Canadian Carbonization Research Association

2014-2015 Annual Report

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 tremendous value to its member companies and to the financial health of the associated industries. The value and quality of its research is becoming more recognized on a global basis as demonstrated by the recent increase in membership.

"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 member's 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 and therefore 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 construction, the pilot Energy Recovery Oven and operation of the new pulverized coal/fuel test rig, a new page has been turned at CCRA and at the Canmet ENERGY Laboratory. These new pilot facilities will enable CCRA members to initiate research programs utilizing this greener technology and to further develop other greener technologies.

Globally, the Canadian Carbonization Research Association is self-standing in its ability to continue to grow and meet its member's 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
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Technical Committee Report

The CCRA Technical Committee held four meetings during Fiscal Year 2014-15: one in Hamilton (AM Dofasco), June 2014, two in Vancouver (Teck), September 2014 and March 2015 and one in Ottawa (CanmetENERGY), December 2014.

The 2014-15 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.

Technical Committee Meetings

Four Technical Committee Meetings were held during 2014-15 fiscal year:

Meeting No.	Location	Date
227	Hamilton, ON	June 17-18, 2014
228	Vancouver, BC	September 23-24, 2014
229	Ottawa, ON	December 2-3, 2014
230	Vancouver, BC	March 24-25, 2015

Major accomplishments/highlights:

1. During FY 2014-15, the CCRA presented four papers at AISTech 2014 Conference, Indianapolis, May 2014: *'Development of TGA Technique for Carbon Type Characterisation in Blast Furnace Dust'*, *'Mineral Matter Transformation in Small-Scale Coke Oven for Evaluation of CSR/CRI'*, *'Coal Stockpile Moisture and Cokemaking'* and *'Energy Recovery Pilot Coke Oven Design'* and presentation on *'Effects of Organic Liquids on Coking Properties of a High-Inert Western Canadian Coal' at* Canadian Institute of Mining, Metallurgy and Petroleum Convention, Vancouver, May 2014 and Western Canadian Coal Society Meeting, Vancouver, September 2014. Also, a paper on Carbon Type Differentiation Technique using TGA was written and submitted for publication in Ironmaking and Steelmaking journal.
2. On **coke fissuration** (CCRA 84), efforts continued on commissioning high-temperature dilatometer with a new design to try overcome friction between piston and retort to generate repeatable contraction profiles/rates of both contracting and expanding coals post resolidification. Issues around coal melting and resolidification during test remain a challenge.
3. On **Blast Furnace energy reduction initiatives** (CCRA 91), results of PCI runs on different rank coals and blends at O_2-enrichment levels 21-28% and under N2, were reported. Manuscripts on this work were also written for presentation at AISTech 2015, Cleveland and Metec 2015, Düsseldorf, Germany. Future work will focus on International coals to better understand how coal properties such as petrography, rheology and ash characteristics affect burnout and on effect of natural gas injection on coal burnout.

4. On the use of **Renewable energy for the steel industry** (CCRA 70), SHO coking results with 5% coal substitution with washed an unwashed bio-char (hardwood charcoal & Virginia pine) significantly reduced CSR of the resultant coke. Bio-char produced by fast pyrolysis appears to cause more significant CSR reduction. The effect of acid washing is marginal and within the repeatability limit of CSR measurement. Going forward, plan is to test combustibility of bio-char in PCI rig to optimize injection conditions of bio-char. Analysis of algae samples from Pond Bio Fuel/US Steel Canada's revealed the presence of high Ash & VM contents of low calorific value. A new concept of briquetting bio-char with met coal fines was put forward with objective of possibly improving coke quality, reducing GHG emission and improving technical competitiveness of western Canadian coking coal products.
5. On **Energy Recovery Coke Oven** (CCRA 77), construction of Pilot Oven Facility continued with heat-up anticipated by December 2015 and commissioning by March 2016. During 2014-15, fabrication of key structural components was completed including floor beam, refractory, shell (lower & upper pieces) and coal loading machine.
6. On **Influence of organic liquids on coking properties** (CCRA 90), findings on Phase 1 - treated and untreated high-inert Western Canadian coal and effect on coke quality were presented at CIM 2014 & WCCS meeting in Vancouver. A paper will be written for journal publication. Work for Phase 2 was discussed and will go ahead using a core sample provided by Glencore to compare washing using organic liquid, water and Boner jig on coke quality.

