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SUMMARY REPORTS OF PROGRESS ON
USBM/OMOL/CANMET RESEARCH PROJECTS, 1988-1989

by

John E. Udd, E.D. Dainty, and L. Geller

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Canmet Information
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555, rue Booth ST.
Ottawa, Ontario K1A 0G1

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John E. Udd*

E.D. Dainty**

L. Geller**

ABSTRACT

Through Memoranda of Understanding between CANMET, the Ministry of Labour of the Province of Ontario, and the United States Bureau of Mines, exchanges of data and technology are taking place in two areas of mining research. These are: (1) Wire Ropes and Hoisting Technology; (2) Rock Mechanics and Ground Control. In a third area, namely Diesel Emissions Control, the M.O.U. expired two years ago. Nonetheless, communications continue while talks are being held concerning a further M.O.U.

In this report a summary is presented on the progress that has been made since the previous report was presented in June, 1988.

*Director, Mining Research Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa, Ontario.

**Research Scientist, Canadian Explosive Atmospheres Laboratory, Mining Research Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa, Ontario.

Keywords

CANMET, Diesel Emissions, Ground Control, Hoisting Technology, Joint Research, Memorandum of Understanding, Ontario Ministry of Labour, Rock Mechanics, Wire Ropes, United States Bureau of Mines

RAPPORTS SOMMAIRES SUR L'AVANCEMENT DES
PROJETS DE RECHERCHE, 1987-1988 - USBM/OMOL/CANMET

par

John E. Udd*

E.D. Dainty**

L. Geller**

RÉSUMÉ

Conformément et suite à des mémoires d'entente entre CANMET, le Ministère de la main d'oeuvre d'Ontario et le Bureau des Mines des Etats-Unis, se font des échanges de données et de technologies dans deux domaines particuliers de la recherche minière. Ceux-ci sont: (1) les câbles de hissage et la technologie du hissage; (2) la mécanique des roches et le contrôle des terrains. Dans un troisième domaine, celui du contrôle des émissions diesel, le mémoire d'entente expira il y a deux ans, néanmoins les discussions se poursuivent quant au renouvellement de l'entente de collaboration.

Dans le présent rapport, un sommaire est présenté sur les progrès réalisés depuis le dernier rapport daté de juin 1988.

*Directeur, Laboratoires de Recherche Minière, CANMET, Énergie, Mines et Ressources Canada, Ottawa, Ontario.

**Agents de Recherche, Laboratoire des Atmosphères Explosives, Laboratoires de Recherche Minière, CANMET, Énergie, Mines et Ressources Canada, Ottawa, Ontario.

Mots-clés

CANMET, émissions diesel, contrôle du terrain, technologie de hissage, recherche conjointe, Ministère Ontarien de la main d'oeuvre, mécanique des roches, câbles de treuil, United States Bureau of Mines

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INTRODUCTION

by

John E. Udd

Director

Mining Research Laboratories

Through an "umbrella" Memorandum of Understanding between CANMET and the United States Bureau of Mines, dated April 2, 1981, the staff of CANMET/MRL are now formally participating in two cooperative research projects. There are also frequent communications on a variety of topics not covered by such formal arrangements.

This report contains summaries of the progress that has been made, on those subjects covered by M.O.U.s, since the previous report was presented at the annual USBM/CANMET review meeting, held at Devon, Alberta, on July 14, 1988.

The first of the cooperative projects started under the M.O.U., on Diesel Emissions, began in December, 1981 and was concluded in June, 1987. The project also involved the Ministry of Labour of the Province of Ontario. The details of the progress which was made during 1988-1989 are included in a summary report which has been prepared by E.D. Dainty. CANMET's research in diesel emissions reduction technology are continuing and are now at an advanced stage of technology transfer and commercialization. It is to be noted that no joint meetings have been held since May, 1987 - just prior to the conclusion of the agreement. The staff of CANMET and the USBM continue to exchange information, however, and are drafting a successor Memorandum of Understanding. The Ontario Ministry of Labour, because of a change in its efforts, will not, by their own agreement, be a party to this successor M.O.U.

The second project, also involving the province of Ontario's Ministry of Labour, on Wire Rope and Hoisting Technology, was commenced in September 1983 and extended to a termination date of September 30, 1988. It was subsequently extended, in April, 1988 to September 30, 1993. The details of the progress made during 1988-1989 are given in a summary report which has been prepared by Lorant Geller.

