Energy, Mines and Resources Canada
Énergie Mines et Ressources Canada

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

ENERGY RESEARCH

ENERGY TECHNOLOGY ACTIVITY
LONG-TERM PLANS 1983-1988

Minerals and Earth Sciences Program
Research Program Office
January 1983

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CANMET ENERGY TECHNOLOGY ACTIVITY
LONG-TERM PLANS, 1983-88

PART I

INTRODUCTION

CANMET's Energy Activity long-term plans emphasize the major policy thrusts of the National Energy Program. CANMET is the research arm of the Department of Energy, Mines and Resources and is Canada's leading agency for mineral and fossil energy research. The total mineral and energy FY 82-83 budget was $54.3 million employing 771 scientists, engineers, technicians and support staff. In FY 83-84, the energy component will rise, but level off to give a total budget of $63 million and 810 person-years (PY), in accordance with the planning exercise conducted through the Interdepartmental Panel on Energy R & D.

CANMET has five research divisions and a technology information division. Each contributes greatly to energy research objectives. Details are presented later; here, by way of introduction are some examples.

The Energy Research Laboratories respond to R & D objectives in bitumen, heavy oil and synthetic crude upgrading; coal combustion, gasification and liquefaction; and improvements to domestic heating furnaces.

The Mining Research Laboratories contribute to coal and uranium reserve assessment, develop safer equipment for underground mining (especially diesel exhaust clean-up and electrical safety certification), and develop more efficient mining technologies.

The Mineral Sciences Laboratories respond to objectives in coal preparation, processing of radioactive ores, and materials for advanced energy conversion systems.

The Coal Research Laboratories have one laboratory in Nova Scotia conducting research into coal mining safety, especially ventilation, and two laboratories in Alberta conducting research into coal mining, preparation, and carbonization, together with some work into bitumen recovery.

The Physical Metallurgy Research Laboratories conduct research into materials for petrochemical processing, coal combustion, oil and gas pipelines, and offshore structures.

CANMET maintains a close partnership with Canadian energy industries and electrical utilities by encouraging innovative R & D, often through cost-shared programs. The Branch seeks to develop Canada's petroleum and coal-based resources by improving extraction and upgrading technologies and improving utilization of the primary products. It addresses materials problems associated with pipelines operating in extreme climatic conditions transporting oil, gas and coal to both domestic and export markets. All avenues of technology transfer are used to ensure that federal R & D efforts reach Canadian industry, its intended beneficiary, and an Office of Technology Transfer has been established to assist in this transfer.

In addition to its core funding (A-base resources), CANMET receives National Energy Program (NEP) resources through four of the six Tasks of the Interdepartmental Panel on Energy R & D, namely:

1. Energy Conservation

2. Oil Sands and Heavy Oils; Coal Supply and Combustion

5. New Liquid Fuels

6. Conventional Energy Systems: Oil, Gas and Electricity.

CANMET's research efforts supporting Task 3 (Nuclear Energy) and Task 4 (Renewable Energy Sources) are supported with-in its A-base resources. Energy R & D at CANMET is focused on the self-sufficiency thrust of the NEP and is consistent with the following NEP R & D priorities:

- to develop alternatives to gasoline

- to increase efficiences of energy use

- to develop new energy sources.

In response to these priorities, CANMET has started many new projects, some of which are coal-bitumen coprocessing, distillate treatment, and conversion of natural gas to liquid fuels.

NEP resources are incremental to the regular A-base funding which supports the base of continuing research activities in mineral and energy technology.

Part I of this document outlines the Energy Technology Activity of CANMET; its objectives, priorities, resources and management structure. Part II presents in detail the project objectives, goals and resources of each sub-activity.

ENERGY TECHNOLOGY ACTIVITY

Objective

To ensure the availability to Canada of adequate technology for the extraction, processing, use and conservation of energy resources.

Priorities

Priorities address development of technological options to support sustained self-sufficiency in energy needs, especially with respect to non-conventional sources, by:

(i) concentrating R & D on the most economically significant energy alternatives;

(ii) minimizing hazardous effects of conversion processes; and

(iii) diversifying sources and technological routes to enhance flexibility, especially in seeking alternatives to conventional liquid fuels.

The following R & D needs, in order of priority, have been identified.

1. R & D related to bitumen/heavy oil recovery and upgrading to overcome technical and economic constraints to development and to optimize the utilization of synthetic products as refinery feedstocks.

2. R & D to permit increasing integration of synthetic products from bitumen, heavy oil, shale oil and natural gas into the end use system as liquid transportation fuels.

3. R & D in coal to allow its combustion under environmentally-acceptable conditions, especially to minimize acid rain.

4. R & D to develop the use of coal as a supplementary source of liquid fuels and as a source of energy in the processing of bitumen.

5. Development of technology related to improving productivity and to reducing health and safety risks in the mining, processing and transporting of coal and oil sands.

6. R & D related to rock properties as may affect design of permanent storage facilities for nuclear wastes.

7. Development of new energy conservation technologies including R & D related to replacing oil by natural gas and wood, a better utilization of natural gas.

8. R & D in materials behaviour and fabrication in support of new energy processing technologies and offshore oil and gas developments.

9. Transfer of appropriate technologies to industry to achieve energy policy goals.

The above priorities indicate CANMET's appreciation of the need for research and development to obtain oil self-sufficiency for Canada. While liquids from bitumen/heavy oils remain a high priority, recognition of the future role of coal in the Canadian economy and energy scene has led to the formation of the Coal Research Laboratories, a new division of CANMET, to deal with the supply aspects of coal. A new CANMET laboratory, located in Cape Breton and a component of the Coal Research Laboratories is dedicated to coal mining health and safety, and is now starting to recruit its staff complement.

STRATEGIC SUB-ACTIVITY OBJECTIVES

The Energy Technology Activity is divided into the following sub-activities: Conservation, Petroleum Supply, Coal, Nuclear, and Renewable Energy. The strategic sub-activity objectives are listed in this section.

CONSERVATION

To develop the technologies required to increase oil and gas utilization efficiencies in residential and industrial applications. Specifically:

a. by 1984, to increase the seasonal efficiencies of residential heating systems by 20 per cent;

b. by 1985, to develop and demonstrate technology to improve fuel utilization efficiencies in industry by 15 per cent; and

c. by 1986, to develop process modifications in the industrial minerals industry to decrease the energy content per unit of production by 10 per cent.

PETROLEUM SUPPLY

To develop and demonstrate new improved technologies which will overcome the technical constraints for the exploitation of Canadian petroleum resources and the integration of synthetic fuels derived from bitumen/heavy oils into the end-use system. Specifically:

a. by 1986, to determine and demonstrate the appropriate technologies for treating effluent water from bitumen/heavy oil recovery operations and, by 1990, to establish the technical/economic viability of miscible flood technology for enhanced recovery of heavy oils;

b. by 1985, to establish upgrading technologies for bitumen/heavy oils/residuals to increase the liquid product yields by 15% with comprehensive assessments of the products as refinery feedstocks;

c. by 1987, to complete the initial phase of determining the technologies to deal with problems caused by increased amounts of synthetic crudes in refinery feedstock and to develop and promote novel technologies;

d. by 1984, to complete the initial phase of developing improved technology for catalytic conversion of asphaltenes to liquids and, by 1986, to complete the initial phase of developing methods for converting pitch to liquids and hydrogen;

e. by 1984, to evaluate fabrication technologies for pressure vessels to be used in hydrocarbon processing plants;

f. by 1986, to characterize the performance of materials for pressure vessels under simulated in-service conditions, to establish a data base on stress-corrosion cracking and hydrogen damage characteristics of Canadian-produced linepipe steels, and to develop advanced welding shop capabilities for fabricating heavy-section pressure vessels for energy conversion systems;

g. by 1987, to complete in-house and contract projects on steels for offshore structures (corrosion fatigue, low-temperature fracture, development of improved steels); and

h. by 1988, to rationalize the effects of composition and processing on the toughenss and weldability of controlled-rolled, micro-alloyed steels for both linepipe and offshore applications.

COAL

To develop and improve technologies for ensuring the thorough assessment of Canada's coal reserves, as well as their optimal exploitation of mining, processing and utilization, consistent with acceptable environmental standards. Specifically:

a. to assess and report biennially on Canada's coal reserves and production capability, and by 1984 to develop a computer-based methodology for coal reserves assessment;

b. to develop and evaluate alternative technologies for underground coal mining by conducting laboratory, field and in-mine demonstration projects; by 1985, to compile a manual on subsidence and related strata control problems for inclusion in mine design studies, and by 1986 to develop and field test continuous mine atmospheres monitoring systems for underground coal mines;

c. on a continuing basis, to provide a safety certification service for equipment and materials for use in coal mines;

d. by 1984, to complete the design and installation of a new, versatile coal preparation pilot-plant facility and thereafter to continue the development, through field demonstration using mobile coal treatment plants, to improve procedures for cleaning fine, oxidized and high sulphur coals;

e. on a continuing basis, to evaluate the coking characteristics of Canadian coals for domestic and export markets, and by 1984 to determine the potential of coke dry-quenching to improve product quality and conserve energy;

f. on a continuing basis, to characterize the suitability of selected Canadian coals for synthetic gas production and, by 1984 to complete an assessment of using sulphur sorbents in the gasification of eastern coals;

g. by 1985, to assess the suitability of significant Canadian coals for various liquefaction technologies and to investigate ways to decrease liquefaction costs;

h. by 1987, to assess and demonstrate the technical and economic feasibility of increasing liquid yield by 25% during upgrading by coprocessing domestic coals with bitumen, heavy oils and residuals;

i. on a continuing basis, to produce data on conventional combustion performance and emission characteristics of Canadian coals destined for power generation in both domestic and export markets;

j. by 1985, to develop and demonstrate the technologies required for ccal-liquid mixture utilization, and by 1986 to develop and demonstrate technologies which minimize acid rain pre-cursor generation, e.g., atmospheric fluidized-bed combustion and low NO_x burner designs; and

k. by 1987, to characterize materials needed for heat transfer tubes in ccal-burning fluidized-bed combustion furnaces.

NUCLEAR

To develop and apply technology to assess thoroughly Canada's nuclear fuel reserves, to improve the efficiency, safety and recovery of by-products from uranium extraction processes, and to participate in studies to ensure ultimate safe disposal of high-level radioactive wastes. Specifically:

a. on a continuing basis, to prepare annual inventories of Canada's uranium reserves and production capabilities, and by 1984, to compile a manual of optimal uranium mine evaluation procedures;

b. by 1985, to complete studies on conventional sulphuric acid processing technology and, by 1986, to assess hydrochloric acid extraction and other novel processes; and

c. by 1985, to develop field techniques for demonstrating laboratory assessment of thermal and ion transport properties of rock at high temperatures, simulating conditions for high level radioactive waste disposal.

RENEWABLE ENERGY

To develop efficient and environmentally-acceptable technologies for utilizing renewable energy resources. Specifically:

a. by 1983, to evaluate the safety and combustion performance characteristics of wood-fired residential heating appliances; by 1984, to design and by 1985, to test a high-efficiency low-pollution wood space heater;

b. by 1985, to promote the demonstration of wood utilization in steam generation for central heating and industrial processes;

c. by 1985, to document the combustion characteristics of biomass fuels such as processed wood waste and alcohols; and

d. by 1986, to develop materials for improving efficiencies of electrochemical energy conversion and storage devices.

RESOURCES

CANMET's FY 83/84 submission for resources for the Energy Technology Activity is 416 person-years (PY) and $41 million. This submission comprises 299 PY and $15 million as A-base complement; and 117 PY and $26 million obtained through four Tasks of the Interdepartmental Panel on Energy R & D. Some adjustments for inflation and restraint are expected. Resources for new projects have yet to be approved. A breakdown of the resources by sub-activity is shown in Table 1.

Table 1 - Resource Allocations by Sub-Activity, 1983-84

	PY	$K
Conservation	8	1800
Petroleum Supply	97	10772
Coal	151	18860
Nuclear	28	1110
Renewables Energy	13	1410
Support Services		
Information and Library	16	1150
Technical (Engineering)	26	1250
Management and Admin.	77	4410
Totals:	416	40762

PROGRAM DEFINITION

CANMET has departmental responsibility for the performance and sponsorship of research and development in minerals and energy as described in the Resources and Technical Surveys Act (RS 1970-72). The general provisions of the Act do not explicitly indicate how the branch is to orient its efforts or plan effective use of its resources. It is, however, assumed that government-sponsored R & D should be accessible to all Canadians and be undertaken to ensure the widest possible dispersion of its effects throughout Canadian society. Consistent with this assumption, CANMET adopts the stance of a public sector agency with a mission to provide R & D under circumstances where the private sector cannot be expected to invest in long-term R & D deemed to be in the economic and social interest of the public. This fundamental assumption is basic to planning at CANMET and, together with the customary imperatives of resource allocation, comprises the frame of reference for planning, programming and project selection.

A project selection exercise was carried out at CANMET prior to the June 30, 1982 meeting of the Interdepartmental Panel on Energy R & D. The projects not selected at that stage could be pursued if additional resources become available.

Each Sub-Activity is divided into Technologies making 42 Technologies in total. Each Technology consists of a number of projects. An algorithm has been developed specific- ally for the Energy Technology Activity to rank the Technologies. This algorithm requires a judgement on each of five factors:

1. relationship between the Technology and the objectives of the Activity and Sub-activities;

2. impact of the anticipated contribution to the overall energy program of each Technology;

3. R & D effort to be invested to achieve the objectives of the Technology;

4. scientific merit of the projects that form the Technology, in terms of innovation, technology transfer possibilities, and potential for future development; and

5. probability of success of the projects included in the Technology, on the basis of available resources and project difficulty.

MANAGEMENT AND PROGRAM IMPLEMENTATION

Most of the R & D effort at CANMET is classified as "mission-oriented". CANMET uses a matrix management system in which program management (the Research Program Office) interacts with laboratory line management in planning, programming and evaluation of R & D efforts within the program activity structure. The relationship of the Energy Technology Sub-activities to responsibility centres within CANMET is shown in Table 2.