7. On **Mineral matter and coke reactivity** (CCRA 81), analysis results of coal and coke minerals performed by the Canadian Light Source showed that main factor affecting reactivity of coke is the transfer of S between pyrite (FeS_2) and calcite ($CaCO_3$) in coal during coking. The major difficulty in mineral analysis using XRD is that amount of Ca and Fe in crystalline phase is very small – this prevents establishing relation between CSR/CRI and minerals in coke. A method to estimate mineral composition of coal from ash chemistry analysis was developed and mining of CanmetENERGY database indicated that Ca and Mg in Western Canadian coal exist as ankerite leading to supposition that CSR/CRI of resultant coke is related to ankerite content in coal.
8. On **Technical Merits of Western Canadian Coals** (CCRA 87), coke trials using USA coals (AM Dofasco & US Steel Canada) at target Ro 1.11 and 1.16 were completed. It found that minimum blend MF required for USA coal blends was 500-800 ddpm – higher than 100-200 ddpm result in the NKK (Japan) tests with international coals. Further studies using USA

and/or other international coals are planned. Papers were written for presentation at AISTech 2015, Cleveland and Metec 2015, Düsseldorf, Germany.

9. On **Factors affecting coke bed permeability** (CCRA 82), findings from CCRA oven benchmarking project observed that coke permeability from Carbolite oven is better than from 18in. oven – due to lower degree of stabilization. Stabilization results in smaller mean coke size although coke shape measured by image analysis is not significantly affected by stabilization.
10. On **Standards** (CCRA 54), work presented on compressibility of coal bed at various moistures to develop a better understanding of relationship between bulk density measured using ASTM cone method and actual bulk density and gradient in an industrial coke oven. Also, information was presented on Sapozhnikov Plastometer including background information on the operation and interpretation of results as this test is important to Asian clients (China) of western Canadian coal. Historical LQSI-SGS RR results on CSR/CRI and Coke Stability/Hardness for CanmetENERGY from September 2011 to June 2014 were presented and discussed. Papers were written on importance of coal BD control for presentation at AISTech 2015 and Metec 2015 conferences. Canada still plans to organize ISO Inter Laboratory Study on coal dilatation.

11. On **Database analysis** (CCRA 76), work continued on trying to establish a CSR prediction model – using data from two current CCRA projects (Mineral Matter & Technical Merits of WCC), it was shown that CRI and Hardness can be related to coal properties allowing estimation of CSR. Presentations were also made on *"Improved Prediction of ASTM Stability"*, which requires only ash chemistry and indicates a possible way of improving predicted stability values and *"CSR, CRI and Cold Coke Strength Quick (and dirty) method to Predict CSR from Prox, FSI and ash chemistry"* - a continuation of previous Database analysis work to predict CSR.
12. On **International Research Collaboration** (CCRA 75), discussions and data exchange held between CanmetENERGY and CPM (France) on high-temperature dilatation, coal petrography, and oxidation. Also, some collaboration work was established with INCAR (Spain) on coke textures produced in the 18" MWO with and without charcoal addition.
13. On **Small-Scale Carbonization Facility for Cold & Hot Coke Strength Determination** (CCRA 88), a number of commercial vessel samples with CSR in narrow range 65-75 were run in both the Carbolite and SHO and showed no significant bias. Selected samples for Sole Heated CSR were run to determine test repeatability and effect of BD (loading pressure) was examined

to determine influence of this parameter. CSR repeatability was found to be very good and BD to have minor effect on resulting CSR value.

14. On **Benchmarking of Movable Wall Ovens** (CCRA 92), presentation was made on the ccomplete 2014 results including carbonization conditions and coke properties from CanmetENERGY Carbolite and 18in. ovens and CONSOL Horseshoe oven (triplicate tests in each oven). Although significant differences surrounding maximum wall pressures were found between ovens, repeatability of wall pressure profiles in individual ovens was good. CSR/CRI and ASTM Stability/Hardness were comparable for Carbolite and 18in. ovens. The higher coke M40/I40 from Carbolite oven is attributed to larger mean coke size. The lower coke stabilization and higher coke fissure-free size from Carbolite oven is due to fewer coke drops compared to coke from 18in. oven. The oven benchmarking work will be repeated in FY 2015-16 using the same steelmaker coal blend

Oven Utilization:

CanmetENERGY oven utilization statistics for 2014-15 (Table 1) shows the following in comparison with 2013-14.

1. Sole-Heated Ovens

- CCRA – 14 vs 15 trials
- Coal Companies – 165 vs 206 trials (38% Canmet, 35% Stelco, 27% SHO3)
- Steel Companies – 76 vs 80 (42% Canmet, 30% SHO3, 28% Stelco)

In total, usage of sole-heated ovens in 2014-15 was 255 trials - compared to 301 trials in 2013-14 (15% lower).

2. Sole-Heated Oven Coke Reheats - CSR

- CCRA – 25 vs 5
- Coal Companies – 96 vs 114
- Steel Companies – 35 vs 21

In total, 156 reheats of sole-heated oven cokes for CSR determination – vs 140 in 2013-14.

3. CSR Determination

- CCRA – 57 vs 11
- Coal Companies – 219 vs 247
- Steel Companies – 71 vs 43

In total, 347 CSR evaluations were performed – vs 301 in 2013-14.

