Canadian Carbonization Research Association

2015-2016 Annual Report

September 2, 1965 – September 2, 2015

50 YEARS OF RESEARCH SUPPORTING THE CANADIAN COAL AND CARBONIZATION INDUSTRIES

Table of Contents

Chairman's Remarks

Since its inception in 1965, the Canadian Carbonization Research Association (CCRA) has provided an excellent framework for technological cooperation between government and industry, which has been very successful for both parties. The CCRA is a unique organization in being Canada's only technical support for the Canadian metallurgical coal and coking industries. This organization continues to be of real value to its member companies and to the financial health of the associated industries. The value of its research is becoming more recognized on a global basis.

"The CCRA is a unique organization in being Canada's only technical support for the Canadian metallurgical coal and coking industries."

The role played by the CCRA in the past and to be continued in the future is to strive to meet its members' needs. The CCRA technical program continues to evolve as the demands of the coal, cokemaking and ironmaking industry change with the issues facing Canada. With new members, arise more ideas leading to potential solutions for some of the technical issues facing the coal and steel industries. It is important to continue sharing our research findings with fellow researchers and industry. The CCRA has again published its work in several international journals and presented papers at both domestic and international conferences. These papers can be found on the CCRA website, www.cancarb.ca.

With the pilot Energy Recovery Coke Oven construction near completion and the new pulverized coal/fuel test rig up and running, the R&D capability of CCRA and CanmetENERGY has increased tremendously. There is a new wave of research the CCRA is undertaking with the development of bio-based carbon to mitigate GHG emissions in our industries. We look forward to these new technical challenges.

With the downturn in the coal industry due to low oil prices, the CCRA membership decreased this year. However, three key members representing coal (Teck), cokemaking (SunCoke Energy) and ironmaking (ArcelorMittal Dofasco) industries remain in the Association and the CCRA will stay in touch with its past members. There is a strong possibility that these members will rejoin the Research Association when better economic times return.

Globally, the Canadian Carbonization Research Association is self-standing in its ability to continue to grow and meet its members' requirements. This remarkable co-operative relationship between the coal industry, steel industry and government is truly unique and its R&D program will continue to address its members needs today and in the future.

Ted Todoschuk,
Chairman, Board of Directors

Technical Committee Report

Technical Committee Meetings

The CCRA Technical Committee held four meetings during Fiscal Year 2015-16:

Meeting No.	Location	Date
231	Ottawa, ON	June 8-9, 2015
232	Vancouver, BC	September 15-16, 2015
233	Ottawa, ON	December 1-2, 2015
234	Vancouver, BC	March 9-10, 2016

The 2015-16 Research Program consisted of four main research areas:

1. Energy and CO_2 Reduction in the Coal and Steel Industry
2. Energy and Environment
3. Fundamental Aspects of Coal and Coke Utilization
4. Database, Standards and Procedures

In total, 15 projects were part of the Research Program although several projects were not progressed.

Major accomplishments/highlights:

1. During FY 2015-16, the CCRA presented three papers at AISTech 2015 Conference, Cleveland, May 2015, four papers at Metec InSteelCon 2015 Conference, Germany, June 2015 and one paper at ICCS&T, Australia, September 2015. Also, papers on TGA technique for diagnosing PCI efficiency and effect of organic liquids on coking properties of high-inert WC coal were respectively published in Ironmaking & Steelmaking journal and submitted for publication in Fuel Processing Technology journal.

2. On **coke fissuration** (CCRA 84), a summary report on efforts made between 2012 and 2015 on commissioning the Automazione high-temperature dilatometer was prepared. Its main conclusion was to discontinue work on the HTD as its design is not capable of measuring the volumetric contraction of semi-coke. Going forward, the plan is to conduct tests in the larger-scale sole-heated oven and pilot oven with the aim to elucidate fissuration behavior/patterns in coals of different VM content and geologic origin.

3. On **Blast Furnace energy reduction initiatives** (CCRA 91), burnout results on different rank coals and blends at varying O/C ratios in the reactor, were reported. Results of a benchmarking study of the PCI rig were presented and how a CFD model can provide useful predictive information on coal burnout under BF conditions before experiments are carried out. Also, the capability and limitations of the feeder were described and installation of NG capability for the rig was completed.

4. On the use of **Renewable energy for the steel industry** (CCRA 70), SHO coking result with 5% coal substitution with ash free bio-char (0.2% ash) produced by Hydro Thermal Carbonization process (HTC) at Carleton U. led to 15 point drop in CSR – due to incorporation of reactive (high VM & O content) bio carbon throughout coke matrix. On the other hand, combustion experiments in PCI rig with same biochar in 75% coal/25% char injectant did not affect total burnout.

Both experimental and modeling work on bio-chars produced by different processes (fast pyrolysis, torrefaction and HTC) found that the suitability of bio-char for replacement of PCI depends on the pyrolysis conditions employed in producing the bio-char.

5. On **Energy Recovery Coke Oven** (CCRA 77), construction of Pilot Oven Facility continued with heat-up anticipated by September 2016 and commissioning by March 2017. During 2015-16, the following components received attention: installation of buckstays, installation of power transformer and control cabin, completed layout for exhaust gas system, modeling of coal loading machine, design of door handlers. The main risk in getting the oven running by September 2016 was electrical (installation of feeds to transformer and from cabin & tunneling). SunCoke indicated that it would available to provide assistance and expertise with the startup process and would provide all the coal for commissioning of the oven, which will be from their current blend.

6. On **Influence of organic liquids on coking properties** (CCRA 90), results from Phase 2 on effects of organic liquids on an exploration sample from NE BC that underwent attrition, sizing and considerable handling did not reveal any difference between the clean coal composite and coke from the Boner Jig and the Organic Liquids washed coal. This result was similar to that reported in US Steel patent by DuBroff and coworkers in 1985 in that organic liquids treatment had no negative effect on coke quality.

7. On **Mineral matter and coke reactivity** (CCRA 81), the mineral estimation technique developed to analyze the mineral matter composition of WC coals found that major Ca and Mg containing mineral in all samples is ankerite ($Ca(Fe,Mg,Mn)(CO_3)_2$) with Mg/Ca ratio = 0.2. Definition of a new parameter, mineral ratio, calculated from amount of ankerite and Free-Fe available in coal, found that CRI is strongly depended on the mineral ratio of the coal at low Ro but not at high Ro.

8. On **Technical Merits of Western Canadian Coals** (CCRA 87), discussions were held on pursuing the work by using a number of Australian coals of varying rank and blending with WC coals for measuring coke quality. No pilot oven work materialized in 2015-16.

9. On **Standards** (CCRA 54), the CCRA contracted J. St James with organizing an Inter Laboratory Study on coal dilatation to ultimately enable valid comparisons of dilatation data between different laboratories. Also, review of the Sapozhnikov test in relation to the ISO 20362 draft with recommendations were made and updates provided on Transportable Moisture Limit (TML) and its importance for western Canadian coals. A complete report on the ISO/TC27 meeting held in the USA, September 2015 was presented.

10. On **Database analysis** (CCRA 76), it was shown that CSR generally decrease as ankerite content in WC coal increase and that factors affecting CSR are strongly inter-related.

11. On **International Research Collaboration** (CCRA 75), a visit to BHP Pullenvale (Australia) took place to view their ERCO and discuss issues relating to oven operation and future collaboration – information obtained could be very helpful to the ERCO team during startup and beyond.

12. On **Small-Scale Carbonization Facility for Cold & Hot Coke Strength Determination** (CCRA 88), a prediction model was developed to address the discrepancy between the measured CSR of MWO coke and SHO coke. It focuses on predicting MWO coke CSR from SHO coke properties (CSR, CRI and texture data). With this model, bias of overestimating CSR from SHO oven coke was successfully eliminated.

14. On **Benchmarking of Movable Wall Ovens** (CCRA 92), 2015-16 results including carbonization conditions and coke properties from CanmetENERGY Carbolite and 18in. ovens (duplicated tests in each oven) were presented. Both gas pressure and wall pressure in the respective pilot ovens were found to be highly reproducible. As expected, the wall pressure measured in the 18in oven tests was higher than that of the Carbolite oven tests due to the inherent designs of the respective ovens. Carbolite oven produced slightly bigger coke compared to the 18in oven and leading to slightly higher I_{40} value in the IRSID test. This is attributed to the lower wall temperature of the Carbolite oven and resulting in longer coking time. The other coke quality parameters including ASTM stability and hardness, CSR and CRI were found to be essentially identical between the two ovens. The oven benchmarking work will be repeated in FY 2016-17 using the same steelmaker coal blend.

