

## Underground Coal Mining Safety Research - A Novel Canadian Initiative

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**ABSTRACT:** Since 1998 underground coal mine safety research in Canada has been spearheaded by the Underground Coal Mining Safety Research Collaboration (UCMSRC). UCMSRC is a collaborative "in-kind consortium" which brings together all of the principal stakeholders such as industry, labour, regulators, inspectors and universities, in jurisdictions where underground coal mining is active (Federal and Provincial - Nova Scotia, Alberta and British Columbia). The main goal is to contribute to improving safety and health in underground coal mining in Canada by collaboratively identifying and addressing related technology and knowledge gaps in key areas common to current/potential operating mines.

### 1 INTRODUCTION

The underground coal mining industry in Canada is small and geographically wide spread. Individual companies operate only one or two mines; the economies of scale that allow for large research budgets are absent. In addition, mining conditions are often difficult, and markets cyclical.

Over the last four decades, health and safety-related research in underground coal mining in Canada has been typically carried out by the operating companies through a combination of in-house expertise and specialist contractors and consultants with significant technical and financial support from the Federal Government.

The latter input has primarily been provided through the Mining & Mineral Sciences Laboratories (MMSL) of the Canada Centre for Mineral & Energy Technology (CANMET) of the Federal Department of Natural Resources, Canada (NRCan, formerly Energy Mines & Resources). Between 1982 and 1998 the Cape Breton Coal Research Laboratory in Sydney, N.S. spearheaded government investment in coal mine health and safety issues.

CANMET's research directions continue to evolve in response to changing needs of clients - both external and internal clients. In a major programme change in 1998 the CANMET Coal Mine Health and Safety programme was shut down because the industry could no longer provide the funds required to maintain cost-sharing quotas. However, following

consultation with industry stakeholders, CANMET began a new research initiative in this area, known as the Underground Coal Mining Safety Research Collaboration (UCMSRC).

This paper outlines in turn the background, development, establishment, key features, initial progress and potential future development of this new research initiative.

### 2 UNDERGROUND COAL IN CANADA

Coal mining in Canada began on Canada's east and west coasts. In the east, the first recorded mine was at Grand Lake, New Brunswick in 1639. In the west, coal mining began in 1836 on Vancouver Island, British Columbia. As the railroads moved west from central Canada in the late 1800s, mining spread to eastern British Columbia, Alberta and Saskatchewan.

During the first half of the twentieth century half of Canada's energy needs were supplied by coal. By 1960, however, petroleum products (crude oil and natural gas) had replaced coal as the energy source of choice and coal's share had dropped to 20 per cent.

The change happened so rapidly that coal-mining communities found themselves facing mine closures and job losses if they could not find a new market for their product. Many of them could not and in many places coal mining, especially underground coal mining, all but disappeared.

The coal industry began a comeback of sorts as oil price rises and strong demand for metallurgical coal in the Pacific Rim allowed producers to exploit these markets. In 1960, Canada mined 11 million tonnes of coal. In 1979, it mined 33 million tonnes. In 2001, production stood at over 70 million tonnes. However, almost all of this coal was surface mined, with the exception of underground mines on Cape Breton Island, on the Alberta / British Columbia border and on Vancouver Island.

In the last decade, underground coal mining was restricted to the offshore deposits in the Sydney Coalfield of Nova Scotia (undersea longwall retreat mining), a room and pillar underground operation at Grande Cache in the Alberta Rockies, and an underground room and pillar mine at Campbell River on Vancouver Island off Canada's west coast.

In 2000, the Alberta mine went into liquidation as a result of high debt and low coking coal prices. The mines in Nova Scotia, run as a Federal Crown Corporation, closed in 2001 as the Federal Government determined that the operations were no longer economically viable. In 2003 there was only one operating underground coal mine in Canada, at Campbell River on Vancouver Island.

## 2.1 Future Prospects

Despite the bleak recent history, the future looks more promising for the underground coal mining industry. Several years after the closure of the Cape Breton underground mines, the Provincial Government is offering the remaining viable coal leases to interested parties. There is the possibility of at least one undersea underground coal mine being established.