4. Coke Stabilization

14 coke stabilization trials were done in 2014-15 vs 7 in 2013-14 (Measure of coke size distribution, ASTM S/H, Extended IRSID). These were all done for steel companies.

Movable Wall Ovens

- CCRA – 22 vs 9 trials (19 in Carbolite, 3 in 18 inch oven)
- Coal Companies – 107 vs 130 trials (All in Carbolite oven)
- Steel Companies – 39 vs 32 trials (All in 18 inch oven)

In total, usage of movable wall ovens in 2014-15 was 168 trials compared to 171 trials in 2013-14 (2% lower).

Table 1

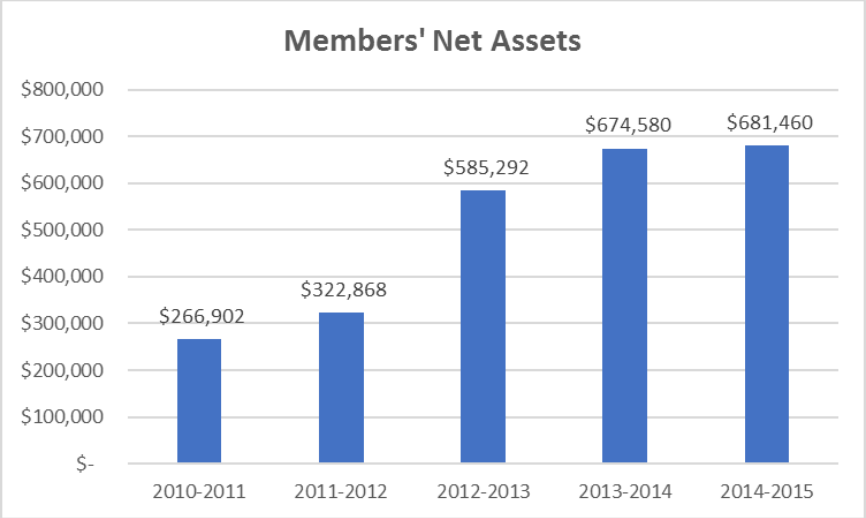
Utilization of CanmetENERGY Facilities

Oven Tests				
April 1, 2014 March 31, 2015				
Oven	**CCRA**	**Coal Companies**	**Steel Companies**	**Totals**
SHO	**14**	**165**	**76**	**255**
Stelco	6	58	23	87
Canmet	3	62	32	97
Oven 3	5	45	21	71
SHO Coke Reheats	**25**	**96**	**35**	**156**
CSR	**57**	**219**	**71**	**347**
Coke Stabilization			**14**	
Movable Wall Oven	**22**	**107**	**39**	**168**
18 inch	3	0	39	42
Carbolite	19	107	0	126

Year in Review

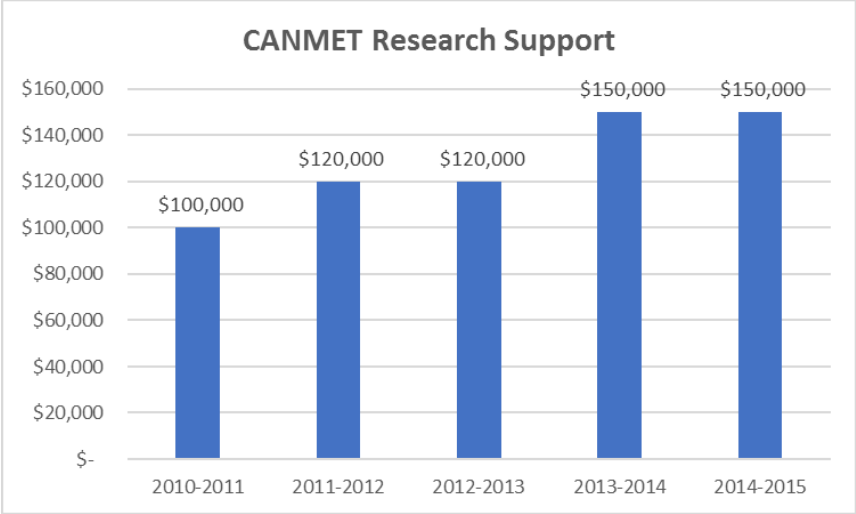
Despite the continuation of industry financial challenges due to current lower than desirable commodity pricing realities, CCRA membership remained stable during the 2014-2015 fiscal year.

Financially, the Members' Net Assets for at the end of the year totaled $681,460 approximated the $674,580 reported in 2013-2014 reflecting a fiscal year result slightly above the break-even level.



Total revenues are down some $97,000 largely attributable to CCRA not requiring member contributions towards the Non-Recovery Oven Project and a planned reduction in the Member Research Levies for the year.

