Energy, Mines and Resources Canada

Office of Energy Research and Development

Énergie, Mines et Ressources Canada

Bureau de recherche et de développement énergétiques

Canada

FEDERAL ENERGY R&D: TASK 6

CONVENTIONAL ENERGY SYSTEMS

OIL, GAS, ELECTRICITY

ACCOMPLISHMENTS

1981 - 1983

Office of Energy R&D
August 1984

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TASK 6: CONVENTIONAL ENERGY SYSTEMS - OIL, GAS, ELECTRICITY

ACCOMPLISHMENTS: 1981-83

Introduction

Task 6 was established in 1981-82 in response to the National Energy Program. The NEP-Update of 1982 increased the priority for supporting R&D in the conventional energy systems of oil, gas, and electricity. This report describes the key accomplishments in the Task mainly during the past three years of significant funding growth (Figure 1).

There are over 150 projects now underway in Task 6, but many of these only began in 1983-84. Each year they contribute to our knowledge base with the results of early stages of research leading to more development, and with implementation or commercialization occurring further in the future. The items in this report were selected from projects which have yielded results implemented by industry or by government agencies responsible for regulation or the provision of services. Only in areas of fundamental research have basic advances in knowledge been identified as accomplishments.

The R&D carried out in Task 6 has as its primary role to provide the federal government with a technical basis to meet its responsibilities. These are:

- to regulate oil and gas developments, particularly in the Canada Lands, through departments such as COGLA and Transport Canada;

- to provide essential services such as weather, sea and ice forecasting and hydrographic charts, and a regional understanding of environmental and geotechnical processes in the Canada Lands through departments such as Environment Canada, Fisheries and Oceans, and Energy, Mines and Resources;

- to provide "independent" expert opinion in public fora such as environmental impact evaluation hearings convened by FEARO or COGLA, or Commissions of Enquiry;

- to evaluate national hydrocarbon reserves and resources;

- to assist Canadian supply and service industries to be competitive;

- to establish national standards, for example in calibration of electrical equipment by the NRC; and

- to encourage a sharing of research programs and results nationally, for example amongst utilities through the Canadian Electrical Association.

In order to do this, Task 6 resources are divided into eight programs as illustrated on Figure 1.

These programs are carried out in-house and through contracts and contributions by seven departments and agencies, viz.: COGLA, EC, EMR, F&O, NRC, PWC, TC. An estimated 70% of the Task's annual budget is eventually contracted-out to the private sector. Industry is closely involved in the planning, the technical reviews, and the research.

Accomplishments are, to a degree, more easily and quickly realised in this Task. This is partly because the research is frequently shorter-term and aimed at meeting a specific need. Furthermore, the Task benefits from often being an enhancement of ongoing programs in existing laboratories, and from having the participation of established industries. Frequently, energy R&D has provided the seed-money for a project which has later been carried through to commercial application using other industrial support funds of the Federal government, such as PILP.

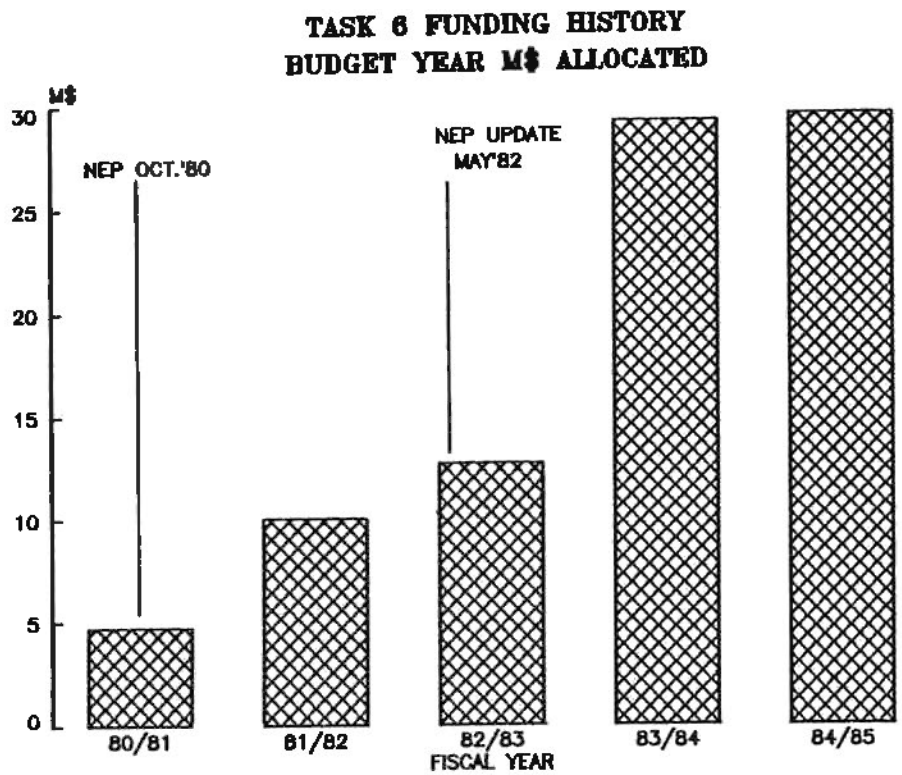
Priorities for the Task are assigned regionally as illustrated on Figure 2. Some 96% of the budget is devoted to the Priority One group in which there is a high industrial interest in production before 2000. A watching brief of some 4% of Task resources is devoted to longer-term opportunities in, for example, the High Arctic and the West Coast.

Within the bounds of pragmatism, Panel-funded oil and gas R&D is limited to the natural and engineering sciences with the objectives of developing technologies, models or methods relating to finding and producing conventional oil and gas, safely and efficiently.

With this background, the focus of the following report is to describe the major accomplishments in the Task 6 programs, each section being prefaced by the Program objective.