Table 2 - Relationship of Energy Technology Sub-activities to CANMET Responsibility Centres

Program Sub-Activity	ERL[1]	PMRL[2]	MSL[3]	MRL[4]	CRL[5]
Conservation	x		x		
Petroleum Supply	x	x			x
Coal	x	x	x	x	x
Nuclear			x	x	
Renewable Energy	x		x		

1 Energy Research Laboratories

2 Physical Metallurgy Research Laboratories

3 Mineral Sciences Laboratories

4 Mining Research Laboratories

5 Coal Research Laboratories

The Research Program Office has responsibility for planning and designing programs with laboratory directors acting in advisory capacities. The Research Program Director is assisted by three assistant program directors, whose responsibilities cover the five sub-activities within the Energy Technology Activity. These officers formulate program objectives, develop strategies and select the appropriate technical responses to perceived R & D needs. As well, they are responsible for monitoring work progress and program evaluation, including contracted-out R & D.

Technology leaders are laboratory personnel who interact with the assistant program directors for the purpose of administering program affairs in the performing laboratories and who assist in selecting the most cost-effective group of projects to meet a particular Technology objective. Allocation of resources between sub-activities is the responsibility of the Research Program Director. Laboratory directors and managers are responsible for implementing operational plans, work performance, and control. Reports are prepared for the Research Program Office on a regular basis describing the project status.

CANMET management receives formal advice and recommendations on research priorities from the National Advisory Committee on Mining and Metallurgical Research, NACMMR, - a representative body formed by Order-in-Council to advise the Minister of Energy, Mines and Resources, Canada. The committee provides a national perspective on R & D needs and its recommendations are taken into account in formulating energy research plans.

CANMET, through the Research Program Office, contracts a considerable amount of research to the private sector and universities. In all cases where the requisite capabilities are available in Canada, Canadian contractors are engaged, in accordance with Treasury Board guidelines. In addition, the department enters into research agreements with universities for performing certain R & D which coincides with program activities. Unsolicited proposals coordinated by Supply & Services Canada may also be funded where these support the Energy program objectives.

INTERNATIONAL PROGRAMS

CANMET participates in international technology exchange agreements. This involvement brings expanded expertise to bear at low cost and accelerates technical progress as well as reducing duplication of efforts between countries. CANMET participates with the Coal Association of Canada in the International Committee for Coal Research.

a) International Energy Agency (IEA)

Under the umbrella of the Working Party on Fossil Fuels (CANMET provides the international chairman), CANMET participates in the following coal agreements:

- Technical Information Service
- Coal-liquid mixtures in utility steam generators
- Atmospheric pressure fluidized-bed combustion for industrial or district heating boilers and for power generation
- Control of nitrogen oxide emissions during coal combustion
- Coal Pyrolysis (under negotiation)

CANMET also participates in an IEA R & D program concerning the production of hydrogen from water (photocatalytic water electrolysis); and in an agreement on energy conservation in the cement industry.

b) United States

EMR (CANMET) supports a program for the stimulation of technology developments in the in situ production of bitumen and heavy oils. The program falls within the terms of reference of a memorandum of understanding for cooperation in R & D signed between EMR (CANMET) together with Alberta Oil Sands Technology Research Authority (AOSTRA) and the Saskatchewan Department of Mineral Resources with the U.S. Department of Energy.

CANMET liases with the National Bureau of Standards (NBS) of the U.S. Department of Commerce on materials for offshore structures. This will result in a joint CANMET/NBS International Workshop on the Performance of Concrete Offshore Structures in an Arctic Environment, to be held at NBS in Maryland, USA.

c) Japan

Under the Canada-Japan Science and Technology Consultations, and arising from the Canada/Japan coal and heavy oil R & D mission in September 1980, CANMET with the Alberta Research Council, the British Columbia Ministry of Energy, Mines and Petroleum Resources, the Saskatchewan Department of Mineral Resources and Saskoil is participating in an exchange of coal samples and liquefaction test results with the Ministry of International Trade and Industry of Japan. There is also an exchange of scientists under this agreement.

d) Federal Republic of Germany

Under the Canada/FRG S & T Agreement, CANMET is discussing the possibility of bilateral cooperation with the Federal Republic of Germany in the areas of coal liquefaction and coal slurry pipeline transportation.

e) United Kingdom

CANMET maintains cooperative research efforts on coal combustion with the British Coal Utilization Research Association and the Imperial College of Science and Technology. EMR is a member of The Welding Institute and CANMET is a supporting member of the British Flame Committee.

f) European Coal and Steel Committee (ECSC)

CANMET participates with the European Coal and Steel Committee on R & D related to materials for offshore structures.

PART II

ENERGY TECHNOLOGY SUB-ACTIVITIES

CONSERVATION

PETROLEUM SUPPLY

COAL

NUCLEAR

RENEWABLE ENERGY

SUPPORT SERVICES FOR THE ENERGY TECHNOLOGY ACTIVITY

Detailed technology objectives, description, resources, and expected outputs.

Resources shown are in 1983 dollars.

SUB-ACTIVITY: CONSERVATION

Residential Heating Systems

Technology Objectives

To develop and improve the technologies required to increase the efficiency of utilization of oil and gas in domestic heating appliances. Specifically:

by 1984 to develop methods of measuring seasonal efficiencies of residential furnaces, and to increase observed levels by 20%, and

by 1987 to establish approved technologies for ultra-efficient gas-fired domestic air and water heating.

Description

While overall energy conservation strategies for houses will contribute to achieving high efficiency of energy use, one key component of the system is a high efficiency space heating furnace matched to house demand. To achieve this, the project is designed to develop techniques for measuring the seasonal efficiency, as opposed to the steady state efficiency, of both retrofitted and new designs of oil and gas furnaces. Marked improvements in seasonal efficiency will be sought, in the short term, by retrofitting existing units with new burner heads and flue gas handling systems. In the longer term, and in keeping with the priorities of the National Energy Program, the major effort will be expended on the development, field testing and certification of ultra-high-efficiency gas furnaces incorporating such design features as controlled or pulsed firing rate, and flue gas condensing systems.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	180(4)	180(4)	180(4)	180(4)	180(4)
Energy R & D	480(2)	510(2)	510(2)	510(2)	510(2)
Total	660(6)	690(6)	690(6)	690(6)	690(6)
Contract $ (included in above)	220	250	250	250	250

Major Outputs

1. Development of retrofit systems for existing oil and gas furnaces (1984).

2. Development of an economic design of high performance gas furnaces which will permit an increase in seasonal heating efficiencies from 60 to 90% (1987).

3. Field test data and certification of retrofit and new systems (1987).

SUB-ACTIVITY: CONSERVATION

Energy Conservation in Industrial Processes

Technology Objectives

To increase the efficiency of oil and gas utilization in industry, and to develop technologies to reduce the energy content per unit of production. Specifically:

by 1985 to develop and demonstrate technologies to improve fuel utilization efficiencies in industrial boilers and process heaters by 15%, and

by 1986 to reduce the energy content per unit of production of the industrial minerals industry by improving comminution technology, kiln operations, and by incorporating mineral wastes, such as fly ash and slags, as supplementary cements, and

by 1987 to evaluate the application of plasma technology as an energy source in boiler operations, and in mineral extraction and processing. Also, on a continuing basis, to provide technical support to extra-mural programs on waste heat recovery, synfuel utilization, and evaluation of new engine technologies.

Description

The potential for direct fuel conservation in industry will be addressed through improvements in burner design, ignition devices (including plasma torches), low-Btu gas utilization, and load-following controls. Improved performance systems will be assembled and evaluated at specific industrial sites under the ENERSOLVE program designed to achieve rapid transfer of available technology to industry.

In addition to the ignition application referred to above, plasma torch technology will be examined as a source of energy for ore drying and for the pyrometallurgical extraction of metal values from beneficiated minerals. This effort is in keeping with the policy of reducing the mineral industry's dependance on fossil fuels and will contribute to assessment of the potential for electrification of mineral processing.

A significant part of the resources will be directed toward the industrial minerals sector because it spends more on energy as a production input than any other industrial sector. Through the efforts of the industrial minerals Task Force on Energy Conservation, a 15% reduction in energy consumption per ton of output has been achieved since the base-line year of 1974. This has been obtained fairly readily by better housekeeping and by elimination of wasteful practices inherited from the cheap fuel era. Further improvements in energy productivity require improving the equipment design, process modification, fuel switching, use of supplementary and less energy intensive materials as partial replacement of portland cement, and the optimization of energy flows within the total production operation. All these areas require R & D elements to establish basic and process design information regarding the various processes involved and the properties, mode of action and effectiveness of materials for use as supplementary cements.

Special efforts will be directed at the cement, brick and clay products industries. Contracted-out R & D projects on improved comminution technology; more efficient kiln and oven firing; and improved utilization of waste products, e.g., fly ash, slags and silica fume as materials for supplementary cements share the common objective of reducing the energy content in each unit of product.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	40(1)	80(2)	80(2)	80(2)	80(2)
Energy R & D	1100(1)*	1100(1)	1200(1)	1200(1)	1200(1)
Total	1140(2)	1180(3)	1280(3)	1280(3)	1280(3)
Contract $ (included in above)	858	883	978	978	978

* includes new ERD proposal on Plasma Technology, 100 (0) not yet approved.

Major Outputs

1. Control systems for increased efficiency in oil and gas process heating (1985).

2. Assistance in the demonstration of waste heat recovery technologies in industrial processes waste incineration and thermal power generation (1986).

3. Evaluation of the combustion characteristics of alcohols, synthetic fuels, and fuel blends (1986).

4. Development of improved comminution technology to permit product quality control on an optimum energy basis (1986).

5. Computerized control package to permit operation of kilns and dryers at peak energy efficiency (1986).

6. Development of technology to derive cementitious materials from mineral waste, and test concretes made from such supplementary cements (1987).

SUB-ACTIVITY: PETROLEUM SUPPLY

Treatment of Bitumen/oil Emulsions and Effluent Waters

Technology Objectives

To promote the development and application of optimized technology for the treatment of wellhead production fluids produced by thermal in-situ recovery of bitumen and heavy oil. Specifically:

by 1986 to have developed new generation polymers and expertise in the separation of field produced emulsions and treatment of produced waters so that the mobile pilot plant laboratory (under development) may be used to optimize oil recovery and water treatment at specific field locations under variable production conditions.

Description

A major in-house program is directed toward developing and improving methods for treatment of emulsions and effluent water from bitumen/heavy oil recovery operations. A mobile pilot plant is being established to develop appropriate methods for site-specific problems. CANMET is recognized as the lead agency for emulsion treating and the program includes substantial co-operative projects with industry and provincial agencies.

Energy R & D resources are directed to technology transfer via the establishment and field-operation of a mobile laboratory; to the development of requisite analytical and process control capabilities; and contract-out studies on new processes, e.g., a pilot plant study of the application of oleophilic techniques to the separation of field-produced oil/water emulsions.

A-base resources support more basic in-house R & D cooperative contract-in studies on new generation polymers.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	-(+1*)	-(+1)	-(+1)	-(+1)	-(+1)
Energy R & D	1120(4)	1120(4)	800(4)	800(4)	800(4)
Total	1120(4+1)	1120(4+1)	800(4+1)	800(4+1)	800(4+1)
Contract $ (included in above)	108	400	200	200	200

* one unfunded person-year

Major Outputs

1. Development, with manufacturers, of engineered polymers for separation of stable emulsions (contract and annual reports to 1988).

2. Transfer of emulsion separation and water treatment technology to industry via on-site mobile pilot plants backed by in-house analysis and on-going R & D (1986 - 1988).

3. Development, via contracts of an oleophilic process for the separation of oil/water emulsions (Phase I, contract report 1984).

4. Development of chemical and mechanical processes for separation of emulsions and treatment of recycle and effluent waters (Phase I, contract reports 1984).

SUB-ACTIVITY: PETROLEUM SUPPLY

Extraction of Bitumen from Mined Oil Sands 420201

Technology Objectives

To promote the development and demonstration of improved and new processes for the extraction of bitumen from mined oil sands. Specifically, to participate with AOSTRA and industry in:

- the planning, construction and operation of an Oil Sands Demonstration Centre aiming at construction of core facilities by mid-1985;
- further development of the UMATAC Taciuk Processor retort process for extraction of a pipelineable synthetic crude for further upgrading at a central facility, aiming for commercialization by 1990.

Description

CANMET's major contribution in the development of new technologies for separation of bitumen and sand supports the establishment and operation of an Oil Sands Demonstration Centre in cooperation with AOSTRA and industry. This is an approved project within the NEP and is aimed at development of new processes for the next generation.

In-house contract funds may be applied to development of extraction processes which are more compatible, than hot water processes, both with hydrogen upgrading of bitumen and with the environment. The UMATAC retort process has been developed by AOSTRA to a stage where cooperative development with AOSTRA and industry is warranted. This process has attracted current attention because of its potential application in mini-scale oil sand operations which would serve a central hydrotreater.

In-house R & D is concerned with the development of CANMET's leading role in solvent extraction applied to the mineral industry.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	50(1)	50(1)	50(1)	50(1)	50(1)
Energy R & D	50(0)	1500(0)	1600(0)	1100(0)	1100(0)
Total	100(1)	1550(1)	1650(1)	1150(1)	1150(1)
Contract $ (included in above)	50	1500	1600	1100	1100

Major Outputs

1. Establishment of an AOSTRA/Industry (including EMR) Oil Sands Demonstration Centre in the vicinity of Fort McMurray by 1985 (Phase II study report, July 1983).

2. Cooperative development of an alternative extraction process(es) which may be commercialized by 1990 (annual status reports).

3. Research reports furthering the development of solvent extraction technology applicable to oil sands (annual reports).

SUB-ACTIVITY: PETROLEUM SUPPLY

In-situ Recovery of Bitumen and Heavy Oil

Technology Objectives

To develop improved technologies for in-situ bitumen/heavy oil production in order to increase the efficiency of recovery, reduce production costs, broaden the application of thermal recovery technology, use ancillary fossil fuels to generate steam and deal with environmental issues. Specifically:

by 1985 to contribute significantly to understanding of the fundamentals of steam stimulation processes;

by 1987 to demonstrate the use of ancillary solid fuels and produced waters for generation of steam and CO_2 for injection into oil reservoirs;

by 1990 to contribute significantly to the development of specific thermal and chemical technology for in-situ primary production of bitumen and heavy oils.