Notwithstanding the drop in 2014-2015 total revenues, CCRA maintained its CANMET research support at $150,000, unchanged from the 2014 levels. The cumulative research support made to CANMET by CCRA over the last five years totaled $1.2 million in direct support including the contributions to the non-recovery oven project and an additional $5.2 million in research and development testing by CCRA members.



Although CCRA was not incorporated until 1981, it began as an active unincorporated Association on September 2, 1965 which will result in CCRA achieving its 50th anniversary during the upcoming fiscal year. This milestone will represent a proud moment for CCRA which will have supported the coal and carbonization sectors in partnership with Natural Resources Canada – CANMET for five decades.

Audited Financial Statements

crawford
smith &
swallow

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Financial Statements

March 31, 2015

crawford smith & swallow

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Financial Statements

March 31, 2015

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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, 2015, 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, 2015, 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
May 26, 2015

CRAWFORD, SMITH AND SWALLOW
CHARTERED ACCOUNTANTS LLP

LICENSED PUBLIC ACCOUNTANTS

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF FINANCIAL POSITION

March 31, 2015

Assets	2015 $	2014 $
Current Assets		
Cash	277,171	361
Temporary investments	1,350,413	1,359,655
Accounts receivable	1,342	312,881
Sales tax recoverable	31,442	964
Prepaid expenses		8,850
	1,660,368	**1,682,711**
Liabilities and Members' Net Assets		
Current Liabilities		
Accounts payable and accrued liabilities	10,200	8,661
Due to CANMET	968,708	979,470
Deferred income		20,000
	978,908	1,008,131
Members' Net Assets	681,460	674,580
	1,660,368	**1,682,711**

Signed on behalf of the Board:

_____ Director

_____ Director

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF OPERATIONS AND CHANGES IN MEMBERS' NET ASSETS

for the year ended March 31, 2015

	2015 $	2014 $
Revenue		
Confidential research and development	1,326,422	1,415,184
Research levies	190,000	190,000
Non-recovery oven contributions		67,000
Consulting funding	6,425	7,710
Membership fees	800	700
Interest income	8,481	7,183
Other income	55	1,733
PWC funding	60,000	
	1,592,183	1,689,510
Operating Expenses		
Confidential research and development	1,326,422	1,415,184
CANMET research support	150,000	150,000
Consulting	8,857	8,857
Outside research	75,213	
Meeting	834	
Office	17,562	16,639
Professional fees	6,415	9,542
	1,585,303	1,600,222
Excess of Revenues over Expenses	6,880	89,288
Members' Net Assets, Beginning of Year	674,580	585,292
Members' Net Assets, End of Year	**681,460**	**674,580**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

STATEMENT OF CASH FLOWS

for the year ended March 31, 2015

	2015 $	2014 $
Operating Activities		
Excess of revenues over expenses	6,880	89,288
Changes in working capital components - note 2	260,688	130,464
Funds provided by operating activities	267,568	219,752
Investing Activities		
Decrease (increase) in temporary investments	9,242	(264,328)
Increase (Decrease) in Cash	276,810	(44,576)
Cash, Beginning of Year	361	44,937
Cash, End of Year	**277,171**	**361**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2015

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, 2015

2. Statement of Cash Flows

Changes in working capital components include:

	2015 $	2014 $
Accounts receivable	311,539	(312,881)
Sales tax recoverable	(30,478)	39,304
Prepaid expenses	8,850	(8,850)
Accounts payable and accrued liabilities	1,539	1,238
Due to CANMET	(10,762)	391,653
Deferred income	(20,000)	20,000
	260,688	**130,464**

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 $ 7,722 (2014 - $ 7,769).

Credit risk

Credit risk is the risk that a counterparty will be unable to fulfil its obligations on a timely basis or at a reasonable cost. The Association has accounts receivable which are exposed to credit risk. The Association monitors, on an ongoing basis, the credit risk to which the Association is exposed and takes measures to mitigate any risk of loss. Provisions against losses from bad debts are recorded according to credit risk, historical trends, general economic situations and other information. Accounts receivable are net of an allowance of nil.

Credit facilities

The Association has not obtained any external credit facilities and relies solely on annual revenues plus accumulated working capital to finance its annual cost of operations.

The extent of the Association's exposure to the above risks did not change during the year.

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

NOTES TO FINANCIAL STATEMENTS

for the year ended March 31, 2015

4. Related Party Transactions

Fees amounting to $ 14,658 (2014 - $ 13,181) 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.

6. Comparative Figures

Certain prior year's figures have been reclassified to conform with the current year's presentation.