In Alberta, a new underground room and pillar operation producing coking coal at Grande Cache obtained government approval and began work in 2004. In north eastern British Columbia at least one company has developed plans for combined surface and underground operations to tap low ash coking coal reserves, although such projects are still in the early stages.

Even with these new opportunities, however, the Canadian underground coal mining industry is small by any standards, presenting significant challenges to the regulatory bodies.

## 2.2 The Canadian Coal Mine Safety Regulatory Infrastructure

In Canada, individual Provinces and Territories have autonomy over a number of social areas, including occupational safety and health and the regulation of

mineral resource extraction. Each Province and Territory has its own mines safety program, and conducts safety inspections to ensure compliance. Provincial Mines Chief Inspectors meet annually, and there are Provincial Eastern and Western regional Mine Rescue Competitions.

The Federal Government oversees national issues, such as defence and foreign policy, but also retains regulatory and safety inspection powers over its own employees and a number of other industries. Until recently the underground coal mines that were worked by Cape Breton Development Corporation (CBDC), a Federal Crown Corporation, fell under a Federal Coal Mines Safety Act and inspection service.

Nova Scotia repealed its coal mining regulation Act in 2003 and new mine regulations came into effect in November 2003. The regulations are essentially prescriptive in nature, and as well as establishing qualifications and duties, set out rules for the use of explosives, electricity, diesel equipment and the like.

British Columbia has a single mines safety code which includes sections relating to underground coal mines. Again, the code is largely prescriptive in nature. The province reviews and updates this code every four to five years, with the last update completed in 2003.

Alberta is the only other Province with specific underground coal mine regulations. Very recently the Province completed a major overhaul of all Occupational Health and Safety legislation which replaced most industry specific regulations under the OHS Act with codes of practice. The mining section of the code of practice varies little from the previous regulations, but the general code now includes a requirement for hazard assessment of all workplace tasks, although risk assessments are not recognised.

Coal mine safety inspection services in all three provinces are limited. In the absence of any working underground coal mines in Nova Scotia the complement of inspectors and support staff is small and inspections are limited to a small number of surface mines and non-coal underground mines. In British Columbia two Provincial employees have underground coal mining experience and qualifications, one of whom is directly responsible for compliance, although the staff resource base is somewhat larger as British Columbia also has operating underground hard rock mines. In Alberta, mines inspection is contracted out. At present, the underground coal mine inspector, the electrical inspector and mechanical inspector are semi-retired consultants based out of Calgary, but actually resident in neighbouring British Columbia.

### **2.3 Underground Coal Mine Safety Research and Development**

Canada was founded on its rich natural resource base, so it is not surprising that the Federal Government established an oversight department to assist in the development of technologies and techniques to maximize the benefit of these resources to the nation Natural Resources Canada (formerly Energy, Mines and Resources) - CANMET (Canadian Centre for Mineral and Energy Technology) has played a significant role in mine technology and mine safety in both coal, hard rock, and salt/potash mining in Canada

CANMET has historically been active in underground coal mine research The Western Laboratory, with offices in Edmonton and Calgary, Alberta, was involved in ground control and subsidence research in underground coal mines, coal preparation and oil sands in western Canada, and also initially conducted work in the east In the late 1970's, during the resurgence of interest in coal, Alberta with support from the Coal Association of Canada and the Federal Government established its own Provincial facility, the Coal Mine Research Centre, which also involved itself in strata control and mining technology

In 1979 a frictional ignition at CBDC's No 26 Colliery in Glace Bay resulted in a methane explosion that killed 12 miners Acting on the recommendations of the inquiry into the accident, CANMET established the Cape Breton Coal Research Laboratory (CBCRL) in 1982 With 15 scientists and support staff, it conducted safety and health related research into ventilation, strata control and mining methods for 16 years, mostly in eastern Canada, but also in the west when required, supporting the CANMET Western Research Laboratory

CBCRL provided a catalyst for safety research in the Canadian underground coal mining industry through comprehensive joint collaborative research programs with the mining companies Through research contracts it maintained underground coal mining expertise at university mining schools and consulting firms In 1992 they provided support services to the mine rescue operations after the explosion at Westray Mine