A third tripartite project involving the same partners, on Rock Mechanics and Ground Control was started in April, 1986. The M.O.U. was signed on April 1, 1986 for a five-year period and will end on March 31, 1990. A summary report of progress during the past year, by J.E. Udd, is also included in this document.

AN UPDATE AS OF JULY 1, 1989 ON THE
COOPERATIVE RESEARCH PROJECT
ON WIRE ROPE AND HOISTING TECHNOLOGY

by

Lorant Geller
Canadian Explosive Atmospheres Laboratory
Mining Research Laboratories

BACKGROUND

In-situ non-destructive testing of mine-shaft wire-ropes, with electro-magnetic (EM) type instruments, has been practised internationally for many decades. Over the years a range of much improved instruments was developed by scientists in a number of countries, notably in Canada and the USA. It is generally acknowledged that the safety of mine-shaft hoisting has increased manifold since the use of EM rope testers has become widespread, often on a mandatory basis. Unfortunately, however, wire-rope failures, involving serious material damage if not loss of life, still occur. This happens even in situations where regulatory testing requirements have been followed to the letter, and where the failed ropes had been declared fit for further use.

A tripartite effort was initiated in September 1983 by CANMET, the Ontario Ministry of Labour, and the US Bureau of Mines. While this group's work is not limited to the evaluation of EM type rope testers, much of the current efforts are so directed. A general overview of the joint activities up to May 1, 1988, have been described in MRL Divisional Reports #85-69, #86-63, #87-53, and #88-24. The present report brings this account up-to-date.

JOINT ORGANIZING COMMITTEE MEETINGS

The aforementioned tripartite activities have been monitored and coordinated by means of Joint Organizing Committee meetings. These were held alternately in Canada and in the USA. The Canadian ones took place in Toronto (1984), Sudbury (1985) and at Elliot Lake (1987); the American ones in Pittsburgh (1984 and 1986) and at Spokane (1985). All were well attended and did full credit to the organizing skill and enthusiasm of their respective hosts. Details of the abovementioned meetings were given in the MRL reports referred to earlier.

The most recent joint meeting was held on October 18-19, 1988, at the MSHA National Mine Health and Safety Academy at Beckley, West Virginia. This academy serves as the central training facility for federal mine inspectors and mine safety professionals from other US government agencies, the US mining industry, and labour. It is one of only six Federal Academies recognized by the US Congress. Every courtesy and necessity was most generously provided, to ensure the success of the joint meeting. This included detailed information about the organization's history, their current activities, as well as a tour of their facilities and copies of their publications.

Fourteen people were in attendance. Of these, nine represented the USBM and MSHA, two were from the Academy hosting the event, and three represented Canada (CANMET, the Ontario MOL, and the OMA). A keen interest was expressed by our American hosts in exploring the possibility of close cooperation with Canada in satisfying any Canadian program needs.

TASKS AND RESPONSIBILITIES

Discussion at the Beckley joint meeting included the following themes:

- 1) Extra high-strength wire-ropes: here the major problems are concerned with metal aging, and with the appropriate socketing techniques needed under the circumstances.

- 2) Accidents: Copies of the latest MSHA lists were provided and discussed. The Ontario MOL presented specific occurrences of special interest, such as accounts of failed ropes and sockets, and of a muck-flow accident. Details of these, and of the lessons to be learned, were discussed.

- 3) Unusual rope constructions:
 - a) the use of Kevlar ropes in mine shafts. This is an area with interesting possibilities for the future, and with no prior experience to draw on in Canada. Accounts by our US colleagues about their relevant test results were, therefore, of particular value and interest.

 - b) Plastic Valley Filled (PVF) type rope constructions. This is an area where our US colleagues have little prior experience, while several such ropes are in use, on an experimental basis, in Canada. Canadian accounts were, therefore, of great interest to the USBM. The foregoing represents a good example of the value of our complementary work.

- 4) Operational experience: Largo Albert, of the OMA, provided panel members with a deep insight into a wide range of practical problems that confront the operating hoist/maintenance-man on a daily basis, and that must be appreciated by researchers when setting up their laboratory experiments. His presentation included problems such as:
(a) proper socketing under operational conditions in the mine;
(b) a brake-rod failure: its causes and consequences; (c) the use of wedge-thimbles (instead of the standard Crosbie clips); problems due to extra weight and to rope-whipping; (d) the use of aluminum, instead of steel, conveyances: problems with inadequate welds; (e) problems with pressure lubrication, including cases when the lubricant supply was exhausted before the job was finished.