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Schedule 1

FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF OPERATIONS AND MEMBERS' NET ASSETS

for the year ended March 31, 2015

	2015 $	2014 $	2013 $	2012 $	2011 $
Revenues					
Confidential research and development	1,326,422	1,415,184	832,221	1,231,511	365,705
Research levies	190,000	190,000	210,000	210,000	104,000
Non-recovery oven contributions		67,000	363,000	191,151	8,850
Consulting funding	6,425	7,710	7,875	9,000	
Membership fees	800	700	700	700	400
Interest income	8,481	7,183	9,615	5,896	4,120
Other income	55	1,733	169	26,532	1,000
PWC funding	60,000				
	1,592,183	1,689,510	1,423,580	1,674,790	484,075
Operating Expenses					
Confidential research and development	1,326,422	1,415,184	832,221	1,231,511	365,705
CANMET research support	150,000	150,000	120,000	120,000	100,000
Non-recovery oven			180,700	237,000	
Consulting	8,857	8,857	8,679	8,679	
Outside research	75,213				
Meeting	834		1,523	3,486	2,126
Office	17,562	16,639	12,138	12,128	7,633
Professional fees	6,415	9,542	5,895	6,020	5,860
	1,585,303	1,600,222	1,161,156	1,618,824	481,324
Excess of Revenues over Expenses	6,880	89,288	262,424	55,966	2,751
Members' Net Assets, Beginning of Year	674,580	585,292	322,868	266,902	264,151
Members' Net Assets, End of Year	**681,460**	**674,580**	**585,292**	**322,868**	**266,902**

See accompanying notes

CANADIAN CARBONIZATION RESEARCH ASSOCIATION

Schedule 1 - continued

FIVE YEAR FINANCIAL REVIEW

UNAUDITED STATEMENT OF FINANCIAL POSITION

as at March 31, 2015

	2015 $	2014 $	2013 $	2012 $	2011 $
Assets					
Current Assets					
Cash	277,171	361	44,937	7,513	5,246
Temporary investments	1,350,413	1,359,655	1,095,327	1,011,183	550,773
Accounts receivable	32,784	313,845	40,268	208,445	11,492
Prepaid expenses		8,850			
	1,660,368	**1,682,711**	**1,180,532**	**1,227,141**	**567,511**
Liabilities and Members' Net Assets					
Current Liabilities					
Accounts payable and accrued liabilities	10,200	8,661	7,423	10,272	8,920
Due to CANMET	968,708	979,470	587,817	894,001	289,889
Deferred income		20,000			1,800
	978,908	1,008,131	595,240	904,273	300,609
Members' Net Assets	681,460	674,580	585,292	322,868	266,902
	1,660,368	**1,682,711**	**1,180,532**	**1,227,141**	**567,511**

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

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 Associations 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 andthe 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 form CCRA member companies and later CCRA employedpersonnel for this purpose. In 1968 a new facility location was chosen at Bell's Corners 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 alsorelocated 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 coal.

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 becoming 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.

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 objects.

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.

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 objects," 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 CRA/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 Bell's 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 steelcompanies. The PCI facilities at Bell's Corners was proving its value in the injectionprogram. 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 its 30th Anniversary of its founding. Because of the 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 the old confidential oven test 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 the another down turn in steel and coal industries with two of the three Canadian steel and a coal producers 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 it is hoped that new members can be attracted as the economy in these industries improves. 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.

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

The cokemaking industry is down to three steel producers, and because of economic conditions, only one is currently 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 a "Understanding" document created in 1984. This document was has been modified with the latest update completed in 2000.

Over the years CCRA and CANMET have carried out many research and development programs to improve the metallurgical coal and cokemaking operations of the 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. A laboratory to conduct carbonization research is beyond the feasibility of any one company so the single shared Canadian lab 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 exporters of metallurgical coal as well it will supply a growing proportion of the coking coal used in Eastern Canada during the next few years.

As CCRA celebrated its 40th Anniversary in 2005, the future looked more promising than it has for several years, despite the economic ups and downs of the industries that CCRA represents. The continued CCRA/CANMET partnership has benefited Canada as the participating industries have gained new information as a result of the R&D. International recognition has bee 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 Bell's 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 Ross was associated with CCRA he presented numerous papers on the industry.

In 2007, two new coal companies join 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.

In the spring of 2009, the Algoma representative Bob Lamour retired after being on the Technical Committee and a Board member. Bob was replaced by Eilal Kaukolin. Barry Ryan retired from the BC Government Ministry of Energy, Mines and Petroleum Resources and as there was not a replacement named, the BC Government is no longer a CCRA member.

Dr. John Price and Dr. John Gransden, both retired from Natural Resources Canada during the 2009. These two gentlemen have been at Bells Corners for many years and their departure represents a significant loss to CCRA. CCRA wishes to thank them both for their contributions to Carbonization in Canada and wish them all the best in their retirement.

Unfortunately, 2008/2009 continued to represent a tough economic climate for the steel and coal industries as the overall economic downturn has caused a dramatic reduction in steel demand which results in a drop in metallurgical requirements.