However, national concern over the rising level of public spending in the mid-1990's led to large cuts in budget across all of the civil service CANMET was identified as a "service" department that could assist in its own financing by performing "cost

recovery" work Unfortunately, the small size of the underground coal mining industry could not support CBCRL to the desired amount, and it was closed in 1998, shortly before the closure of the CBDC mines

### **3 DEVELOPMENT OF UCMSRC**

The Federal Government's 1995 Program Review within CANMET involved a business case evaluation of all programs CANMET's Cape Breton Coal Research Laboratory (CBCRL) in Sydney, Nova Scotia was re-profiled as a research program known as the Coal Mining Health & Safety Program (CMHS) A 3-year plan to attain financial self-sufficiency was established in 1996 and reviewed in late 1997 when it was reluctantly recognized that, with a small client base, recent strong performance was clearly not sustainable in the long term It was announced in February 1998 that CMHS and hence the CANMET Sydney Laboratory should cease operations in March 1998 However, CANMET made clear their desire to stay active in this research area

In the summer of 1998, CANMET approached CMHS stakeholders for their ideas on how CANMET could continue to meet their technology research needs in this field A questionnaire was sent to 22 stakeholders including operators, inspectors, regulators, researchers (government, private, universities) These stakeholders represented all the jurisdictions involved in underground coal mining Federal, Alberta, British Columbia & Nova Scotia Of the 13 responses received, 11 were supportive Workplace safety and health remained important factors in underground coal mining and there was strong support by the stakeholders for CANMET to continue collaborative research in underground coal mining safety

A draft agreement, including work plans for the initial project areas, was prepared and circulated to stakeholders for consideration It was finalized as a Memorandum of Understanding (MOU) for UCMSRC on September 24, 1998 Seventeen stakeholder organizations signed the MOU to become participants in UCMSRC, with 2 other organizations requesting a continuing role but as Associate Members (without voting privileges) The participants include operators, labour, regulators, inspectors and university researchers, across four jurisdictions (Federal, Nova Scotia, Alberta, British Columbia) The MOU outlined the basic details of what the UCMSRC was about, how it would work, how it was to be funded and what was required of participants

The MOU has since been renewed several times. However, in order to facilitate those stakeholders/participants who were unable to sign the MOU due to "legal" concerns, a simplified Letter of Understanding (LOU) was prepared for the period October 1, 2003 to September 30, 2004 to replace the MOU. The LOU is renewed for each subsequent year.

Committed to constructive dialogue and project implementation, participants benefit from dialogue with others involved in the underground coal mining industry across Canada, and from participating in project selection and research work, also sharing the findings of the research.

#### 4 KEY FEATURES

##### 4.1 Structure and Operation of UCMSRC

The purpose of UCMSRC is to provide a forum for dialogue and research involving stakeholders in Canadian jurisdictions where underground coal mining is active. The main goal is to contribute to improving safety and health in underground coal mining in Canada by identifying and addressing related "gaps" in technology and knowledge in key areas common to current/potential operating mines.

The organizational structure is relatively simple. An Executive Committee, consisting of three representatives from CANMET (the Chairperson, Secretary and Technical Advisor, the chair having the casting vote) and one member from each participating organization, is responsible for all decisions on direction, management and control, including discussion, selection and approval of projects and the people to work on them.

A Technical Forum Committee, comprising the three CANMET representatives (who are responsible for minutes, documents, liaison and coordination of day-to-day activities), at least one member from each of the participating stakeholders and a Technical Advisor discusses technical issues and coordinates project proposals and directions at regularly scheduled meetings. It also coordinates project teams and provides guidance for new projects that are approved by the Executive Committee. The Executive Committee and Technical Forum Committee meetings are usually held together in an effort to make the most effective use of participants' time.

Finally, project teams are formed as necessary to carry out each project. All project team leaders and members are approved and appointed by the Executive Committee (and may include participant

staff who are not on the Executive Committee). Project teams carry out the work and communicate via conference call and electronic media, formally reporting progress to the Executive Committee on a regular basis.