CCRA-CanmetENERGY Papers 2015-2016

1. Ray, S., Giroux, L., MacPhee, J.A., Ng, K.W., Todoschuk, T. *"Evaluation of PCI Coals in New Injection Facility at CanmetENERGY (Ottawa)"*, AISTech Proceedings, Cleveland, May 2015.
2. Leeder, W.R., Ng, K.W., Giroux, L., MacPhee, J.A., Todoschuk, T., Howey, C. *"Predictive Model for Blending Coals Part 2: US Coals"*, AISTech Proceedings, Cleveland, May 2015.
3. Ng, K.W., Giroux, L., MacPhee, J.A., Ng, K.W., Todoschuk, T. *"Industrial Study on Coal Handling Bulk Density"*, AISTech Proceedings, Cleveland, May 2015.
4. Ray, S., Giroux, L., MacPhee, J.A., Ng, K.W., Todoschuk, T. "Study of PCI Coals in New Injection Rig at CanmetENERGY (Ottawa)", Metec InSteelCon 2015 Proceedings, Dusseldorf, Germany, June 2015.
5. Ng, K.W., Giroux, L., MacPhee, J.A., Ng, K.W., Todoschuk, T. *"Industrial Study on Coal Handling Bulk Density"*, Metec InSteelCon 2015 Proceedings, Dusseldorf, Germany, June 2015.
6. Leeder, W.R., Todoschuk, T., Howey, C., Giroux, L., Ng, K.W., MacPhee, J.A., *"Predictive Model for Blending Coking Coals to Produce High Strength Coke"*, Metec InSteelCon 2015 Proceedings, Dusseldorf, Germany, June 2015.
7. Ng, K.W., Giroux, L., MacPhee, J.A., Todoschuk, T., Taggart, L., Scott, G. *"Development of a TGA Technique for Carbon Differentiation in BF Dust and Sludge"*, Metec InSteelCon 2015 Proceedings, Dusseldorf, Germany, June 2015.
8. Holuszko, M.E., Leeder, R., Mackay, M., Giroux, L., MacPhee, J.A., Ng, K.W., Dexter, H. *"Effects of Organic Liquids on Coking Properties of a High-Inert Western Canadian Coal"*, International Conference on Coal Science & Technology, 2015 Proceedings, Melbourne, Australia, September 2015.
9. Ng, K.W., Giroux, L., MacPhee, J.A., Todoschuk, T., Taggart, L., Scott, G. *"Carbon type differentiation technique for diagnosing pulverised coal injection efficiency"*, Ironmaking and Steelmaking, DOI: http://dx.doi.org/10.1179/1743281215Y.0000000034.
10. Holuszko, M.E., Leeder, R., Mackay, M., Giroux, L., MacPhee, J.A., Ng, K.W., Dexter, H. *"Effects of Organic Liquids on Coking Properties of a High-Inert Western Canadian Coal"*, Submitted to Fuel Processing Technology (FUPROC-D-16-00075), January 2016.

Facilities Utilization:

CanmetENERGY oven utilization statistics for 2015-16 (Table 1) shows the following in comparison with 2014-15.

1. Sole-Heated Ovens

- CCRA – 4 vs 14 trials
- Coal Companies – 110 vs 165 trials (95% SHO3, 4% Canmet, 1% Stelco)
- Steel Companies – 125 vs 76 (51% SHO3, 49% Canmet)

In total, usage of sole-heated ovens in 2015-16 was 239 trials - compared to 255 trials in 2014-15 (~6% lower).

2. Sole-Heated Oven Coke Reheats - CSR

- CCRA – 19 vs 25
- Coal Companies – 4 vs 96
- Steel Companies – 66 vs 35

In total, 89 reheats of sole-heated oven cokes for CSR determination – vs 156 in 2014-15 (43% lower).

3. MWO CSR Determinations

- CCRA – 20 vs 57
- Coal Companies – 113 vs 219
- Steel Companies – 60 vs 71

4. Coke Stabilization

14 coke stabilization trials were done in 2015-16 vs 14 in 2014-15 (Measure of coke size distribution, ASTM S/H, Extended IRSID). 12 were done for coal companies and 2 for steel companies.

5. Movable Wall Ovens

- CCRA – 5 vs 22 trials (2 in Carbolite, 3 in 18-inch oven)
- Coal Companies – 109 vs 107 trials (97 in Carbolite, 12 in 18-inch oven)
- Steel Companies – 51 vs 39 trials (All in 18-inch oven)

In total, usage of movable wall ovens in 2015-16 was 165 trials compared to 168 trials in 2014-15 (2% lower).

6. PCI Test Rig

- CCRA – 7 tests
- Coal Companies – 0 tests
- Steel Companies – 15 tests

In total, 22 PCI tests were done in 2015-16 compared to 13 tests in 2014-15 (70% higher)

Table 1

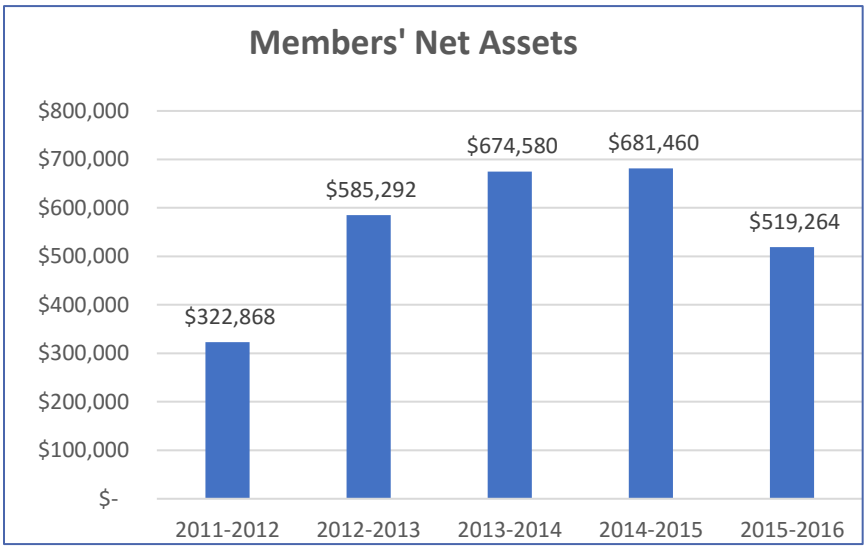
Utilization of CanmetENERGY Facilities

Oven Tests				
April 1, 2015 March 31, 2016				
Oven	**CCRA**	**Coal Companies**	**Steel Companies**	**Totals**
SHO	**4**	**110**	**125**	**239**
Stelco	0	2	0	2
Canmet	1	4	61	66
Oven 3	3	104	64	171
SHO Coke Reheats	**19**	**4**	**66**	**89**
CSR	**20**	**113**	**60**	**193**
Coke Stabilization	0	12	**2**	14
Movable Wall Oven	**5**	**109**	**51**	**165**
18 inch	3	12	51	66
Carbolite	2	97	0	99
PCI Test Rig	**7**	**0**	**15**	**22**

Year in Review

Despite the continued financial challenges faced by the industry due to lower than desirable commodity prices, CCRA membership remained stable again during the 2015-2016 fiscal year.

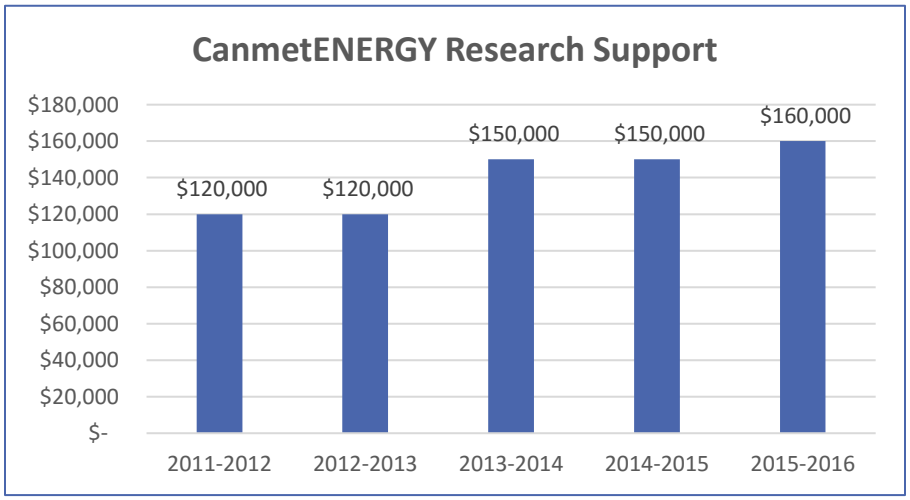
Financially, Members' Net Assets at year end totaled $519,264 reflecting a 23.8% reduction from that reported in 2014-2015 fiscal year. This reduction reflects the impact of a $162,196 deficiency of revenues versus expenses for the year. This difference is largely due to an expense of $151,427 for the Energy Recovery Coke Oven Project allocated in previous years.