Description

CANMET supports a minimal in-house R & D program on the fundamentals of steam stimulation. Most of the resources are devoted to contracts for the stimulation of technology developments aimed at early increases in the production of bitumen and heavy oil in western Canada. In-situ production is considered to be inherently more compatible with mini-scale projects than surface mining projects and therefore deserves special attention at this time.

The use of ancillary solid fuels has been identified as a potential way to increase oil production because currently about one third of the produced heavy oil is used to generate steam for injection. The wet oxidation of solid fuels may be economic because of reduction in water treatment costs and benefits to be derived from reservoir injection of the generated high-quality steam plus CO_2.

NEP support is anticipated for cooperative projects with industry, provincial agencies and the US Dept of Energy.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	140(3)	140(3)	140(3)	140(3)	140(3)
Energy R & D	700(1)*	450(2)	450(2)	450(2)	450(2)
Total	840(4)	590(5)	590(5)	590(5)	590(5)
Contract $ (included in above)	633	335	335	335	335

* new ERD proposal, not yet approved

Major Outputs

1. Contract reports on the feasibility of using ancillary solid fuels (1984).

2. Shared-cost development of the Zimpro-AEC process for wet oxidation of solid fuels using field-produced water with no pretreatment (1983-86, status reports mid 1983).

3. Shared-cost field trials to demonstrate the technical and economic feasibility of wet oxidation for in-situ oil recovery (1986-88).

SUB-ACTIVITY: PETROLEUM SUPPLY

Development and Improvement of CANMET Hydrocracking Technology for Upgrading Bitumen, Heavy Oils and Residuals

Technology Objectives

To develop new upgrading processes and improve existing technologies by monitoring new developments, by pilot-plant and bench-scale experiments, and by performing fundamental research on the chemical and physical processes of hydrocracking.

Description

Fundamental studies of the chemical reactions and physical processes occurring during upgrading are required to develop new, or to improve existing, upgrading technologies. In-house research entails bench-scale, autoclave and pilot-scale experiments, detailed chemical and spectroscopic analyses, kinetic studies, and computer modelling. Existing hydrocracking processes in development and at the commercial stage will be monitored to assess the technical and economic viability of such technologies and their ability to meet Canada's needs.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	855(9)	1255(11)	1655(11)	1755(11)	1755(11)
Total	855(9)	1255(11)	1655(11)	1755(11)	1755(11)
Contract $ (included in above)	150	225	400	400	400

Major Outputs

1. Reports of bench-scale and pilot-plant studies for evaluation and development of additives and processing schemes.

2. Reports on fundamental studies of the physical and chemical processes occurring during upgrading of different feedstocks.

3. Reports on contract studies in support of new technology development.

SUB-ACTIVITY: PETROLEUM SUPPLY

Support of the Commercialization of the CANMET Hydrocracking Technology

Technology Objectives

To support the commercialization by Petro-Canada of the CANMET Hydrocracking Process. To support the design, construction and operation of a 5000 barrel per day demonstration unit to be built in Montreal. To develop further CANMET Hydrocracking technology.

Description

The CANMET Hydrocracking Process has been developed using the pilot-plant facilities at ERL. EMR has entered into an agreement with Petro-Canada for the commercialization of the process. The first stage is the construction in Montreal of a 5000 barrel per day demonstration unit scheduled for completion in 1984. To support the design and construction of the demonstration unit and the further commercialization of the process, the pilot plants at ERL are fully committed for at least the next five years. Experiments will be performed to optimize operational conditions, yields and conversions; to characterize new feedstocks; and to further develop hydrocracking technology.

To utilize more of Canada's large reserves of heavy oil, development of a commercially viable process for upgrading heavy oil, bitumen and residue to distillate fuels will help to reduce Canada's reliance on imported oil.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	610(16+1*)	610(16+1)	610(16+1)	610(16+1)	610(16+1)
Energy R & D	-	-	-	-	-
Total	610(16+1*)	610(16+1)	610(16+1)	610(16+1)	610(16+1)
Contract $ (included in above)	-	-	-	-	-

* one unfunded PY

Major Outputs

1. Reports on pilot-plant studies in support of commercialization of the CANMET Hydrocracking process and in support of the demonstration unit.

SUB-ACTIVITY: PETROLEUM SUPPLY

Thermal Oil Shale Conversion and Catalytic Residuum Conversion Technology

Technology Objectives

To develop improved technologies for conversion of bitumenous residual fractions, asphaltenes and shale oils to usable liquid fuels and hydrogen.

Description

An assessment of hydroretorting of Canadian oil shales is to be conducted initially by contract. This study will be complemented by in-house research. Catalytic conversion of asphaltenes will focus on development of catalysts capable of converting high-molecular asphaltenic species. The major problem is to overcome rapid catalyst deactivation that is caused by adsorption of large asphaltenic molecules on the catalyst surface. This research is part of a major activity to develop improved catalytic or additive systems for upgrading of bitumens, heavy oils and refinery residuals. A new technology will be developed to obtain additional liquids by catalytic pyrolysis and gasification of the residuals that remain after primary upgrading.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	60(1.5)	60(1.5)	60(1.5)	60(1.5)	60(1.5)
Energy R & D	400(5)	400(5)	400(5)	400(5)	400(5)
Total	460(6.5)	460(6.5)	460(6.5)	460(6.5)	460(6.5)
Contract $ (included in above)	70	70	70	70	70

Major Outputs

1. Yearly reports by a contractor on the assessment of oil-shale hydroretorting. Completion of a study that assesses liquid yields obtainable from such treatment of Canadian oil shales (1984).

2. Annual reports on the catalytic conversion of asphaltenes. Completion of the initial phase of developing improved technology for catalytic conversion of asphaltenes to liquids (1984). Patent coverage will be sought if applicable.

3. A report on progress of experimental system construction for catalytic pyrolysis gasification (1983). Experimental results to be reported yearly henceforth.

4. Completion of the initial phase for developing methods of converting pitch to liquids and hydrogen (1986).

SUB-ACTIVITY: PETROLEUM SUPPLY

Development of Disposable Catalysts for Residuum Hydrocracking and Co-processing Technologies

Technology Objectives

To develop alternative disposable catalysts or additives to obtain an improved liquid product from hydrocracking bitumens, heavy oils and refinery residuals. To optimize additives for specific feedstocks. To develop and test disposable catalysts or additives for co-processing of coal with feedstocks of petroleum origin.

Description

Within a range of feasible processing conditions, the liquid product of hydrocracking oil sand bitumen, heavy oils or refinery residual oils can be improved in quality and/or quantity if more effective catalysts or additives are used. These agents may exhibit multifunctional effects which need to be investigated and understood through a series of complex experimental tests.

Autoclave reactor studies are planned for the development of catalyst and additives to improve the liquid yield in co-processing of Canadian coals with bitumen, heavy oils and residuals. The experiments will serve in part to assess the technical feasibility of the co-processing approach.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	260(3.5)	260(3.5)	260(3.5)	260(3.5)	260(3.5)
Total	260(3.5)	260(3.5)	260(3.5)	260(3.5)	260(3.5)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Reports on advances in additive development for hydrocracking (1983 - 1985).
2. Reports on catalyst performance in upgrading (1983 - 1985).
3. Assembly of Compressor Stirred-Tank Reactor (CSTR) system for co-processing studies (1983).
4. Reports on testing of additives for co-processing (1986 - 1988).

SUB-ACTIVITY: PETROLEUM SUPPLY

Improved Process Development by Characterization of Synthetic Crudes and Their Distillate Products

Technology Objectives

To promote the development of new improved upgrading technologies by characterization of feeds and products in bitumen and heavy oils processing and in coprocessing with Canadian coals. To separate and characterize desirable components that play roles as hydrogen donors, hydrogen shuttling compounds or could be used as additives to improve product quality. To characterize undesirable components that cause problems during upgrading or utilization of synthetic fuels.

Description

Characterization studies are needed to give better insight into the various chemical reactions that occur during processing in order to optimize conditions and to assess product quality for utilizations. Characterization studies of processing feeds are also useful for predicting the required severities of treatment. The fates of different components in the feeds and products obtained at various processing severities are studied in relation to hydrocracking and co-processing of bitument/heavy oils with coal. Included are studies on asphaltene conversion, coking propensities of polynuclear aromatic compounds, and hydrogen donor reactions.

Identification of nitrogenous, sulphurous and aromatic components that are problematic in upgrading and utilization of synthetic crudes is required for development of industrial methods to segregate them or convert them to desired products. Investigation continues to determine the most desired components in upgraded synthetic fuels for utilization in diesel and jet engines.

All characterization studies are accompanied by development of new analytical procedures as new requirements become evident.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	420(4.5)	595(5)	540(5)	540(5)	540(5)
Total	420(4.5)	595(5)	540(5)	540(5)	540(5)
Contract $ (included in above)	25	50	100	100	100

Major Outputs

1. Annual reports on the chemical characterization of hydrocracking feeds and products. Completion of a comprehensive hydrocracking feed and product assessment (1983).

2. Annual reports on the chemical characterization of specific components relevant to upgrading and utilization. Completion of the study to identify the major significant problematic and desired components that are relevant to the production of specification transportation fuels (1985).

3. Annual reports on the chemical characterization of feeds and products from coprocessing investigations. Completion of a comprehensive feed and product characterization for coprocessing of bitumen/heavy oils with coals (1986).

4. Annual reports on new/improved analytical methods.

SUB-ACTIVITY: PETROLEUM SUPPLY

Development of Novel Industrial Separation Processes

Technology Objectives

To develop chemical and physico-chemical methods for separating certain undesirable compounds that cause operational problems during recovery of bitumens and heavy oils and the subsequent upgrading and utilization of their synthetic fuels. Preliminary assessment of the feasibility for industrial application of these methods are included.

Description

Methods of segregating catalyst deactivating components in synthetic fuels are being developed. This allows greater catalyst activity for the production of transportation fuels for diesel and jet engines. Based on previous results, it appears that the more problematic nitrogenous compounds could be removed economically. Further research is being conducted to investigate the possibility of isolating sulphur compounds and segregating aromatic components by such novel methods as reverse osmosis.

In-situ recovery of bitumen/heavy oils produces large amounts of stable emulsions which must be broken to obtain additional oil. The water from these emulsions must be acceptable for recycling or releasing to the environment. While the use of emulsion-breaking surfactants shows promise, results to date have shown that substantial water is still found in the oil layer or oil is found in the water layer. Since these surfactants could be costly and environmentally undesirable, alternate methods are being considered. For example, inexpensive sorbents have, in most cases, produced oil-free water. Regeneration of the sorbent is also being investigated.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	620(4.5)*	930(5)	1510(7)	1390(7)	1390(7)
Total	620(4.5)	930(5)	1510(7)	1390(7)	1390(7)
Contract $ (included in above)	70	120	700	600	600

* includes new ERD proposal on sorbents, 200(2), not yet approved

Major Outputs

1. Annual progress reports on the segregation of compounds that are problematic during upgrading and utilization of synthetic fuels.

2. Completion of a comprehensive study of industrial segregation of problematic compounds. Specifically to have developed a process for the removal of catalyst deactivating nitrogenous components (1985).

3. Annual reports on feasibility assessments of new methods to break water/heavy oil or bitumen emulsions with inexpensive sorbent materials.

4. Demonstrate long-term sorbent reliability for emulsion breaking (1985).

SUB-ACTIVITY: PETROLEUM SUPPLY

Catalytic Refining of Synthetic Crude Distillates to Specification Transportation Fuels

Technology Objectives

To determine suitable catalytic processes to increase the quantity and improve the quality of transportation fuels produced from synthetic crudes and unconventional refinery feedstocks.

Description

In-house and contract research is directed to improving the quality of naphthas and middle distillates to meet gasoline, diesel and jet fuel specifications. Initial efforts will be on conversion of aromatics and ring opening of naphthenes through catalytical hydrocracking and hydrotreating. Such processing will be required for middle distillates originating from oil sand bitumens, heavy oils and refinery residual oils. Utilization of cat-cracker products for diesel pools may require similar treatment. Synthetic crudes originating from coal may pose additional problems because heteroatom removal is more difficult when refining coal-derived liquids. Also, oxygenates within synthetic crudes can cause rapid catalyst deactivation and thereby increase process costs substantially.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	120(3)	120(3)	120(3)	120(3)	120(3)
Energy R & D	1290(4)	2180(4)	2360(4)	2730(4)	2730(4)
Total	1410(7)	2300(7)	2480(7)	2850(7)	2850(7)
Contract $ (included in above)	520	1065	1725	2085	2085

Major Outputs

1. Report on catalytic hydrotreating of Suncor and Syncrude distillates (1983).

2. Report on conversion of aromatics and naphthene ring opening (1984), complemented by annual contract research reports.

3. Report on the upgrading of coal-derived liquids (1985).

4. Reports on options available to obtain higher cetane numbers for diesel fuels originating from unconventional feedstocks (annual contract reports to 1987).

5. Reports on options available in refining of coal-derived liquids to specification fuels (annual contract research reports to 1988).

6. Experimental work to upgrade distillates from the CANMET Hydrocracking pilot plant will assist Petro Canada in its commercialization efforts.

SUB-ACTIVITY: PETROLEUM SUPPLY

Conversion of Natural Gas to Liquid Fuels

Technology Objectives

To establish by 1987 in-house knowledge which allows promotion of novel technology for the production of hydrocarbon liquid fuels from natural gas and related feedstocks such as CO an H_2 mixtures.

Description

The existence of a substantial surplus of methane makes any technology which can convert this gas to liquids without the retorting stage very attractive economically. The thermodynamic feasibility for single stage conversion of methane to liquids will be established, then the construction of a suitable reactor system will be required to promote this new technology.