The prime means of communication is by telephone conference call. Typically participation in the collaboration involves commitment of less than 1 day per month of participants' time, plus one visit per year to a 'round table' meeting.

The Executive Committee strives to reach consensus on all matters. In the event of an impasse, decisions are made by a simple majority of those present, with the chair having the casting vote. Also, any approved project work involving work at a mine site will also require prior written approval from the operating company.

The Technical Advisor facilitates the on-going technical work. These duties include:

- the preparation of a "Technical Discussion" document for each meeting in which the latest technical information and news from the underground coal mining industry worldwide is summarized for the UCMSRC participants, with input also from the three CANMET representatives
- technical advice to the UCMSRC
- editing of technical papers undertaken by UCMSRC participants
- preparation of technical papers/information as directed by the UCMSRC

##### 4.2 Resources & Funding

For the first 5 years there were no cash contributions/payments required from participants except CANMET. UCMSRC relies on in-kind contributions from all participants to ensure the work (as defined for projects approved by the Executive Committee) can be achieved.

CANMET provided not only in-kind resources to support up to 2 full time position equivalents and appropriate administrative costs but also provided direct financial resources to support up to 3 postgraduate students across the three provinces and direct financial support for a technical advisor (\$250k per year).

The in-kind contributions include provision at no cost to UCMSRC of the following: appropriate time of staff and administrative support services, materials, equipment and approvals (e.g. in the case of any in-mine work), and travel, accommodation expenses (for example, to attend occasional in-person meetings).

Unfortunately, due to reduced CANMET - MMSL budgets, direct funding for UCMSRC was ended in September 2003. Despite the lack of direct funding, CANMET - MMSL continues to support UCMSRC by providing up to 2 full time position equivalents, maintaining the "secure" ugcoal.ca web site, and covering appropriate administration costs, amongst other things.

With this reduction in CANMET funding, UCMSRC has looked to alternative sources of funding. In the fall of 2003 the three provinces (Nova Scotia, Alberta and British Columbia) where there is underground coal mining were approached. Each province was requested to contribute \$7,500. Nova Scotia and Alberta each contributed \$7,500 for a total of \$15,000 on a "one-time" basis.

How to obtain future funding continues as an important issue with UCMSRC and various avenues are currently being explored. Given the expertise of Canadian coal operators in steeper seams, and in both longwall and room and pillar mining methods, as well as the extensive background in health and safety aspects, one option being explored is to expand the work of the UCMSRC to include overseas components.

## 5 PROJECT WORK

### 5.1 Project Selection

The Executive Committee seeks projects with significant potential impact, e.g. on safety and also on production and/or resource utilization, and with as wide as possible support from participants. The following project selection and approval criteria apply:

- a project topic/subject must relate to the improvement of safety and health of either active or potential underground coal mine operations in Canada and preferably also have potential significant impact
- a project should be agreed to by as wide as possible a support base across the participants, and ideally should be agreed to by the operators from all three provinces and by at least one other participant in each province.

The collaboration has produced a significant body of work, considering the limited funding available.

### 5.2 Geotechnical Review of Canadian Coalfields

Funded by CANMET and by the mining companies operating at the time, this project was aimed at

evaluating the geotechnical conditions existing in the major Canadian underground coal mining areas and describing standard methods for geological and geotechnical assessment purposes.

UCMSRC produced two separate reports which described the geological setting of the three major underground production areas and sought to standardise geological and geotechnical assessment between the various mines. Additional input and rock testing services were provided by CANMET staff.

### 5.3 Explosion Protection

Explosion protection in underground coal mines is an emotive issue in Canada, with strong opinions held on a wide range of subjects by all industry stakeholders. It was an explosion at No. 26 Colliery at Glace Bay, N.S. that provided the impetus for the establishment of CANMET's Coal Mine Health and Safety program, and the repercussions of the explosion at Westray Colliery in Stellarton, N.S. In the early 1990's are still being felt through the industry.