CCRA increased the level of direct CANMET Research Support to $160,000, the highest level in the last five years, despite a CCRA reduction of revenues totaling $470,000.

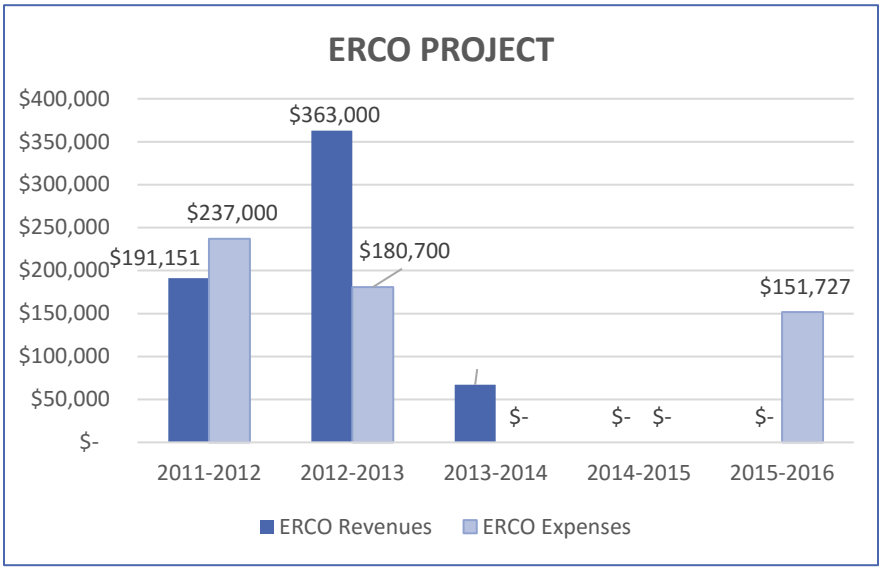
Total revenues in 2015-16 are lower by about $470,000 largely attributable to a reduction in confidential research and development testing at CanmetENERGY, reduced research levies and funding for PWC study from the levels reported in 2014-2015.

Notwithstanding the drop in total revenues during 2015-2016, CCRA increased its CanmetENERGY research support to $160,000, a $10,000 or 6.7% increase from the levels in the two previous fiscal years. The cumulative CCRA direct research support to CanmetENERGY over the last five years totaled $1.3 million including the contributions to the Energy Recovery Coke



Oven Project and an additional $5.8 million in research and development testing by CCRA members.

During the year, CCRA made a further $151,727 contribution to the Energy Recovery Coke Oven (ERCO) Project. Since fiscal year 2011-2012, CCRA has made investments of $569,427 to the ERCO Project.



Although the CCRA was not incorporated until 1981, it began as an active unincorporated Association on September 2, 1965. In 2015, therefore, the CCRA celebrated its 50th anniversary. This milestone represents a proud achievement for CCRA, which has supported research in the coal and carbonization sectors for five decades in close partnership with Natural Resources Canada – CanmetENERGY.

Audited Financial Statements

crawford
smith &
swallow

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Financial Statements

March 31, 2016

crawford smith & swallow

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Financial Statements

March 31, 2016

Table of Contents

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INDEPENDENT AUDITORS' REPORT

To the Members of the
Canadian Carbonization Research Association

We have audited the accompanying financial statements of the Canadian Carbonization Research Association, which comprise the statement of financial position as at March 31, 2016, and the statements of operations and changes in members' net assets and cash flows for the year then ended and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements
Management is responsible for the preparation and fair presentation of these financial statements in accordance with Canadian accounting standards for not-for-profit organizations, and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditors' Responsibility
Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with Canadian generally accepted auditing standards. Those standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditors' judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditors consider internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion
In our opinion, the financial statements present fairly, in all material respects, the financial position of the Canadian Carbonization Research Association as at March 31, 2016, and the results of its operations and its cash flows for the year then ended in accordance with Canadian accounting standards for not-for-profit organizations.

Niagara Falls, Ontario
November 7, 2016

CRAWFORD, SMITH AND SWALLOW
CHARTERED ACCOUNTANTS LLP

LICENSED PUBLIC ACCOUNTANTS

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF FINANCIAL POSITION

March 31, 2016

Assets	2016 $	2015 $
Current Assets		
Cash	261,201	277,171
Temporary investments	682,838	1,350,413
Accounts receivable	5	1,342
Sales tax recoverable	36,664	31,442
	980,708	**1,660,368**
Liabilities and Members' Net Assets		
Current Liabilities		
Accounts payable and accrued liabilities	18,746	10,200
Due to CANMET	442,698	968,708
	461,444	978,908
Members' Net Assets	519,264	681,460
	980,708	**1,660,368**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF OPERATIONS AND CHANGES IN MEMBERS' NET ASSETS

for the year ended March 31, 2016

	2016 $	2015 $
Revenue		
Confidential research and development	944,529	1,326,422
Research levies	165,000	190,000
Consulting funding	6,425	6,425
Membership fees	800	800
Interest income	5,699	8,481
Other income		55
PWC funding		60,000
	1,122,453	1,592,183
Operating Expenses		
Confidential research and development	944,529	1,326,422
CANMET research support	160,000	150,000
Non-recovery oven	151,727	
Consulting	3,000	8,857
Outside research		75,213
Meeting	816	834
Office	17,192	17,562
Professional fees	7,385	6,415
	1,284,649	1,585,303
Excess (Deficiency) of Revenue over Expenses	(162,196)	6,880
Members' Net Assets, Beginning of Year	681,460	674,580
Members' Net Assets, End of Year	**519,264**	**681,460**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF CASH FLOWS

for the year ended March 31, 2016

	2016 $	2015 $
Operating Activities		
Excess (deficiency) of revenue over expenses	(162,196)	6,880
Changes in working capital components - note 2	(521,349)	260,688
Funds provided (used) by operating activities	(683,545)	267,568
Investing Activities		
Decrease in temporary investments	667,575	9,242
Increase (Decrease) in Cash Position	(15,970)	276,810
Cash, Beginning of Year	277,171	361
Cash, End of Year	**261,201**	**277,171**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2016

Organization

Canadian Carbonization Research Association (the "Association") is a national organization which initiates, coordinates and provides funding towards research and development having particular importance to the coal and carbonization industries of Canada. The organization was incorporated under the Canada Corporations Act as a not-for-profit association in July 1981. In January 2014, the Association was issued a Certificate of Continuance under the Canada Not-for-profit Corporations Act.

1. Significant Accounting Policies

The financial statements of the Association are the representations of management prepared in accordance with Canadian accounting standards for not-for-profit organizations, consistently applied. Because a precise determination of many assets and liabilities is dependent upon future events, the preparation of periodic financial statements necessarily involves the use of estimates and approximations. These have been made using careful judgement in the light of available information. The financial statements have, in management's opinion, been properly prepared within reasonable limits of materiality and within the framework of the accounting policies summarized below:

Financial reporting framework

The Association, being a not-for-profit organization, chose to establish their financial statements in accordance with Canadian accounting standards for not-for-profit organizations, issued by the Chartered Professional Accountants of Canada.

Revenue recognition

Membership fees, research levies, consulting funding, PWC funding and other income are recognized in the fiscal year for which they have been assessed. Confidential research and development revenues are recognized when the related services are provided. Non-recovery contributions are voluntary in nature and recognized in the year of receipt.

Financial instruments

The Association's financial instruments consist of cash, temporary investments, accounts receivable, accounts payable and accrued liabilities and due to CANMET. Financial instruments are initially measured at fair value on acquisition and are subsequently measured at amortized cost. Transaction costs and financial fees associated with financial instruments carried at amortized cost are recorded as adjustments to the initial fair value recognized, and amortized over the life of the financial instrument.