- 5) Laboratory test results: Experimental test results were presented by the Spokane and Pittsburgh laboratories of the USBM. These include experiments with an extensive range of EM test instruments on (a) test-ropes that include artificial defects, as well as (b) on wire-ropes that are first subjected to loading and bending cycles on a special fatigue-testing machine. Experiments with artificially corroded wires were also discussed.

- 6) Data on comparative destructive/non-destructive rope tests: the USBM is in the process of obtaining comparative data, similar to those accumulated by the Ontario MOL for several decades. It will be instructive to compare results.

- 7) Joint Canada/US paper for the September 11-15, 1989, ICSMRI Conference: a joint paper has been agreed on for the 23rd International Conference of Safety in Mines Research Institutes, to be co-authored by Messrs. Geller, Anderson, Miscoe and Mitchell. Its title is "The Safety of Mine-shaft Wire-ropes - Cooperative Work by Canada and the US". A list of seven specific points was tabled at Beckley, and discussed as the basis for this joint paper. These points have been accepted and followed up on. The joint paper has been written, and accepted for presentation, at the conference in question.

- 8) ASTM E7.07.01 sub-committee: several of our US colleagues at Beckley are also members of this ASTM sub-committee, concerned with drawing up a proposal for standard terms and definitions to be used in the field of wire-rope testing with EM type instruments. CANMET, also on behalf of the Ontario MOL, tabled a five-page list of specific comments re: the proposed terms and definitions. It was agreed that the chairman of the US members of the joint committee (Grant Anderson) would transmit this list to the ASTM sub-committee.

- 9) CANMET's in-house work on evaluating EM rope testers: details were provided about progress achieved by CANMET in this area of research, in particular as to its analysis of the extensive data bank assembled by the Ontario MOL's Rope Testing Laboratory in Toronto. The relevant CANMET reports #88-78 and #89-14 were tabled and discussed.

- 10) CANMET's contracted work with Tektrend and WRI: an update of this contracted work was provided to panel members. Both the USBM and the MSHA representatives agreed to support CANMET's efforts, e.g., by providing an independent review of the reports and charts to be obtained from the contracted instrument operators, as well as by themselves participating in obtaining some of the field measurements. This work is proceeding as discussed at the Beckley meeting. It is perhaps, the most significant ongoing activity at this time.

- 11) Hoisting conference: an interesting account given of the June 1988 "International Conference on Hoisting" - organized by the CIM in Toronto - by Largo Albert, the conference's technical chairman.

SUMMARY

The group's cooperative work is progressing very satisfactorily, with benefits to all participants. The joint meeting proper was characterized by the wealth and variety of practical and theoretical information exchanged, as well as by its congenial and open atmosphere. The next annual meeting is scheduled for October 1989 in either Toronto or Montreal, to be hosted by either the Ontario Ministry of Labour's Health and Safety Branch, or by CANMET. It is planned to combine this meeting with the de-briefing seminar of the Tektrend contract, mentioned in this report.

AN UPDATE AS OF JULY 1, 1989
STATUS OF USBM/OMOL/CANMET COOPERATIVE PROJECT ON
ROCK MECHANICS AND GROUND CONTROL

by

John E. Udd
Mining Research Laboratories

A tripartite Memorandum of Understanding, for a cooperative project on Rock Mechanics and Ground Control, for a five-year period, was signed on April 1, 1986. The first meeting, between senior managers, to initiate the project and to define the topics which would be addressed, was held at the USBM Pittsburgh Research Centre on November 18, 1986.

At that time, it was decided that the most appropriate structure for the project would consist of a Management Advisory Panel, to provide overall direction, reviews, and guidance, and a number of Technical Committees which would be devoted to specific topics. Four areas of research were selected for immediate attention. These were: "Rockbursts and Outbursts"; "Support Systems"; "Coal Mine Design"; "Metal/Non-metal Mine Design".

It was agreed that each party would identify participants for the Technical Committees and that these persons would be asked to decide amongst themselves on the dates and locations for their meetings.

Subsequently, the Management Advisory Panel met at CANMET's Elliot Lake Laboratory on April 21, 1987 (with the two following days involving mine tours and visits to Denison Mines, at Elliot Lake, and to INCO, at Sudbury). There have been no formal meetings at the management level between all three participants since that time, although the progress has been reviewed in meetings between CANMET and USBM Laboratory Directors.

