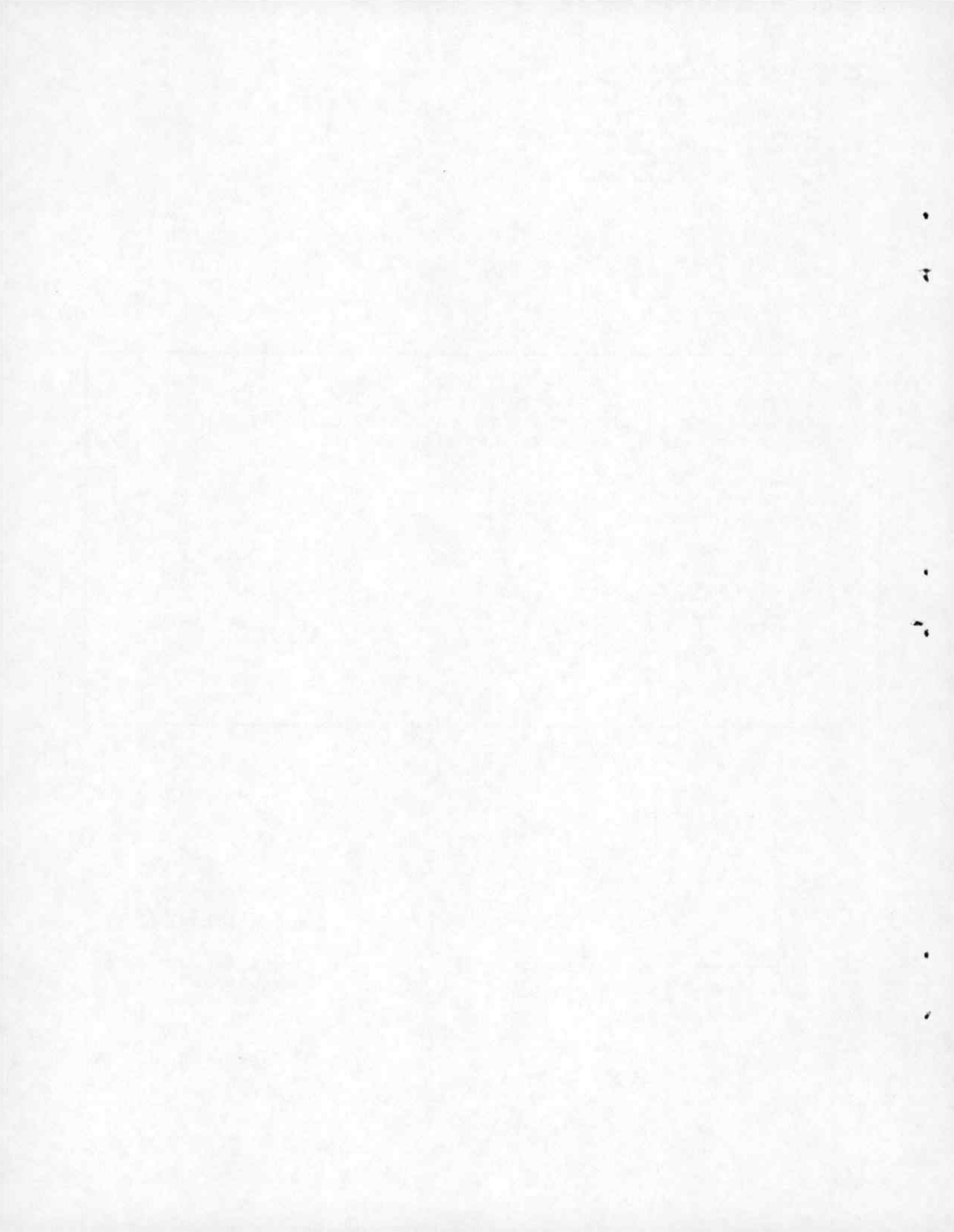
JULY 1982

ENERGY RESEARCH PROGRAM  
ENERGY RESEARCH LABORATORIES  
DIVISIONAL REPORT ERP/ERL 82-38 (CF)

  
Declassification Date:  
August 1984

This document was produced  
by scanning the original publication.

Ce document est le produit d'une  
numérisation par balayage  
de la publication originale.