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2016

2. Statement of Cash Flows

Changes in working capital components include:

	2016 $	2015 $
Accounts receivable	1,337	311,539
Sales tax recoverable	(5,222)	(30,478)
Prepaid expenses		8,850
Accounts payable and accrued liabilities	8,546	1,539
Due to CANMET	(526,010)	(10,762)
Deferred income		(20,000)
	(521,349)	**260,688**

3. Financial Instruments

Transactions in financial instruments expose the Association to certain financial risks and uncertainties. These risks include:

Interest rate risk

Interest rate risk is the risk that future cash flows of a financial instrument will fluctuate due to changes in market interest rates. The Association holds investments that earn income at varying rates of return which are which are dependent upon market conditions. Accordingly, the Association is exposed to the effects of fluctuations in market rates. Interest received in the year amounted to $ 8,274 (2015 - $ 7,722). As a result of a decrease in temporary investments during the year, the Association's exposure to interest rate risk has decreased over the prior year.

4. Related Party Transactions

Fees amounting to $ 13,575 (2015 - $ 14,658) were charged by Burlington Management Services Inc. ("BMSI") to the Association for the year. BMSI is owned by the Treasurer of the Association.

5. Taxation Status

The Association is exempt from income taxes as it has complied with the necessary provisions of the Federal and Provincial Tax Acts. Consequently, no provision for income taxes is reflected in the accounts.

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Schedule 1

FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF OPERATIONS AND MEMBERS' NET ASSETS

for the year ended March 31, 2016

	2016 $	2015 $	2014 $	2013 $	2012 $
Revenues					
Confidential research and development	944,529	1,326,422	1,415,184	832,221	1,231,511
Research levies	165,000	190,000	190,000	210,000	210,000
Non-recovery oven contributions			67,000	363,000	191,151
Consulting funding	6,425	6,425	7,710	7,875	9,000
Membership fees	800	800	700	700	700
Interest income	5,699	8,481	7,183	9,615	5,896
Other income		55	1,733	169	26,532
PWC funding		60,000			
	1,122,453	1,592,183	1,689,510	1,423,580	1,674,790
Operating Expenses					
Confidential research and development	944,529	1,326,422	1,415,184	832,221	1,231,511
CANMET research support	160,000	150,000	150,000	120,000	120,000
Non-recovery oven	151,727			180,700	237,000
Consulting	3,000	8,857	8,857	8,679	8,679
Outside research		75,213			
Meeting	816	834		1,523	3,486
Office	17,192	17,562	16,639	12,138	12,128
Professional fees	7,385	6,415	9,542	5,895	6,020
	1,284,649	1,585,303	1,600,222	1,161,156	1,618,824
Excess (Deficiency) of Revenues over Expenses	(162,196)	6,880	89,288	262,424	55,966
Members' Net Assets, Beginning of Year	681,460	674,580	585,292	322,868	266,902
Members' Net Assets, End of Year	**519,264**	**681,460**	**674,580**	**585,292**	**322,868**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Schedule 1 - continued

FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF FINANCIAL POSITION

as at March 31, 2016

	2016 $	2015 $	2014 $	2013 $	2012 $
Assets					
Current Assets					
Cash	261,201	277,171	361	44,937	7,513
Temporary investments	682,838	1,350,413	1,359,655	1,095,327	1,011,183
Accounts receivable	36,669	32,784	313,845	40,268	208,445
Prepaid expenses			8,850		
	980,708	**1,660,368**	**1,682,711**	**1,180,532**	**1,227,141**
Liabilities and Members' Net Assets					
Current Liabilities					
Accounts payable and accrued liabilities	18,746	10,200	8,661	7,423	10,272
Due to CANMET	442,698	968,708	979,470	587,817	894,001
Deferred income			20,000		
	461,444	978,908	1,008,131	595,240	904,273
Members' Net Assets	519,264	681,460	674,580	585,292	322,868
	980,708	**1,660,368**	**1,682,711**	**1,180,532**	**1,227,141**

See accompanying notes

CCRA History

From Concept to Reality

During a visit to the Booth Street lab of Energy Mines & Resources (EMR), F.J. Pearce, who worked for The Steel Company of Canada, Limited was discussing the coke and coal situation with Dr. J. Walsh and J. Chisholm and it was apparent that Industry and EMR should develop a formal Research/Technical relationship. With the approval of senior government and Stelco management, F.J. Pearce was asked to contact all of the Canadian coal and steel companies in order to form the basis for the relationship.

From this initial discussion, the concept of the Canadian Carbonization Research Association was developed from the responses to F.J. Pearce's contacts. Dr. Walsh and J. Chisholm sought the approval of senior government management and A. Ignatieff of EMR was in complete support of the idea, and this cleared the way for the concept to become reality.

The Canadian Carbonization Research Association (CCRA) was formed on September 2,1965 – 50 years of Research supporting the Canadian Coal and Carbonization Industries

The Canadian Carbonization Research Association (CCRA) was formed on September 2, 1965 with the adoption of a Constitution by the Canadian Steel and Coal industries, as a mechanism to promote and establish carbonization research in Canada. The Association's original members were C.W. Drake of Algoma Steel Corporation, W.J. Riva of Canmore Mines Limited, J. John of Crows Nest Industries, J.E. Ludberg of Dominion Foundries and Steel Limited, T.G. Cassidy of Dominion Tar & Chemicals Ltd, R.P. Nicholson of Dosco Steel Ltd, F.J. Pearce of The Steel Company of Canada Limited and J. H. Walsh of The Mines Branch of Energy, Mines and Resources.

Others at this founding meeting were H.N. Paulencu of Stelco, A. Ignatieff, J.C. Botham, D.S. Montgomery and J.H. Hudson of CANMET. They were representatives of the major cokemaking steel producers, independent coke producer, major metallurgical coal miners, major coal tar users of the day and the Federal Government area involved with these Industries.

The first Chairman of the Board of Directors was C.W. Drake, with J. Ludberg as Treasurer and J. Walsh as Secretary. The Technical Committee Chairman was F. Pearce with R. Zavitz, R. Nicholson and J. Botham of EMR as Secretary.

CCRA is a unique co-operative research and development effort between Industry and Government which became a model for many other industry/government R&D joint efforts. CCRA and CANMET have had different opinions on what R&D priorities should be the focus of the Joint Program, however, through dialogue and discussion, these differences have always resulted in a consensus based program. The winner in this whole matter has been R&D in Canada and we look forward to the continuation of this joint effort for years to come.

The Early Years

The original members of CCRA and the senior officials of EMR were successful in convincing the Minister of EMR to establish a coal carbonization laboratory in Canada. The first Laboratory was located at The Mines Branch on Booth Street in Ottawa and centered around a 12inch Wide Pilot Coke Oven, a newly designed Sole heated Oven and the BM/AGA Coke Oven. J. Walsh managed this new facility and the other EMR staff helped with the operation including J.C. Botham, who later became the Technical Manager.

At first, the operation of the equipment was often performed by personnel from CCRA member companies and later CCRA employed personnel for this purpose. In 1968, a new facility location was chosen at Bells Corners, 20 km west of downtown Ottawa, where a laboratory was to be built. CCRA played a significant role in getting this new Laboratory. EMR provided the building facilities and CCRA members supplying much of the carbonization equipment for the new lab. The new lab was to center around a new 18 inch silica brick movable wall oven. A 30 pound coke oven was also part of the new facilities and the BM/AGA Oven was redesigned and rebuilt.

In December 1968, the group at the Mines Branch responsible for coal and ironmaking were also relocated to Bells Corners.

Expanding Activities in the 1970's

In 1970, J. Ludberg of Dofasco became Chairman of the Board. W. Gardner joined the research staff at CANMET and was charged with getting the new 18 inch oven operational, relocating the 12 inch oven to Bells Corners and redesigning the BM/AGA oven. The coal preparation plant from Booth Street was moved to Clover Bar in Western Canada. Research work was managed by J.C. Botham under the direction of the Technical Committee and centered on coal pipelining, additives to coking charges, hot briquetting, form coking and petrographic methods for all coals.

Arrangements were made to establish a coking facility at Clover Bar to accommodate the western Canadian Coal producers. Algoma arranged to donate their Koppers pilot coke oven with alumina refractory. A mini fluidized bed was constructed for heating coal for hot briquetting as part of the form coke project. By 1974, this facility was operational. EMR hired Dr. J. Gransden and Dr. J. Price who became the backbone of the Technical program and have gained international recognition as carbonization scientists.

