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CANMET
Canada Centre for Mineral and Energy Technology
Centre canadien de la technologie des minéraux et de l'énergie

COAL SUPPLY IN NOVA SCOTIA: R & D NEEDS

by

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SUMMARY

Expansion of coal production in Nova Scotia from 2 mtpy in 1980 to 5.5 mtpy in 1990 will pose severe challenges in mining safety, and in overcoming emissions from burning the relatively high sulphur coal. Major R & D is required to help meet these challenges. Effort is required in all aspects, including resource and reserve assessment, planning, ground control, working environment, coal cleaning, and in-situ gasification of otherwise unexploitable coal. The major R & D thrust, however, should be in coal mining technology, in safety underground, and in physical coal cleaning to remove sulphur.

At least one R & D group must be established in Nova Scotia, either as part of or working closely with Devco, to work on mining and underground safety. This group must be independent of production operations. Coal preparation can be dealt with by existing organizations, notably CANMET.

Proper coordination and adequate funding of required R & D is essential. The recently-suggested Advisory Board for Eastern Coal, with representatives from Maritime groups, provincial and federal governments, would be an appropriate coordinating body.

INTRODUCTION

The importance of coal as an energy resource in Canada is nowhere more apparent than in Nova Scotia, where there are both heavy reliance on imported oil and large reserves of good quality coal. This importance is well recognized; Nova Scotia's announced policy is to increase coal production from an expected 2 million tons in 1980 to 3 million tons in 1985, and to 5.5 million tons in 1990.

An expansion of this magnitude requires, among other things, the most efficient and effective approach to mining, both to ensure the required production is achieved with the available resources, and - most important - that safety is maintained. This challenge to mining engineering is exacerbated by the difficult, undersea mining required for the greater part of Nova Scotia's coal.

All Maritime coal is relatively high in sulphur, and current exploration indicates the sulphur content of future production will be higher still. Control of sulphur emission from burning coal, and of sulphur content in metallurgical coal, will be essential to expanded use of Nova Scotia coal.

Many of the challenges inherent in expanded coal production and use are best met with the help of applied research and development. This report is intended to establish a framework for R & D into coal mining and preparation in Nova Scotia, taking into account known and anticipated problems, existing R & D projects and capability provincially, nationally and internationally, and resources likely to be available. The scope of this report is R & D relevant to: coal resource assessment; coal reserves and quality; mining coal economically and safely; and preparing coal to meet carbonization needs and environmental constraints when burnt.

BACKGROUND

Nova Scotia's energy planning currently includes a substantial use of coal for electricity generation and steam raising. The anticipated demand for thermal coal, and the supply capability to meet this demand with a margin for contingencies, is as follows:

Thermal Coal Demand in Nova Scotia - million tpy

	1980	1985	1990	2000
Demand	1.3	2.3	3.8	4.4
Supply Capability	1.8	2.9	4.9	5.4

In addition, steady metallurgical coal production of about 1 million tons per year is forecast. Thus supply capability is expected to increase 40% by 1985 over 1980, and more than 100% by 1990 over 1980. (Appendix A includes the basis for this data.)

Most of Nova Scotia's coal resources (95%) lie offshore in the Sydney coalfield. The associated submarine mines are operated by Devco (the Cape Breton Development Corporation). Actual and potential onshore operations, in the Sydney and other coal fields, are either private or are under the aegis of Novaco (the Nova Scotia Coal Corporation, a provincial Crown Corporation). In simple terms, the provincial coal supply strategy leans heavily on offshore production by Devco, with on-shore surface operations a) meeting the forecast gap between Devco's supply and expected demand between 1980 and 1985, and b) acting as a rapid-start-up contingency supply.

Figure 1 of Appendix A shows required production capacity by 1985 to be 0.75 MTY from Lingan and No. 26 mine (Devco's two major producing mines at present), 1.1 MTY from Prince Mine by 1986 (development for Prince is presently in hand), 1.0 MTY from Donkin I in 1986, rising to 2.0 MTY by 1988, and 1.0 MTY from Donkin II in 1992. Lingan, Prince, No. 26 and the Donkin mines are or will be Devco operations. In addition, a smaller mine in the Sydney field, underground but onshore, is expected to start in 1982 and eventually produce 0.5 MTPY. Less than 0.1 MTPY is produced by the several small underground operations presently producing from other than the Sydney coalfield. From this scenario, it is clear that development on schedule of the Prince and Donkin Mines is vital. Substantial delay in opening any one of the mines would cause a shortfall that probably could not be covered by contingency plans. If such a shortfall arose, it would either be covered by increased use of oil or natural gas, or by diverting metallurgical coal to thermal use. In either case Canada suffers a loss, either from increased oil imports, lost coal sales or increased metallurgical coal imports (to replace Devco shipments). Of importance to planning in general and R & D in particular therefore is ensuring as far as possible that the planned developments proceed as scheduled. It also is important to expand contingent (or actual) production capability elsewhere in Nova Scotia.