Movable-Wall Coke Oven Tests and Related Analyses of  
Component Coals and Blend B From the Line Creek Extension  
Project Submitted by Crows Nest Resources Limited

Project No. 03-3-1/11-11  
Job No. 3394-R

by

J.G. Jorgensen\* and T.A. Lloyd\*\*

INTRODUCTION

The evaluation of coals for Crows Nest Resources Limited is a continuing divisional project in which periodic investigations are undertaken as requested by the company.

This report is Investigation No. 11 in the series and includes evaluation data on coals specified in a letter dated April 2, 1982 from H.S. Stellmach, Manager, Utilization Technology, Crows Nest Resources Limited. A copy of this letter appears in Appendix 1. Included in the report are the following coal samples:

ERL Lab No.	COKE OVEN Test No.	SEAM No.	ADIT No.	BC LAB No.
2707-82	910	6	25	1692
2708-82	898	7	27	1833
2709-82	900	8	28	1956
2710-82	901	10B	29	1977
2757-82	902	3U	30	1988
2758-82	905	3L	22	2308
3082-82	909	Blend"B"		B-2401

Composition of Blend B	
Seam No.	%
3U	5
3L	5
4U	12
6	10
7	18
8	20
106	30

Additional blends will be carbonized and reported at a later date as part of this investigation. The results of testing the coal samples from Seam 4U appears in another report dealing with Project 03-3-1/11-10.

The coal samples were cleaned at Birtley Engineering, Calgary and sent to the Energy Research Laboratories, CANMET Bells Corners Complex near Ottawa. The samples were crushed, blended and carbonized in the CANMET 12-inch width movable-wall coke oven. Representative samples were taken for chemical, physical, thermal rheological and petrographical analyses. The results are tabulated in Tables 1 to 7.

---

\*Head, Petrographic Section, \*\*Head, Conventional Carbonization Section, Combustion and Carbonization Research Laboratory, Energy Research Laboratories, CANMET, Energy, Mines and Resources, Ottawa, Canada. KIA OG1

TABLE 1 Chemical Analyses of Component Coals

<u>Identification</u>							
Laboratory Number .....	2707-82	2708-82	2709-82	2710-82	2757-82	2758-82	3082-82
Description .....	Seam 6 Adit 25	Seam 7 Adit 27	Seam 8 Adit 28	Seam 10B Adit 29	Seam 3U Adit 30	Seam 3C Adit 22	Blend B
<u>Classification</u>							
Rank (ASTM) .....	mvb	mvb	mvb	mvb	mvb	mvb	mvb
International System .....	433	434	421	433	534	533	432
Specific Volatile Index .....	189	190	191	191	182	173	186
Carbon (dmmfb) .....	90.1	89.3	90.1	90.4	87.8	86.7	91.4
<u>Proximate Analysis (db)</u>							
Ash .....	9.1	9.8	9.1	9.9	9.1	8.7	9.4
Volatile Matter .....	23.2	24.1	22.0	21.7	25.7	27.3	21.6
Fixed Carbon .....	67.7	66.1	68.9	68.4	65.2	64.0	69.0
<u>Gross Calorific Value (db)</u>							
Btu per pound .....	14020	13955	14010	13870	13960	13850	13840
<u>Ultimate Analysis (db)</u>							
Carbon .....	81.1	79.6	81.0	80.6	79.0	78.4	81.8
Hydrogen .....	4.3	4.4	4.1	4.2	4.5	4.4	4.8
Sulphur .....	0.50	0.49	0.33	0.51	0.84	0.44	0.43
Nitrogen .....	1.1	1.1	1.0	1.0	1.0	1.1	1.1
Ash .....	9.1	9.8	9.1	9.9	9.1	8.7	9.4
Oxygen (by difference) .....	3.9	4.6	4.5	3.8	5.6	7.0	2.5
<u>Ash Analysis (db)</u>							
SiO <sub>2</sub> .....	57.3	56.9	55.8	64.4	52.9	57.8	58.9
Al <sub>2</sub> O <sub>3</sub> .....	29.4	25.5	29.9	29.8	29.1	27.4	28.2
Fe <sub>2</sub> O <sub>3</sub> .....	4.3	5.4	8.0	1.9	4.8	5.4	4.7
TiO <sub>2</sub> .....	1.9	1.8	1.8	1.7	1.8	1.3	1.6
P <sub>2</sub> O <sub>5</sub> .....	2.0	3.3	0.6	0.8	3.8	1.9	1.8
CaO .....	2.3	3.8	1.1	1.1	4.2	2.6	2.4
MgO .....	0.0	0.5	0.0	0.0	0.0	0.6	0.5
SO <sub>3</sub> .....	0.4	0.5	0.3	0.2	0.5	0.8	0.5
Na <sub>2</sub> O .....	0.1	0.1	0.1	0.1	0.1	0.1	0.1
K <sub>2</sub> O .....	0.7	0.7	0.3	0.5	1.0	1.1	0.6