FIGURE 1

ENERGY R&D TASK 6:
CONVENTIONAL ENERGY SYSTEM:
OIL, GAS, ELECTRICITY
FUNDING DISTRIBUTIONS



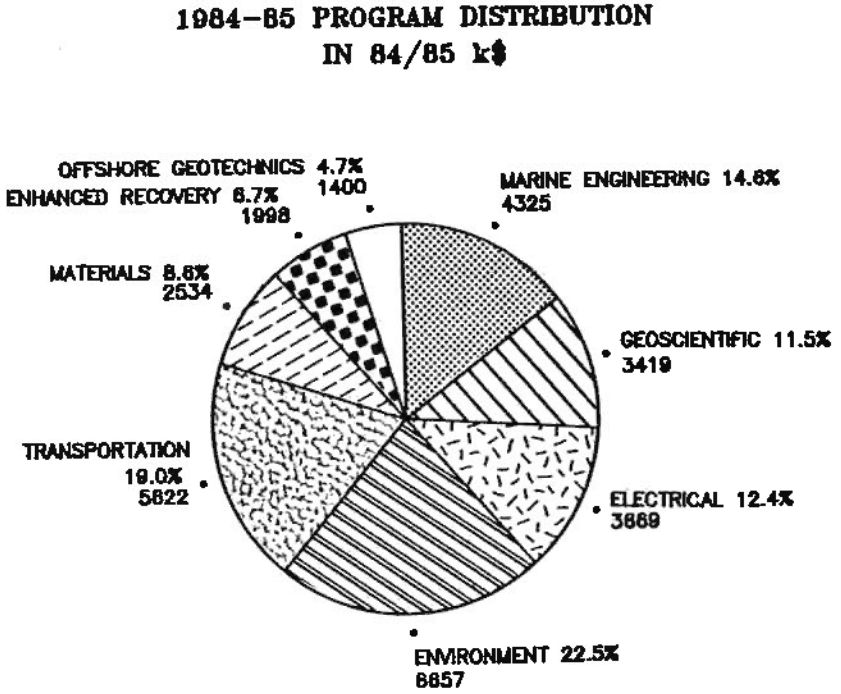
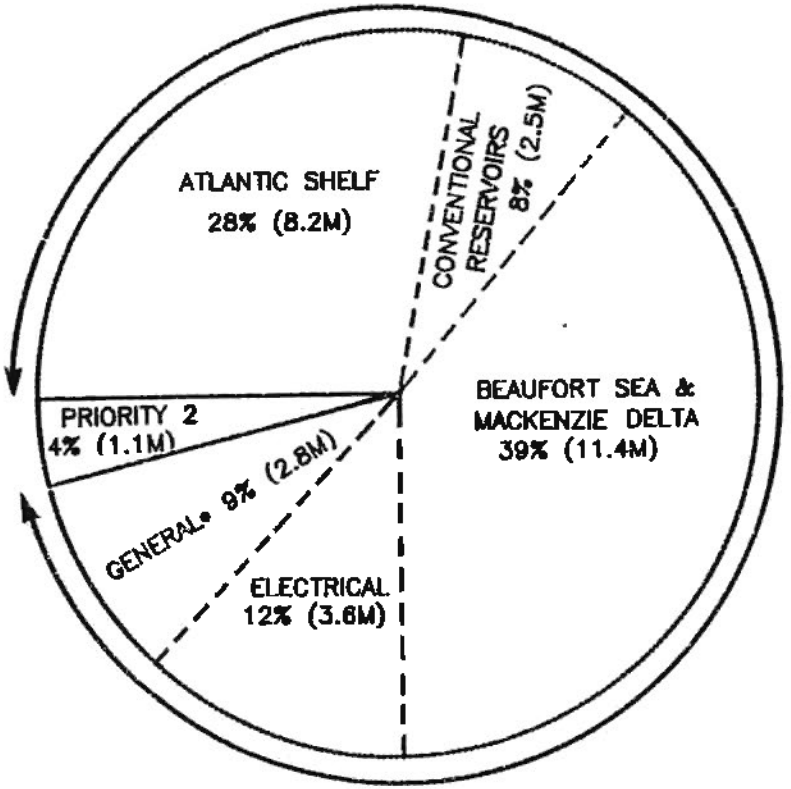


FIGURE 2

ENERGY R&D TASK 6: CONVENTIONAL ENERGY SYSTEMS
OIL, GAS, ELECTRICITY
PRIORITIES & DISTRIBUTION

1984–85 FUNDS IN 84/85 M$



PRIORITY 1
96%(28.5M)

PRIORITY 2:
HIGH ARCTIC (FAR–OFFSHORE BEAUFORT, ARCTIC ISLANDS, SVERDRUP BASIN)
LABRADOR SHELF & ATLANTIC SLOPE, WEST COAST, SHALES, "TIGHT" GAS

*GENERAL: R&D IN OIL & GAS, APPLICABLE BOTH TO ATLANTIC & BEAUFORT

PROGRAM 6.1 - GEOSCIENCE R&D

OBJECTIVE:

To provide improved understanding of petroleum reservoirs and geological hazards (hydrates, permafrost, stability) faced in hydrocarbon developments.

A capability to geochemically correlate Canadian frontier crude oils and condensates with source rocks has been established at the Institute for Sedimentary and Petroleum Geology (ISPG-GSC-Calgary). Geochemical correlation is a relatively new, high specialized, and important technique for the petroleum industry. It contributes to an understanding of hydrocarbon evolution, character, and potential. The industry has welcomed the ISPG facility as the only one in Canada providing petroleum analyses using a gas chromatograph-mass spectrometer. Correlations have to date been performed for the Hibernia field, and for Alaskan North Slope-Beaufort oils in cooperation with industry and the USGS.

EMR has recently published "Oil and Natural Gas Resources of Canada - 1983" (GSC Paper 83-31). To date, 18 publications, including 5 GSC Open File Reports, funded by the Energy R&D Panel, have contributed information to this important re-assessment of Canada's hydrocarbon resources. They research aspects of the oil and gas resource potential of parts of the Western Sedimentary Basin, the Beaufort Sea, and Canadian oil shale deposits in British Columbia, the Prairies including Manitoba, Ontario, New Brunswick and Nova Scotia.

In 1981, the Atlantic Geoscience Centre (AGC-GSC) participated with U.S. partners in the Large Aperture Seismic Experiment (LASE). This was a three ship, multichannel reflection seismic survey across the West Atlantic continental slope and the thick deepwater sedimentary basin. The research has provided an improved fundamental understanding and models of tectonic activity in this rifted continental margin, with implications for assessing the degree of thermal maturation of potential oil source rocks.