An issue which is not clear from the scenario as outlined above (though it is clear from Fig. 2, Appendix A) is the relatively high sulphur levels of much of Nova Scotia's coal. Although sulphur emission restrictions being developed elsewhere may be neither relevant nor applied in Nova Scotia (for example, a U.S. standard is maximum SO_2 emission of 1.2 lbs per million Btu, equivalent to uncontrolled burning of approximately 0.8% sulphur coal), it is unlikely that coal with 5% or more sulphur can be burnt without removing sulphur before, during or after combustion. Coal preparation can remove sulphur before combustion, and has the advantages that the coal can be cleaned away from the power plant (i.e. before shipment), and also that sulphur removal and combustion are not directly dependent. (For example, flue gas desulphurization and combustion are linked in the sense that if the FGD unit breaks down, combustion must stop or sulphur be emitted.) Thermal coal preparation thus merits R & D attention in Nova Scotia.

R & D ISSUES

Resource/Reserve Assessment

Planning mines is handicapped considerably by the lack of borehole data available. Additional offshore drilling will be done, but at the cost of $0.5 million per hole (1979) there will never be as many as the planners would like. There is, therefore, the challenge of a) ensuring maximum data is extracted from the holes that are drilled, and b) of enhancing the data from drilling by other methods. Of significance is the distribution of sulphur; if accurate contours of sulphur levels within the coal bed can be formed, "selective" mining to some extent can be used to reduce the problem of sulphur emission.

R & D might include:

i) Ensuring maximum data is gathered from holes that are drilled. There is the possibility that geophysical logging of the holes could be enhanced, and/or more information deduced from the logs run. It is possible a technique for logging sulphur levels down the hole could be developed. It seems unlikely, however, that there is room for improvements in core sampling and analysis.

ii) Developing seismic techniques for location of coal strata offshore. Seismic techniques are used successfully on land for strata delineation. Offshore it is unlikely similar success could be achieved because proper transmission and reception of groundwaves would be difficult.

iii) Extending drilling and seismic measurements from the current undersea workings. The best access to coal strata is from the mine operations themselves and maximum advantage should be taken of this. As well as drilling in the same seam as the workings, drilling, with associated sampling and other data gathering, can access seams above and below.

iv) Using geostatistical techniques to maximize data obtained from drilling for orebody development has been particularly successful in some mining applications. This could be relevant to Nova Scotia coal deposits - and particularly to sulphur content prediction.

The descriptions above would also be relevant to on-shore coal field evaluation, but the costs of drilling on-shore are much less, and, although data gathering should be maximized, R & D needs are less significant.

Mine Planning

Several issues concern the mine planner. Coal must be won at minimum cost, i.e. development work (usually more costly than actual mining) should be minimized and optimum sizes of rooms or faces chosen. Safety aspects, at the planning stage primarily pillar sizes and ventilation, must be adequately treated. Recovery should be a maximum consistent with safe and economic mining.

Appropriate R & D might include:

i) Developing concepts of improved ventilation as mining becomes further offshore. Ultimately, ventilation will restrict the distance offshore to which mining can go. Offshore islands appear to be the only possibility for substantially improved ventilation.

ii) Reviewing pillar sizes, minimum cover to seabed, and length on longwall faces. There appears to be scope for applying established rock mechanics principles to these mine design parameters, and, in conjunction with field measurements and observations, so ensuring they are optimum.

The observations of pillar narrowing in Lingan mine are particularly valuable. The development and imminent startup of a short longwall face at Prince mine similarly offers an unparalleled opportunity for rock mechanics studies and evaluations.

iii) Optimizing extraction ratio. To some extent, maximizing resource recovery and maximizing immediate or operating returns may be incompatible. However, there is clearly a responsibility with the mine planner to ensure good recovery of a resource, particularly because, once mined, further extraction of coal left in longwall pillars is presently impossible.

Ground Control

Ground conditions at the two main Devco mines (Lingan and No. 26) appear to be well-controlled by the current empirical practice. Conditions at the Prince mine development are not as good; in parts of the development acceptable hypotheses to account for ground conditions, especially roof and floor heave, must be developed and taken into account in the actual mining layouts and operations. Donkin ground conditions are as yet unknown, but it would be prudent to assume there will be difficulties.

R & D could be applied to:

i) Evaluating pillar sizes and behaviour in Lingan and No. 26 mine. A set of design criteria for pillars could be developed, from observation of pillar geometry, depth of cover, and pillar behaviour in the current operations. This would both establish the engineering basis of the present layouts and provide data for new mines.

ii) Monitoring Prince mine development and mining start-up. There are fruitful areas of study in the Prince mine. Investigation to determine why there is roof and floor movement in development headings is needed; at present this seems attributable to swelling clays or lateral tectonic stresses.

Analyses of stresses in the strata around the development may result in a different development heading geometry for better ground control. Similarly, analyses of stress will help select the optimum pillar and face dimensions for longwalls.

Although not included in the energy scenario, it would be of interest to review the possibilities of restarting mining in such areas of Nova Scotia as the Springhill Basin. Mining in this basin was affected by ground control problems, and any new operations would lean heavily on rock mechanics analyses. However, access to the strata - in effect mining development - would be needed before effective R & D would be possible.

Explosion and Fire Safety

The major safety hazard in coal mining is the explosion of methane/air/coal dust mixtures. Conventional practice is: a) to monitor methane levels and cease operations before an explosive concentration is reached, b) to eliminate sources of ignition to the extent possible, and c) to spread rock dust to act as a suppressant to coal dust ignition. In addition, methane is drained before and during operations, and areas where methane might accumulate are ventilated.