TABLE 2 Physical Tests and Fusibility of Ash of Component Coals

<u>Identification</u>										
Laboratory Number .....	2707-82	2708-82	2709-82	2710-82	2757-82	2758-82	3082-82			
Description .....										
	Seam 6	Seam 7	Seam 8	Seam 10B	Seam 3U	Seam 3L	Blend			
	Adit 25	Adit 27	Adit 28	Adit 29	Adit 30	Adit 22	B			
<u>Coal Pulverization</u>										
Sieve Analysis										
Passing	Retained On									
	1/4 in.	%	0.1	0.1	0.4	0.2	0.1	0.2	0.2	
1/4 in.	1/8 in.	%	10.8	9.8	13.1	11.8	13.8	12.6	12.3	
1/8 in.	1/16 in.	%	16.5	16.3	18.2	17.7	19.9	19.1	18.1	
1/16 in.	1/32 in.	%	18.9	20.3	20.0	19.8	21.4	22.3	19.8	
1/32 in.	.....	%	53.7	53.5	48.3	50.5	44.8	45.8	49.6	
Total Passing	1/8 in.	%	89.1	90.1	86.5	88.0	86.1	87.2	87.5	
<u>Grindability</u>										
Hardgrove Index .....	93	83	81	75	74	77	82			
<u>Fusibility of Ash</u>										
Initial Deformation Temp. ...	°F 2590	2355	2665	2700+	2375	2515	2335			
Softening Temp. Spherical ...	°F 2700+	2625	2700+	2700+	2700+	2700+	2700+			
Softening Temp. Hemispherical	°F 2700+	2700+	2700+	2700+	2700+	2700+	2700+			
Fluid Temp. ....	°F 2700+	2700+	2700+	2700+	2700+	2700+	2700+			

TABLE 3 Thermal Rheological Properties of Component Coals

<u>Identification</u>							
Laboratory Number .....	2707-82	2708-82	2709-82	2710-82	2757-82	2758-82	3082-82
Description .....	Seam 6 Adit 25	Seam 7 Adit 27	Seam 8 Adit 28	Seam 10B Adit 29	Seam 3U Adit 30	Seam 3L Adit 22 (Resample)	Blend B
<u>Linear Expansion</u>							
Bd. 52 lb/ft <sup>3</sup> at 2% moisture...%							
<u>Gieseler Plasticity</u>							
Start .....	°C 438	424	446	432	424	428	433
Fusion Temp. ....	°C 454	440	-	444	434	441	477
Max. Fluid Temp. ....	°C 468	462	467	466	459	464	464
Final Fluid Temp. ....	°C 483	489	480	492	487	476	489
Solidification Temp. ....	°C 489	491	489	496	490	487	491
Melting Range .....	°C 45	66	34	60	63	48	56
Max. Fluidity .....	dd/m 10.1	245	3.0	165	225	50	51
Torque .....	g.in. 40	40	40	40	40	40	40
<u>Dilatation</u>							
Ti - Softening Temp. ....	°C 408	392	413	398	393	395	404
Tii - Max. Contraction Temp. ....	°C 464	447	486	450	441	450	455
Tiii - Max. Dilatation Temp. ....	°C 482	476	-	480	473	476	480
Contraction .....	% 29	29	24	30	30	28	28
Dilatation .....	% 18	56	Nil	27	67	7	-3
<u>Free Swelling Index</u>							
F.S.I. ....	7½	8	3	7	8½	7½	7½