Since the beginning of formal collaboration, the technical committees have met several times. The details of these, and planned future meetings are as follows:

Rockbursts and Outbursts Technical Committee:

Sudbury, Ontario	March 12, 1987
Minneapolis, Minnesota	June 7, 1988
Elliot Lake, Ontario	September 20, 1989

Support Systems Technical Committee:

Nepean, Ontario	June 3, 1987
Spokane, Washington	November 17, 1987
Sydney, Nova Scotia	June 22, 1988
Denver, Colorado	July 18, 1989
Sudbury, Ontario	May, 1990

Coal Mine Design Technical Committee:

Pittsburgh, Pennsylvania	June 24, 1987
Sydney, Nova Scotia	June, 1988

Metal, Non-Metal Mine Design Sub-Committee

Bells Corners, Ontario	June, 1987
Denver, Colorado	July 29-31, 1987
Sudbury, Ontario	October 19-23, 1987
Spokane, Washington	July, 1988
Sudbury, Ontario	February, 1989

The present memberships of the Management Advisory Committee and the four Technical Committees are as follows:

USBM/OMOL/CANMET COOPERATIVE PROJECT
ON
ROCK MECHANICS AND GROUND CONTROL

Structure of Committees

Management Advisory Panel

D. Ames	OMOL	(Sudbury)
D.D. Bolstad	U.S.B.M.	(Spokane)
D. Brown	CANMET/CRL	(Devon)
D.R. Forshey	U.S.B.M.	(Washington)
E.E. Hollop	U.S.B.M.	(Denver)
P. Kivisto	OMOL	(Sudbury)
G. Larocque	CANMET/MRL	(Bells Corners)
J.N. Murphy	U.S.B.M.	(Pittsburgh)
D.B. Stewart	CANMET/CRL	(Devon)
J.E. Udd	CANMET/MRL	(Bells Corners)
L.V. Wade	U.S.B.M.	(Twin Cities)

Rockbursts and Outbursts
Technical Committee

D. Ames	OMOL	(Sudbury)
T. Aston	CANMET/CRL	(Sydney)
B. Brady	U.S.B.M.	(Denver)
D.G.F. Hedley	CANMET/MRL	(Elliot Lake)
T. Iannacchione	U.S.B.M.	(Pittsburgh)
M. Jenkins	U.S.B.M.	(Spokane)

Support Systems
Technical Committee

D. Ames	OMOL	(Sudbury)
A. Annor	CANMET/MRL	(Sudbury)
T. Aston	CANMET/CRL	(Sydney)
T. Barczak	U.S.B.M.	(Pittsburgh)
L. Boldt	U.S.B.M.	(Spokane)
J. Goris	U.S.B.M.	(Spokane)
S. Tadolini	U.S.B.M.	(Denver)

Coal Mine Design
Technical Committee

T. Aston	CANMET/CRL	(Sydney)
G. Haslett	CANMET/CRL	(Sydney)
R. King	U.S.B.M.	(Pittsburgh)
N. Kripakov	U.S.B.M.	(Denver)
L. Powell	U.S.B.M.	(Twin Cities)
T. Smelser	U.S.B.M.	(Spokane)

Metal, Non-Metal Mine Design
Technical Committee

P. Campbell	OMOL	(Sudbury)
G. Johnson	U.S.B.M.	(Denver)
J. Pathak	CANMET/MRL	(Bells Corners)
M. Poad	U.S.B.M.	(Spokane)
R. Thill	U.S.B.M.	(Twin Cities)

As seen from the table each of the Committees has met at least twice. If one considers the numbers of people involved and the frequency of meetings, it can be readily appreciated that much effort is being put into the joint project from all parties. This reflects a common North American interest and high priority given to rock mechanics and ground control. Most of those involved in the committees have been very enthusiastic about the contacts being made and of the value of the M.O.U. to their respective organizations.

Reflecting this enthusiasm, each of the Technical Committees started out with very ambitious agendas. In most cases it was recommended that meetings should be held semi-annually, and that these should be coordinated to be held in conjunction with major technical events. Further, it was also recommended that site visits should also be included in the plans. For the most part, these plans have been followed. Many of the meetings have been planned to coincide with either symposia or conventions of technical societies, and have been either preceded or followed by visits to local mines.

Because all of the groups have focussed on aspects of rock mechanics and ground control, there has been the potential for overlapping of interests. Because of this, some of the groups have requested that the Management Advisory Committee provide direction concerning activities. Specifically:

- Instrumentation and ground support are areas of common interest for all of the Technical Committees. Reviews of the state-of-the-art on both are proposed action items for the Metal/Non-Metal Mine Design and the Support Systems Committees, respectively. There is concern that there could be an overlap and duplication of effort.