Appropriate R & D might be:

i) Assessing the potential for eliminating ignition due to cutting picks striking mineral zones in coal. Non-incendiary materials are used in tools, and it would be relatively simple to determine if they would be of value in coal cutting. Although an apparently "obvious" line of enquiry, there appears to be no information as to the suitability of such materials. Similarly, the possibility of alternative cutting procedures, e.g., water jets, could be studied.

ii) Assessing explosion cut-off devices. Recent developments indicate that explosion suppression after ignition may be possible by ejecting an inert gas rapidly, e.g., around a coal cutting machine. This type of protecting mechanism would be a valuable addition to current safety measures.

iii) Ensuring maximum ventilation efficiency. Particularly in some of Devco's operations that are remote from the mine portal, the problem of getting adequate air to the working face is severe. Minimizing losses consistent with not building up explosive mixtures adversely (e.g., in the gob) is an important R & D topic.

iv) Optimizing methane drainage practice. Methane drainage is recognized as important at Devco and there are plans to exploit commercially the gas so recovered. However, current practice appears to be based on British empirical practice, and it seems appropriate to set up a program of systematically varying orientations and lengths of drain holes, and correlating this with gas recovered.

v) Assessing methane sources, and monitoring methane emissions. Methane control would be greatly enhanced if there were better knowledge of methane sources. This requires monitoring methane throughout the operations, and should include determining methane emission potentials of the coal (by drilling ahead of mining) and correlating this with actual emission when mined.

vi) Determining the influence of coal dust on explosions. Coal dust exaggerates the severity of methane/air explosions, and may form an explosive mixture with air in its own right. Before optimum control strategies can be developed, the contribution of particular coals and particular mining techniques to the dust problem must be assessed.

vii) Determining influence of production rates on methane levels. It is probable that high production, continuously operated faces result in higher methane levels (due to greater rate of liberation of gas from cut coal). The influence of this on safety, and its relationships to production economics, should be studied.

The results of R & D described above would be applicable to all coal mines in the province. Because of the rates of production at Devco (point vii above), emphasis should be placed on Devco operations.

Underground Environment

Adequate ventilation, suppression of dust, and suppression of emissions from diesel equipment, are the factors affecting the working environment. Ventilation considerations are effectively those described under Explosion and Fire Safety above. Diesel emission work is underway extensively now (see below), and in any event is not appropriate to direct mining R & D. Dust control is important. Its influence on explosions has been mentioned. It has an equally significant, if less dramatic, influence on worker health.

Appropriate R & D would include:

i) Assessing origins and levels of dust, and appropriate control. The nature of the coal and more important, the winning technique, affect dust levels. Ventilation velocities also affect dust levels, and the compromise between higher velocities for methane sweeping and lower velocities to reduce dust needs study. Substantial effort is applied to dust control in other countries, and an appropriate route might be to lean on this work.

Extraction Ratio

In exploiting any finite resource, consideration must be given to the percentage of the resource that is recovered. In underground mining, there is usually a need to compromise between immediate production at least cost, and maximizing long term recovery. At present, this is compounded by the effective impossibility of recovering more coal from mined-out seams. The trade-off between immediate return and long-term recovery is influenced by economics and the policy of the resource owners. However, engineering assessment provides the basis for economic/policy decisions.

Appropriate R&D would include:

i) Detailed investigation of layouts and mining techniques for optimum recovery. Engineering analysis, supported by the relatively powerful numerical models now available, can produce reliable assessments of recovery and associated costs of production.

In-situ Gasification

Following from the above it is unlikely that any mining system will give an overall recovery (i.e., ratio of coal extracted to total coal in the region "sterilized" by mining) much greater than 50%. In addition, there are usually seams which cannot be mined by conventional techniques. Recovering an additional part of these resources is attractive both to mine operators and resource owners. The only likely prospect for such recovery is an in-situ conversion of part of the coal to gas or liquid, which can then be pumped. In-situ gasification is presently the more feasible approach.

Gasification in-situ is based upon burning part of the coal, and using the heat generated to pyrolize the surrounding coal; giving off gas. The constituents of this gas depend upon the combustion atmosphere (either air or oxygen, introduced from "surface," with or without steam), but are principally CO, H_2 and hydrocarbons. Surface above is in quotes because, at Devco in particular, it might be possible to use existing workings for access that would otherwise be impossible.

Appropriate R & D would be:

i) Assess and develop techniques for gasifying a) mined out areas and b) seams that are not likely to be mined by conventional methods. A suitable approach would be: to assess the gasification potential of the bituminous coal (current Canadian experience is with sub-bituminous shrinking coal, which favours gasification by increasing permeability as it is heated; however, there has been some foreign experience with bituminous coal); to make preliminary assessment of gasifying mined-out areas; and to assess the feasibility of access (i.e., production/injection wells) from existing workings, and the effect of this on production/safety.