TABLE 4 Petrographic Analysis of Component Coals

<u>Identification</u>							
Laboratory Number.....	2707-82	2708-82	2709-82	2710-82	2757-82	2758-82	3082-82
Description.....	Seam 6	Seam 7	Seam 8	Seam 10B	Seam 3U	Seam 3L	Blend
	Adit 25	Adit 27	Adit 28	Adit 29	Adit 30	Adit 22	B
<u>Distribution of Vitrinite Types</u>							
V-6.....%							
V-7.....%							
V-8.....%							
V-9.....%					9.9	12.6	1.1
V-10.....%	0.6	3.7	0.4		42.9	42.4	11.7
V-11.....%	12.1	42.3	11.4	2.40	12.5	17.1	19.6
V-12.....%	38.5	16.2	19.1	31.6	0.7	2.2	16.9
V-13.....%	3.9		3.8	13.9			3.7
V-14.....%							
V-15.....%							
V-16.....%							
V-17.....%							
V-18.....%							
<u>Reactive Components</u>							
Total Vitrinite.....%	55.1*	62.2	34.7	47.9	66.0	74.3	53.0
Reactive Semi-fusinite (1/3).....%	15.1*	12.3*	24.8*	18.9*	11.0*	4.3	16.4*
Exinite.....%	0.1	0.2	0.0	0.0	0.9	0.7	0.0
Total.....%	70.3	74.7	59.5	66.8	77.9	79.3	69.4
<u>Inert Components</u>							
Inert Semi-fusinite (2/3).....%	15.1**	12.3**	24.9**	18.9**	11.0**	8.6	16.4**
Micrinite.....%	2.4	2.2	2.4	2.4	1.7	1.5	2.8
Fusinite.....%	7.1	5.3	8.1	6.5	4.2	5.7	6.2
Mineral Matter.....%	5.1	5.5	5.1	5.4	5.2	4.9	5.2
Total.....%	29.7	25.3	40.5	33.2	22.1	20.7	30.6
<u>Petrographic Indices</u>							
Mean Reflectance.....%	1.23	1.17	1.22	1.26	1.05	1.05	1.16
Balance Index.....	1.65	1.14	2.60	2.16	.77	0.72	1.49
Strength Index.....	4.72	4.55	4.48	4.96	3.92	3.94	4.47
Stability Index.....	54.95	60.58	42.22	51.50	53.3	53.15	54.5

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



TABLE 5 - Carbonization Data

Test Identification Number.....	910	898	900	901
Data of Test.....	1982-05-11	1982-03-25	1982-03-31	1982-04-01
Laboratory Number.....				
Description.....	1692 Seam 6	1883 Seam 7	1956 Seam 8	1977 Seam 10B

CARBONIZATION DATA

Net Weight of Charge (wet).....lb	586.5	593.9	599.5	584.0
Moisture in Charge.....%	3.1	2.8	2.8	2.8
ASTM Bulk Density (wet).....lb/ft <sup>3</sup>	-	48.8	48.8	-
Oven Bulk Density (db).....lb/ft <sup>3</sup>	50.3	51.1	51.6	50.2

CARBONIZATION RESULTS

Gross Coking Time.....hr:min	9:25	10:30	10:20	10:30
Maximum Wall Pressure.....lb/in <sup>2</sup>	0.45	0.72	0.32	0.42
Coke Yield Actual.....%	77.8	78.1	78.3	78.0
Mean Coke size.....in	2.09	2.13	2.01	1.97
Apparent Specific Gravity.....	0.930	0.951	1.03	0.967

Screen Analysis of Coke

(cumulative percentage retained on)

3 inch sieve.....	9.5	7.8	8.8	4.2
2 inch sieve.....	50.8	54.9	45.6	44.9
1 1/2 inch sieve.....	80.0	83.4	73.6	75.2
1 inch sieve.....	94.5	95.3	93.8	94.7
3/4 inch sieve.....	95.8	96.4	95.5	96.4
1/2 inch sieve.....	96.5	97.1	96.2	97.1
Percentage -1/2 inch (breeze).....	3.5	2.9	3.8	2.9

Tumbler Test (ASTM)

Stability Factor.....	57.6	61.1	50.7	58.5
Hardness Factor.....	66.7	67.5	67.6	70.5

Japanese Drum Test (JIS)

(cumulative percentage retained on)

	*	**	*	**	*	**	*	**
50 mm sieve.....	23.3	4.7	21.0	3.4	14.2	2.0	24.1	10.5
25 mm sieve.....	89.2	73.7	90.3	75.9	85.8	68.2	88.5	73.5
15 mm sieve.....	93.0	80.8	93.9	83.4	92.4	79.5	94.2	83.5