An increased demand for diesel fuel places renewed interest in Fischer-Tropsch synthesis. Current research efforts are towards designing and constructing a fully automated high-pressure system to study catalysts. Computerized studies will establish optimal catalyst reaction conditions to produce synthetic fuel in the diesel range.

A new research project has been started to develop semi-conductor catalysts for the production of synthetic fuels from CO_2, CO and organics.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	40(1)	40(1)	40(1)	40(1)	40(1)
Energy R & D	600(3)*	850(4)	800(4)	800(4)	800(4)
Total	640(4)	890(5)	840(5)	840(5)	840(5)
Contract $ (included in above)	130	250	250	250	250

* includes new ERD proposal on catalysts, 200(0), not yet approved

Major Outputs

1. Annual progress reports. Report on the methodology used for Fischer-Tropsch and single stage conversion of methane (1984).

2. Construction of high-pressure system to study catalysts (1984).

3. Reports on development of semi-conductor catalysts (1984 - 1986).

4. Contracts (Annual reports)
   (a) Catalytic activity of supported bimetallic cluster in Fischer-Tropsch synthesis (Dalhousie University).
   (b) Construction and activation of a Fischer-Tropsch catalyst testing laboratory (Queen's University).
   (c) New catalyst for conversion of simple alcohols into synthetic gasoline (Centre du Recherche Industriel du Quebec).

SUB-ACTIVITY: PETROLEUM SUPPLY

Materials for Hydrocarbon Processing

Technology Objectives

To develop a data base on materials behaviour in support of materials selection for hydrocarbon processing. Specifically:

by 1984 develop and evaluate fabrication and inspection technologies for pressure vessels;

by 1985 characterize materials for heavy oil recovery operations;

by 1986 characterize and evaluate properties and simulate in-service performance of pressure vessel materials;

by 1986 develop advanced welding technologies for the fabrication of heavy-section pressure vessels for energy conversion systems; and

by 1988 detail materials degradation processes in tar sands mining and in pipeline transport.

Description

The future requirements of the petrochemical industry in terms of processing plants for the treatment of tar sands, heavy oil, coal gasification, etc., project a demand for reactor vessels of increasing size and service capability. If this demand is to be met by Canadian fabricators, the level of technology must be increased to allow them to be competitive with offshore industry, which in many instances already possess the technological capability.

The fabrication of large, thick-walled steel pressure vessels for energy conversion systems, such as upgrading of bitumen and heavy oils, liquefaction and gasification of coal, and coprocessing of coal with bitumen, requires development of welding processes and procedures for both mill and field fabrication. The welding systems must be able to join pressure vessel steels in the thickness range of 175 mm to 400 mm and produce welds of such quality that they will meet NDE inspection and mechanical property requirements specified in pressure vessel codes.

Linked with the technology to fabricate large vessels is the optimization of service performance. In this regard, the petrochemical industry must have assurance that the integrity of the vessels will be adequate. Thus, the metallurgical structure and mechanical properties of the vessel materials must be compatible with the service environment.

The wear of pipelines carrying tar sands tailings is being studied. Materials are being studied for application in tar sands mining operations. In-situ recovery of heavy oils results in materials exposed to high-temperature, corrosive, and erosive environments. Materials problems are being studied in experiments under simulated operating conditions.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	240(6)	240(6)	240(6)	240(6)	240(6)
Energy R & D	610(4)*	610(2)	230(2)	230(2)	230(2)
Total	880(10)	880(8)	470(8)	470(8)	470(8)
Contract $ (included in above)	351	415	75	75	75

* includes new ERD proposal for 1 PY, not yet approved

Major Outputs

1. Characterization of materials for heavy oil recovery (1984).

2. Preparation and evaluation of narrow gap welds (1984).

3. Development and assessment of non-destructive inspection systems for pressure vessels (1984).

4. Assessment of temper embrittlement and notch toughness of heavy-section welds (1984).

5. Production and evaluation of experimental welds of heavy-section steel plate - CONTRACT (1985).

6. Assessment of hydrogen embrittlement of pressure vessel weldments (1985).

7. Characterization of materials for tar sands mining (1988).

SUB-ACTIVITY: PETROLEUM SUPPLY

Materials for Oil and Gas Pipelines

Technology Objectives

To develop a data base on steel properties for pipeline fabrication, degradation, inspection and repair technologies. Specifically:

by 1985 establish the effects of mechanical damage on crack initiation and growth, and develop a rational basis for inspection standards for oil and gas transmission pipelines;

by 1986 establish data bases on stress-corrosion cracking and hydrogen damage characteristics in Canadian-produced linepipe steels;

by 1987 develop the technology for producing Grade 483 (X-70) pipeline fittings;

by 1987 develop advanced welding techniques for linepipe of Grade 483 (X-70) and higher;

by 1987 develop non-destructive examination technologies for detecting degradation of pipelines and monitoring stress; and

by 1988 rationalize the effects of composition and processing on the properties (including weldability) of Grades 483 (X-70), 552 (X-80), and possibly 621 (X-90) linepipe steels.

Description

There are three main parts of this technology:

1. Development and evaluation of high-strength steels for pipelines.

2. Degradation and inspection of pipelines.

3. Fabrication of pipelines - development of high-strenth fittings and advanced welding techniques.

PMRL's unique facilities for melting steel and rolling plate on an experimental scale and for analyzing microstructures are being used to promote an understanding of the interrelationships between steel chemistry, processing and mechanical properties. It is anticipated that this work will enable Canadian steel producers to enlarge their range of steel chemistries to produce Grades 483 (X-70), 552 (X-80), and possibly 621 (X-90) linepipe steels. It is also expected that this research will lead to steels of greater toughness at the Grade 483 (X-70) strength level.

Pipeline failures result from several causes: stress-corrosion cracking, hydrogen damage, mechanical damage, defects resulting from manufacture or fabrication. The acceptable limits of defects are being studied. Non-destructive techniques are being studied to improve defect detection and

monitoring. A new magnetic inspection method is being developed to detect stresses on a pipeline. Technology transfer is facilitated by a reactive cost-shared R & D program on stepwise cracking with Canadian industry.

While there has been a great effort to produce large-diameter linepipe of high strength and toughness, but the development of pipeline fittings to match these properties has lagged behind. Consequently, there is a need - addressed in this technology - to develop a method for producing Grade 483 (X-70) pipeline fittings. Welding techniques with heat input lower than now used are being developed with the aim of improving toughness of the seam weld heat-affected zone.

Resources $K (PY)

	83/84	84/85	85/86	86/87	87/88
A-Base	570(10+1*)	570(10+1)	570(10+1)	570(10+1)	570(10+1)
Energy R & D	100(0)	100(0)	100(0)	100(0)	100(0)
Total	670(10+1)	670(10+1)	670(10+1)	670(10+1)	670(10+1)
Contract $ (included in above)	100	100	100	100	100

* 1 unfunded PY

Major Outputs

1. A rational basis for inspection standards for oil and gas pipelines (1985).

2. Data bases on stress-corrosion cracking and hydrogen damage characteristics of Canadian-produced linepipe steels (1986).

3. Development and evaluation of steels, welding consumables, and processes for Grades 448 (X-65) and 483 (X-70) fittings (1987).

4. Advanced welding techiques for linepipe steel of Grade 483 (X-70) and higher (1987).

5. Non-destructive examination technologies for detecting pipeline defects and degradation, and for monitoring stress (1988).

6. Data base on composition-processing-properties of Grades 483 (X-70) and 552 (X-80) linepipe steels (1988).

SUB-ACTIVITY: PETROLEUM SUPPLY

Materials for Offshore Structures

Technology Objectives

To provide, on an ongoing basis, materials research support to Canadian industry and regulatory agencies of government on the structures, vessels, and pipelines required to develop offshore and arctic hydrocarbon resources. Specifically:

by 1987 develop competitive steel plate products for future domestic markets in offshore structures, pipelines and arctic vessels through joint EMR-industry funding of R & D projects proposed by Canadian industry;

by 1987 complete in-house and contract projects on steels for offshore structures such as corrosion fatigue, low-temperature fracture, development of improved steels; and

by 1987 complete a data base on composition, processing, and properties (including weldability and low-temperture fracture) for steels that Canadian mills could produce.

Description

If the oil and gas resources in the offshore east coast and in the Arctic are to be developed safely, with a minimum threat to the environment, and with the maximum economic benefit to Canada, Canadian industry and government must upgrade their materials technology by developing improved steels and fabricating techniques and sophisticated structural integrity monitoring systems. Accordingly, in this program R & D are being carried out on steels and concrete for use in offshore structures and on inspection technology.

One project, "Steels and Concrete for Offshore Structures", comprises a package of in-house and contract work on materials and on materials fabrication technology. It includes work on corrosion fatigue, fracture of steels at low temperatures, and development of improved steels.

It is anticipated that research on concrete will begin in 1983/84, including evaluation of concrete for use in offshore structures (fatigue, long-term durability, accelerated test methods, corrosion of steel reinforcements in the splash zone, and ductility of ultra-high-strength concrete) and evaluation of concrete repair techniques (epoxy injection) for multi-year underwater performance.

A second project "Structural Integrity Monitoring of Offshore Structures", is aimed at developing and evaluating, in the laboratory, techniques to detect, measure, and monitor defects and their growth in offshore structures, with the aim of developing quantitative fracture control plans to eliminate catastrophic failures.

A third project, "Cost-shared Industrial R & D", involves a 50/50 cost-shared program on materials for Canadian eastern and arctic offshore systems, which is being established using federal government contracting procedures to solicit industrial proposals. This cost-shared program includes steel development, evaluating under Canadian conditions foreign-developed technologies, and large-scale engineering types of research related to steel production and fabrication of components for offshore structures.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	1917(10)*	2249(10)	2293(10)	2313(10)	2313(10)
Total	1917(10)*	2249(10)	2293(10)	2313(10)	2313(10)
Contract $ (included in above)	1035	1558	1578	1593	1593

* includes new ERD proposal, 307(1), not yet approved

Major Outputs

1. Corrosion fatigue life of welded T-joints in artificial sea water - CONTRACT (1983).

2. Corrosion fatigue life of "monopod" nodes in sea water - CONTRACT (1985).

3. Correlation of laboratory-scale and large-scale corrosion fatigue tests with nodes (1986).

4. Quantitative fracture control plans (1987).

5. Data base on composition-processing-properties (including weldability and low-temperature fracture) for steels that Canadian mills could produce (1987).

SUB-ACTIVITY: COAL

Coal Reserve Assessment

Technology Objectives

To establish and maintain a capability for assessing Canada's coal resources, reserves and production. Specifically:

continuing to issue biennial assessments of Canada's coal reserves and production capability; to maintain facilities for analyzing Maritime coals in accordance with a federal-provincial agreement;

by 1984 to develop a computer-based methodology for coal reserve assessment;

by 1985 to establish a coal quality data file for Canadian coals in place (cooperatively with GSC); and

by 1986 to develop geophysical techniques for borehole logging of coal quality (cooperatively with GSC).

Description

Canada's coal production is expected to expand substantially during the next two decades. In the short term, demand will be for domestic power generation and for export of both thermal and metallurgical coal. Later, possibly after the year 2000, coal may be needed as feedstock for coal conversion plants to produce both liquid and gaseous fuels.

Orderly development of Canada's coal industry requires knowledge of the national reserves. An objective of the National Coal Resources Data Base is to contain knowledge of recoverable coal estimated for specific areas at given prices using current technology, quality data, mining restrictions, and environmental impact data. A computer-based assessment system will be established to collect, process and calculate data from developers, producers and provincial authorities to produce coal reserves estimates.

Optimal scheduling of mine development can be reliably undertaken only if coal quality is established and recorded in a national data base, either traditionally by sample analysis or by other techniques such as borehole logging. Priority in quality determinations will be given to foothills and plains coals which are predominantly destined for domestic use.

A coal map file will be compiled together with analyses of Nova Scotia coals as part of a federal-provincial agreement. In addition, sampling and analyses will be conducted to form the basis of an Analysis Directory of Canadian Commercial Coals.

Resources	$K (PY) 83/84	84/85	85/86	86/87	87/88
A-Base	210(4+3*)	210(4+3)	210(4+3)	210(4+3)	210(4+3)
Energy R & D	-	-	-	-	-
Total	210(4+3)	210(4+3)	210(4+3)	210(4+3)	210(4+3)
Contract $ (included in above)	-	-	-	-	-

* three unfunded PY's

Major Outputs

1. Biennial assessment of Canadian coal reserves and production capability.
2. Computer methodology for reserve assessments (1984).
3. Development of a data base for quality of coal in-place (1985).
4. Development of coal quality assessment from geophysical logging (1986).
5. Report on analyses and results on Nova Scotia coals.
6. Coal reserves map file.
7. Analysis Directory of Canadian Commercial Coals.

SUB-ACTIVITY: COAL

Coal Mining

Technology Objectives

To determine and foster adoption of the most appropriate mining technologies in Canada. Specifically:

continuing to conduct state-of-the-art reviews of mine operational problems to determine the potential for improvements in technology and to prepare R & D programs to address the problems, i.e., equipment maintenance, personnel and materials transport, computer assisted mine design;

continuing to identify, evaluate and promote through the mechanism of funded demonstration projects, the adoption of appropriate new mining technology to the various coal mining regions of Canada; and

by 1988 to demonstrate the application of longwall methods for the underground mining of moderate to steep dipping coal seams in the mountain areas of western Canada.

Description

Currently, coal production in Canada is predominantly from surface mining operations, which have expanded dramatically over the last decade largely as a result of advances in equipment productivity and surface mining technology. It is anticipated however, that over the long term much of Canada's future coal production will have to be produced from underground mines. Increases in production from underground coal mines to meet the expected long-term market demands will require improvements in underground coal mining productivity and safety commensurate with those demonstrated by surface mining in recent years. Such improvements in productivity and safety will depend both on the continued improvement of mining methods and equipment now in use, and on the development and application of new, higher productivity mining technology.

Current efforts related to the improvement of existing mining methods in Canada are specifically directed to fostering the continued development of hydraulic mining of steeply dipping, thick coal seams in mountain areas; to the implementation, through demonstration projects of new technology from Europe to improve roadway ground support and ventilation control in the undersea longwall mines in Nova Scotia; and to development of computer-based technology to assist in surface mine design and operations control.