In the early 1970's a major concern of the CCRA research was reliability of petrography to predict the coking quality of Western Canadian coal and considerable work was done to address the issue of reactive semi-fusinite in coal. When the "energy crisis" developed in 1973/74 concern about energy self-sufficiency came to the forefront. A considerable amount of research was done to determine if Western Canadian coal blends could make satisfactory coke for Blast Furnace operations. This crisis also resulted in a number of oil companies getting involved in the coal mining business and Shell Canada, Esso Resources, BP Canada and Gulf Canada became CCRA members.

The organization underwent a substantial change in 1975 when the movable wall coke oven crew, which had grown to six, switched from being CCRA employees to becoming EMR term employees, to conform with Government policy. CCRA established a new Treasurer system to handle the organization's financial affairs and research funding. This change resulted in the Treasurer's position becoming an appointed officer with full financial authority for the Association. Mr. G.A. Chapman was appointed Treasurer and has held that Office since that time.

Incorporation of CCRA & Facility Changes – the 1980's

CCRA was incorporated under The Canadian Corporations Act on July 16, 1981, as a non-for-profit research association. Letters patent set out the organizational structure with each member company putting forward a representative for election to the Board of Directors, and Active members appointing each a Technical Committee member.

CCRA Objectives:

(1) To conduct Research and Development of importance to the coal and carbonization industries in Canada,

(2) To co-ordinate and support Canadian carbonization Research in and related to steel, foundry, smelting and coal industries,

(3) To affiliate with national and international organizations or associations having similar objectives.

The administration of CCRA is the responsibility of the Board of Directors to whom the Officers and other appointed positions report. The objectives of CCRA are set out in the Letters patent:

(1) To conduct Research and Development of importance to the coal and carbonization industries in Canada,
(2) To co-ordinate and support Canadian carbonization Research in and related to steel, foundry, smelting and coal industries,
(3) To affiliate with national and international organizations or associations having similar objectives, for the benefit of Canada.

In the early 1980's, new research studies centered around the correlation of coke and processing conditions from pilot ovens with that from industrial ovens. Gas and wall pressure measurements in pilot and industrial coke ovens were emphasized.

This area of study included a unique study which took place at Algoma Steel's battery number 6, which was scheduled to be demolished. The study used the battery to carbonize very high pressure coking blends to determine what the high coking wall pressures would do to an oven and if it could even cause wall failure.

One of the Technical highlights of CCRA has to be the CCRA/NKK Technical Exchanges that took place, in Canada and Japan. Four Technical Exchanges took place where both sides presented papers on their research work. The delegations generally involved 12 to 15 representatives from each country and was highly successful.

The fourth exchange took place, in Tokyo Japan in 1983 with about 20 CCRA representatives participating in the technical meetings and the tours of the Japanese steel mills that followed.

By the latter part of the 1980's the international energy crisis had subsided, coal and steel prices were dropping, and both industries were entering a period of highly competitive markets. Coal injection into the blast furnace was introduced in Europe and Japan. Many new projects were initiated by the Technical Committee in this period, one of which was the upgrading of coking quality of Canadian coals through wash plant control, while others included CSR and carbon texture, vertical temperature distribution in a coke oven, effect of partial oxidation of a component coal on coke quality, to mention a few.

A project to study coal injection into a blast furnace was approved and a special facility was built at Bells Corners. CCRA and Canadian Steel Industries Research Association co-sponsored a study "Strategic Ironmaking Study " with CANMET to review where ironmaking technology might go over the following 20 years. This study was completed in 1990 and became the road map for the steel industry for many years.

Difficult Times in the Coal and Steel Industries – the 1990's

Canadian coal exports had doubled over the past decade but global warming was becoming a concern because of the effect on the environment. Research was aimed at reducing the cost of coke and energy for Canadian steel makers and finding a niche for Canadian coal. PCI work became very important to both the coal and steel companies. The PCI facilities at Bells Corners was proving its value in the injection program. A CCRA sponsored project at the University of British Columbia on coke oven modeling was completed and the model now resides at CANMET for all to use.

In 1995, CCRA celebrated the 30th Anniversary of its founding. Because of difficult economic conditions in the coal and steel industries, membership had declined to eight members and EMR was undergoing a review and CCRA was asked to prepare an Impact statement for their review.

By 1997, the CCRA/CANMET fee structure underwent a significant change with confidential oven test work increasing substantially. The Board of Directors approved By-law Number 2 to create a new category of Membership, the "Connected Member". This was a category for members who were not eligible to join as full members but wished to be part of CCRA.

Consolidation of the Coal Industry and the challenges of the 2000's

The year 2000 saw another downturn in steel and coal industries with two of the three Canadian steel company members and one coal producer having to drop their CCRA memberships because of financial considerations. The reduction in members complicated CCRA's financial situation as the Association had to dip into its limited reserves to maintain its commitments to CANMET.

The consolidation of the metallurgical coal producers at the end of 2002 further complicated the financial situation for CCRA as there was now only one coal and steel member. The Association and CANMET co-operated to keep CCRA as a viable entity and hoped that new members could be attracted when the economy in these industries improved. R. Leeder remained as Chairman of the Board of Directors and T. Todoschuk as Chairman of the Technical Committee.

Membership levels are dependent on the number of Companies eligible for membership as well as the business climate. The number of Metallurgical coal producers was substantially reduced in 2002 with the formation of Elk Valley Coal, which incorporated most of the producers under one organization.

The cokemaking industry was down to three steel producers, and because of economic hardships, only one remained a CCRA member. CANMET has a special category membership in CCRA "Associate Member" which carries full representation and voting privileges without CCRA fees. Other membership categories are Connected, Affiliated, and Inactive.

The CCRA /CANMET relationship has evolved over the years and this was formally put into an "Understanding" or Agreement document created in 1984. This document was modified with the latest update completed in 2000.

International recognition has been achieved for the R&D work performed through the CCRA/CANMET partnership

Over the years, CCRA and CANMET have carried out many research and development programs to improve the metallurgical coal and cokemaking operations of its members. Many of these have had far reaching effects which have been documented in studies carried out by consultants for the government showing the economic effects of the Joint R&D Program. The benefits to Canadian industry have been substantial, however, it could not have taken place without the joint efforts of CANMET and CCRA. Having a laboratory to conduct carbonization research is beyond the feasibility of any one company so the single shared Canadian lab at Bells Corners has allowed the continuation of R&D in this field in Canada.

The fields of R&D covered by the joint CCRA/CANMET program include energy and fuel conservation, stabilization of supply, GHG reduction, mining, processing, transportation, production of iron, environment, and safety. At any specific time the R&D program places priority on the most pressing problems while not ignoring the long term work necessary for the future.

The CCRA/CANMET R&D program has provided Technical Information to the Canadian metallurgical coal industry that is accepted by their international customers as reliable, accurate and unbiased. This has allowed Canadian metallurgical coal to compete on the International market and retain jobs in Canada. The export of Canadian Coal generates a significant amount of foreign exchange and assists with Canada's balance of payments. Canada is one of the major exporting country of metallurgical coal and supplies a growing proportion of the coking coal used in Eastern Canada.

As CCRA celebrated its 40th Anniversary in 2005, the future looked more promising than it had in the last few previous years, despite the economic ups and downs of the industries represented by the CCRA. The continued CCRA/CANMET partnership benefited Canada as the participating industries gained new information as a result of the R&D. International recognition was achieved for the R&D work performed through the CCRA/CANMET partnership.

At the end of 2006, Dr. Ross Leeder , the longest serving member of the Board retired. Ross had joined the Technical Committee in 1971 when he was a member of the CANMET staff at Bells Corners. He chaired the Technical Committee before moving to the Board of Directors. Ross became Chairman of the BOD in 1989-90 and again in 1999 to 2006. During the 35 years of his association with CCRA, Ross presented numerous papers on the industry.

In 2007, two new coal companies joined as Connected Members, Peace River Coal and Western Canadian Coal Corp and Dr. Barry Ryan joined as an Individual Connected Member representing the British Columbia Government.

In 2008, George Chapman celebrated his 30th anniversary as Treasurer of the Association. Peace River Coal became a full member of the Association and Essar Steel Algoma Inc. joined as a Connected Member. That same year, after a career spanning 35 years, Dr. John Price took retirement from his position as Senior Research Scientist and Manager of Energy for High Temperature Processes at CANMET.

In early 2009, Dr. John Gransden, also Senior Research Scientist in coal carbonization, retired from CANMET. The departure of Drs. Price and Gransden, both dedicated research scientists, represented a significant loss to the CCRA within a very short time period. CCRA thanked them for their valuable contributions to Carbonization in Canada and wished them all the best in their retirement. In the spring of 2009, the Algoma representative Bob Lamour retired after being a long-standing member on the Technical Committee and Board. Bob was replaced by Ms. Eila Kaukolin. Barry Ryan retired from the BC Government Ministry of Energy, Mines and Petroleum Resources and, as there was no replacement named, the BC Government abandoned its membership.