Vitrinite reflectance provides a world wide standard of thermal maturation of sedimentary rocks. It is used, along with organic material type, to calibrate models depicting petroleum source rock maturation and products. An automated system and method for measuring vitrinite reflectance has been established in-house at AGC. Interpretation of the vitrinite reflectance and analysis of other data from several wells on the northeastern Grand Banks showed that fully mature oil source rocks occurred at or near the bottom of many of the wells and were the source of oil encountered in marginally mature beds in the Hibernia field. On the Scotian Shelf similar studies confirmed the presence of fully mature source rocks below about 4 km in the Sable Island area. However, the nature of the organic matter is such that, at the zone of peak generation, the product formed is wet gas; hence, gas and condensate is recovered instead of oil in the Venture field. These data are used directly in the hydrocarbon resource assessment program at the GSC and COGLA.

A sidescan survey was completed of 5000km^2 around the epicentre of the 1929 Grand Banks earthquake on the continental slope south of Newfoundland. It showed that surficial slumping is widespread on the continental slope within 50km of the epicentre, and that the turbidity current generated was 300m thick and sufficiently powerful to sweep seabed gravel into waves. Subsequent coring and seismic reflection profiles have helped define the slumping process. A two month microseismicity survey in the same area detected two local earthquakes and provides a bound to the magnitude-frequency plot of earthquakes, required to assess risk to offshore structures. This information is useful in the preparation of standards by the Canadian Standards Association Task Force on the design of offshore structures.

A high resolution seismic profiling survey of the upper continental slope off St. Pierre Bank and the central Scotian Shelf was completed. The data processed thus far has been used;

- to estimate the recurrence interval of large seismic events in the Laurentian Channel area;
- to define general styles of Quaternary instability on different parts of the continental slope; and
- as a regional guide for the interpretation of well-site surveys (e.g. Acadia and Shubenacadie).

Consultants such as Geomarine Associates have used these results to help interpret seismic risk (Mobil at Venture), and to provide a framework for reassessing site studies (COGLA).

Seabed instability was investigated on two areas of the Scotian Slope using the Seamarc system. The study showed significant stripping off or slumping of sediment, large debris flows, and active creep on slopes. All these processes were observed in an area where two exploratory wells have been drilled and more are planned. The results are important to companies in their assessment of risk inherent in sediment instabilities on the continental slope. Recommendations based on this work were made to the Ocean Ranger Commission on future design criteria to accommodate slope instabilities.

A chirp sonar has been developed under contract with Dalhousie University. It provides, for the first time, the ability when towed from a deep-tow vehicle (such as the Seamarc 1 System) to obtain detailed acoustic information from deep-water (1000 metre plus depth) sands. It will be deployed in surveys of the Laurentian Fan and will provide information which will improve the depositional model for these modern deep sea sediments for use as an analogue when exploring for ancient hydrocarbon-bearing deposits. Shell has welcomed this work as likely to provide a better understanding of the potential of deep water facies as reservoirs.

A large winch was custom built by Timberland of Woodstock, Ontario, to allow the GSC to carry out seabed research on the continental slope. The winch design is owned by the Crown. It is now being used in testing a Huntec '70 Ltd. deep-water boomer-sidescan system being developed under a PILP project, and by Hepburn of Toronto to supply a winch for use by PGC on the West Coast. Hampton Engineering Ltd. of London, Ontario, now have orders to supply 18 cranes developed as part of the total handling system (winch, crane, cable).

A seismic network was deployed on the Queen Charlotte Islands and on the mainland and islands along the eastern boundary of Hecate Strait, during the summer of 1983. Three hundred seismic events were recorded and the data has been published. An understanding of the seismicity of active

faults associated with the Queen Charlotte fault system is critical to an evaluation, by industry and government regulatory agencies, of the seismic hazard to petroleum development and LNG ports being considered. The region has the highest earthquake risk in Canada, with very large historical events up to 8 Richter (1949).

Jones Sound is a potential tanker route out of the Sverdrup Basin and, by physiographic analogy with Lancaster Sound, may have hydrocarbon potential. The opportunity of a survey by the Canadian Hydrographic Survey on CSS Baffin in 1983 was used by AGC-GSC to collect geological and geophysical data and sediment samples along precisely positioned hydrographic charting tracks. Much of the seafloor proved to be covered with up to 15m of fine clay, veneered in parts with coarser material, resting on glacial till and bedrock. This work will be continued in future under the NOGAP program. AGC also obtained colour aerial videotape coverage along 1135 km of Jones Sound coastline. Audio commentary, which provides more detailed description of physical shore zone and sediment characteristics, was added to the tapes. The videotapes provide a variety of users in government and industry with a first hand, continuous view of this coastline. This information is useful in responding to environmental emergencies such as oil spills; in coastal land use planning for marine terminals or aircraft landing and pipeline crossing sites; and in a variety of scientific studies such as coastal geology mapping and monitoring coastal changes and fluctuations in tidewater glacier positions.

A serious limitation to fundamental research into moisture regime and migration in freezing soils was the lack of a non-destructive monitoring technique. A technique to locate breaks in telephone cables has been modified to the purpose for low salinity soils, and is now for the first time providing continuous moisture and heat balance measurements in laboratory and field situations. The Canadian consulting industry is using the technique for non-destructive moisture determinations on core samples.

The environmental isotope characteristics caused by fractionation on freezing have been separated from those which indicate the origin and time of formation of permafrost. Relatively young and climatically unstable permafrost can now be identified and rates of freezing

determined. These results are ultimately of value to the pipeline industry in assessing the risk of frost-heave, and natural permafrost behaviour.

Detailed temperature, seismic velocity and geological profiles have been made at 80 offshore hydraulically jet-drilled holes in the southern Beaufort Sea, and used subsequently by industry to locate borrow material and to assess the geotechnical aspects of well sites and pipeline routes and design. Shallow sediment velocity studies have been conducted in the Beaufort Sea using a specially designed multichannel refraction seismic eel. The resulting regional overview of shallow velocities and a generalised velocity-depth curve for the 0-50m sub-bottom zone has been used by contractors in the interpretation of shallow seismic records for site investigations. Theoretical and physical modelling facilities for evaluating the distribution of subsea permafrost have been established at the University of Calgary. Energy R&D funding supported the development of technologies, methodologies, and facilities used in the above program.