Coal Preparation

Future coal cleaning requirements in Nova Scotia will probably apply both to metallurgical and to thermal coals. Metallurgical coal preparation is currently done by Devco at the Victoria Junction plant. The requirement is primarily to reduce ash and sulphur to levels acceptable for coke making, whilst retaining the appropriate coal macerals. At present the products are satisfactory. However, there are indications that future metallurgical coal will contain finely disseminated sulphur as pyrite, and fine grinding will be required to liberate this sulphur. Thus the coal product will be fine, and this raises the problems of efficiently handling a large amount of fines, and dewatering the product to acceptable levels. There is potentially the third problem of producing coke from a high-fines coal.

Thermal coal preparation is concerned with removing sulphur. Nova Scotia coal ranges in sulphur content from 2% to 7% or more, and it appears likely that future coal production will increasingly be in the high end of this range. Future restrictions on SO_2 emission are uncertain, but it is unlikely that emissions corresponding to a sulphur content in the raw coal of more than 4% will be acceptable, and much more stringent requirements - say 2% sulphur equivalent - could be enforced. Physical coal cleaning to reduce sulphur is presently at least as attractive as the alternatives to SO_2 control (these are: control during combustion, most probably by fluid-bed combustion with limestone; and stack gas clean-up). Physical cleaning uses established technology, and separates sulphur reduction from the combustion operation. However, the costs associated with physical cleaning, and the percentage of coal recovered, reflect the higher value of metallurgical coal, for which present coal cleaning techniques have largely been developed. Cheaper techniques, which are simple and handle large quantities of coal and remove enough pyrite to meet environmental requirements, would greatly increase the attractiveness of sulphur removal by coal preparation.

Physical preparation techniques can remove only inorganic sulphur. Much work, particularly in the USA, is devoted presently to developing techniques of removing both organic and inorganic sulphur. These perforce involve destructive processing of coal, with relatively sophisticated chemistry. Costs are very high - at least $20/ton in 1979 - and it appears unlikely these techniques will have relevance in Nova Scotia for preparing thermal coal, particularly in view of the relatively lenient emission standards anticipated compared to those of the USA. (Chemical preparation, because of the destruction of the coal structure, is precluded for metallurgical coal preparation).

Appropriate R & D could include:

1. Economic assessment of coal preparation applied to thermal coals. A starting point for assessing coal preparation for sulphur removal would be a detailed economic appraisal of the cost of coal cleaning. The options of cleaning at the mine end of the power plant would be compared with alternative sulphur control techniques (FBC, FGD).

2. Development of low-cost, bulk techniques for removing a good part of the pyrite sulphur. The emphasis would be on removing enough sulphur to meet projected emission requirements (say from 5% to 3%) and recovering at least 90% heat value. Water and rejects treatment would be important.
3. Assessing coal blending as a technique for meeting sulphur requirements. Judicious blending of low and high sulphur costs could meet emission standards. An assessment of equipment, coal available, and characteristics of the resulting product (e.g., ash content, ash fusion temperature) from the combustion viewpoint would be needed.
4. Developing techniques to carbonize coal with high fines content. Various approaches, e.g., partial briquetting, could solve the problem of making coke from high fines coal. Their particular application at Devco would require development and evaluation in the context of local requirements. The problems of handling/dewatering the fine coal economically would also require attention.

RANKING OF R & D

Priorities for R & D must take into account the overall objectives, both short and long term, the extent to which present technologies are adequate, the likelihood of success of particular R & D, and the availability of resources to carry out required R & D. Objectively, priorities are best set by cost-benefit analysis that takes into account all relevant factors (e.g., supply and cost of oil if coal-for-oil is a main objective, cost of coal, training miners). However, apart from the complexity of such analyses, many intangibles, e.g., the "cost" and "benefit" of safe working conditions, cannot be assigned dollar values.

For the purposes of this report, an attempt to rank R & D can be based on the following.

1. The overriding objective is to use coal as a major source of energy in Nova Scotia (quantities are given by year in Appendix A).
2. To meet this objective, coal must a) be mined with good assurance of adequate supply, and b) be burned without exceeding emission controls that may be set in future.
3. In order to mine coal with assurance of supply,
   a) reserves must be identified,
   b) appropriate mining techniques must exist,
   c) safe working conditions must be established.
4. In order to burn coal within required environment controls,
   a) emitted sulphur levels must be below legislated levels,
   b) eventually, NO_x and possibly other emissions (heavy metals, CO_2) must be below levels that may be legislated.
5. Current technology for identifying reserves is adequate, though - for offshore coal particularly - it is expensive. It is not clear that current mining techniques are adequate, in view of the ground control problems that are observed in the Prince Mine Development. It is not clear that the working environment as at present will be adequate in future. Ventilation will pose increasingly more difficult problems, and avoiding explosions similar to that of February, 1979, must be a paramount concern. Existing coal cleaning technology for sulphur (pyrite) removal is adequate, though relatively expensive for thermal coal processing. There is currently no technology for controlling NO_x and other potentially hazardous emissions.
6. In terms of capability in Canada for appropriate R & D there is capability in the private sector for reserve assessment R & D; there is basic expertise in government, in quasi-government groups, and in universities for mining R & D, but essential support within industry is presently inadequate in N.S.; there

is expertise in government and in universities for coal preparation R & D.