Green House Gas has become a major thrust of the joint R&D program in the last couple of years and the research program reflects this issue. During this year the Technical Committee and the Board of Directors have spent a significant amount of time putting together information on the development and financing of a NonRecovery Pilot coke oven so the joint CCRA/CANMET program can look at this new cokemaking technology.

Because the cost of such a facility is critical to have Government participation at both the Federal and Provincial levels and include other parties such as Ontario Hydro Generation as partners. Planning studies were prepared for future presentaton.

The Current Decade

The 45th anniversary of CCRA's creation was celebrated in 2010. CCRA continued to advocate for a Non-recovery pilot coke oven by meeting with the Minister of NRC in December of that year. Shortly thereafter, a new Minister of NRC 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 a Non-Recovery Pilot Coke Oven (NRO) for Bell's Corners. The NRO technology is one of the latest approached to coke ovens and pilot facilities are nearly non-existing, so little R&D can be carried out. CCRA's goa was to put Canada at the leading edge of this technology by having a facility where our members can determine how coal behaves in this type of the oven and what is needed to allow the Canadian steel industry to determine the value of this technology to control emissions and product quality.

The projected budget for the NRO facility is nearly $1 million. It is hoped that this funding will 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 members as US Steel Canada, SunCoke Energy, Inc. joined. Grande Cashe Coal Corp. also rejoined the Association after an absence of some years.

CCRA signed a contract with Hatch Inc to carry out the preliminary design of a pilot scale Non-Recovery Oven with the final report due in the summer of 2012. Funds for this work were raised by some of the CCRA members contributing to a fund for this specific purpose. CCRA has also signed a Non Repayable Contribution Agreement with Natural Resources Canada to assist with the costs. The Canadian Steel Producers Association has also contributed to the project. The goal is to secure the funding to enable the construction of the facility during the next fiscal year.

The new NRO will be located at Bell's Corners CanmetENERGY facility with the other coking facilities. A major project to add a Energy Recovery Pilot Coke Oven (ERO) started in 2012/2013 with Hatch being contracted to develop a preliminary design for a facility which will put Canada on the leading edge of a new coke oven technology. The engineering design study was financed by contributions from CCRA member companies and a forgivable loan from Natural Resources Canada.

With the design complete, planning on the location and support facilities got under way with one of the existing movable wall ovens being relocated to facilitate the ERO. Planning is under way to obtain financial support to construct the actual oven.

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 .

During 2014/2015 work continued on the Energy Recovery Pilot Coke Oven. CCRA has joined with CanmetENERGY to provide a web site for Canadian Carbonization. The web site can be accessed at www.cancarb.ca and it contains timely information on the activities of CCRA/CanmetENERGY research and development programs and other information on the Canadian Coal and Coke industry.

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.

2014-2015 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

2014-2015 Board of Directors

COMPANY	NAME	PHONE (FAX)
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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

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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 2014-2015

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 Fissuratio n**	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. Netzsch horizontal High-Temperature Dilatometer (Germany) purchased by CPM, France has been evaluated. 2. CanmetENERGY experiencing difficulty with HTD from Automazione (Italy) to measure HT contraction in semi-coke post resolidification. To date, effects of high-temperature lubricants, paper materials, sample length, piston material, weight & diameter, guider with spring load on piston have been explored. 3. TGA trials completed for detecting loss of VM at resolidification (primary gases) and beyond – derivative profiles. The latter profiles reveal interesting transitions/mechanisms of weight loss which have some resemblance to expansion changes observed in CPM horizontal diameter. 4. NSC (Japan) paper on use of a High-Temperature Dilatometer examining effect of coke contraction on mean coke size has been reviewed. 5. Coals sent to CPM France for testing in Netzsch horizontal High-Temperature Dilatometer. Data analysed via PCA technique. 6. Thyssen Krupp, Germany contacted for experience and issues in vertical HT dilatometer. 7. A3 work plan for HTD tabled at March 2014 meeting. 8. New design of HT dilatometer is required to address problem of piston jamming and to measure small HT contraction using non-intrusive device.