Studies are also in progress to evaluate alternate mining methods and technology best suited to improving underground mine productivity for flat to moderately steep dipping coals of the western plains and mountains. Current efforts are directed to detailed engineering examinination of the potential for application of modern, mechanized longwall mining methods to mountain area coal seams. Extensive field trials will likely be required to

demonstrate the practicality of this method in the difficult geologic conditions of the mountain setting.

Application of coal mining technology, particularly that of large surface coal mines, to the vast oil sands resources of northern Alberta are also being investigated. Ultimately, underground mining of oil sands will also be required and studies of likely technological needs for such development are being initiated.

Resources	$K (PY) 83/84	84/85	85/86	86/87	87/88
A-Base	375(5)	455(6)	455(6)	455(6)	455(6)
Energy R & D	500(1)	1500(1)	2230(1)	1000(1)	1000(1)
Total	875(6)	1955(7)	2685(7)	1455(7)	1455(7)
Contract $ (included in above)	378	1374	2104	868	868

Major Outputs

1. Report on the technical feasibility of longwall mining in mountain area coal seams of moderately steep dip (1983).

2. Report on the economic and technical feasibility of modular approach to oil sands (surface) mining projects (1983).

3. State-of-the-art review on mine maintenance scheduling and planning practice in Canada (1984).

4. Longwall mining demonstration project in a western Canadian mountain-area coal seam (1988).

SUB-ACTIVITY: COAL

Strata Mechanics

Technology Objectives

To develop strata mechanics technology for the improvement of ground control in underground coal workings. Specifically:

continuing to develop and apply strata mechanics instrumentation in joint projects with coal mine operators to establish and evaluate specific identified strata control problems in coal mines;

by 1985 to compile a manual on subsidence and related strata control problems related to hydraulic mining of coal in thick, steeply dipping seams; and thereafter to extend this work to other major underground coal mining methods, particularly longwall mining;

by 1985 to compile a comparison of rock strata response and rock/support interaction to rapid driveage of underground roadways in coal mine sedimentary rocks by conventional drill and blast and by machine-bored tunnelling methods.

Description

The inducement of overlying strata to collapse in a predictable manner into mined-out workings without endangering the safety of workers in adjacent operating areas is the basis of most modern, high productivity underground coal mining methods. Continuation and expansion of underground coal mining in Canada relies on improving our understanding of strata mechanics and incorporating this understanding into mine design and operational control. Efforts in strata mechanics research include specific local ground control problems such as rock fall prevention, more general mine operational aspects such as pillar sizing and roadway supports, and regional aspects of underground mining such as subsidence of the overlying ground mass. Work in all of these areas, in addition to relating to operational aspects of working mines, is directed to the application of modern analytical techniques to develop better predictive models for use in design of new mines and mining methods. There is a continuing emphasis on relating in-mine monitoring of strata behaviour due to mining induced stresses to predicted responses based on laboratory materials testing and strata mechanics models.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	845(7)	665(7)	665(7)	665(7)	665(7)
Energy R & D	-	-	-	-	-
Total	845(7)	665(7)	665(7)	665(7)	665(7)
Contract $ (included in above)	250	250	250	250	250

Major Outputs

1. Development and application of strata mechanics instrumentation in joint R & D projects in underground coal mines, evaluating specific strata control problems with companies.

2. Report on subsidence and related underground strata control R & D at operating mines (1985).

3. Development of a strata behaviour manual for hydraulic mining of thick coal seams (1985) and thereafter extension of this technology to other mining methods.

4. Evaluation of rock response to rapid driveage of roadways in coal mines (1985).

5. Development of computer-based strata mechanics analytical models (1988).

SUB-ACTIVITY: COAL

Coal Mine Atmospheres

Technology Objectives

To develop and encourage the adoption of technology to improve the quality of underground mine atmospheres to reduce safety and health risks to workers. Specifically:

continuing to consolidate expertise in ventilation theory and practice to effect improvements in ventilation measurements and systems in Canadian mines;

by 1985 to demonstrate the beneficial impact of diesel emissions toxicity reduction equipment through in-mine trials using dedicated equipment in operating situations in a collaborative effort with the U.S. Bureau of Mines and the Ontario Ministry of Labour;

by 1985 to classify the hazard ratings of Canadian coal dusts;

by 1986 to develop and evaluate contaminant and ventilation parameter sensors and systems for use in continuous mine environment monitoring;

by 1987 to complete the development of an Air Quality Index (AQI) mathematical expression relating contaminant levels in mine air, incorporating mutagenic assays and PNA analyses, to permit prescription of ventilation rates for specific diesel machines;

by 1987 to develop and demonstrate systems for the detection and prevention of methane/coal dust explosions in underground coal mines; and

by 1988 to evaluate contaminant levels of noxious underground mine working places through the use of continuous mine atmospheres monitoring.

Description

CANMET has pursued mine atmospheres research along two basic thrusts. Firstly, that of identifying and quantifying contaminants and associated risk levels in mine air; and secondly that of developing strategies to reduce contaminants and risks to acceptable levels as established by regulatory agencies. This research pertains both to the health and the safety aspects of mine atmosphere contaminants. The health aspects of current work pertain mainly to the risks posed to workers by toxic emissions from diesel equipment used underground. The safety research is focused on the risk presented by methane and coal dust and their respective and combined explosion risks. Research on dust and other health risk contaminants in mine atmospheres is done under CANMET's Minerals Research Program.

Current research on the health risks posed by diesel equipment has reached the field demonstration stage of emissions toxicity reduction. Field

demonstrations are in the form of in-mine trials of dedicated equipment fitted with the devices and operated over extended periods in regular mining operations. This work is currently being done as a collaborative effort with the U.S. Bureau of Mines and the Ontario Ministry of Labour. Additional work on this project is done under the CANMET Minerals Research Program.

Additional research on health risks posed by mutagens and PNA's in underground mines is continuing. Results from this work will be included in the Air Quality Index (AQI) to further refine it to a comprehensive criterion of contaminant levels in mine air.

Safety research aspects of mine atmospheres technology are currently focused on quantifying the risk levels of methane and/or coal dust explosion in underground mining of the various Canadian coals; developing scaling relationships relating laboratory data to the actual mine environments; and development of systems to prevent such methane/coal dust explosions.

An overall priority in both health and safety aspects of the mine atmospheres work is the development of a system for continuous monitoring of mine air for the detection and quantification of contaminant levels. A basic system for air sampling now exists. Over the next several years accurate and reliable sensors and analytical systems to automatically evaluate coal mine contaminant concentrations will be developed. Following this, in-mine surveys will be possible on a continuous basis, to determine reliability the quality of air in various underground workplaces. Some additional sensors related to hard rock mine atmospheres are being developed under CANMET's Minerals Research Program.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	680(6)	800(9)	800(9)	800(9)	800(9)
Energy R & D	855(4)	877(4)	707(4)	687(4)	687(4)
Total	1535(10)	1677(13)	1507(13)	1487(13)	1487(13)
Contract $ (included in above)	640	598	477	468	468

Major Outputs

1. Demonstration of effectiveness of diesel emissions toxicity reduction systems through in-mine trials (1985).

2. Report on the classification of the explosion hazard of specific various Canadian coals (1985).

3. Issuance of a comprehensive report on the Air Quality Index (AQI) for underground mine atmospheres (1987).

4. Development of a system for the detection and prevention of methane/coal dust explosions in underground mines (1987).

5. Development of atmospheric contaminant sensors for methane, dust and diesel emissions (1988).

SUB-ACTIVITY: COAL

Coal Mining Safety Certification

Technology Objectives

To provide a national service for the certification of flameproof equipment, gas detectors and fire resistant materials to be used in explosive atmospheres in coal mines and other dangerous industrial environments, and to develop appropriate new standards to meet changing industry conditions. Specifically:

continuing to investigate the factors affecting fire and explosion safety of equipment and materials used in coals mines and other similar explosive atmospheres through the investigation of such accidents;

continuing to encourage incorporation of new safety features into coal mining equipment, materials and maintenance through the upgrading of certification standards;

by 1985 to develop procedures for evaluation of impact and static electricity safety hazards posed by materials in coal mines (such as aluminum);

by 1986 to evaluate changes which would be required in the flameproof equipment and fire-resistant materials certification standards for use underground in oil sands mines;

by 1988 to develop means for evaluating safety performance of equipment and materials, such as pressure hoses, under working conditions.

Description

In 1953, as a result of the unanimous desire of provincial inspectors from coal mining provinces, the federal government established a laboratory for safety certification, on a cost-recovery basis, of coal mining electrical equipment for use in explosive underground environments. This original mandate has evolved slowly over the years concurrently with developments in coal mining technology to include numerous fire-resistant materials and fluids, diesel machinery and explosive gas detection equipment in both underground and industrial hazardous locations. Research efforts to improve the quality of both the certification service and the standards utilized as the basis for such certification, continues.

Thorough research of risks and safety requirements in advance of establishing standards is needed. Thus the laboratory must anticipate equipment, materials and mining developments some years in advance to ensure that appropriate standards are available. The advent of more complex, robot-like mining equipment and underground mining in oil sands are future areas currently being addressed.

Resources	$K (PY) 83/84	84/85	85/86	86/87	87/88
A-Base	280(7)	280(7)	280(7)	280(7)	280(7)
Energy R & D	-	-	-	-	-
Total	280(7)	280(7)	280(7)	280(7)	280(7)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Certification certificates for flameproof, intrinsically safe electrical equipment and gas detectors for use in coal mines; for diesel equipment and fire-resistant materials (converyor belts, electric cables, hydraulic fluids, ducts and pipes) for use in all underground mines; are issued on an as-requested basis. A summary listing of all valid certificates is issued annually.

SUB-ACTIVITY: COAL

Coal Preparation

Technology Objectives

To develop and demonstrate coal preparation techniques to improve upon current levels of coal recovery (productivity) and to meet environmental standards while producing clean coal products suited for application to conventional combustion, carbonization, and potential future conversion processes. Specifically:

by 1984 to complete the installation of a new versatile pilot-plant facility;

by 1985 to characterize Canadian coals for washability and to demonstrate improved effluent water treatment;

by 1986 to develop a comprehensive suite of computer models for preparation plant processes;

by 1986 to demonstrate the feasibility of fully automated preparation plants;

by 1988 to demonstrate improved technology for the economical upgrading of high sulphur coals to meet stringent environmental controls for combustion and conversion.

Description

Coal preparation to remove ash, sulphur and other contaminants is generally necessary for coals destined for carbonization and conversion uses. In addition, as more coal destined for thermal power generation is being transported over long distances, upgrading requirements are being introduced to reduce transportation costs, and to meet environmental controls such as for sulphur emissions. International competition in coal supply markets is increasing and Canada must be able to improve the quality of our clean coal product while maintaining high resource productivity to remain competitive.

Research in this technology is directed both to the improvement of coal recovery (productivity) and to the reduction of undesireable impurities (sulphur). Major advances in both objectives are anticipated through the development of accurate, reliable computerized process controls and plant automation, which, following laboratory pilot testing will be evaluated through in-plant demonstration projects.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	350(7)	350(7)	350(7)	350(7)	350(7)
Energy R & D	990(6)	890(6)	790(6)	790(6)	790(6)
Total	1340(13)	1240(13)	1140(13)	1140(13)	1140(13)
Contract $ (included in above)	245	170	150	150	150

* includes ERD proposal for 2 PY, not yet approved

Major Outputs

1. Installation of the new, versatile coal preparation pilot-plant facility (1984).

2. Report on the washability of Canadian coals (1985).

3. Demonstration of the feasibility of fully automated coal preparation plant technology (1986).

4. Demonstration of economical techniques for cleaning high-sulpher coals to meet new, stringent environmental controls for combustion and conversion (1988).

SUB-ACTIVITY: COAL

Fine Coal Cleaning

Technology Objectives

To develop and demonstrate techniques to improve the recovery and quality of coal fines from coal preparation plant process streams. Specifically:

by 1988 to develop technology for the significant improvement in recovery of clean coal product from fine and oxidized coal feed in coal processing plants; and to demonstrate such technology through the use of mobile fine coal treatment plants in field trials at processing facilities.

Description

A major problem in the achievement of higher quality clean coal product together with higher overall coal recoveries from coal processing plants is the treatment of coal fines. This is particularly true with western Canadian coals which, because of their friable nature, contain substantial proportions of fines by the time they reach the processing facilities. The recovery of a high quality clean coal product from the raw feed is complicated by the presence of mineral contaminents within the same size and density ranges as the coal fines. Current practice in the industry is generally to either include the entire fine portion of the coal with no, or minimal treatment, thereby reducing the overall product quality, or to reject the coal fines thereby reducing overall recovery ratios.

The research in this task is dedicated to the investigation of the behaviour of fine and oxidized coals in relation to upgrading and dewatering processes in order to develop techniques to improve recovery ratios. This technology will be field tested at operating coal processing plants through the use of mobile fine coal treatment plants to be built as part of this program.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	570(8)	570(8)	570(8)	570(8)	570(8)
Energy R & D	900(1)	1000(3)	1000(3)	1000(3)	1000(3)
Total	1470(9)	1570(11)	1570(11)	1570(11)	1570(11)
Contract $ (included in above)	110	226	400	400	400

Major Outputs

1. Development and demonstration in pilot plant facilities of fine coal cleaning technology (1988).

2. Construction and field testing of mobile fine coal treatment pilot plants (1988).

SUB-ACTIVITY: COAL

Carbonization

Technology Objectives

To develop cokemaking technologies that extend coking coal resources, improve coke quality and conserve energy, and to determine the coking characteristics of Canadian coals in support of resource evaluation and export markets. Specifically:

by 1984 to establish the effects of quenching methods including dry quenching, on coke quality;

by 1985 to formulate and demonstrate blends that consist entirely of Canadian coals for high-quality coke-making;

by 1987 to develop test methods that adequately reflect the coking characteristics of western Canadian metallurgical coals;

by 1987 to develop and demonstrate techniques for producing coke of adequate quality from coals that are unsuitable for conventional coke-making;

continuing to perform pilot-scale coking tests on Canadian metallurgical coals and coal blends, in cooperation with industry; and

continuing to conduct basic research on coal properties relevant to carbonization applications.