\*30 revs \*\*150 revs

TABLE 6 - Carbonization Data

Test Identification Number.....	902	905	909
Data of Test.....	1982-04-06	1982-04-14	1982-05-06
Laboratory Number.....			
Description.....	1988	2308	2401
	Seam 3	Seam 3	Blend B
	Upper	Lower	

CARBONIZATION DATA

Net Weight of Charge (wet).....lb	570.5	581.9	574.2
Moisture in Charge.....%	3.1	3.1	3.1
ASTM Bulk Density (wet).....lb/ft <sup>3</sup>	48.4	50.3	
Oven Bulk Density (db).....lb/ft <sup>3</sup>	48.9	49.9	49.9

CARBONIZATION RESULTS

Gross Coking Time.....hr:min	10:15	10:05	9:10
Maximum Wall Pressure.....lb/in <sup>2</sup>	0.63	0.34	0.33
Coke Yield Actual.....%	75.8	74.1	78.2
Mean Coke size.....in	2.06	2.08	2.02
Apparent Specific Gravity.....	0.897	0.894	0.955

Screen Analysis of Coke

(cumulative percentage retained on)

3 inch sieve.....	5.4	9.3	7.3
2 inch sieve.....	50.6	51.2	47.3
1 1/2 inch sieve.....	81.7	78.3	75.5
1 inch sieve.....	95.0	93.8	94.2
3/4 inch sieve.....	96.3	95.2	95.8
1/2 inch sieve.....	97.1	96.2	96.8
Percentage -1/2 inch (breeze).....	2.9	3.8	3.2

Tumbler Test (ASTM)

Stability Factor.....	54.2	48.7	55.6
Hardness Factor.....	63.8	62.1	67.6

Japanese Drum Test (JIS)

(cumulative percentage retained on)

	*	**	*	**	*	**
50 mm sieve.....	25.0	5.4	20.6	3.4	22.5	5.0
25 mm sieve.....	88.3	72.7	86.5	66.6	88.1	72.7
15 mm sieve.....	93.5	81.8	92.8	80.1	94.0	82.7

\*30 revs \*\*150 revs

TABLE 7

Analyses of Coke Oven Charges and Resultant Cokes

<u>Identification</u>							
Test Number.....	910	898	900	901	902	905	909
Date Charged.....	82-05-11	82-03-25	82-03-31	82-04-01	82-04-06	82-04-14	82-04-14
Description.....	Seam 6 Adit 25	Seam 7 Adit 27	Seam 8 Adit 28	Seam10B Adit 29	Seam 3U Adit 30	Seam 3L Adit 22 (Resample)	Blend B
<u>Coke Oven Charge</u>							
Laboratory Number.....	2707-82	2708-82	2709-82	2710-82	2757-82	2758-82	3082-82
<u>Proximate Analysis (db)</u>							
Ash.....%	9.1	9.8	9.1	9.9	9.1	8.7	9.4
Volatile Matter.....%	23.2	24.1	22.0	21.7	25.7	27.3	21.6
Fixed Carbon .....	67.7	66.1	68.9	68.4	65.2	64.0	69.0
Sulphur (db).....%	0.50	0.49	0.33	0.51	0.84	0.44	0.43
<u>Resultant Coke</u>							
Laboratory Number.....	2856-82	2855-82	2857-82	2858-82	2859-82	2862-82	3240-82
<u>Proximate Analysis (db)</u>							
Ash.....%	12.3	11.2	10.8	12.1	11.8	11.7	11.8
Volatile Matter.....%	1.2	1.2	1.2	1.0	2.0	1.3	1.2
Fixed Carbon.....%	86.5	87.6	88.0	86.9	86.2	87.0	87.0
Sulphur (db).....%	0.35	0.35	0.27	0.39	0.67	0.40	0.38