A report prepared under contract on permafrost testing methods is being used by specialists in government, industry, and universities to prepare a Permafrost Testing Manual. Characterisation of the occurence of frozen ground in typical soil materials and natural settings is in progress.

A relationship has been established between creep velocity and increasing salinity in fine-grained, frozen, saline soils. This is an important parameter for designers of building foundations in saline permafrost regions.

A geotechnical drilling program was completed in the Illisarvik area of Richards Island, Northwest Territories, as reported in GSC Open File Report 941. The report also contains a description of the area's surficial geology. This work was done in support of ongoing experiments related to understanding the processes of permafrost formation.

A program of geotechnical investigations of the seabottom sediments was carried out, under the Permafrost Subprogram, in the area between Pullen and Hooper Islands near Tuktoyaktuk, NWT, in March and April 1984. This project was the first project of its kind and scope in the region, with good drill records, good ground temperature measurements and determination of geotechnical properties and of physical (acoustic) parameters at known depths in the same holes. This will therefore permit a much better understanding of the relationship between the various parameters determined and also improve the quality of numerical models and of geological and geophysical interpretations of the seabed permafrost conditions in the nearshore zone of the southern Beaufort Sea. A preliminary account of the fieldwork was well received at a workshop on "Acoustic Geotechnical Correlation" in April 1984, sponsored by the GSC and the oil and gas industry. Oil and gas exploration companies active in the Beaufort Sea are interested in the results: Esso, in particular, wishes to use the results as input for the design of the proposed offshore-onshore pipeline from Adgo to Richards Island: the likely first step in Beaufort Sea oil production expected prior to 1990.

The presence and character of alpine permafrost has been assessed at a test site near Summit Lake, B.C., in the Canadian Rocky Mountains. Originally, the project was intended to contribute information for the evaluation and modelling of the proposed Foothills Alaska Highway Gas Pipeline project.

An outdoor facility to verify engineering design concepts of chilled large-diameter pipelines buried in frost susceptible ground has been operated by industry (Canadian Arctic Gas Study Ltd., followed by Foothills Pipelines (Yukon) Ltd.) in Calgary for almost ten years: the longest running field experiment of its type in the world. A continuous record is available of the effects of several different methods of burial to mitigate the impact of frost heave on an operating pipeline. EMR has helped maintain this facility through 1983 in return for the complete historical data set and has negotiated its continued operation for several more years before closing with a series of meltdown experiments required to develop regulatory guidelines for eventual reclamation of gas pipelines operating in the North. EMR's participation through the Earth Physics Branch (EPB-EMR) has provided public access to data which is important from engineering regulatory and scientific viewpoints. The site will now be instrumented and geophysically surveyed to enable some fundamental studies of the mechanism of ongoing

heave which has been observed to occur despite the frost table being fairly stable for several years.

The Calgary frost heave facility has experimental limitations in that whilst pipe temperatures are controlled, the ambient air and ground temperatures and water table vary in their natural cycles. A cooperative research agreement between France and Canada has enabled Canadian universities (Carleton, Ecole Polytechnique) and the Earth Physics Branch of EMR to use a facility of the Centre de Geomorphologie at Caen, Normandy. The Caen facility has permitted a series of controlled medium-scale experiments on an 18m long chilled pipeline section buried across a junction of freezing silt and sand. The effects of each variable on the frost-heave process have been studied independently with complete knowledge of the energy and moisture balance. The resulting data on frost heave, pipe deformation and stresses, soil stress, ground temperature and moisture, has been coordinated with laboratory studies in Canada on creep, frost heave and suction water-content of frozen soils. A major seminar on this work was well attended by the pipeline industry. The concensus was that the information and techniques will be important for engineering predictions, when evaluating test results from "semi-controlled" facilities such as at Calgary, and when designing a Canadian controlled environment laboratory. The program has trained five Canadians as field project managers in permafrost science.

Energy R&D resources have expanded an existing NRC program of research in gas hydrates to study hydrates of natural gas. Such hydrates are potentially both a drilling hazard and a fossil fuel resource. The objective of this laboratory program is to advance the fundamental scientific understanding of gas hydrates. Outside of the Soviet Union, the NRC is the major centre of excellence in this field, and was first in characterizing 40 of the 110 known gas hydrates. The 1983/84 research program has provided an improved understanding of methane hydrate formation and stability particularly in sea-water; has improved traditional methods of defining the presence, compositions,

temperature regimes, thermal conductivities and decomposition mechanisms of gas hydrates; has developed the theory of oxygen-18 enrichment of melt-water as an index of the recent presence of gas hydrates; and has identified three new gas hydrates.

The well logs from all wells drilled for oil and gas exploration north of 60° N have been analyzed under contract to determine the presence of gas hydrates and the base of permafrost. Gas hydrates appear from this study to be more prevalent than at first thought, occurring in 20 to 30% of the wells and at depths reaching to almost 2km. Permafrost thickness likewise is greater than earlier predictions, reaching to depths greater than 800m in the Arctic Islands and to almost 750m in the Mackenzie Delta/Beaufort Sea areas.

In order to establish the hazard posed by the decomposition of gas hydrate, a laboratory study by the University of Alberta has grown hydrate in natural materials and studied the geotechnical properties of the mixture. The results from this study, a world first, are now being used in a computer program to simulate an arctic well producing conventional hydrocarbons through shallow zones of gas hydrate.

PROGRAM 6.2 - MARINE ENGINEERING

OBJECTIVE:

To improve the safety of marine hydrocarbon exploration and production systems through technologies and regulations.

Through research on safety techniques, a diving bell system has been developed with significant safeguards for operators. This controlled emergency ascent system has been developed on contract through Can-Ocean Resources Ltd. of New Westminster, British Columbia. It includes two alternative methods which could be used in a redundant mode for controlling the emergency ascent of a diving bell. One method is a buoyancy control system; the other is a drop-weight system. Specialized testing is complete and the prototype has been certified by DNV, ABS, and Lloyd's. This system is the first of its kind in the world and should give Canadian industry a significant opportunity to develop such systems for worldwide marketing.