- the Coal Mine Design Committee, on finding that other groups are discussing support has recommended that it be restructured, if necessary, to reflect a common interest in subsidence.

The Management Advisory Panel has recognized that there are areas of possible duplication, but believes that these will be resolved as the Committees mature and as communications and awareness improve. To date, this appears to be happening.

As regards the Coal Mine Design Committee, there have been reported to be "doubts and uncertainties as to what agenda should be encompassed by such a committee". The committee has not met in over a year and should probably be disbanded.

At the most recent meeting between CANMET and USBM Mining Research Laboratory Directors an item of high priority for the next year will be to demonstrate the benefits and achievements resulting from their work. The individual Directors formed partnerships with their various counterparts to develop brief charges for each of the project Technical Advisory Committees. In essence, we are endeavouring to determine the successes and opportunities for each of the Committees, and to chart courses for the future. Input, either by attendance or written submissions, to each of the meeting of Directors reviewing the Committees has been sought from the Ontario Ministry of Labour.

It is suggested that the next meeting of the Management Advisory Panel should be held concurrently with the next meeting of Laboratory Directors, to be held at Beckley, West Virginia, probably in June, 1990.

The findings and recommendations of the various review groups should be presented at that time, and, after discussions and approvals, the Technical Committees charged accordingly.

It must be mentioned that both the Diesel Emissions Control and Wire Rope projects are also to be reviewed in this manner - as well as one topic not covered by an M.O.U.; Sulphide Dust Explosions and Control.

AN UPDATE AS OF July 1, 1989
STATUS OF CANMET DIESEL PROGRAM

by

E.D. Dainty
Canadian Explosive Atmospheres Laboratory
Mining Research Laboratories

BACKGROUND

CANMET, the Ontario Ministry of Labour (OMOL) and the United States Bureau of Mines (USBM), collaborated from 1982 to 1987 under a formal Memorandum of Understanding to develop diesel emissions reduction technology. This collaboration resulted in the successful development of the ceramic filtration technology applied to mining machinery. As there are a number of important issues in this field currently being addressed, a renewed Memorandum of Understanding is in process. CANMET will provide its suggestions for incorporation into a draft document initiated by the Twin Cities USBM facility.

CERAMIC FILTER DEVELOPMENTS

The transfer of the technology developed during the collaborative period was systematically transferred by CANMET to Engine Control Systems, Ltd. (ECS) of Newmarket, Ontario. This transfer process officially ended on March 31, 1989. During the prior three year period, the company worked with CANMET and six major Canadian Mines to complete the applications engineering aspects for mining machinery. Application to heavily-loaded production machinery responsible for the bulk of the pollutant

generation, has been successfully achieved. The Brunswick Mine in Bathurst, New Brunswick, is the first to widely apply the filters to their diesel machinery. That company formalized their experience in a document entitled "Diesel Particulate Filter Underground Trial at Brunswick Mining and Smelting's No. 12 Mine" - March 1989. The conclusions in that report are attached. Of particular note is the \$400,000 maintenance savings per year in this particular operation.

To continue the improvement of diesel ceramic filtration systems, three studies have been identified, as follows:

1. complete the development of an effective backpressure monitoring system,
2. finalize the development of a filter regeneration system for low temperature exhaust engines such as the two-stroke engine, and
3. characterize the potential for increased mine productivity resulting from filter application.

CANMET is considering implementation of such studies. There is potential here for CANMET/USBM cooperation.

UNDERGROUND ENVIRONMENT MONITORING

CANMET has in recent years concentrated on the measurement of pollutants underground. As a result, several monitoring studies have been undertaken providing: (1) a pollutant data base, (2) confirmation of environmental improvement as a result of application of emissions reduction technology, (3) some insight into the degree of validity of the monitoring of CO₂ as a surrogate for other diesel-generated

pollutants, (4) experience in continuous monitoring of the mine environment leading to an appropriate degree of mine ventilation automation in order to provide a suitable environment at the least cost.

The major issue in all of this work is the establishment of a suitable soot level in the environment and consequently the discrimination of soot from other dusts by continuous monitoring equipment. The Canadian mining industry has expressed a desire to participate in a mine pollutant survey, particularly featuring soot measurement. Such a study would be another excellent candidate for inter-agency collaboration.