NOTE - Replot Blend B

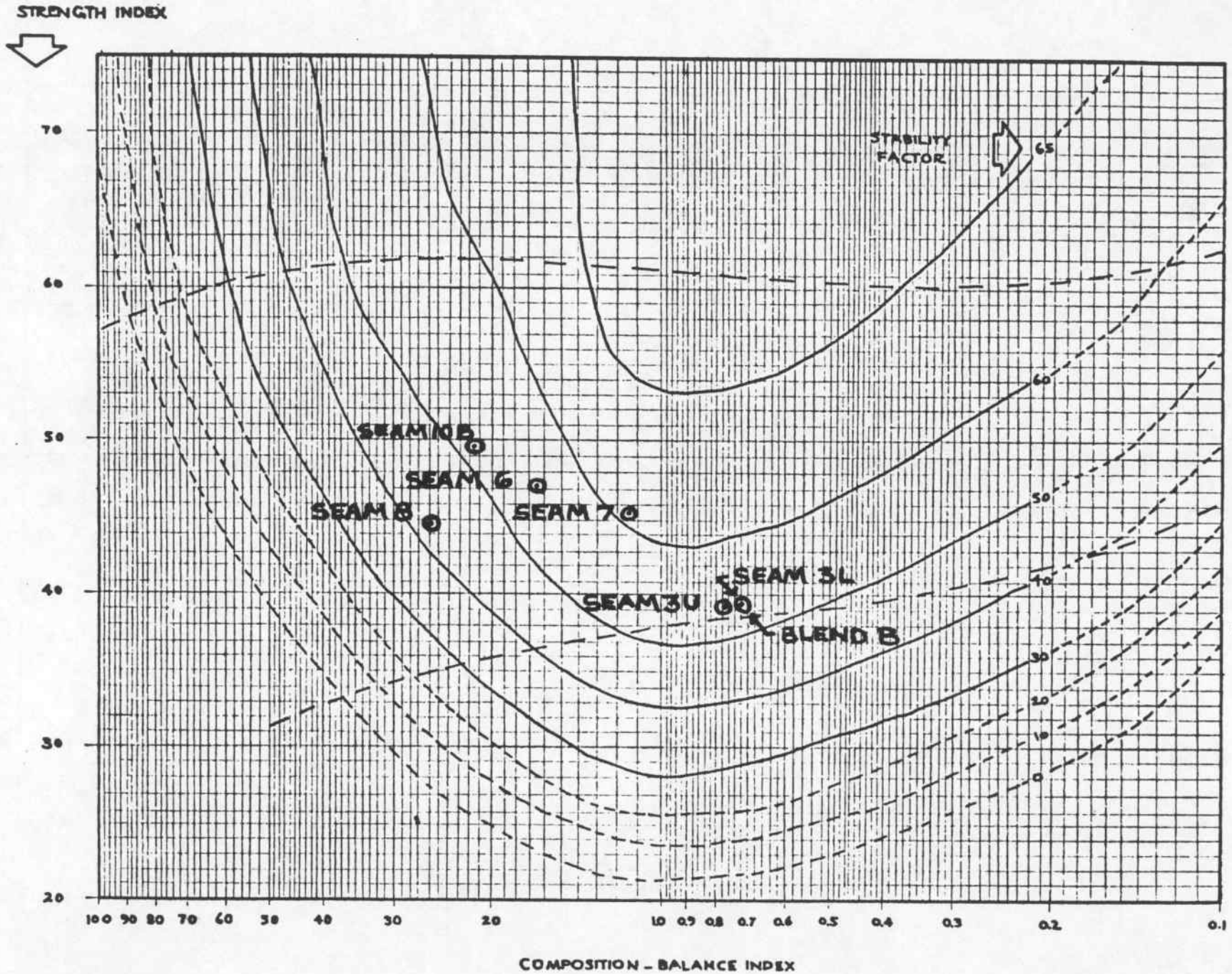