The above basis for ranking R & D is grossly oversimplified, and very crude, but it does indicate that coal R & D priorities in N.S. should be as follows:

1. Coal mining R & D, to ensure coal can be produced.
2. Working environment R & D, particularly safety, to ensure coal will be produced.
3. Coal preparation R & D, to develop low-cost, bulk cleaning of pyrite sulphur.

Below these in priority would be a variety of other R & D projects, including improved reserve assessment techniques, carbonization R & D, in situ gasification, commercial methane production, etc.

R & D RESOURCES

Canadian R & D capabilities in appropriate coal R & D areas are broadly outlined below.

Resources/Reserve Assessment

There is relatively little current R & D into using seismic or geophysical logging techniques for better identification of coal resources/reserves. Saskatchewan Research Council has capability in geophysical logging, and has done some research work in recent years. Most R & D in geophysical logging is done by borehole logging companies, which usually develop their own proprietary tools. Scintrex, of Toronto, in the mid-1970's developed a down-the-hole sulphur analyzer, using neutron activation. Their tests indicated an accuracy of $\pm$ 15% with 95% confidence on total sulphur determinations of 1% to 8%. They have not carried this tool to commercial availability.

Ground Control

CANMET maintains in Calgary a coal research group with expertise in ground control. Further hard rock mining ground control skills are found among staff at CANMET's Elliot Lake Laboratory. The Coal Mining Research Centre (CMRC) has a mining research group in Edmonton. Various universities - those with mining departments, e.g., Queen's, McGill, University of Alberta - have expertise in ground control, and some directly coal-related R & D is underway. Some ground control studies are being conducted by coal producers, principally Kaiser Resources Ltd. and McIntyre Mines Ltd.

There is no ground control R & D ongoing in Nova Scotia; the Mining Department at NSTC is probably the only group with applicable expertise.

Explosion and Fire Safety

CANMET maintains a strong group (CEAL) in Ottawa in the field of certifying underground equipment, and in related R & D. CANMET has smaller groups involved in methane emission prediction and coal dust explosion hazards (in Ottawa) and in methane drainage and monitoring and spontaneous combustion (in Calgary). Several Canadian consulting companies have expertise in methane-related mining problems, but by their nature are not directly involved in R & D. Algas Resources, Ltd., of Calgary is actively pursuing methane drainage for commercial exploitation, including development of improved techniques. Algas is presently working with Devco on methane drainage; their work, alhough not directly safety-related, has beneficial effects in this respect.

Underground Environment

CANMET's Ottawa laboratories are concerned with diesels and their effect on the underground environment; work on dust effects in coal mines is underway at CANMET's Elliot Lake Laboratories. Various university mineral engineering departments have expertise in mine ventilation practice. No work directly applicable to N.S. - e.g., ventilating offshore - is underway.

In-Situ Gasification

Alberta Research Council is the only Canadian group with direct experience of in-situ gasification. CANMET is beginning contracted studies with B.H. Levelton Associaties of B.C.; these studies will include a preliminary look at N.S.

Coal Preparation

CANMET has a strong coal preparation group in Edmonton, and a smaller group, concentrating largely on sulphur removal from maritime coal, in Ottawa. CMRC is developing a preparation R & D group. Several university groups are working on aspects of coal preparation; UBC, U of Alberta, U of Western Ontario are in the vanguard. Ontario Hydro have a small but well-equipped R & D group. The NRC in Ottawa has expertise in aspects of coal preparation, notably spherical agglomeration. NBRPC has expertise in sulphur removal particularly. In N.S. several groups - NSRF, NRC(ARL) - have expertise in sulphur removal, but not particularly in conventional physical cleaning.

Extra-Canadian Resources

*Outside Canada, substantial R&D in most aspects of coal production relevant to N.S. is carried on. Of most significance is research in West Germany (numerous institutes including Bergbau-Forschung, Kernforschungsanlage Juelich, and Steinkohlenbergbauverein), United Kingdom (Mining Research and Development Establishment, and the Health and Safety Executive Laboratories), and the U.S.A. (Dept. of Energy, which includes the Bureau of Mines).

In exploration, geophysical techniques "through-water" are being investigated in the U.S. to detect zones of weakened rock beneath surface water. Radio waves as a tool to map underground structures are also being studied.

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*Much of the following material is gleaned from the Project Register for 1979 produced by the Mining Technology Clearing House.

Seismic techniques for coal measure location are being developed in the U.K. and W. Germany; equipment suitable for use in the workings has been assembled in the U.K.

Ground control R & D receives considerable attention. In the U.S. efforts range from studies of the influence of geology on roof, pillar and floor stability, to operational guidelines for stress measurement. There is also work on stress control techniques - modifying stress concentrations by changing geometry and scheduling of entries - and on determining from model analysis the constitutive relations governing the behaviour of coal strata. Stress effects around roadways are also under study in the U.K., while the basic rules for applying rock mechanics to longwall operations are the subject of R & D in W. Germany.

Much work in the area of mining hazards has been devoted in the U.S. and Europe to flame suppression by chemical inhibitors, and by triggered barriers. These latter are at the stage of prototype trials; INIEX in Belgium is assessing their use for stopping methane/coal dust explosions. Methane control receives wide attention. In W. Germany there is work on methane drainage from surface; in the U.S. there has been an evaluation of geologic influence on methane emissions/production in coal measures; and in the U.K. the prediction of methane content from surface exploration has been researched. Some U.S. work is concerned with water jet cutting of coal in longwall operations, which may have the potential of removing one source of ignitions.