Early in 1982, the Hydraulics Laboratory of NRC submitted a proposal to transform two of its existing shallow water wave basins into one large deep water wave basin. Funding was provided by NRC and the Panel on Energy R&D which recognized the importance of such a structure for the design and operation of offshore structures in the Canadian coastal zone. The new Offshore Engineering Wave Basin is one of the three best in the world. Not only is its size impressive (30 m. x 50 m. x 3 m., with a deep section of 6 m.), but it will soon have short, as well as long wave generating capacity. The first series of model tests in this new deep water wave basin was commissioned by the Royal Commission on the Ocean Ranger Marine Disaster. A 1:40 scale model of the semi-submersible drilling rig "Ocean Ranger" was built to simulate the events which may have played a role in the sinking of this vessel on 15 February 1982. The same model will be used to study the dynamics of semi-submersible drilling rigs in ocean waves, in order to assist with the development of regulatory procedures concerning the design and operation of these structures in Canadian waters. Recently the Wave Basin has been used by Dome Petroleum to test the design of an artificial island for offshore hydrocarbon development.

The Marine Statistics (MAST), Duration Statistics (DUST), and Contour Analysis Program (CONAN) are designed to manipulate large banks of meteorological data, in order to provide marine climatological design parameters for industry and regulatory agencies. They were developed by the Atmospheric Environment Service (AES) of Environment Canada and are now available through the Canadian Climate Centre of AES. They may be accessed directly on the AES HQ computer in Downsview, Ontario. These programs were introduced to industry and other government agencies (eg. COGLA) through a series of workshops. The system outputs are now being heavily used by government and industry groups specializing in marine meteorology and offshore engineering in Canada and elsewhere. In particular, the MAST program is used to provide information to support applications to COGLA for work on the Canada Lands. A Canadian company is now being licensed to market this software.

The Adams Island Ice Interaction Studies consist of an experimental stage to observe and measure the ice interaction processes and environmental driving forces around a small island, and an analytical stage to develop models for predicting ice forces. This work will improve our ability to assess the adequacy of design criteria for ice loading on offshore marine structures proposed for hydrocarbon exploration and production. The results of the field measurements have already been used by NRC during their participation in the hearings on the Beaufort Sea Environmental Impact Statement.

Dynamically positioned drilling vessels in Davis Strait encountered difficulties with sudden surface rip currents exceeding three knots associated with high amplitude internal waves, or solitons. The Atlantic Oceanographic Laboratory (F&O at BIO) has since determined that solitons are a frequent occurence, resulting from a tidal effect at the Atlantic slope. The associated surface rip currents and some very strong bottom currents in shallow waters can affect sediment movement, the stability of seabottom structures, and drilling operations along the east coast continental shelves. Offshore operators are now benefitting from this research. Bow Valley Offshore Drilling Ltd. are recognizing solitons in their jack-up drill rig design criteria. Petro-Canada and Mobil are including soliton effects in their planning for Hibernia development.

In the area of wave hindcasting, a new technique of adding a kinematic analysis of the wind fields followed by a blending

of the resulting winds with those produced by the boundary layer model was found to vastly improve the accuracy of hindcasting waves. The model was developed, and the software supplied. The model is now operational in the Marine Environmental Data Service (MEDS) of Fisheries and Oceans.

Another wave hindcasting project was designed to determine the importance of a description of wind-generated wave spectral climatology to offshore operations and the design of offshore structures, and to develop procedures for presenting this climatology. The study found that using the so-called "standard spectra" to represent waves in Canadian waters was not appropriate, indeed that it was dangerous to assume one of the standard forms without first having determined the consequences of this assumption by referring to the spectra which had actually been measured for that area. This conclusion is important to the safe design of offshore structures for oil and gas production.

A study of concrete curing in seawater at $0^{\circ}C$ was undertaken by PWC. The results show that 90% strength can be obtained in 28 days, which is contrary to the conventional understanding. Research is now continuing to test concrete durability and curing duration tests are being completed. If successful, there will be considerable potential for economic savings to the construction industry.

PROGRAM 6.3 - OFFSHORE GEOTECHNICS

OBJECTIVE:

To improve the knowledge of seabed conditions in the Canada Lands for development and regulation.

The joint industry-government sponsored seismometer network for the Beaufort Sea records earthquake events on a continuous basis in a seismically active region. Results are being used by federal agencies to determine peak ground accelerations for establishment of building codes for offshore oil production facilities. Industry is using the results for designing such offshore structures capable of withstanding maximum anticipated earthquake loading.

A joint industry-government sponsored overview of the regional geological framework of the southern Beaufort Sea has been completed which assesses the seabed in terms of its impact on hydrocarbon exploration and production. The study, carried out by M.J. O'Connor & Associates Ltd. of Calgary, has led to an established perspective on the upper 100m. of sediment. The results of the study are being used by industry to predict conditions at new drill sites and to establish constraints on production design criteria for offshore oil development structures. The results of the study have been used by federal scientists to assist COGLA in the drafting of well site regulations and guidelines; to advise DIAND on the technical aspects of offshore sand and gravel resource management; and to provide the basis for a technical assessment of the Environmental Impact Statement submitted by industry to government in support of Beaufort Sea oil production.

Another cooperative effort between government and industry has been the regional technical zonation of sediment properties in the Beaufort Sea. Results to date have been used by Beaufort Sea Operators to assess potential borrow sites for island construction material; to evaluate foundation conditions at prospective exploratory drill sites; and to establish initial design criteria for preliminary oil production facility concepts. Results have provided federal scientists with the perspective and

information necessary to advise federal agencies on sediment properties and to make a technical intervention on soil properties at the review of the Beaufort Sea EIS.

A program to survey the top of the ice bonded permafrost in the Beaufort Sea is now 75% completed on 1:250,000 base maps. It was accomplished by use of industry and government seismic records which were interpreted inhouse and under contract using innovative methods, such as the iso-offset time section, and borehole correlation to delineate detailed structure. The oil industry has used this information for seismic interpretation and well site evaluation.