During 2008 and 2009, the steel and coal industries were faced with difficult economic climate as the world economic downturn caused a dramatic reduction in steel demand which resulted in a drop in metallurgical coal requirements.

For several years prior to 2008-09, Greenhouse gases (GHG) became a major thrust of the joint R&D program and the research program reflected that reality.

In 2009, the Technical Committee and the Board of Directors spent a significant amount of time and effort gathering information on the development and financing of an Energy Recovery Pilot coke oven for the joint CCRA/CANMET program to examine this alternative/new cokemaking technology. The elevated cost for building such a facility led the CCRA to seek Government participation at both the Federal and Provincial levels and include other parties such as Ontario Hydro Generation as partners.

The Current Decade

The 45th anniversary of CCRA's creation was celebrated in 2010. CCRA continued to advocate for an energy recovery pilot coke oven by meeting with the Minister of NRCan in December of that year. Shortly thereafter, a new Minister of NRCan was appointed and the letter authorizing the initiative was delayed. Work on the project however continued and an engineering study to develop a proposal and cost for the pilot facility was initiated. In 2010-2011, the Association started on a very ambitious project to carry out engineering, design, construction and commissioning of an Energy Recovery Pilot Coke Oven (ERCO) at Bells Corners. The ERCO technology is an alternate approach to traditional slot coke oven and pilot facilities using ERCO technology are essentially non-existant, so R&D cannot be carried out. CCRA's goal for this project was to put Canada at the leading edge of this technology by having a facility where its members are able to investigate how coal behaves in this type of oven and determine information needed to allow the Canadian steel industry to evaluate this technology for controling emissions and coke product quality. This facility would also be used to showcase the cokemaking merits of Western Canadian coals using this technology globally.

The projected budget for the ERCO facility was nearly $1 million. It was hoped that funding would come from a variety of sources: Industry, Federal and Provincial governments and power generation firms as a feature of this technology is co-generation.

The 2011–2012 fiscal year produced an increase in CCRA members as US Steel Canada, SunCoke Energy, Inc. joined. Grande Cache Coal Corp., Alberta also rejoined the Association after being absent for some years.

CCRA signed a contract with Hatch Engineering, Mississauga, Ontario to undertake the preliminary design of a pilot scale Energy Recovery Coke Oven with the final report due in the summer of 2012. Funds for this project were raised by some of the CCRA members contributing to a fund for this specific purpose. CCRA also signed a Non Repayable Contribution Agreement with Natural Resources Canada to assist with the costs. The Canadian Steel Producers Association (CSPA) also contributed to the project. The goal was to secure the funding to enable the construction of the facility during fiscal year2012-13. The new ERCO is to be located at Bells Corners CanmetENERGY facility with the other coking facilities. In 2011-12, SunCoke ENERGY was invited to join CCRA as a strategic partner in developing the energy recovery cokemaking technology as they have owned and operated commercial ovens using this technology for many years.

With the design of the pilot ERCO completed, planning on the location and support facilities were undertaken with one of the existing movable wall ovens (Carbolite) relocated to facilitate the required laboratory space for construction of the ERCO.

During the 2013/2014 fiscal year, CCRA was obligated to transition from its original "letters patent" legal structure to comply with the requirements of the new "Not-for-Profit" Corporations Act. As of January 1, 2013 CCRA received it's "Certificate of Continuance" as Corporation Number 117455-0 Industry Canada.

CCRA has joined with CanmetENERGY to provide a web site for Canadian Carbonization Research Association. The web site can be accessed at www.cancarb.ca and contains timely information on the activities of CCRA/CanmetENERGY research and development programs and other information on the Canadian Coal and Coke industry as a whole.

CCRA celebrated its 50th year milestone of providing research support to the Coal and Carbonization industries on September 2, 2015.

Chairman of the Board of Directors CCRA

Year	Name	Company
1965 – 1966	C.W. Draker	Algoma Steel Limited
1967 – 1968	F.J. Pearce	The Steel Company of Canada Limited
1969 – 1970	J.E. Ludberg	Dominion Foundries and Steel Limited
1971 –1972	J.S. Anslow	The Steel Company of Canada Limited
1973 – 1974	J.O. Thomas	DEVCO
1975 –1976	A.M. Cameron	Algoma Steel Limited
1977-1977	J.T. Collier	DEVCO-SYSCO
1978 – 1979	W.A. Riva	Kaiser Resources Limited
1980 – 1980	J.E. Ludberg	Dofasco Limited
1981 – 1982	A. Johnson	Gulf Resources Limited
1983 –1984	A.W. Kay	Stelco Inc.
1985 – 1986	R. Sagi	Denison Mines Limited
1987 – 1988	W. Becken	Dofasco Inc.
1989 – 1990	W.R. Leeder	Denison Mines Limited
1991 – 1992	K. Carnes	Fording Coal Limited
1993 – 1994	H. Stelmach	Line Creek Resources Limited
1995 –1996	T. Benner	Dofasco Inc.
1997 –1998	W. Jonasson	Algoma Inc.
1999 – 2000	W.R. Leeder	Teck Corporation
2001 – 2002	W.R. Leeder	TeckCominco Corp.
2003 – 2006	W.R. Leeder	Elk Valley Coal Limited
2007 – Current	T. Todoschuk	ArcelorMittel Dofasco Inc.

2015-2016 Corporate Officers

COMPANY	NAME	PHONE (FAX)	CCRA POSITION
ArcelorMittal Dofasco Inc.	Mr. Ted Todoschuk Principal Researcher ArcelorMittal Dofasco Global R&D - Hamilton ted.todoschuk@arcelormittal.com	905-548-4796 (905-548-4653)	Chair
Teck	Mr. Cam Howey Global Manager Technical Marketing Teck Coal Ltd. cam.howey@teck.com	403-806-7730 Cell: 403-921-4403 (403-263-7923)	Vice Chair
Burlington Management Services Inc.	Mr. George Chapman President, Burlington Management Services Inc. bmsiccra@cogeco.ca	905-938-9191	Treasurer
CanmetENERGY	Dr. Louis Giroux Research Scientist, Industrial Energy Systems Industrial Innovation Group CanmetENERGY Natural Resources Canada lgiroux@nrcan.gc.ca	613-996-7638 (613-995-9728)	Secretary

2015-2016 Board of Directors

COMPANY	NAME	PHONE (FAX)
CanmetENERGY	Dr. Brian Farnand S&T Director, Industrial Innovation Group CanmetENERGY Natural Resources Canada bfarnand@nrcan.gc.ca	613-996-7977 (613-995-9728)
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US Steel Canada	Mr. Scott Dedrick Divisional Manager, Blast Furnace & Coke Ovens US Steel Lake Erie Works sdedrick@uss.com	519-587-4541 x5527 Cell: 519-410-0604
Teck	Mr. Cam Howey Global Manager Technical Marketing Teck Coal Ltd. cam.howey@teck.com	403-806-7730 Cell: 403-921-4403 (403-263-7923)
AngloAmerican/Peace River Coal	Mr. David Lortie Manager, Resource Evaluation Peace River Coal Inc. david.lortie@angloamerican.com	604-699-6610 (604-689-3480)
SunCoke Energy, Inc.	Dr. John Quanci Vice President, Engineering and Technology SunCoke Energy, Inc. jfquanci@suncoke.com	630-824-1941 Cell: 610-496-5989
Boreas Coal Ltd. (Glencore Coal Ltd.)	Mr. Daryl Thomas Manager Glencore Coal Ltd. daryl.thomas@glencore-ca.com	604-453-4443 Cell: 604-318-9227
Colonial Coal International Corp	Mr. John Perry Chief Operating Officer Colonial Coal International Corp jperry@ccoal.ca	604-568-4961
Ram Coal Corporation	Mr. Lloyd Metz Executive Vice-President, Mining Ram Coal Corporation lmetz@ramcoal.com	604-681-8030 x250 Cell: 604-763-4180
Riversdale Resources	Mr. Steve Mallyon Managing Director Riversdale Resources Steve.Mallyon@rivresources.com	605-684-6845 Cell: 403-563-1267