In situ gasification is receiving a great deal of attention in the U.S., with studies ranging from mathematical modelling of the reaction trials to full-scale trial burns. Environmental effects are also being studied, particularly effects on groundwater and on the working environment, for example, through gas escaping through fissures. All the U.S. studies are concerned with gasifying sub-bituminous coal. In Europe, as well as general R & D in in-situ gasification, W. German research in gasifying bituminous coal in situ is particularly interesting in the context of N.S. coals.

Coal preparation, particularly for sulphur removal, is an area of increasing attention. A strong emphasis on chemical treatment has developed in the U.S., mainly because anticipated and actual maximum emission levels met would require removal of organic as well as inorganic sulphur. In W. Germany there is work on pyrite removal, both by jigs - the Batac jig particularly - and by superconducting high intensity magnets. In recent years there have been U.K. studies of automatic coal blending and of sulphur determination - both in situ and on surface - through neutron-prompt gamma ray measurement.

RECOMMENDATIONS

Highest priority in coal R & D in Nova Scotia should be given to:

a) production aspects of coal mining, especially offshore Cape Breton,
b) safe working environment underground,
c) physical coal cleaning for sulphur removal.

a) requires an R & D group to be established in Nova Scotia, preferably in Cape Breton. Such a group at a minimum would consist of two mining engineers and three technicians; it should either be an integral part of, or be well-supported by, Devco. It should expect to call on the services of other groups within Canada for technical advice, analysis, review of programs, etc.; chief among these groups are CANMET and CMRC. If an integral part of Devco, its independence from operating demands must be assured.

b) similarly requires an R and D group in Nova Scotia. The same group described for a) could be enlarged to deal with the underground environment. However, a nucleus for such a group is already in place at the Atlantic Coal Institute (of the College of Cape Breton), and developing this group would be preferable. Support would be required, particularly from Devco; as well as funding the group must be assured of adequate access to Devco's mining operations and independence in its work.

c) can be undertaken by existing organizations, particularly CANMET. The existing maritime groups, e.g., NBRPC, NSRF, with coal preparation expertise should be encouraged to concentrate on physical coal cleaning. Pilot plant studies - essential in coal preparation R and D - should be carried out in the Edmonton plant of CANMET (WRL).

Coordination and a unified approach to funding will be essential in effectively launching and completing the R and D described. Appropriate organizations are being set up in the maritimes; the suggested Advisory Board on Eastern Coal, proposed at a May 7 meeting at Atlantic Regional Laboratories of NRC, if it becomes a reality should have the responsibility for carrying out these recommendations.

ACKNOWLEDGEMENTS

This report leans heavily on the advice and support of Hans Bielenstein*, Don Dainty and Dave Hedley, of CANMET, and also owes much to the encouragement and support of the Cape Breton Development Corporation, particularly Roy MacLean, and the Nova Scotia Department of Mines and Energy, particularly John Amirault.

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*Now with Intermin Consultants of Calgary.

APPENDIX 'A'

Coal Supply/Demand in Nova Scotia

(These figures are from the Nova Scotia Task Force on Energy Reports in Preparation 1980)