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
		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. 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.	1. Rank coals for their burnout in a horizontal bench-scale PCI simulator rig. 2. Examine BF dust & 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.	1. CanmetENERGY bench-scale PCI simulator construction completed in Q3 2013-14. 2. Results presented to CCRA during 2013 & 2014 on degree of burnout on selected coals. 3. CFD modeling of PCI simulations on different VM coals has been performed and being continued. 4. Results presented on characterizing BF dusts as per their different carbon types (char, coke and soot) via TGA. 5. Plan presented for validating accuracy of TGA technique for speciation of carbon type in blast furnace dust. Chars from injection rig and hot cyclone found to be suitable for synthetic char preparation. 6. A3 work plan for PCI rig tabled at December 2013 meeting. 7. Paper 'Development of TGA Technique for Carbon Type Characterisation in Blast Furnace Dust' presented at AISTech conference, Indianapolis, May 4-7 2014. 8. Abstracts submitted to AISTech 2015 & METEC InSteelCon 2015 on PCI /TGA work.
		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. 2. Explore potential of biomass from algae as a C source for bio-cokemaking and PCI.	*Bio-cokemaking* 1. Sole-Heated Oven work on high CSR WC coal with as-received and washed bio-car bon was completed. 2. Charcoal in coal blend affects both coke hot and cold strengths. Stability and hardness is maintained by manipulating size of charcoal added to coal blend. 3. Bench-scale laboratory work done on effect of different parameters for extracting minerals from charcoal to improve suitability for bio-cokemaking. 4. Review of charcoal-making technologies currently available and new bio-char briquette preparation technology developed in Japan. 5. CCRA updated Ontario Ministry of the Environment, March 2012 on R&D work. In June and September 2012, CCRA held meetings with major stakeholders from various levels of government, private sector and

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
					universities to present its research program and to become familiar with other bio-based carbon research currently taking place in Canada. Going forward, main challenge and requirement will be to convert raw biomass to a usable 'mineral-matter free' bio-char. Main driver for this work is possibility of a C tax imposed on industry by governments. 6. Papers presented at Metec-InSteelCon, Germany, June 2011 and AISTech, Atlanta, May 2012. 7. CCRA updated Canadian Steel Producers Association in January 2014 on R&D work related to utilization of bio-carbon. 8. Construction and use of small-scale laboratory apparatus (2 kg capacity) for demineralization of bio-char. 9. Performed bench-scale work on 'Solid Bio-Char Pre-Treatment for Coke and Iron Making' from 2013-14 PERD funding. 10. Meeting with U. Guelph School of Engineering professors Dutta and Chiang to discuss processing and use of bio-carbon for iron and steel applications. 11. Meetings with Canadian Forest Service (CFS) and Hunter Farms (Eastern Ontario) to point out specifications needed for bio-carbon materials for coke- and iron-making. *Bio-fuel injection* 1. Flowsheet on coal washing from UCC Energy (White Mining Ltd and CSIRO, 2011) using acid/alkali leaching to dissolve mineral matter presented at November 2012 meeting. Based on flowsheet, charcoal demineralization process was proposed. 2. Paper on "Selection of Biofuel for Direct Injection in Blast Furnace Ironmaking presented at Scanmet IV conference, Sweden, June 2012. 3. Paper on "Use of Biofuel in Canadian Ironmaking" presented at ICCS&T 2013, October 2013.

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
2. Energy and Environment	***To determine options for alternative cokemaking in Canada***	**CCRA 77 Coke and Power - Energy Recovery Cokemaking**	1. Evaluation of energy savings and coke 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.	1. Determination of funding source(s) available for this large-scale project - approximately $2M will be needed over 5 years. 2. Site preparation engineering design and materials purchasing.	1. Hatch engineering design of pilot-scale Energy Recovery Coke Oven completed in October 2012. 2. Funding obtained through federal ecoEII program towards purchase and design of new oven and for long-term R&D program, 2012-2016. 3. Research program has been developed. Emphasis has been placed on coke quality, heat/energy recovery and environment. CCRA member companies need to provide value added justifications surrounding technical R&D issues. 4. CCRA members approached to contribute financially towards building of new oven. 5. CanmetENERGY's Carbolite pilot coke oven was successfully relocated, reconstructed and recommissioned in Q4 of 2012-13–cost covered by CCRA. 6. Detailed funding plan for scheduling ordering and purchasing of materials, hiring contractors for construction of ERCO has been prepared. Updates provided to CCRA on progress in construction of new ERCO with projected timeline and budget. 7. Oven construction & financial update provided to CCRA during 2014-15. 8. Paper 'Energy Recovery Pilot Coke Oven Design' presented by Hatch at AISTech conference, Indianapolis, May 2014.
3. Fundamental Aspects of Coal and Coke Utilization	***To understand the fundamental science of coal and coke utilization in order to improve energy efficiency***	**CCRA 80 Plant Coal Quality Upgrading**	1. To characterize the metallurgical properties of mine circuits to better understand how to improve coke quality and hence energy efficiency for both the coal and steel industries.	1. A plan to characterize the metallurgical properties of coarse, medium, fine and tailing circuits for the new coal members has been accepted.	1. Work plan "Quality Characteristics of Wash Plant" was presented-objective is to determine ways to improve quality of washed coal and resultant coke. 2. Characterize heavy, medium and fine circuit products at Anglo American/Peace River Coal Trend mine-conduct rheological and oxidation tests to determine which ones are suitable for such coals.