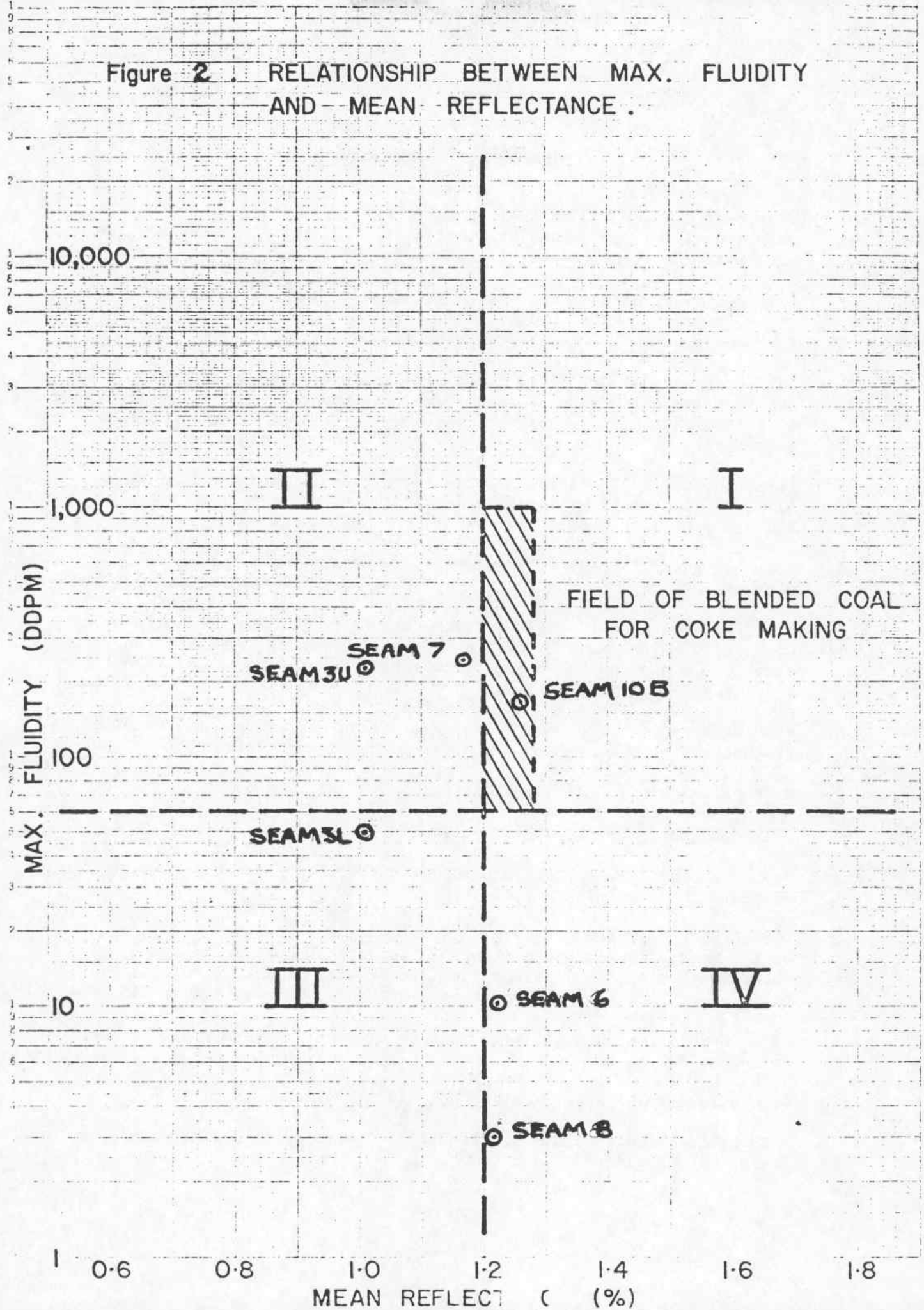