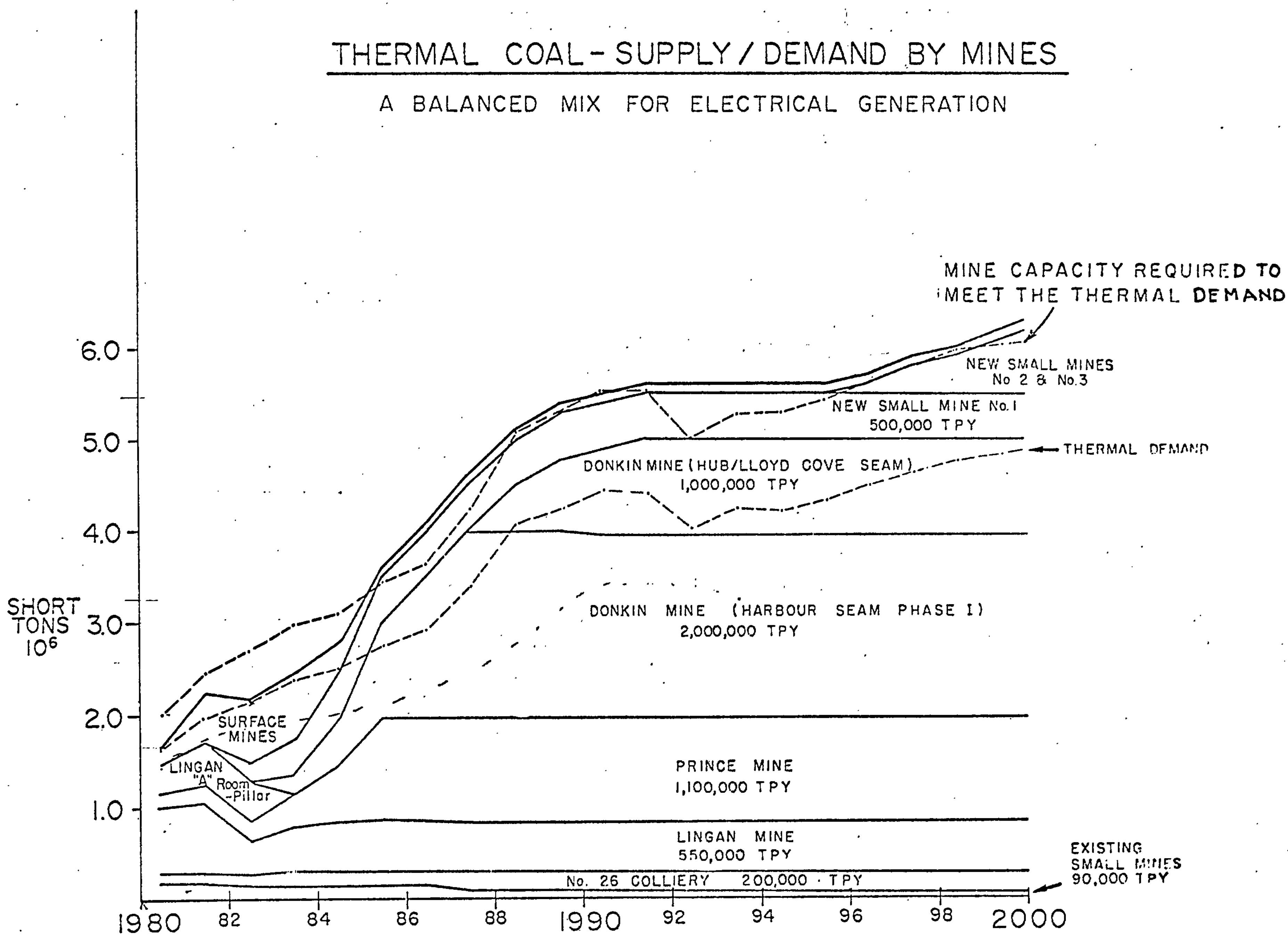
THERMAL COAL - SUPPLY / DEMAND BY MINES
A BALANCED MIX FOR ELECTRICAL GENERATION
MINE CAPACITY REQUIRED TO MEET THE THERMAL DEMAND
NEW SMALL MINES No 2 & No.3
NEW SMALL MINE No.1 500,000 TPY
THERMAL DEMAND
DONKIN MINE (HUB/LLOYD COVE SEAM) 1,000,000 TPY
DONKIN MINE (HARBOUR SEAM PHASE I) 2,000,000 TPY
SHORT TONS 10^6
SURFACE MINES
LINGAN "A" Room -Pillar
PRINCE MINE 1,100,000 TPY
LINGAN MINE 550,000 TPY
EXISTING SMALL MINES 90,000 TPY
No. 26 COLLIERY 200,000 TPY
6.0
5.0
4.0
3.0
2.0
1.0
1980
82
84
86
88
1990
92
94
96
98
2000

Fig. 1

NOVA SCOTIA COAL RESOURCES
IN SITU - SHORT TONS

COAL BASIN	DISTRICT	SEAM	THICK-NESS (ft)	DIP	DEMONSTRATED	INFERRED	STRIP RATIO	NEAR SURFACE RESOURCES	PROXIMATE ANALYSES ASH(%)	SULPHUR %	MOISTURE %	VOLATILE MATTER	FIXED CARBON	CALORIFIC VALUE
SYDNEY	PT. ACONI	PT. ACONI*	3.5			44,000,000			8.35	5.6				12,000
		HUB*	7.4	2.5°	175,000,000				12.9	4.3				12,100
		SYDNEY MAIN	3.0	5°			20:1	1,280,000	16.0	4.8	2.4			11,200
		INDIAN COVE	3.0	3°-7°			20:1	3,200,000	22.8	7.4	1.6			10,600
		LOWER MILLPOND	2.6	3°-7°			20:1	2,048,000	18.4	6.0	2.3			11,000
		PHALEN	2.4	6°			20:1	464,000	11.7	5.1	2.1			12,200
	SYDNEY MINES	SYDNEY MAIN	3.3	5°	632,000				9.75	2.96				
		LLOYD COVE*	4.5		60,000,000	121,000,000			7.15	4.9				12,600
		BACK PIT*	3.5		60,000,000	4,000,000			11.5	6.2				
		INDIAN COVE	4.2	7°	600,000				16.81	5.54				
		COLLINS	3.9	6°	244,000				17.14	6.87				
	NEW WATERFORD	HUB*	5.0		79,000,000				14.9	3.8				13,700
		HARBOUR*	6.1		141,000,000	24,000,000			5.0	2.0				14,000
		BOUTHILLIER	3.0-4.0		41,000,000				18.0	6.3				
		BACK PIT	3.5		20,000,000				11.7	5.4				
		PHALEN*	7.0		187,000,000	9,000,000			6.0	2.5				14,700
		MULLINS	2.7-6.5	3°-5°	78,000,000		20:1	2,496,000	12.2	5.0				
	GLACE BAY	PT. ACONI*	6.1	8°		104,000,000			6.1	4.44				13,000
		LLOYD COVE*	10.8		369,000,000	190,000,000			10.8	3.9				13,800
		HUB*	10.7		374,000,000	186,000,000			14.2	5.2				13,700
		HARBOUR*	9.7		486,000,000	251,000,000			9.4	3.8				14,700
		PHALEN*	5.6		85,000,000	47,000,000			20.0	4.2				14,200
		O'DELL	2.5	5°			20:1	3,200,000	23.7	6.6	1.5			11,400
		GARDINER	2.5	5°			20:1	3,200,000	16.0	4.3	1.6			13,000
		MC RURY	3.0	8°			20:1	526,000	18.0	7.8				11,560
	PORT MORIEN	HARBOUR*	9.0		18,000,000									
		PHALEN*			29,000,000	3,000,000			10.0	4.0				
		EMERY	4.0		14,000,000									
		GARDINER	2.5	5°			20:1	3,200,000	16.0	4.3	1.6			13,000
		SPENCER	3.0	7°			20:1	1,088,000	8.8	3.0				13,500
		TRACY	4.5	10°	85,000,000		20:1	5,470,000	15.1	5.9	2.5	35.5	53.3	12,667