2015-2016 Technical Committee Members

COMPANY	NAME	PHONE(FAX)
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ArcelorMittal Dofasco Inc.	**VICE CHAIR:** Mr. Ted Todoschuk Principal Researcher ArcelorMittal Dofasco Global R&D - Hamilton ted.todoschuk@arcelormittal.com	905-548-4796 (905-548-4653)
CanmetENERGY	***SECRETARY:*** Dr. Tony MacPhee Research Scientist CanmetENERGY Natural Resources Canada tmacphee@nrcan.gc.ca	613-996-4440 (613-995-9728)
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CCRA Consultant	Dr. Barry Ryan bryan@islandnet.com	604-886-1906
CCRA Consultant	Dr. John Price j.t.price@rogers.com	613-592-4397
CCRA Consultant	Dr. J.F. Gransden gransdenjk@sympatico.ca	613-592-2684
Sr Technical Consultant Teck Coal Ltd.	Dr. Ross Leeder ross.leeder@teck.com	604-531-6382 Cell: 403-617-6110

Appendix 1 – CCRA Technical Committee Planning Table for 2015-2016

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
1. Energy and CO_2 Reduction in the Coal and Steel Industry	***To develop the technical understanding to improve energy efficiency and coke quality for higher productivity and lower coke rate blast furnace operation***	**CCRA 84 Coke Fissuration**	1. To establish and understand coke fissuration mechanisms. 2. To determine how coke fissuration affect coke quality including size, shape, strength and stabilization.	1. Review existing literature on the topic. 2. Investigate rate of contraction phenomena.	1. The high-temperature dilatometer work presented to the CCRA during 2012-15 period did not provide information on high temperature contraction, namely about the reported 1st maximum rate of contraction near coal resolidification dictating coke size and 2nd rate of contraction in 650-800C range dictating coke strength. Decision was taken at December 2015 meeting to discontinue the high-temperature dilatometer work. 2. Coke fissuration work will be pursued upon examination of fissuration patterns in coke produced in the sole-heated oven.
		CCRA 91 Blast Furnace Energy Reduction Initiatives	1. To address importance of PCI burnout of different rank coals in simulated Blast Furnace tuyere-raceway rig.	1. Rank coals for their burnout in a horizontal bench-scale PCI simulator rig. 2. Examine BF dust &	1. Results presented to CCRA in 2013- 2015 on degree of PCI coal burnout and CFD modeling of PCI simulations on different VM coals. 2. Results presented on characterizing BF dusts as per their different carbon types (char, coke and soot) via TGA. 3. Paper 'Development of TGA Technique for Carbon Type Characterisation in Blast Furnace Dust' presented at AISTech conference, Indianapolis, May 4-7 2014.

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
			2. To develop analytical method to quantify source of carbon (coal, char, coke) in Blast Furnace dust & sludge. 3. To quantify the changes in coke properties associated with higher temperature degradation after primary slag attack.	sludge for their sources of carbon. 3. Quantify the changes in coke properties associated with higher temperature degradation after primary slag attack/ smelting of iron ore.	4. Papers presented at AISTech 2015 & METEC InSteelCon 2015 on PCI /TGA work. 5. Paper on TGA technique published in Ironmaking & Steelmaking journal. 6. For CanmetENERGY injection rig: (i) Improve feed rate stability (ii) Define coal size range (iii) Inject Bio-char (iv) Install NG injection system and plan for injection of coal & NG. 7. Assess PCI burnout of different rank international coals and bio-carbons under N_2, various O_2 enrichment levels (O/C ratios) and NG environments. Also study effect of coal properties on burnout. 8. Develop TGA reactivity test to better understand char/coke burnout characteristics. 9. Pursue TGA trials to quantify amounts of carbon (char, coke & soot) in BF dust & sludge to monitor effectiveness of auxiliary fuel injection.
		CCRA 70 Renewable Energy for the Steel Industry	1. To investigate the **short-term** solutions for utilizing bio carbon in ironmaking.	1. Charcoal addition to existing blends for bio-cokemaking and application for PCI.	***Bio-cokemaking*** 1. CCRA updated Canadian Steel Producers Association in January 2016 on R&D progress related to utilization of bio-carbon in cokemaking. 2. Analysis of small samples of biomass from various sources/suppliers including Hunter Farms, Carleton University, Pond Biofuels, Airex, etc. for potential suitability in ironmaking.

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
				2. Explore potential of biomass from algae as a C source for bio-cokemaking and PCI.	3. Biochar acid washing rig at CanmetENERGY for demineralization of bio-char (PERD funding 1013-2015). 4. Sole-Heated Oven work on high CSR WC coal with as-received and washed bio-carbon. 5. Establish collaboration with raw biomass supplier (FPInnovations and Canadian Forest Service and bio-char producers to promote the development of bio-economy. 6. As part of NRCan new C-base funding cycle (2016-2020), preparation of proposals under heat management and fuel switching priority areas. 7. Need to address possible funding support from NRCan and NSERC and define roles and responsibilities of BC provincial government, coal companies, University & Bio-Carbon producer. ***Bio-fuel injection*** 1. Burnout results on blend of Carleton University bio-char and hv coal showed comparable trend as coal alone. ***Bio-briquette*** 1. Presentation on concept of producing a bio-briquette comprised of coal fines and bio-char that maintains a high coking potential and reduces GHG emission.
2. Energy and	***To determine options for alternative***	**CCRA 77 Coke and Power - Energy**	1. Evaluation of energy savings and coke	1. Determination of funding source(s)	1. Oven construction & financial update provided to CCRA during 2015-16.

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
Environment	***cokemaking in Canada***	**Recovery Cokemaking**	quality improvements (size, strength and CSR) achievable with this technology for Canadian coals. 2. Determine the impact of Canadian coals in international coal blends using this technology. 3. Investigate potential of ERCO for producing a suitable biocarbon material for iron and steel making.	available for this large-scale project - approximately $2M will be needed over 5 years. 2. Site preparation engineering design and materials purchasing.	2. SunCoke provided guidance/training in January 2015 for laying brickwork with mortar and casting Si and SiC pieces. 3. Paper 'Design of Energy Recovery Pilot Coke Oven' presented by Hatch at Metec 2015 conference, Germany, June 2015 and AISTech conference, Indianapolis, May 2014. 4. Construction of pilot energy recovery oven to continue during 2016 with anticipated completion in May 2016. 5. Commissioning of pilot oven will begin in Q2 2016-17 (~10 trials) – conditions to be established based on members input. SunCoke will be providing all the coal required for the commissioning process. 6. Establish clear research plan for pilot-scale Energy Recovery oven. Consider Sun Coke Energy proposal tabled at December 2014 meeting – establishing standard coking conditions in industrial oven to optimise coke quality from their US mv coal.
3. Fundamental Aspects of Coal and Coke	***To understand the fundamental science of coal and coke utilization in order***	**CCRA 80 Plant Coal Quality Upgrading**	1. To characterize the metallurgical properties of mine circuits to	1. A plan to characterize the metallurgical properties of	1. No activity planned for 2015-2016.

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
Utilization	***to improve energy efficiency***		better understand how to improve coke quality and hence energy efficiency for both the coal and steel industries. 2. To determine which "oxidation/aging" parameters best reflect the caking/coking ability of each circuit and coal.	coarse, medium, fine and tailing circuits for the new coal members has been accepted.	
		CCRA 90 Influence of Organic Liquids on Coking Properties	1. To investigate the effects of organic liquids in the coal washing process on coal and coke quality.	1. Examination of ACARP C17051 report on influence of organic liquids on coal carbonisation properties. 2. A work plan to study the effects of	1. Phase 1 work on untreated & treated Western Canadian high-inert coal was presented at 2013-14 meetings. It was also presented at CIM 2014 convention, Vancouver, May 2014, at Pittsburgh Coal Conference, October 2014 and at ICCS&T, Australia, September 2015. Manuscript was submitted to Fuel Processing Technology journal in January 2016 for publication. 2. Phase 2 work on organic liquids vs water based methods for washing exploration drill core sample were presented at Sep 2015 meeting. Results indicate that

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				organic liquids on coal and coke quality of Western Canadian coals was tabled and accepted.	the three samples analysed & coked are very similar in all their properties.
		CCRA 81 Mineral Matter and Coke Reactivity	1. To study the effects of coal (coke) mineral matter on CRI and CSR. 2. To determine if high strength after reaction can be achieved with highly reactive coke.	1. A plan to characterize mineral matter and its influence on reactivity has been tabled and accepted. 2. Mineral characterization will be done on coal, semi coke and post CSR coke from sole-heated oven to understand the changes in the chemistry of minerals during coal to coke	1. Data presented at Sep 2015 meeting showing evidence that mineral form in coal is not the most important factor determining reactivity of resultant coke. In fact, transformation of minerals during coking has a more significant effect on properties of the coke. 2. Minerals in MWO and SHO cokes are essentially identical supporting similar CRI and CSR for cokes produced by different carbonization routes. 3. XRD-RIR technique is adequate and accurate for identifying minerals. 4. Paper 'Mineral Matter Transformation in Small-Scale Coke Oven for Evaluation of CSR/CRI' presented at AISTech conference, Indianapolis, May 2014.