Description

Canadian exports of metallurgical coal depend significantly on CANMET's internationally-recognized test facilities that are operated cooperatively with industry (through the Canadian Carbonization Research Association) for assessing the coking qualities of coals. These facilities also enable research to improve the coking qualities of lower grade coals, thus extending resources, and to formulate blends of Canadian coal which will permit reductions in the large volume of imported metallurgical coal. Conventional international test methods for assessing and predicting coking characteristics underestimate the quality of western Canadian coals. Development of appropriate tests, although a long-term task and requiring considerable basic research, will enhance the competitive position of the western coal industry. Characterization studies that are being carried out on metallurgical coal and coke concern both conventional and alternative cokemaking technologies, and will include an evaluation of coke quenching methods from the viewpoints of product quality and energy conservation.

Resources	$K (PY) 83/84	84/85	85/86	86/87	87/88
A-Base	850(20+7*)	850(20+7)	850(20+7)	850(20+7)	850(20+7)
Energy R & D	-	-	-	-	-
Total	850(20+7)	850(20+7)	850(20+7)	850(20+7)	850(20+7)
Contract $ (included in above)	-	-	-	-	-

* 7 unfunded PY's

Major Outputs

1. Quantify the effects of quenching methods on coke quality and energy conservation (1984).

2. Develop formulations for high-quality coke made entirely from blends of Canadian coals (1985).

3. Improve test methods for accurately predicting the coking characteristics of western Canadian coals (1987).

4. Develop new techniques by which adequate-quality coke can be produced from coals that are presently unsuitable (1987).

5. Continue to produce data for industry on the coking qualities of metallurgical coals and coal blends.

SUB-ACTIVITY COAL

Gasification

Technology Objectives

To promote gasification technology for Canadian coals and related feedstocks for application in advanced coal-to-electricity conversion processes, in indirect coal liquefaction via the synthesis route, and in methanol production. Specifically:

by 1985 to develop a library of gasification characteristics of Canadian coals, coal-derived chars, and bitumen and petroleum-derived chars;

by 1985 to complete a theoretical assessment of co-gasification with natural gas using high-moisture coals and wood;

by 1987 to develop advanced technology for removing solid particulates and corrosive inorganic gases from hot gas produced by a gasifier; and

by 1987 to develop gasification technology for conversion of lignites, coal rejects, and char residue from tar sands plants, to synthesis gas.

Description

Projected Canadian needs for synthetic natural gas are limited to remote locations with insufficient demand to justify pipelining of natural gas. The emphasis in gasification R & D is therefore directed toward potential applications in more efficient, combined-cycle conversion of coal to electricity, the production of gas as a feedstock for the synthesis of liquid fuels, and energy recovery from residues such as coke, char and pitch which cannot be readily utilized by conventional technology.

In-house efforts concern the cataloguing of gasification parameters of Canadian coals under various conditions, relevant to different gasification technologies. Considerable emphasis is on the gasification parameters of pyrolysis residues from Canadian coals. Gasification kinetics of inert materials in these coals are also being investigated. It appears that some Canadian coals, e.g., B.C. bituminous coals, are unsuited for direct liquefaction and therefore might be converted to liquid fuels via gasification followed by "Fischer-Tropsch" synthesis (as used in South Africa) or by the "Methanol-to-Gasoline" process (Mobil).

A number of gasification studies are performed under both fully and partially funded contracts. These include a feasibility study for producing methanol from Onakawana lignite and research on fluidized and spouted-bed gasification techniques. Also proceeding by contract is development of advanced technology for hot gas clean-up. This is essential to make combined cycle power generation economically competitive with conventional technology for thermal power generation. Research on gasification of residues such as oil sands coke pursues the dual options of producing a fuel gas which can be used on-site for steam-raising, and producing a synthesis gas as feedstock for production of high-cetane-number transportation fuels.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	60(1.5)	60(1.5)	60(1.5)	60(1.5)	60(1.5)
Energy R & D	650(3)*	795(3)	1250(3)	1250(3)	1250(3)
Total	710(4.5)	855(4.5)	1310(4.5)	1310(4.5)	1310(4.5)
Contract $ (included in above)	275	275	530	630	630

* includes new ERD proposal 300(1), not yet approved

Major Outputs

1. Library of gasification characteristics of Canadian coals and other potential gasification feedstocks (1985).

2. A new system for hot gas clean-up based on inexpensive throw-away solid absorbers (1987).

3. Technology for conversion of solid feeds to synthesis gas as feedstock for production of transportation fuels (1987).

4. Reports from various contractors on different aspects of gasification, e.g., efficiency of combined cycle power generation, comparison of different gasification technologies with respect to Canadian coals, environmental impact of gasification, utilization of gasification by-products.

SUB-ACTIVITY: COAL

Evaluation of Liquefaction Processes for Canadian Coals

Technology Objectives

To develop Canadian interest and expertise in coal liquefaction as a future source of liquid fuels. Specifically:

by 1987 to accumulate a data base on the liquefaction behaviour of different Canadian coals using different processing approaches by an in-house and contracting-out program.

Description

Most of the studies in this project are carried out under contract and are either fully or partially funded as a cooperative effort with industry. These studies address the problems of suitability and economic reality of applying the more advanced technologies to various Canadian coals. Fundamental studies and applications of novel and less advanced processing methods including pyrolysis are being performed. The contracts program is intended to develop interest and coal liquefaction expertise in Canada, in addition to providing an information data base.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	2310(5.5)	1995(5.5)	1945(5.5)	1985(5.5)	1985(5.5)
Total	2310(5.5)	1995(5.5)	1945(5.5)	1985(5.5)	1985(5.5)
Contract $ (included in above)	1399	1159	1209	1249	1249

Major Outputs

1. New experimental research facilities at ERL covering novel R & D areas.

2. Completion of investigation of new research concepts for potential application to Canadian coals (1987).

3. Reports from an extensive contract-out program.

SUB-ACTIVITY: COAL

Development of Novel Liquefaction and Pyrolysis Technologies

Technology Objectives

To develop flash hydropyrolysis of coal as an alternative route to production of liquid fuels and combustible char. To develop joint projects with Japanese agencies which will lead to faster implementation of the technology in Canada.

Description

The Canada/Japan coal liquefaction initiative has been established as the result of the Heavy Oil/Coal Conversion Technical Mission to Japan during September, 1980. Japan has considerable interest in coal-derived liquids, initially as a replacement for oil in oil-fired electrical utilities. There is an active coal liquefaction research and development program now being carried out by the Agency of Industrial Science and Technology (AIST) at government and industrial research laboratories. A major part of this program is directed towards the evaluation of Australian and Chinese coals as primary liquefaction feedstocks. Canadian coals will become a part of this testing program and will be compared to Chinese and Australian coals as potential feedstocks for direct hydroliquefaction processes being developed by the Japanese.

The International Energy Agency's Coal Pyrolysis project began in January, 1978. Countries participating were West Germany, the U.K. and Sweden. Experimental work for Phase I of the project was carried out at Bergbau-Forschung in Essen, West Germany. Phase II is currently underway and is scheduled for completion in December 1982. This part of the work consists of continuing laboratory research and engineering studies for one of the larger scale Small Process Development Units (SPDU's) to be constructed and used in Phase 2b of the project.

It is recommended that ERL/CANMET join the project at the beginning of Phase II, which is scheduled to run for four years from January 1983 to December 1986. A proposal to this effect was made to the Executive Committee of the IEA Coal Pyrolysis group in May of this year, and this was provisionally accepted.

Subject to ratification of this agreement, the current IEA plans for Phase 2b are as follows:

Two SPDU's are to be used; a combined hydropyrolysis and cracking unit and a hydropyrolysis unit standing alone. The former unit will be built at Bergbau-Forschung in Essen, and the latter is near completion at Ontario Research Foundation in Mississauga.

Resources	$K (PY) 83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	400(1.5)*	450(1.5)	450(1.5)	330(1.5)	330(1.5)
Total	400(1.5)	450(1.5)	450(1.5)	330(1.5)	330(1.5)
Contract $ (included in above)	300	350	350	230	230

* includes new ERD proposal, IEA Coal Pyrolysis 300(1), not yet approved

Major Outputs:

1. Annual progress reports.

2. Access to information obtained in completed Phase I and current Phase II of the IEA project, as well as full participation in Phase II (1983).

3. Data on hydropyrolysis of Canadian coals in a 1 kg/hr scale apparatus (1984).

4. Technical evaluation of Japanese processes for larger scale operation in Canada (1985).

5. Assessment of the suitability of coals from Canadian deposits for the most advance liquefaction technologies, and reports on contracts concerning other aspects of coal liquefaction (1986).

6. Completion of advance phases of fundamental studies in support of coal liquefaction technology development and application (1987).

SUB-ACTIVITY: COAL

Development of Coprocessing Technology of Coal with Bitumen, Heavy Oils and Residuals

Technology Objectives

To develop technology with bench and pilot scale facilities for the co-processing of various Canadian coals with bitumen/heavy oils/residuals in order to obtain significant increases in quantities of liquid synthetic fuels. Specifically:

by 1986 to assess and demonstrate the economic and technical feasibilities of increasing liquid yield by 25% during bitumen/heavy oils/ residuals upgrading through co-processing with domestic coals.

Description

Coprocessing of coals with bitumen/heavy oils/residuals if technically feasible, would be a unique direct liquefaction technology that obviates need for costly recycling of solvent. This development is intended to exploit a somewhat unique Canadian situation as the bitumen/heavy oil deposits are of reasonable proximity to coal deposits. In fact, some of the tar sand deposits contain substantial amounts of coal (lignite) and during bitumen sand separation, the coal remains in the bitumen. In eastern Canada, refinery residuals might be processed with Nova Scotian coals.

These in-house developments are supported by extensive efforts under contract as well as by cooperative studies with industry.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	210(6)	210(6)	210(6)	210(6)	210(6)
Energy R & D	675(2.5)	550(3.5)	550(4.5)	550(4.5)	550(4.5)
Total	885(8.5)	760(9.5)	760(10.5)	760(10.5)	760(10.5)
Contract $ (included in above)	350	350	250	250	250

Major Outputs

1. Annual Progress Reports.
2. Completion of a pilot plant for process development of coprocessing technology and operation thereafter (1984).
3. Completion of the initial phase of bench scale studies of coprocessing (1985).
4. Completion of an initial phase and more advanced phases thereafter of fundamental chemical studies in support of coprocessing (1985).
5. Completion of a study on additives that promote coprocessing operations (1986).
6. Completion of a bench-scale study under contract on coprocessing Saskatchewan lignites with heavy oils (1987).

SUB-ACTIVITY: COAL

Construction and Operation of a Bitumen/Heavy Oil and Coal Coprocessing Pilot Plant

Technology Objectives

To design, construct and operate a bitumen/heavy oil and coal co-processing pilot plant. To provide engineering data that will be used to generate information from which a technical and economic evaluation of co-processing will be made, and to scale-up the process to demonstration/ commercial scale.

Description

Bench scale and preliminary pilot-plant experiments have indicated considerable promise for hydroliquefaction of mixtures of coal and heavy oil. To develop this process to a stage where it can be commercialized, it is planned to construct a 240 kg per day pilot plant in addition to the existing heavy oil hydrocracking facilities which are fully committed to support commercialization of CANMET hydrocracking. In Fiscal Year 1982/83 the National Energy Program provided 7 PY and $3000 K for the purchase of some pilot-plant components and the coal preparation unit.

Whereas the bench-scale facilities investigate the effect of the process variables on the product quantities and qualities in short experimental runs, the large pilot plant will attempt to solve problems that normally result from long experimental runs lasting up to 60 days.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	80(2)	80(2)	80(2)	80(2)	80(2)
Energy R & D	2000(8)	1500(11)	900(11)	900(11)	900(11)
Total	2080(10)	1580(13)	980(13)	980(13)	980(13)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Complete design and procurement stage (1983).

2. Complete construction and commissioning of unit (1985).

3. Commencement of development work (1986).

SUB-ACTIVITY: COAL

Conventional Combustion

Technology Objectives

To produce data on the conventional combustion performance and emission characteristics of Canadian coals destined for power generation in domestic and export markets. Specifically;

by 1985 to produce a catalogue of combustion performance and emission characteristics of commercially-important Canadian coals, and updating annually thereafter;

continuing to determine the significant performance characteristics, with respect to electricity generation applications, of coal from newly developed deposits; and

continuing to determine the effects of coal cleaning on the flame, heat transfer and emission characteristics of thermal coals for utility and industrial applications.

Description

The need for evaluation of the combustion performance of Canadian coals has been amply demonstrated by industrial and utility demands for the services of the Combustion and Carbonization Research Laboratory over the past ten years. The demand is expected to increase over the next ten years as new coal sources come on stream and as attention turns to lower grade resources. The need for combustion performance data must be met if coal is to make its full contribution to energy self-reliance in the production of electricity and industrial heat, and if healthy export markets are to be maintained.

Users of conventional coal technology need data on a number of parameters such as grindability characteristics, flame stability, slagging, fouling, heat transfer, pollutant emissions and the performance of stack gas cleanup systems. Much of this information can be generated using the existing, proven R & D facilities at CCRL. However, the specialized combustion evaluation trials commonly demanded by coal suppliers and electric utilities must be supplemented by more fundamental R & D aimed at understanding mechanisms and developing better technology for both increased efficiency of utilization and reduction of emissions. Development of a strong technology also enhances the opportunities for export of Canadian coal and equipment for its utilization.

In the limited areas where suitable private-sector facilities presently exist, some of the required information can be generated by contract. Examples are grinding tests with Canadian coals, and flame radiation modelling. Cost-shared programs for field trials in full-scale utility boilers may be required to verify scale-up factors for pilot-scale results.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	150(3+2)*	150(3+2)	150(3+2)	150(3+2)	150(3+2)
Energy R & D	800(8)	850(8)	950(8)	950(8)	950(8)
Total	950(11+2)	1000(11+2)	1100(11+2)	1100(11+2)	1100(11+2
Contract $ (included in above)	108	128	178	178	178

* 2 unfunded PY's

Major Outputs

1. First edition of catalogue of combustion and emission characteristics of commercially-important Canadian coals (1985).