Figure 1 - Plot of predicted stability factors of component coals and Blend B from petrographic data.

Figure 2. RELATIONSHIP BETWEEN MAX. FLUIDITY AND MEAN REFLECTANCE.



BIBLIOGRAPHY

1. Eddinger, R. Tracy and Mitchell, John, "Pilot-Scale Ovens - Development and Operation; Proc. of Blast Furnace, Coke Oven and Raw Materials Committee", AIME, 15, 148-163 (1956).
2. ASTM Designation: D388-66, "Classification of Coals by Rank".
3. ASTM Designation: D720-67, "Test for Free Swelling Index of Coal".
4. ASTM Designation: D2639-71, "Test of Plastic Properties of Coal by the Constant-Torque Gieseler Plastometer." (Constant torque plastometer used with a solidification, no movement; range-temp., between start and final temperatures).
5. Burrough, E.J., "Specific Volatile Index", Fuels Division Memorandum 97/58-CG, Fuels and Mining Practice Division, Mines Branch, Dept. of M. and T.S., Ottawa, Canada (1958).
6. ASTM Designation: D409-71, "Grindability of Coal by the Hardgrove-Machine Method".
7. ASTM "Proposed Method of Test for Measuring the Coking Pressures of Coals by a Movable-Wall Slot Oven" (presently under consideration for adoption as a standard method of test by Sub-Committee XV of ASTM Committee D-5).
8. ASTM Designation: D291-60, "Cubic Foot Weight of Crushed Bituminous Coal" Procedure A - Procedure for Uncompacted Cubic Foot Weight).
9. ASTM Designation: D293-69, "Test for Sieve Analysis of Coke".
10. ASTM Designation: D294-64, "Tumbler Test for Coke".
11. Japanese Drum Test for Coke, Designated as J.I.S. (Japanese Industrial Standard) K 2151-1972, pp. 12-16).
12. Burrough, E.J., Strong, R.A. and Swartzman, E., "Report of Investigation on the Method Now in Use at the Fuel Research Laboratories for Determination of the Apparent Specific Gravity of Coke", R.I. C.S. 35, Division of Fuel Testing, Department of Mines, Ottawa, August 24, 1934.
13. ASTM Designation: D2014-71, "Expansion or Contraction of Coal by the Sole-Heated Oven".
14. German Industrial Specification No. DIN 51739/March 1951.
15. ASTM Designation: D-2797-72, "Preparing Coal Samples for Microscopical Analysis by Reflected Light".

16. ASTM Designation: D-2798-72, "Microscopical Determination of the Reflectance of the Organic Components in a Polished Specimen of Coal".
17. ASTM Designation: D-2799-72, "Microscopical Determination of Volume Percent of Physical Components of Coal".
18. Shapiro, N., Gray, R.J., "Petrographic Classification Applicable to Coals of all Ranks", Proc. 111, Min. Inst., 1960, 68, 83-97.
19. H. Hoffmann, and K. Koehne, Brennstoff Chemie, 35, (1954), pp 202, 236, 269 and 298.

APPENDIX 1

Letter dated April 2, 1981 from H.S. Stellmach, Manager,  
Utilization Technology, Crows Nest Resources Limited.





# Crows Nest Resources

Eau Claire Place, 525 - 3rd Avenue S.W., Calgary, Alberta (403) 232-4355 **LIMITED**  
P.O. Box 2699, Station M, Calgary, Alberta T2P 2M7 Telex 03-822505

April 2, 1982

Mr. J. Jorgensen  
Energy Research Laboratories  
CANMET  
555 Booth Street  
Ottawa, Ontario  
K1A 0G1

Dear John,

Further to our purchase order CN20740 requesting carbonization trials for our Line Creek Extension project, this memo will clarify some of the items discussed earlier.

By this time you should have received the following samples:

<u>Seam</u>	<u>Adit No.</u>	<u>Lab. No.</u>
3 Upper	30	1988
3 Lower	22	1313
4 Upper	21	197
6	25	1692
7	27	1883
8	28	1956
10b	29	1977

We now do not expect to be sending samples for Seams No. 2, 4 Lower or No. 5 as indicated on the purchase order. The sample for Seam 10a will be delayed until June/July.

During the next week we will also be shipping the following blends to you for carbonization:

Blend	A	B	C	D	E	F
Lab. No.	A-2400	B-2401	C-2402	D-2403	E-2404	F-2405
Seam No.	%	%	%	%	%	%
3U	10	5			50	50
3L	10	5				
4U	24	12				
6	20	10				
7	36	18				
8	-	20	30	50	50	
10b	-	30	70	50		50

... 2

Mr. J. Jorgensen  
April 2/82

2

In addition to the standard chemical, physical, petrographic, rheological and coking analyses, I would also like to obtain the following for Blends A, B and C.

1. Reactivity and Post Reaction strength.
2. Linear expansion.
3. Semi-fusinite breakdown for macerals with reflectance below 2%.

In anticipation of CNRL scheduling more carbonization test work at the Western Research Lab, we are shipping duplicate samples of Blends A, B and C to the WRL. From our discussions, I understand that the cost of two of these duplicate tests will be borne by the Energy Research Laboratories.

The results of the above test program are urgently required for the development of our Line Creek Extension project and I would appreciate receiving preliminary information as soon as it is available.

I will be out of the office until April 19, 1982 and will contact you upon my return to discuss any problems that may have arisen. For your information, we expect to set up an additional program of 4 or 5 carbonization trials during June/July, 1982.

Yours very truly,

*H. S. Stellmach*  
H. S. Stellmach  
Manager, Utilization  
Technology

1

2

3

4

5

6

7