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				transformation. 3. A suite of activities was proposed in 2012 to progress this work.	
		CCRA 86 Performance of Canadian Coals in High-Inert Blends	1. To understand how western Canadian coals behave/work in high-inert blends.	1. Evaluate the performance of high-inert Canadian blends under different pilot oven charge densities and with wet/dry quenching of coke. 2. Investigate potential advantages of microstructure and microtexture in cokes from WC coals.	1. Phase 1 (2011-12) of high-inert Canadian blends consisted of 21 tests in Carbolite oven (7 Lots and 14 trials on 3 blends with R_o, 1.18) to examine effect of inert level, bulk density and quench method on coke quality. Data showed quantitative relationships between CSR and inerts and P_2O_5 for the 7 Lots and importance of dry quenching on coke quality, namely hot and cold strengths and mean coke size. 2. Phase 2 (2012-13), consisted of 14 tests in Carbolite oven on 3 blends with R_o 1.28. 3. Identification of suitable set of Canadian or USA coals for doing Phase 3 work at Ro range 1.10-1.15 at later date.

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		CCRA 87 Technical Merits of Western Canadian Coals	1. To develop fundamental studies that show the technical merits of Western Canadian coals 2. To package existing technical information/data and gather new analysis data for highlighting the fact that Canadian coals prove to make good quality cokes for modifying perception of marketing representatives.	1. To collect key information and generate new data to illustrate the technical merits of Western Canadian coals.	1. Phase 1 - coking 6 coal blends from CCRA 86 high-inert completed in FY 2011-12. 2. Phase 2 and 3 completed in 2012-13 3. Presentation of CCRA paper on 'Predictive Model for Blending Coking Coals – Part 1: Western Canadian Coals' at AISTech 2013 conference. 4. Phase 4 and 5 completed in 2014-15 5. Papers on Canadian/USA modified MOF diagram work presented at AISTech 2015 and METEC InSteelCon 2015. 6. Work may continue if suitable Australian coals can be obtained.

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		CCRA 82 Factors affecting Coke Bed Permeability	1. To determine how bed permeability changes with size and shape consist.	1. Literature review is required to develop testing program.	1. Successful development of standard technique to compare size and shape characteristic as well as bed permeability between different batches of coke. 2. Bed permeability measurements on 18" and Carbolite MWO cokes as part of annual movable wall oven benchmark project (CCRA 92) presented at June 2014 CCRA meeting. 3. Presentation of CCRA paper on 'Coke size and shape characterization for bed permeability estimation' at AISTech 2013 conference. 4. Perform bed permeability trials on 100% US Appalachian blend and blend containing 30% WC coal for determining effect on coke size/shape. 5. Examine effect of varying content of breeze on bed permeability for determining optimal coke size in blast furnace. 6. Investigate effect of coal properties on coke size and penetration of iron ore into the coke bed.

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4. ***Database, Standard and Procedures***	***To develop standards or procedures to enhance the knowledge and utilization of Canadian coal and coke***	**CCRA 54 Standards**	1. The CanmetENERGY business plan includes the development of standards and procedures pertaining to Canadian Coal and Steel industries.	1. To participate in ASTM and ISO meetings. 2. To participate in the development of ASTM and ISO standards for ensuring that Canadian coals and interests are not undermined by new or modified standards.	1. Presentation on Canada's organisation of an Inter Laboratory Study on coal dilatation under ISO to promote better understanding and acceptance of SD2.5 approach developed at CanmetENERGY and currently used by the majority of Canadian laboratories. 2. Presentation on main highlights of ISO/TC27 meeting, S. Africa, August 2013. 3. Outcomes of a recent study on coal bulk density measurements at CanmetENERGY presented at December 2013 meeting. Also, coal BD work done in 2014-15 was reported to ASTM D05 at fall 2014 meeting. 4. Presentations made at CCRA June and September 2014 meetings on Sapozhnikov plastometer. CanmetENERGY is exploring possibility of purchasing this equipment in 2015-16. 5. Abstracts on importance of coal BD control submitted to AISTech 2015 and METEC InSteelCon 2015.
	To generate industrial intelligence from historical data.	**CCRA 76 Database Analysis**	1. To develop relationships for coal and coke properties from existing CanmetENERGY data.	1. To develop a coke strength prediction model based on coal properties.	1. Presentation on Ca & Mg containing minerals in WCC and effect on CSR at June 2015 meeting. 2. Presentations on 'Method to predict CSR from Prox, FSI and Ash Chemistry' and 'Range of Canadian coal MF vs Ro for Blend Formulation' at March 2015 meeting. 3. Presentation made on 'Repeatability and Precision of Coke Quality Measurements at CANMET – Error analysis on tests run in duplicate – CSR, CRI, ASTM Stability, Hardness'.

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					4. Paper 'Coal Stockpile Moisture and Cokemaking' presented at AISTech conference, Indianapolis, May 2014. 5. Mineralogy of Western Canadian coals found to be very different from that of foreign coals and good relation between CRI and estimated ankerite content ($Ca(Fe,Mg,Mn)(CO_3)_2$) for WC coals. 6. CanmetENERGY data showed repeatability in CRI and CSR are different and lower than ASTM values and depend on range considered, e.g., for CSR they are smaller the higher the CSR value. 7. Presentation of CCRA paper on 'Relationship between CSR and Coal Properties' at AISTech 2013 conference.
	To perform co-operative research with National & International Research Leaders in the field	**CCRA 75 International Research Collaboration**	1. To establish technical exchanges or co-operative research studies with International Research groups.	1. To collaborate with foreign R&D institutions involved in similar work as the CCRA.	1. CPM visit to CanmetENERGY in May 2015 for presentations on research activities of both organizations. 2. Technical exchange visit to CPM France in November 2013 showed mutual interests and potential collaboration on PCI, high-temperature dilatometry, petrography, movable wall oven benchmarking and oxidation. 3. Pursue discussions/collaboration with international research groups having similar research interests as the CCRA and with Canadian organizations involved in Bio-Carbon research for enhancing suitability for iron and steel applications.
	To develop the use of small-scale carbonization	**CCRA 88 Small-Scale Carbonization**	1. To develop the use of small-scale	1. Development of method assessing the	1. Correlation presented at Sep 2015 meeting showing relation of MWO CSR with SHO CSR, CRI and SHO coke

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	apparatus for valuable coke quality indicators	**Facility for Cold & Hot Coke Strength Determination**	carbonization apparatus for yielding valuable coke quality indicators.	ambient strength of coke utilising small quantity of coal. 2. CSR measurement on selected component coals from Western Canada in CanmetENERGY's 18 in. Research and Carbolite ovens and Sole-Heated Ovens.	texture. With this relationship, MWO CSR of coke can be estimated from coke prepared in SHO. 2. Presentation in June 2015 on attempt at better understanding some discrepancy between SHO CSR and MWO CSR. 3. A total of 45 pairs from CanmetENERGY's pilot MWO and sole heated ovens showed CSR and CRI obtained by either method have same statistical validity (homogeneous data set). 4. Papers presented at Metec-InSteelCon 2011, ICCS&T 2011 and published in Fuel Journal, December 2013. 5. Perform coke texture measurements on cokes of different CSR to improve CSR evaluation accuracy of SHO carbonization. 6. Examine effect of sole-heated oven coal bed BD and resultant coke ASG on CSR. 7. Perform literature search on small carbonization test facilities in various countries.
	To conduct annual benchmarking of CanmetENERGY movable wall ovens using standard steelmaker blend to ensure reliable/repeatable performance	**CCRA 92 Benchmarking of Movable Wall Ovens**	1. To ensure reliable and repeatable pilot oven wall and gas pressure measurements along with coke quality data.	1. Conduct triplicate tests in CanmetENERGY 18" and Carbolite pilot ovens	1. Complete data on CanmetENERGY 2014-15 oven benchmarking including coke extended Irsid was presented at March 2015 meeting. 2. Benchmarking of CanmetENERGY 18" and Carbolite ovens will be done in duplicate in Q4 2015-16.