2. Improved technology for producing pulverized-coal flames with heat transfer characteristics tailored to specific industrial requirements, (1987).

3. Improved methods for predicting coal combustion performance from bench-scale test data (1987).

SUB-ACTIVITY: COAL

Fluidized-Bed Combustion Technology

Technology Objectives

To develop and demonstrate the technology for fluidized-bed combustion. Specifically:

by 1986 to demonstrate AFBC boilers co-firing high-sulphur coal and wood chips on a commercial-heating-plant scale at CFB Summerside;

continuing to develop a data base of combustion performance data for selected Canadian coals, through pilot-scale R & D, both in-house and contracted-out;

continuing to develop data on sulphur capture mechanisms, and the performance characteristics of selected Canadian limestones and dolomites as sorbents, through pilot-scale and bench-scale R & D, both in-house and contracted-out;

continuing to advance the level of knowledge concerning FBC, including "second generation" systems such as atmospheric recirculating FBC and pressurized FBC, through both in-house and contracted-out R & D;

continuing to expedite the industrial application of FBC by co-sponsoring with industry site-specific research, design and economic studies, and demonstrations.

Description

As in most western nations, Canada is interested in FBC technology for evironmentally-benign utilization of high-sulphur coal, sufficiently developed to permit substantial deployment in the next ten to twenty years. In addition, FBC is perceived to have other applications, more or less specific to Canada, including the combined firing of coal and wood waste in the pulp and paper industry, utilization of coal washery rejects, unreactive fuels such as oxidized coal and residues from heavy oil upgraders, and more efficient electricity generation. However, each of these possible applications generally represents site-specific or localized application, a fact which tends to hinder implementation of the technology through commercial forces alone. Government assistance in R, D & D is required if FBC technology is to make its full contribution to utilization of high-sulphur and low-grade fuels.

With respect to the environmentally-benign utilization of high-sulphur coal, considerable experience with small heating boilers is available to Canada through participation in the nine-nation IEA information exhange agreement on AFBC.

The first Canadian example of FBC boiler technology, the CFB Summerside project, will be commissioned early in 1983, and in the two subsequent heating seasons CCRL will conduct a demonstration program involving three high-sulphur eastern Canadian coals with some co-firing of wood chips. Con-

currently, and extending to 1986, CANMET will be participating in the NSPC/EMR 10,000 h pilot-scale FBC corrosion studies, which are viewed as a pre-requisite to the implementation of AFBC technology for thermal power generation.

Although FBC is on the verge of commercial demonstration, the wide range of potential fuels presents R & D needs that are likely to continue for some years. For example, boiler designers need combustion performance and pollutant emission data on the candidate fuels. To a large extent this can be generated on pilot-scale equipment and CANMET has a program in place to develop a data bank of FBC combustion performance characteristics, using both the in-house facilities at CCRL and private-sector facilities through contracts.

Characterization of limestones and dolomites as SO_2 sorbents is another area requiring R & D. Primarily through a contract with Queen's University, CANMET is supporting studies to optimize sorbent utilization at the Summerside demonstration, and plans to continue into sorbent characterization related to other potential FBC applications. This work is supplemented by bench-scale research at CANMET which investigates the physical and chemical reactions of sulphur capture, and techniques to improve sorbent utilization.

"Second-generation" designs of FBC systems need to be explored, to establish the conditions under which they offer improved performance. For example, recirculating FBC appears better suited for fine-particle-sized fuels such as fluid coke than conventional bubbling-bed FBC and this will be investigated by contract during FY 1983/84. Similarly, specialized applications of FBC such as incineration of coal washery tailings require both R & D and economic analysis in site-specific instances. This is done by co-sponsoring appropriate studies with interested industrial partners.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	175(5)	175(5)	175(5)	175(5)	175(5)
Energy R & D	1375(7)	1385(7)	1385(7)	1385(7)	1385(7)
Total	1550(12)	1560(12)	1560(12)	1560(12)	1560(12)
Contract $ (included in above)	515	515	565	565	565

Major Outputs

1. Demonstration of atmospheric FBC boiler technology, in a typical heating plant application, burning high-sulphur coal with co-firing of wood chips. Both technical performance and economics will be evaluated (1986).

2. Partial data base of combustion performance for Canadian coals (1987).

3. Partial data base on the performance of selected Canadian limestones and dolomites as sulphur sorbents, and an empirical, low cost procedure for determining sorbent performance (1987).

4. Pilot-scale evaluation of combustion performance of coal/water slurries and coal washery thickener underflow in FBC, by contract (1985).

5. Pilot-scale evaluation on suitability of recirculating FBC for combustion of Syncrude coke, with Fort McMurray limestone as sulphur sorbent (1985).

SUB-ACTIVITY: COAL

Coal - Liquid Mixture Fuels

Technology Objectives

To decrease the consumption of valuable premium liquid and gaseous fuels in Canadian industrial and utility applications by developing and evaluating technology for coal-liquid mixture utilization. Specifically:

by 1984 to establish a data base of combustion performance and flame characteristics for several coal-liquid mixtures, through contracted-out research in conjunction with Dutch and Swedish agencies, and in-house research at CCRL;

by 1984 to conduct, by contract, studies to estimate the probable extent of derating resulting when existing oil designed boilers are converted to coal/water slurry;

by 1985 to provide technical support to the $5.5 million coal/water slurry demonstration program being sponsored by EMR Policy Sector-Coal Branch under the NEP at the Chatham generating station of New Brunswick Electric Power Commission; and

by 1987 in support of the IEA Coal-Liquid Mixture Technology Agreement, through in-house and contracted-out R & D, to resolve the problem of burner nozzle erosion by coal/water slurries, to develop technology for coal cleaning in conjunction with slurry preparation, and to evaluate burner materials and burner designs.

Description

Coal-liquid mixtures (CLM) offer the potential of partially or completely replacing oil or natural gas in existing boilers and industrial combustors; while avoiding most of the capital costs of burner retrofit and on-site facilities for coal storage, handling and preparation that would be required if conventional pulverized-coal technology were applied. A further advantage of CLM arises from the possibility of removal of much of the ash and inorganic sulphur from the coal as part of the slurry preparation process.

Four generic types of CLM are under investigation by various agencies around the world. These are coal/oil mixtures, typically 30 to 50 wt % coal; coal/water/oil mixtures, typically 55 wt % coal and 8 to 15 wt % water, the balance being oil; coal/water slurries, typically 65 to 80 wt % coal; and coal-liquid slurries such as methanol-coal or methane-water-coal, typically 60-80% coal.

During the past 5 years, CANMET has put substantial effort into the combustion technology of 30% coal/70% oil mixtures, but in order to decrease the oil content further, work has now been directed towards coal/water/oil and coal/water fuels. However, CANMET does support further development of the NRC spherical agglomeration process as a means of removing ash and sulphur from coal.

With respect to coal/water/oil mixtures, CANMET has co-sponsored with the Iron Ore Co. of Canada, a successful short-term demonstration at Sept-Isles, Quebec. I.O.C. now wishes to proceed with full-scale tests in a pellet induration furnace, both to examine slurry handling problems under winter conditions and to study the effects of coal ash on the quality of the pellets. If these tests proceed, CANMET may be prepared to assist in a technical advisory capacity.

Most of the CANMET effort in CLM is presently directed at coal/water slurries because the potential for oil displacement is much greater. Technological problems associated with the utilization of coal/water slurries are as follows:

a) Slurry production; preparation of stable mixtures with a high coal loading, potential for reducing ash and sulphur in the production process, and the effect of coal type on stability and cleanability.

b) Slurry transport, storage and handling; slurry stability and corrosion/erosion to handling equipment.

c) Burner hardware; nozzle wear, atomization or fuel dispersion, ignition stability and flame shape.

d) Combustion performance; heat transfer characteristics of flames, completeness of combustion, formation of pollutants, and side-effects such as slagging, fouling or corrosion of heat exchange surfaces by ash constituents.

e) Pollutant emissions; primarily particulates, but also SO_2, NO_x and trace elements.

R & D on slurry production, transport, storage and handling is mainly performed by the private sector. About ten companies in the western world are currently involved, some having reached the stage of full-scale commercial production. With respect to burner hardware, private-sector development is being assisted by CANMET through contracted-out studies of wear problems plus contracted-out and in-house studies of burner performance.

Most of the current CANMET activity is directed to R & D on combustion performance and pollutant emissions. Whereas many agencies are engaged in site-specific, fuel-specific demonstrations, CANMET wishes to establish a sound scientific basis for the technology that will permit some level of performance predictability in terms of coal quality, slurry production process and burner/furnace configuration. Toward this end CANMET plans to co-sponsor with Sweden and the Netherlands a pilot-scale evaluation program in which coal/water slurries, manufactured by several suppliers from coals with a range of properties, will be subjected to detailed combustion performance evaluation. This work will be carried out by contract during 1983/84 and will be supplemented by in-house combustion trials at CCRL.

In the longer term, potential Canadian applications for coal/water slurries are being assessed by a contracted-out study. Contracts have been let to estimate the effect of slurry firing on boiler capacity. Canadian companies proposing to produce slurry are being assisted in various ways and the possibilities for full-scale demonstrations are being investigated.

Included in the last category is a large-scale demonstration, already mentioned, planned for NBEPC's Chatham generating station, sponsored by the EMR Policy Sector - Coal Branch.

CANMET also participates in the IEA Coal-Liquid Mixture Technology Agreement, and much of the foregoing work constitutes Canada's contribution to this cooperative effort.

Resources	$K (PY) 83/84	84/85	85/86	86/87	87/88
A-Base	40(1)	40(1)	40(1)	40(1)	40(1)
Energy R & D	550(1)	550(1)	550(1)	550(1)	550(1)
Total	590(2)	590(2)	590(2)	590(2)	590(2)
Contract $ (included in above)	380	380	380	380	380

Major Outputs

1. Computer-based estimates of the derating which results when existing boilers of various types are converted to coal/water slurry fuel (1984).

2. Data base of combustion performance and flame characteristics for several coal/water slurries, covering a range of coal quality, obtained primarily by outside contracts (1984).

3. Demonstration of coal/water slurry firing in small (10 and 20 MW_e) utility boilers (1985).

4. Resolution of burner nozzle erosion problems, evaluation of burner materials and designs, and improved technology for coal cleaning in conjunction with slurry preparation (1987).

SUB-ACTIVITY: COAL

Combustion Technologies for Pollution Abatement

Technology Objectives

To develop and demonstrate novel technology for minimizing the emission of acid rain precursors (SO_2 and NO_x) from conventional thermal power stations, industrial boilers and process heating furnaces. Specifically:

by 1984 — to complete test burns in a large-scale combustor with two Canadian coals to evaluate the validity of NO_x generation data obtained from bench-scale flames, and to assess the effect of limestone injection on SO_x reduction with one of the above coals;

by 1986 — to complete an industrial-scale field trial of NO_x/SO_x abatement technology at the heating plant at CFB Gagetown, N.B.;

continuing — the development of a base of engineering data, covering a range of Canadian coals, for novel equipment adaptable to conventional industrial and utility coal-fired equipment, by which SO_2 and NO_x emissions can be controlled without resorting to flue gas scrubbing.

Description

Staged combustion as a means of controlling NO_x in otherwise conventional gas-fired boilers is now established technology. Its application to coal-fired boilers is still under development, and it has been found that coal properties significantly affect the extent of NO_x reduction. More recently, injection of pulverized limestone into pulverized coal flames has indicated promise as a relatively simple technology for reducing SO_2.

Under the auspices of an IEA research agreement in which CANMET participates, eight Canadian thermal coals were evaluated in an experimental burner to elucidate the role of coal properties and fuel/air mixing on NO_x formation. Plans have been finalized to follow up, during 1984 with large-scale trials with two Canadian coals in which NO_x formation under utility conditions will be studies in a staged burner modified to permit limestone injection for SO_2 abatement. This work is being carried out in cooperation with Swedish and Danish agencies, each of which will also have two coals tested.

Concurrently an industrial-scale (20 MW_e) field demonstration of combined NO_x/SO_2 abatement for pulverized coal firing has been planned for one high-temperature water generator at the heating plant for CFB Gagetown. This is a cooperative project between EMR and DND. Contracts for system design have already been placed, and tests with an eastern Canadian coal are expected to be completed in 1984.

A separate and complementary initiative, partially funded by EMR, is a CEA project to investigate low-NO_x technology for corner-fired utility boilers burning lignite. This is scheduled for completion in 1983.

If the results of the foregoing tests and demonstration prove favourable, significant potential for application exists, particularly in the western Canadian utilities where a moderate requirement for SO_2 reduction is expected in the future, at least for new plants. Further R & D, probably specific to western coals, will be undertaken as the need arises.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	-	-	-	-	-
Energy R & D	1125(1)	1025(1)	875(1)	875(1)	875(1)
Total	1125(1)	1025(1)	875(1)	875(1)	875(1)
Contract $ (included in above)	900	800	630	630	630

Major Outputs

1. Performance data from full-scale tests burns with two Canadian-coals in a utility-scale low-NO_x burner, modified to permit limestone injection (1984).

2. Results of an industrial-scale demonstration of NO_x/SO_x abatement technology at the heating plant of CFB Gagetown, N.B. (1986).

3. Preliminary base of engineering data on novel NO_x/SO_2 control equipment which can be retrofitted to existing pulverized coal-fired boilers.

SUB-ACTIVITY: COAL

Materials for Coal Utilization and Conversion

Technology Objectives

To establish a data base on materials properties and performance in coal combustion and conversion technologies. Specifically:

by 1986 complete the evaluation of materials in the EMR-NSPC fluidized-bed coal combustion project at Point Tupper, N.S.;

by 1986 characterize creep-rupture properties of materials in coal combustion systems;

by 1988 develop protective coatings for materials in high-temperature energy conversion processes; and

by 1988 establish materials selection data for coal utilization technologies.