A number of topics relating to explosion protection have been covered as joint projects by UCMSRC members, including:

- a review of hazardous location zoning regulations in Canada and elsewhere as it pertains to the location and type of electrical equipment used underground, completed by CANMET staff at the request of UCMSRC stakeholders
- a review of the regulations dealing with the cutting off of electrical power during periods of elevated methane concentrations, particularly addressing the methane levels initiating cut-off in Canada and elsewhere, also completed by CANMET staff at the request of UCMSRC stakeholders
- a literature review of recent research into passive and triggered explosion barriers in underground coal mines, funded by CANMET and performed by Dalhousie technical University staff
- a review of international practice relating to the use of stone dust to control explosions, completed "pro bono" by members of the UCMSRC.

### 5.4 Canadian Underground Coal Legislation Review

Currently ongoing is a study aimed at identifying the similarities and significant differences between four

separate underground coal mining health and safety regulations (codes) currently in operation in Canada. This work, when it is complete will, it is hoped, provide a basis for the rationalisation of coal mining legislation in the country, although ultimately it is up to the individual regulators if they choose to take any notice of the results.

#### 5.5 Literature Reviews and "Fact Sheets"

Members of UCMSRC, and contractors paid out of UCMSRC funds, have prepared literature reviews on several important subjects on behalf of the group. These include:

- ◀ A List of International Expertise in Health & Safety in Underground Coal Mines
- Approved Explosives and Explosive Detonators for Use in Underground Coal Mines
- The Use of Fire Resistant Fluids in Underground Mining Equipment
- Explosion Proof Stoppings in Underground Coal Mines
- The Use of Refuge Stations in Underground Coal Mines

"Fact Sheets" are two or four page summaries of the results of UCMSRC investigations, presented in a point-by-point format for easy reference, along with major references to the information covered. These fact sheets are published as web-browser compatible documents, and once approved by the Executive Committee for publication are available to the public.

Fact sheets currently available include:

- Fact Sheet on the Use of Light Metals & Their Alloys in Underground Coal Mines
- Fact Sheet on the Use of Stone Dust to Control Coal Dust Explosions in Underground Coal Mines

#### 5.6 Other Activities

Other activities in support of the UCMSRC include the preparation of a quarterly Technical Review of the industry, which includes overseas and Canadian news and developments summarised from a variety of sources. This document serves a technology gatekeeping role, providing members with an overview of developments around the world.

The UCMSRC operates two web sites. A secure web site, allowing password protected access by members to meeting agenda's, minutes and notes, as well as reports and other documents, is hosted by CANMET. The secure website is accessed through a public portal, which allows members to reach the secure site, and the public to access published

information. This website, [www.ugcoal.ca](http://www.ugcoal.ca), is hosted by one of the UCMSRC participants.

## 6 CURRENT ISSUES IN UNDERGROUND COAL MINE SAFETY AND HEALTH.

The underground coal mining industry in Canada is now small and geographically widespread. With the current heating up of markets for western coking coals, and the release of leases in Nova Scotia, there is reason to hope that a small revival may take place. The current issues in underground coal mine safety and health are summarised below.

### 6.1 Multiple Safety Codes

Four different safety codes (Federal and three provinces) co exist within the Canadian underground coal mining industry.

While this is easy to understand in a political context, it has the effect of complicating the industry by restricting the mobility of equipment and manpower between provinces. This merits activity towards harmonizing regulatory issues and developing national industry competency standards for employees and officials to achieve improved efficiency and cost effectiveness.

### 6.2 Declining Personnel

Each Province must somehow provide inspection expertise in ventilation, electricity, strata control, subsidence, mechanical engineering and general mine safety from a dwindling resource base. Consultants from overseas can offer some relief, but few can offer experience in the conditions encountered in Canada.

The small size of the Canadian underground coal industry is unlikely to encourage the required recruitment into these areas or provide suitable development opportunities for junior staff to maintain an acceptable level of expertise for inspection duties. This warrants more inter-jurisdictional activity to maintain core resources and enhance response to any resurgence in underground coal activity.

Harmonization of regulatory issues and competency standards will assist in this, as would the development of a national resource base of competent inspectors and consultants on specific issues, who could then potentially be shared between Provinces.