At the Federal Environmental Assessment Review of the Beaufort Sea EIS, the GSC was able to identify shortcomings of the present (1980) pipeline design criteria with respect to ice scour and to respond to extensive cross-examination by the Review Panel on the ice scour issue. As mentioned above, research on soil properties provided the basis for EMR's technical intervention at the hearings. Using results of research on subsea permafrost, federal technical experts were also able to comment on the shortcomings of production facility design concepts which dealt simplistically with the differential thaw subsidence problems of permafrost.

At the review of the Environmental Impact Statement for the Venture Development Project, EMR technical experts advised the FEARO Panel of the inadequacy of seismicity information for the design of offshore structures, and on the impact of ice incursions into the producing area. They also provided updated information on the character and potential stability of seabed sediment at Sable Island. A preliminary regional perspective on the geotechnical setting, provided by seabed stability research, was used in discussions of site specific engineering concerns.

The same research program provided the Ocean Ranger Commission with information on the adequacy of seabed information for exploratory drilling, and on the distribution of wreckage on the seafloor to aid in the reconstruction of failure modes.

Energy R&D funds have contributed to the development of the following equipment:

RALPH: An instrument for the study of coastal sedimentary systems and the mechanics of sediment mobility. It consists of an instrument package mounted on a tripod and deployed on the sea floor. It has been used near Venture, off Sable Island, at Hibernia, and in the Beaufort Sea. These deployments were undertaken in cooperation with the petroleum industry.

Ocean Bottom Seismometers (OBS): These gather information on the size and frequency of small earthquakes occurring offshore and provide information on deep crustal structure. This information is used to help set construction standards for offshore structures for petroleum exploration and production and to develop models of crustal evolution. The seismometers have been successfully deployed off the Canadian west coast, in the Beaufort Sea and on the Grand Banks. Each OBS is dropped freely to the sea floor where it continually records up to 28 days, before releasing its anchor weight on command and floating to the surface for retrieval by a research vessel. The University of British Columbia and Dalhousie University have chosen to copy the Bedford Institute OBS design for their own use.

PROGRAM 6.4 - ENHANCED OIL RECOVERY

OBJECTIVE:

To develop the science of enhanced recovery applicable to Canadian light-medium gravity oil reservoirs, both on and offshore.

The first phase of a GSC sponsored study evaluating the technical, geological and economic feasibility of a representative Alberta light oil reservoir for enhanced recovery has been completed. The study was jointly carried out by the Canadian Energy Research Institute (CERI), Computer Modelling Group (CMG), and the Petroleum Recovery Institute (PRI). The study identified various pools with varying degrees of economic exploitability through the application of tertiary recovery methods, promoting considerable interest within the oil industry. Negotiations with a medium sized Canadian company are currently underway to apply the developed technology to a specific pool operated by this company. This would include a detailed geological-engineering study in the fiscal year 1984-85 followed by a pilot test if the techno-economic aspects of such a project are feasible.

A mathematical simulation study for various field conditions conducted by CMG in conjunction with this project will serve as a guideline to determine the extent of technical success and sensitivity of various parameters on different EOR operations. The PRI component will provide a basis for selecting reservoirs amenable to various recovery processes and eliminate costly errors in reservoir selection. It will also provide the basis for EOR potential assessments by government agencies.

A Petroleum Recovery Institute (PRI) study dealing with mobility control in fire-flood and steam-flood projects determined the chemical stability of various surfactants. Of the over 100 surfactants examined, 24 were found to be more amenable at high temperatures as encountered in fire-flood and steam-flood operations. These were tested for their stability at high temperatures and were found to have various degrees of effectiveness in channel blocking and hence mobility control. The results acquired through these experiments serve as a basis for selecting a surfactant for a specific operation, thus eliminating costly

preliminary research. The Alberta Energy Company is currently negotiating with the PRI to use this information in their ongoing Suffield fire-flood project. Successful application of this field test will have widespread application in other projects. It will also serve as a basis for assessment of EOR potential.

A second cooperative project between the GSC and PRI is to devise a method to dispose of flue gases, thus reducing air pollution. This would be accomplished through studying the injection of these gases into oil reservoirs and assessing their effects on the rocks and recovery potential. The results thus obtained indicate that using a mixture of CO_2/SO_2 reduces the miscibility pressures considerably, with substantial savings in operating costs. However, in carbonate reservoirs such a mixture could have detrimental effects, resulting in lost production. These findings have created considerable interest within the industry. Preliminary negotiations are currently underway between PRI and Alberta Oil Sands Technology and Research Authority (AOSTRA) for a field pilot study. Also SUDIC (a sulphur utilization institute) has shown interest in using the technology to dispose of waste sulphur.

A study to develop mine-assisted enhanced oil recovery technology applicable to a Devonian formation in southwestern Ontario has been completed. This study was initiated in cooperation with the Ontario Ministry of Natural Resources, and was carried out by SNC Inc. of Montreal. The findings of this study have been valuable in evaluating and implementing a pilot project during the fiscal year 1984-85. As a component of this project, six wells have been cored and analyzed. The results obtained will help the Ontario Ministry of Natural Resources and EMR determine the residual oil in Ontario fields and the extent of recovery possible through mine-assisted methods. The project has created considerable interest within the industry in Canada as well as in the U.S.A. Preliminary contacts are underway for technical cooperation with Petroleum Mining Corporation of Louisiana, U.S.A.

A GSC sponsored project to develop advanced computer modelling capabilities for phase behaviour and secondary recovery schemes involving miscible displacement has been completed to the extent that it can be used to simulate various enhanced recovery processes. This modelling, which has been carried out by the CMG, has been widely used on a commercial basis by the petroleum industry and by the University of Calgary. It is one of the most sophisticated simulators currently available on the market. It is also being used by the University of Stanford (U.S.A.) for simulation purposes to predict fluid behaviour in enhanced recovery processes.

PROGRAM 6.5 - MATERIALS FOR OFFSHORE STRUCTURES

OBJECTIVE:

To improve construction materials and fabrication, inspection, and repair technologies for offshore hydrocarbon exploration and production systems.

McMaster University, under contract to CANMET, has defined the precipitation mechanism and determined the factors needed to optimize the composition and processing of Ti-N linepipe steels with good toughness in the heat-affected zone (HAZ). As a result of CANMET work, all Stelco continuously cast steel for large-diameter linepipe production now contains an addition of titanium. This development has satisfied a need in the pipeline industry for steels with good HAZ toughness.