Description

In the development of advanced fossil energy conversion and utilization processes, serviceability of materials under high-temperature, high-pressure, corrosive and erosive environments is one of the most important constraints.

The long-term performance of heat transfer materials has been identified as a major problem in coal-fired, fludized-bed combustors for power generation. Under the EMR Oil Substitution Policy, the Nova Scotia Power Corporation is to conduct a program of 1,000 to 10,000 hour testing of candidate materials. CANMET/PMRL is to evaluate the materials tested and, with in-house research support, to characterize materials performance in the engineering sub-systems of fluidized-bed coal combustion technologies.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	255(5)	255(5)	255(5)	255(5)	255(5)
Energy R & D	600(2)	600(2)	600(2)	600(2)	600(2)
Total	855(7)	855(7)	855(7)	855(7)	855(7)
Contract $ (included in above)	375	365	365	355	355

Major Outputs

1. Characterization of wear of materials in coal-liquid fuel utilization systems (1984).

2. Determination of creep-rupture properties of materials in environments typical of those that exist in coal conversion processes (1985).

3. Evaluation of materials in the EMR-NSPC fluidized-bed coal combustor (1986).

4. Characterization of materials in fluidized bed combustion system (1986).

5. Elucidation of corrosion mechanisms that occur in processes for coal conversion and utilization (1987).

6. Development of protective coatings for high-temperature application in coal combustion systems (1988).

SUB-ACTIVITY: NUCLEAR

Uranium Reserve Assessment

Technology Objectives

To determine annually and report biennially on economically mineable uranium reserves and projected production capacities in Canada. To develop appropriate methodologies for assessment of reserves and related economic evaluations.

Description

Reliable estimates of uranium reserves and projected productive capacity are required for review of uranium policy and for allocation of domestic and export quotas to each projected or operating production unit in Canada. Independent estimates of Canadian uranium reserves are also required by the Atomic Energy Control Board (AECB) to fulfill its mandatory function of licensing new uranium mines and exports.

In addition, Canadian uranium reserves and projected production capabilities are also required in aggregated form for international agencies, in particular the International Atomic Energy Agency (IAEA).

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	100(2.5)	100(2.5)	100(2.5)	100(2.5)	100(2.5)
Energy R & D	-	-	-	-	-
Total	100(2.5)	100(2.5)	100(2.5)	100(2.5)	100(2.5)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Biennial reports on Canadian uranium reserves and production capabilities by deposit.

2. Development of a computer-based geostatistical methodology for evaluating uranium resources/reserves (1984).

SUB-ACTIVITY: NUCLEAR

Uranium Mine Evaluation

Technology Objectives

To evaluate mineability and economic criteria for the determination of projected capabilities for established uranium reserves in Canada and to report such production projections with the bienniel reserves reports. To develop methodologies for determination of mineability and production levels of uranium deposits with sensitivity to commodity pricing.

Description

Reliable estimates of projected uranium production capacities in Canada are required for review of uranium policy and for the allocation of domestic and export quotas for each projected and/or operating unit in Canada. It is essential that the federal government have the independent capability to make such production projections, which rely on detailed examination of technical mineability factors and economics.

Projects under this technology are related to the development of a comprehensive mine valuation and production projection system. To facilitate the requirement for regular updating of the projections considering changing reserves and market situations, this work will be directed to the development of computer-based methodologies for mineability assessments.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	140(3.5)	140(3.5)	140(3.5)	140(3.5)	140(3.5)
Energy R & D	-	-	-	-	-
Total	140(3.5)	140(3.5)	140(3.5)	140(3.5)	140(3.5)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Biennial report on Canadian uranium production capability by deposit.

2. Development of cost modelling and mine valuation systems as a manual for optimal mine valuation (1984).

SUB-ACTIVITY: NUCLEAR

Geomechanics in Nuclear Waste Disposal

Technology Objectives

By 1985, to develop and apply, by field and laboratory trials, techniques for assessing the thermal, mechanical, and ion transport properties of rock formations considered suitable for high-level radioactive waste disposal, and to develop an adequate sealing technology for waste repositories.

Description

Nuclear waste disposal - particularly of spent fuel rods - is a critical aspect of nuclear electricity generation. CANMET's program is a part of Atomic Energy of Canada Ltd's long-term strategy for investigating disposal at depth in stable geological formations. CANMET contributes to the determination of how rock behaves under the high temperatures associated with decaying radioactivity.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	230(5)	230(5)	230(5)	230(5)	230(5)
Energy R & D	-	-	-	-	-
Total	230(5)	230(5)	230(5)	230(5)	230(5)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Development of techniques for determination of rock properties at high temperatures (1985).

2. Designs for in-situ tests to determine mechanical and ion transport properties of rock formations (1988).

Comments

This work is done in conjunction with the Geological Survey of Canada, Earth Physics Branch, Atomic Energy of Canada Ltd., Environment Canada, and Ontario Hydro.

SUB-ACTIVITY: NUCLEAR

Conventional Uranium Extraction Technology 441001

Technology Objectives

To improve conventional technology for the treatment of Canadian Uranium ores by sulphuric acid leaching followed by ion exchange and/or solvent extraction, purification and precipitation, in order to improve the competitive position of the industry, to decrease environmental impact, and to improve working conditions.

Description

Present technology for uranium ore processing is well established and gives high recoveries, but improvements need to be made to increase efficiency and decrease in-plant health hazards and environmental problems from effluents. Possible methods for improving conventional sulphuric acid leaching technology for uranium includes new approaches such as direct extraction from slurries (solvent-in-pulp; resin-in-pulp), preconcentration of ores, and use of complexing agents to reduce the radium content of effluent going to the tailings. Yellow cake precipitation and dewatering present problems in uranium mills; improvements would facilitate handling and reduce health hazards. Mineralogical studies are required to guide the development of improved uranium extraction technology.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	330(9)	290(8)	250(7)	250(7)	250(7)
Energy R & D	-	-	-	-	-
Total	330(9)	290(8)	250(7)	250(7)	250(7)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Completion of studies to improve conventional sulphuric acid processing technology (1985).

2. Improvements in effluent control and in-plant hygiene (1988).

SUB-ACTIVITY: NUCLEAR

Alternative Uranium Extraction Technology 441102

Technology Objectives

To effect minimum environmental inpact and promote resource conservation by the development of economically acceptable process technology that would be an alternative to the sulphuric acid process, so that the recovery of uranium and by-products such as thorium, rare earths, nickel and arsenic will be increased, radionuclides will be solubilized for subsequent isolation and disposal, and minimum sulphides and arsenic will be discharged to the tailings.

Description

Alternative technology development aims at recovery of 98% of the uranium, 85% of the thorium, and if applicable 85% of the arsenic, 95% of the nickel and 80% of the rare earths. It also aims to produce tailings containing less than 25 pCi/g of radium and no sulphides. Small-scale research has shown that these goals are attainable. An economic assessment based on available data indicates that for rich ores hydrochloric acid leaching technology may be competitive with conventional technology, but not for leaner ores. Further investigations are required to confirm technical and economic feasibility.

The recovery and separation of rare earth elements as by-products from Elliot Lake uranium ores is likely to become more attractive as markets for selected rare earths develop. Technology for the recovery of thorium should be developed to be available when thorium will begin to be used in the nuclear fuel cycle. AECL has indicated particular interest in thorium availability with respect to the development of new reactor technology.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	310(8)	310(8)	310(8)	310(8)	310(8)
Energy R & D	-	-	-	-	-
Total	310(8)	310(8)	310(8)	310(8)	310(8)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. To assess a hydrochloric acid extraction process (1986).

2. To demonstrate methods for rare earth and thorium recovery (1988).

SUB-ACTIVITY: RENEWABLE ENERGY

Wood-fired Residential Heating

Technology Objectives

To assess the fuel efficiencies, safety characteristics and environmental impact of wood-burning stoves and furnaces, and to optimize these parameters in new wood stove designs. Specifically:

by 1983 to formulate a standard performance code for measuring efficiency;

by 1984 to design and by 1985, to test a high-efficiency wood-burning space heater.

Description

Increasing domestic use of wood stoves and combined wood-oil furnaces for space heating has introduced the requirement for the evaluation of the safety and performance of various designs of appliances. Attention will be on data generation leading to the formulation and testing of new designs optimizing efficiency and reducing emissions. The work is supported by CMHC, the Standards Council of Canada and the Canadian Wood Energy Institute.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	170(3)	170(3)	170(3)	170(3)	170(3)
Energy R & D	290(1)	290(1)	290(1)	290(1)	290(1)
Total	460(4)	460(4)	460(4)	460(4)	460(4)
Contract $ (included in above)	170	170	170	170	170

Major Outputs

1. Data on unit efficiency and air pollution impact for wood stoves and combination furnaces (1985).

2. Continuing support of renewable energy programs in NRC and CANERTEC.

SUB-ACTIVITY: RENEWABLE ENERGY

Biomass Utilization in Industry

Technology Objectives

In co-operation with other Federal and Provincial agencies, to increase the utilization efficiency of renewable energy resources. Specifically:

by 1985 — to promote by field trials and demonstration, the use of wood as fuel in institutional and industrial steam boilers; and

continuing — to assist in the inplementation of ENFOR and CANERTEC programs on biomass conversion by provision of expert advice on combustion technology.

Description

Fuel-switching from oil or gas to wood and wood waste for both direct combustion and for low-BTU gas production is being aggressively pursued in the forest products industry and in remote regions of the country where a high premium on transported oil applies. CANMET expertise on coal conversion technology is being diverted to provide the management of ENFOR, CANERTEC, and Federal/Provincial programs with direction and advice on the engineering aspects of technology development, and on the evaluation and monitoring of federally-supported demonstration projects carried out by the private sector. The CANMET resources used are derived from the Renewables Task of the NEP programme on energy R & D, and will be directly involved on projects related to hogged-fuel utilization; waste wood pellet manufacture and use; wood gasification and conversion to methanol; and wood chip utilization in fluidized-bed combustion systems.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	50(1)	50(1)	50(1)	50(1)	50(1)
Energy R & D	-	-	-	-	-
Total	50(1)	50(1)	50(1)	50(1)	50(1)
Contract $ (included in above)	-	-	-	-	-

Major Outputs

1. Demonstration of efficient, environmentally acceptable combustion systems for steam generation for waste wood (1985).

2. Continuing support of ENFOR and CANERTEC programs.
   Note: In FY 83/84, responsibility for the ENFOR program will move to the Conservation and Non-Petroleum Sector of EMR. Additional CANMET support to monitor technical contracts under this program will depend upon receipt of an additional PY, as promised by CNP Sector.

SUB-ACTIVITY: RENEWABLE ENERGY

Materials for Advanced Energy Conversion Systems

Technology Objectives

To develop materials and fabrication processes for application in renewable energy conversion and storage systems. Specifically:

by 1983 to develop Na-conducting electrolytes and demonstrate thereafter their use in heat-recovery devices;

by 1985 to develop a hydrogen-conducting ceramic electrolyte;

by 1987 demonstrate its application in hydrogen production and energy conversion; and

by 1987 to fabricate materials with a minimum of 10% efficiency in the photo-conversion of solar energy to produce hydrogen and/or electricity.

Description

The technology being developed in CANMET for the fabrication of fast-ion electrolytes will be demonstrated industrially by the production of prototype thermo-electric energy recovery devices. Further modification of ceramic electrolytes will be devised to promote their application in energy storage for transportation, and wind and solar energy capture.

An economical photo-electrochemical cell for the efficient conversion of solar energy either directly to H_2 or to electricity will be applicable to hydrogen production or to solar energy conversion. The technical objective is to achieve high solar conversion efficiencies using cost-effective electrode materials. This work supports an IEA Agreement on hydrogen production by photo-electrolysis.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
A-Base	300(5)	300(5)	300(5)	300(5)	300(5)
Energy R & D	600(3)	600(3)	600(3)	400(3)	400(3)
Total	900(8)	900(8)	900(8)	700(8)	700(8)
Contract $ (included in above)	281	271	271	150	150

Major Outputs

1. Development of Na-conducting electrolytes (1983).

2. Development of H-ion conducting electrolytes and the electrodes (1985).

3. Production of a prototype cell, based on TiO_2 electrodes, for the generation of hydrogen (1987).

4. Development of synthetic MoS_2 and WS_2 films for the photo-production of electricity (1987).

Comments

a) In-house development in materials fabrication technology will be transferred to industry by a comprehensive contracting-out program.

b) Expert assistance is provided to NRC and DND on their contracted-out solar conversion and storage projects.

SUPPORT SERVICES FOR THE ENERGY TECHNOLOGY ACTIVITY

Management, Administration, Information, Library and Technical Support Services

Objectives

To provide support services to CANMET Laboratories and personnel which enable them to achieve their Technology objectives.

Description

Support services are vital to the success of the Energy Technologies. Administrative Services include secretaries, typists and clerks in CANMET central offices and Laboratories (Ottawa, Bells Corners, Elliot Lake, Calgary, Edmonton and Cape Breton) and various support sections such as Personnel and Financial Accounting.

The Technology Information Division provides information officers to do computer literature searches and librarians to maintain an extensive library and to obtain those obscure papers and journals. The Publications section processes the text, edits and publishes CANMET reports and documents, such as these long-term plans, all vital services.

The Technical Services Division provides the electrical and mechanical engineering to design and install new equipment, a machine shop to produce test specimens or manufacture scientific apparatus, a carpentry shop to produce foundry casting patterns, and transport services to the Laboratories.

Resources $K (PY)	83/84	84/85	85/86	86/87	87/88
Information and Library					
A-base	950(16)	950(16)	950(16)	950(16)	950(16)
Energy R & D	200(0)	200(0)	200(0)	200(0)	200(0)
Technical (Engineering)					
A-base	1150(26)	1150(26)	1150(26)	1150(26)	1150(26)
Energy R & D	100(0)	100(0)	100(0)	100(0)	100(0)
Management and Administration					
A-base	3800(71)	3800(71)	3800(71)	3800(71)	3800(71)
Energy R & D	610(6)	610(6)	610(6)	610(6)	610(6)