Program	Program Objectives	Projects	Project Objectives and Deliverables	Specific Project Activity	Status of Current Work, Next Steps or Final Product
			2. To determine which "oxidation/aging" parameters best reflect the caking/coking ability of each circuit and coal.		
		CCRA 90 Influence of Organic Liquids on Coking Properties	1. To investigate the effects of organicliquids 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 organic liquids on coal and coke quality of Western Canadian coals was tabled and accepted.	1. The first coal (untreated & treated Western Canadian high-inert) was analysed at t=0, 1, 3 & 6 months and MWO tests done on 1 & 6 month samples. Progress reports presented at 2013-14 meetings. 2. Work jointly conducted at GWIL UBC, ALS and CanmetENERGY. 3. New work proposal "Organic Liquids vs Water Based Methods for use in Washability of Exploration Drill Core Samples: Effects on Coking Properties and Coke Quality" tabled at December 2013 meeting and further discussed at March 2014 meeting. 4. Phase 1 work presented at CIM 2014 convention, Vancouver, May 2014 and at Pittsburgh Coal Conference, October 2014. 5. Update on Boner Jig, a water based device for washing coal, given at September 2014 CCRA meeting.
		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	1. Work presented confirming complexity of mineral changes during coal to coke transformation. 2. XRD-RIR technique is adequate and accurate for identifying minerals. 3. Minerals in MWO and SHO cokes are essentially identical supporting similar CRI and CSR for cokes produced by different carbonization routes. 4. Calcium sulphate minerals anhydrite and bassanite present in Low-Temperature coal and coke ashes as excess oxygen in ashing furnace promotes reaction between Ca-bearing minerals and S. 5. 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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				during coal to coke transformation. 3. A suite of activities were 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.
		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. It showed that blends of Canadian coals of Ro~1.17 and MF of only 40-50 dd/min can make good quality coke. 2. Phase 2 and 3 (12 Carbolite oven tests) completed in 2012-13 showed that blends of Canadian coals of Ro 1.25 (Ph 2) and 1.12 (Ph 3) and Maximum Fluidity of only ~50 dd/min can make good quality coke – not 200 dd/min as per MOF (Miyazu) 1974 paper. 3. Presentation of CCRA paper on 'Predictive Model for Blending Coking Coals – Part 1: Western Canadian Coals' at AISTech 2013 conference. 4. Carbonization work undertaken on 5 US coal blends at Ro 1.16 in April 2014 and update provided at June and September 2014 meetings. 5. Abstracts on Canadian/USA modified MOF diagram work submitted to AISTech 2015 and METEC InSteelCon 2015.

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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. Bed resistant index data for industrial wharf and BF cokes from AM Dofasco and USS Canada presented at November 2012 and March 2013 meetings. 2. Project has demonstrated successful development of standard technique to compare size and shape characteristic as well as bed permeability between different batches of coke. 3. Presentation of CCRA paper on 'Coke size and shape characterization for bed permeability estimation' at AISTech 2013 conference. 4. 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.
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	1. To develop a coke strength prediction model based on coal properties.	1. Coke strength prediction (stability, I_{40} and CSR) on AM Dofasco movable wall oven database undertaken using PLS modeling – collaboration with Dofasco Process Automation.

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			CanmetENERGY data.		2. Teck coal database under examination and link made with AM Dofasco to harmonize the statistical approach. 3. Multivariate technique for analyzing a large data set and establishing correlations was demonstrated. Using this technique on CanmetENERGY data for developing a coke quality model, coal ash chemistry was found to have the most significant effect on CSR and CRI followed by rheological properties. 4. Presentation made on 'Repeatability and Precision of Coke Quality Measurements at CANMET – Error analysis on tests run in duplicate – CSR, CRI, ASTM Stability, Hardness'. 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. 8. Paper 'Coal Stockpile Moisture and Cokemaking' presented at AISTech conference, Indianapolis, May 2014.
	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. 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.
	To develop the use of small-scale carbonization apparatus for	**CCRA 88 Small-Scale Carbonization Facility**	1. To develop the use of small-scale carbonization apparatus for yielding valuable	1. Development of method assessing the ambient strength of coke utilising small quantity of coal.	1. 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).

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	valuable coke quality indicators	**for Cold & Hot Coke Strength Determination**	coke quality indicators.	2. CSR measurement on selected component coals from Western Canada in CanmetENERGY's 18 in. Research and Carbolite ovens and Sole-Heated Ovens.	2. Data presented on low CSR coke yielding larger difference compared to high CSR coke from the two coke preparation methods– attributed to difference in coke ASG. 3. Papers presented at Metec-InSteelCon 2011, ICCS&T 2011 and published in Fuel Journal, December 2013.
	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. Triplicate tests conducted in CanmetENERGY 18" and Carbolite pilot oven during March 2014. Centre temperatures, wall and gas pressures were compared. 2. Coke properties/quality produced from both MWO at CanmetENERGY were measured and reported to the CCRA at June 2014 meeting.