* OFF SHORE RESOURCES

[ ] AREAS OF IMMEDIATE INTEREST

Fig. 2

NOVA SCOTIA COAL RESOURCES (cont'd)
IN SITU – SHORT TONS

COAL BASIN	DISTRICT	SEAM	THICK-NESS (ft.)	DIP	DEMONSTRATED	INFERRED	STRIP RATIO	NEAR SURFACE RESOURCES	PROXIMATE ANALYSES ASH (%)	SULPHUR %	MOISTURE %	VOLATILE MATTER	FIXED CARBON	CALORIFIC VALUE
PICTOU	WESTVILLE	ACADIA	9.5	16°	14,000,000	3,000,000			14.8	0.8				13,155
		SCOTT	10.0	16°	22,000,000	7,400,000			21.8	1.5				11,800
		THIRD	11'6" TOTAL 3'0" MINEABLE	16°	4,300,000				23.2	1.8	1.4	24.9	51.5	11,270
	STELLARTON	Mc LEOD	4.0	23°	900,000	1,200,000	20:1	61,000	21.6	0.7	2.9			9,840
		FOORD	31.0	23.5°	14,800,000		20:1	5,000,000	26.0	0.5	2.3	27.3	43.0	10,000
		FLEMING	4.0	23°	300,000		20:1	766,000	25.1	1.0	1.5			10,952
		McGREGOR	12.0	23°	2,400,000		20:1		29.3	1.2	1.3			9,838
		NEW	6.0	23°	3,000,000		20:1	400,000	28.4	3.0	2.3			11,117
		PURVIS THIRD	6.5	23°	40,000 50,000		10:1 10:1	40,000 50,000	35.6 28.4		2.1 1.9			
	THORBURN	UPPER McKAY	3.5	20°			20:1	1,200,000	21.0		2.8			11,787
		LOWER McKAY	2.5	20°					20.0		2.6			
COLCHESTER	DEBERT	No. 1	4.0	25–40°	800,000				21.9	1.6				10,666
		No. 2	6.0	25–40°	1,300,000				22.1					
		No. 3	4.0	25–40°	800,000				24.2					
		No. 4	5.0	25–40°	600,000				19.3					
CUMBERLAND	SPRINGHILL † Hazardous mining conditions	SEAMS 3, 1, 7 AND 6	10, 8, 5, 5.5			48,000,000†								
		No 3 UPPER	3.4	34°	400,000				10.3	1.6	3.1	32.7	53.8	
		No 3 LOWER	3.4	34°	400,000				11.6	1.6	2.8	32.7	52.8	
		No. 3	9.5	20°	1,800,000				11.6	1.7	2.8	32.6	53.8	13,225
		COAL A (No. 3 UPPER ?)	3.1	25°	500,000		10:1	220,000	19.1	2.3				
		COALS B+C (No. 3 LOWER ?)	4.6	25°	1,000,000		12.5:1	300,000	23.6	2.5				
		No. 1	8.0	20°	1,500,000	15,000,000	12.5:1	200,000	7.7	1.6	0.9	31.7	59.6	13,605
		No. 6	5.0	22°	1,800,000		12.5:1	50,000	7.4	1.4	2.1	30.8	60.5	13,695
		No. 7	4.0		2,000,000				7.7	1.4	1.4	29.8	61.2	13,626
	SALTSPRINGS	SANDRUN	3.0	38°	4,000,000				28.7		2.9			9,975
	MACCAN	CHIGNECTO	2.3		600,000	600,000			18.4	6.0				10,900
	OXFORD		2.3 ?	12°										
WESTERN CAPE BRETON	ST. ROSE	No. 5	7.8	14°	3,200,000	270,000			11.2	6.4	3.5	33.9	49.2	11,630
	PORT HOOD	6 FOOT	2.5–5.0	15°	18,100,000	8,700,000			19.3	9.6				10,735
	CHIMNEY CORNER	No. 5	3.0	30–40°	2,600,000				12.9	5.6	7.2	32.0	47.9	10,617
		No. 2	3.0	30–40°	2,200,000									

[box] AREAS OF IMMEDIATE INTEREST

Fig. 2 Cont'd