### 6.3 Future Mining Needs

New underground coal mines in Canada are likely to be developed in mining conditions that push the limits of conventional mining methods.

The major potential underground coal resource in Nova Scotia is some 3.5 km offshore. Previous operators drove two tunnels to the coal seams which are now flooded and abandoned. Any kind of mining at this distance from the surface raises safety issues around subsidence and water inflows and emergency egress.

In Alberta, the majority of the remaining coking coal resources are in steep, thick seams. Non-conventional mining methods require considerable additional research for them to be safe and successful.

Mining in these conditions is foreign to most of the world's coal mining community. Competent extraction and inspection personnel are few and far between. There is a need to grow these competencies within the Canadian context to support the underground coal mining industry as it begins to exploit these reserves.

### 6.4 Research Funding

The small size of the underground coal mining industry does not attract significant research funding into underground coal specific safety issues. The slim financial margins of the producers do not allow for much in the way of proactive safety and health research. But in a climate of largely prescriptive legislation, what impetus is there for spending money on finding new and safer ways when the legislation you work under already sets minimum standards?

UCMSRC currently addresses this by allowing its members to identify key safety issues, and then using such resources as it has available, mostly time volunteered by its members, to understand and resolving them. However, in most instances limited additional funding restricts the UCMSRC approach to reviews of current practice overseas.

## 7 DISCUSSION

In some ways the downsizing and uncertainty over the future of the underground coal industry in Canada in the last few years has strengthened the need for closer communication and cooperation between the remaining underground coal mines and other stakeholders. Born out of severe funding cutbacks felt across the Canadian scientific civil

service, UCMSRC has provided a valuable forum for the few underground coal mine industry stakeholders that remain.

That isn't to say that all members share the same ideas; there is almost as much variation as there are members. However, although they may differ in the means of achieving it, each of the members, and the organisations they represent, are committed to ensuring the health and safety of underground coal mine employees.

It is this commitment that ensures the success of UCMSRC and allows members with competing interests to work together on joint projects for the benefit of everyone concerned. Coming from a nation known for almost excessive politeness and recognised international service as an arbitrator and peacemaker, it isn't surprising that this uniquely Canadian approach is enjoying some success.

The four key issues identified as taxing the future development of the Canadian underground coal mining industry, namely competing regulations, intellectual resources, future mining needs and the funding required to address these issues are subjects of active (and often intense!) debate within UCMSRC, which continues to apply itself to facilitate this dialogue and to ensure a supportive environment for any future resurgence of underground coal mining in Canada.

The medium-to-long-term outlook for underground coal mining in Canada has improved somewhat in the last year, largely due to an unforeseen rise in demand for the same metallurgical coal which stimulated a Canadian coal mining resurgence in the early 1970's. Substantial safety and health challenges will be raised as the industry expands.

Subject to obtaining the small amounts of funding required to maintain its activities, UCMSRC has the flexibility to develop further projects as the need arises, primarily through the Technical Forum meetings, but the issue of resources and their application to the challenges presented still remains.

There are two possible solutions. The first is to charge a significant membership fee to participants to guarantee them access to the work produced, and to sell UCMSRC reports to non-members. This, however, may actually result in a reduced membership and hence less resources in the long run.

The second option is to encourage wider, potentially international, participation in UCMSRC on a no-fee basis. However, this might require changes to the operational methods to overcome time zone differences between participants. A third option might be an expanded membership and a nominal fee.

In the interim, however, UCMSRC will continue to provide the only Canadian national forum for health and safety related issues in the underground coal mining industry.

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While acknowledging the assistance and support of UCMSRC members, the author takes sole responsibility for any opinions expressed above, and notes that opinions expressed may not be shared by other members of UCMSRC or the organisations they represent.

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## 9 REFERENCES

All of the publicly available documents discussed above are available for download from the UCMSRC website, [www.ugcoal.ca](http://www.ugcoal.ca).

Additional information on any of the subjects can be obtained from the site webmaster, or from any of the authors at the email addresses given above.