Work has been carried out at McGill University under contract to CANMET on the effects of Mo and Ti microalloying elements on recrystallization and precipitation kinetics of high-strength low-alloy (HSLA) linepipe steels. It is anticipated that knowledge and understanding of the fundamental details of these effects will permit linepipe producers to optimize alloy additions and rolling practice, to reduce microalloying costs, and to improve steel properties. Algoma Steel Corp. and Stelco use and benefit from this activity.

A new laboratory for corrosion fatigue testing of thick plate welded T-joints has been established, providing three separate test frames and related control instrumentation. The facilities are used for a test program on CSA Grade 40.21 steel plate, in cooperation with industry in Canada, and in collaboration with groups in the U.K. and Europe.

The 50/50 cost-shared program on steels for offshore structures has been established. As a result of this new CANMET initiative, two Canadian steel companies contracted to develop plate steels for offshore use and a Canadian fabricator contracted to carry out R&D on the Canadian-developed steels. The Materials and Utilization Subcommittee of industry's National Advisory Committee on Mining and Metallurgical Research (NACMMR) has commended CANMET for this program.

PROGRAM 6.6 - TRANSPORTATION OF OIL AND GAS

OBJECTIVE:

To provide technical support for transportation of oil and gas, through R&D in such areas as navigation technologies and hydrographic services.

Through initial support from Energy R&D funds, and with later assistance from NRC, Targa Electronics Systems Inc. of Ottawa has developed a computer data storage system based on a technology called "bubble memory". The "Bubblebox" was originally designed for use in an electronic navigation system where data is gathered from various pieces of equipment, filtered, then recorded in the Bubblebox logging device. It uses magnetic bubble memory technology which stores data in the form of cylindrical magnetic domains on a thin film of magnetic material. Because it has no moving parts, the Bubblebox is more reliable than traditional technologies and can easily survive rough handling, vibration, dirt and moisture. In addition to hydrographic surveying, Targa is finding a wide range of markets for the recorder: major automobile manufacturers are using the system to store data during vehicle tests, and it is also being engineered into a system which controls and monitors oil well drilling operations. Targa has recently signed an agreement with Genisco Technology Corp. of California which allows Genisco to market one of Targa's data recorders under its own label and share Targa's technology to develop a military version of the bubble memory data recorder. The agreement is expected to be worth about $7 million (U.S).

DOLPHIN (Deep Ocean Logging Profiler Hydrographic Instrumentation and Navigation) is a robot submarine vehicle intended to improve the effectiveness of hydrographic surveying. It was designed and constructed by International Submarine Engineering Ltd. (ISE) of Port Moody, B.C., and supported through the Unsolicited Proposal Program of DSS with funds from the Energy R&D Panel and Fisheries and Oceans at the Bedford Institute of Oceanography. The vehicle, made of aluminum and about 7 metres long, is powered by a conventional diesel engine, taking air from a snorkel approximately 5 metres long. Operationally DOLPHIN cruises 3 to 4 metres beneath the surface at a sufficient speed (13 or 14 knots submerged) to maintain contact with the parent vessel. Trials of the DOLPHIN in open seas were conducted last December on the Scotian Shelf. Previous testing had only been in bays and harbours. In the December tests it was operated for 5 to 6 hours in seven foot seas and general performance exceeded expectations. DOLPHIN

proved to be more manoeuverable than anticipated and was easily retrieved with the parent ship BAFFIN underway at 10 knots. A test with a survey launch running parallel to it showed DOLPHIN to be vastly superior in stability in moderate seas. The next phase of development will be the installation of essential instruments for obtaining accurate depth measuremnts and positions, and design and construction of an operational handling system.

An electronic acoustic sweeping system has been developed to detect submarine pingo-like features in the Beaufort Sea which could pose a hazard to shipping. The system comprises a Sterntow Towfish, providing up to five sounding lines, and a sidescan sonar processing unit to improve signal processing and display. Successful demonstrations were made during 1983 in the Beaufort Sea and off the B.C. coast. Adjustments are now being made to reduce the stress on the main tow cable which has broken when fully flexed during field trials. A dedicated sweep vessel will be acquired by the Canadian Hydrographic Survey by April, 1985, and will, with this sweeping system, provide a capability for rapid, large-scale shipping corridor surveys.

A major effort of the Canadian Hydrographic Survey is to define the tidal characteristics of the Arctic Archipelago. Energy R&D funding has supported the design and acquisition of components for an arctic water level gauging system, the first of which will be installed at the Polaris Mine site on Little Cornwallis Island. Its value is that it will provide permanent year-round tidal measurement under multiyear ice conditions, with the record signalled to a central monitoring station, at significant savings in terms of maintenance and recovery costs.

Field trials of the Sea Marc II side-scan sonar system off the Canadian west coast proved the system to be an effective imaging tool, providing geometrically correct side-scan images. The system was not as easy to use and did not provide as high a quality of bathymetry as the Seabeam system for hydrographic survey use. However, both together can provide a comprehensive remote survey of the seabed.

The practicality of a radar-based ice thickness measurement device has been proved through extensive trials. An operational prototype has now been designed and constructed, and this instrument, together with the associated antennae, are now undergoing preliminary field trials in conjunction with Canadian Coast Guard operations in Lake Melville.

The feasibility of a combined cycle propulsion system for shipping has been assessed. It is based on a Rolls Royce RB211 gas turbine engine with propulsive power extracted both by a power tubine and by an exhaust heat steam boiler/turbine combination. Its potential to increase Canadian content is useful information when negotiating the construction of large LNG carriers. This proposed alternative propulsion system, as compared with a conventional steam turbine plant, has similar capital costs but substantially beter energy efficiency, and would provide a modest increase in Canadian content.

In order to select grades of steel appropriate to vessels operating in cold Arctic environments, it is essential to have a good knowledge of temperatures in various parts of the ship structure. To this end, a heat flow model has been developed and confirmed in full-scale tests. The model now provides designers of Arctic ships with a means of demonstrating compliance with Transport Canada's regulations.

Ice damage on the icebreakers Robert Lemeur and Canmar Kigoriak has been analysed to determine the most likely magnitude and shape of the ice loads which caused the damage, and the role of such factors such as load geometry. A report now in press includes conclusions and recommendations of value to designers and regulators of Arctic Class ships.

Two projects on mathematical modelling as applied to the design of Arctic Class vessels have been concluded:

- the first compared the relative merits of beam modelling and three dimensional finite element modelling for a long limber vessel such as the M.V. Arctic. Further comparison with rigid body models was also conducted. The final report presents conclusions on the relative merits of the various methods depending on their intended use and economic implications, and

will form part of the data bank available to designers and regulators of Arctic Class shipping.

- the second project, comprising three dimensional finite element analysis of M.V. Canmar Kigoriak, continued the work of the preceding project to treat short, relatively rigid vessels. The final report on this project extends the comparisons of the preceding project to deal with this different type of vessel, and provides needed background information for design and regulation. An additional benefit of these two projects is that a Canadian capability, that would not otherwise have existed, has been developed for three dimensional finite element modelling of ships hulls.

The effectiveness of the air cushion ice breaker (ACIB) principle has been demonstrated. In an extensive series of trials at Thunder Bay, a prototype ACIB platform coupled to a small tug has proved able to break ice as well as conventional icebreakers of many times the tonnage of either the tug or the tug-ACIB combination, with consequent substantial savings in cost and fuel consumption. Adoption of the principle by the Canadian Coast Guard is now expected, with progressive extension of its use into the areas of Canada outside the Great Lakes - St. Lawrence region as the need and opportunities present themselves.

A range of alternative icebreaking bow forms has been subjected to preliminary analysis, leading to Canadian tank tests of the best two as compared with the best, current state-of-the-art form. From this, the best form was subjected to high-precision tank tests in European test facilities. Results indicated a 30% reduction in power requirements, as compared with the present bow form, for continuous breaking of level ice, thus providing new design guidance needed for future Arctic Class vessels. Installation of this bow form in a future refit of the MV Arctic is contemplated, offering an opportunity for full scale field trials and demonstration.

A means of protecting propellors of large vessels from damage caused by heavy ice has been evaluated for various configurations, using model and tank tests. The work was contracted for by the Transportation Development Centre of Transport Canada. The results are now available to designers of ships required by industry and government agencies such as the Canadian Coast Guard. The information helps the designer evaluate thrust power and ice protection

requirements, given the type of service expected of the ship.

A locomotive event recorder has been developed and demonstrated. The device is analogous to an aircraft crash recorder, recording a number of key parameters of value in analysing the causes of rail accidents involving hazardous commodities. It has proved reliable, accurate, and durable in service conditions and will provide an "acceptable means of compliance" for regulations now being developed within the Canadian Transport Commission.

A test rig representing a bulk fuel transport tank has been developed and constructed at the University of New Brunswick. It permits controlled heating and continuous observations of conditions within the tank. Thus, it provides Transport Canada with the means of developing and testing interior treatments or devices intended to dissipate or control heat flow from fire conditions external to a road or rail tank vehicle, in order to determine their effectiveness in promoting controlled expansion and venting of the product rather than tank rupture and explosion.

PROGRAM 6.7 - ENVIRONMENT

OBJECTIVE:

To improve forecasting of sea, ice and weather conditions; and to improve understanding of environmental processes in the Canada Lands.

The "Ice Atlas for Canadian Arctic Waterways" was compiled by W.E. Markham of the Atmospheric Environment Service, Environment Canada, with considerable support from energy R&D funds provided through Transport Canada. It consolidates historical AES ice chart data for the period 1959-1974 into weekly ice charts for the Arctic Ocean. It details, in a large four-colour format, the median amounts of all ice and old ice; maximum and minimum reported conditions; timing and amounts of new ice appearance; winter conditions; ice regions; break-up and freeze-up patterns; general patterns of ice movement; ice bergs and ice islands; and climatic conditions including a range of meteorological parameters. It is a major reference used widely by industry, consultants and government departments as a first-order consolidation of basic information required to estimate windows and conditions for marine operations in the Arctic. It has recently been revised by AES to include data collected up to 1980.

In February 1984, drilling operations of the rig JOHN SHAW on the Grand Banks were interrupted and the rig moved to avoid ice. A similar incident last year led to the question of whether such occurrences are abnormal in that area, or to be expected every year. The Atlantic Oceanographic Laboratory (F&O at BIO) examined ice climatology information for the area which had been gathered as part of the Sea Ice Program. Available sea ice data sets were combined into an edited archive for scientific analysis and initial results provided some answers. Pack ice could be expected in this region approximately once every 8 years. However, there appears to be some persistance from one year to the next, i.e. one heavy ice year tends to be followed by another one. Therefore, it would be expected that 1984 would be fairly heavy because 1983 was. The maximum extent of the ice occurs in early March, on average. During the coming year, similar information for the entire Labrador and Newfoundland region will be published and available to rig operators.

The ice forecasting projects have resulted in the following achievements and spin-off benefits to the private sector:

- A free-drift ice forecast model was implemented at Ice Forecast Central to depict vector displacement of sea ice features in the forecast period as guidance in the preparation of ice charts distributed to users throughout Canada.

- The major consultant in the Beaufort Sea Winter Ice Experiment (Intera Environmental Consultants, Calgary) applied for a non-exclusive licence to operate the fine scale ice forecast model. Under contract to Dome Petroleum, they have since been using the model in support of the offshore activities of Dome and other operations in the Beaufort Sea. Research is now focussed on improving what has to date been a poor operational performance.

- As a sub-contractor to Intera for the Beaufort Sea Winter Ice Experiment, Prof. J. Sykes of the University of Waterloo provided a significant contribution to numerical methods in ice forecast models. As a result of this activity, he has led the development of a viable and strong research activity in ice modelling which includes post-graduate research.

- The principal consultant in the development of the ice dynamics model and the mounting of the prototype ice forecast system at Ice Forecast Central (Meteorological and Environmental Planning Ltd.) utilized the expertise gained in model development and operational system design to develop and successfully market an oil spill trajectory forecast system which is widely recognized, nationally and internationally, as state-of-the-art in trajectory modelling. For Canadian applications where sea ice is present, it will be necessary to mesh their oil spill system with the ice dynamics model they have developed in order to maintain and enhance their present commercial advantage.

- The Resource Analysis and Mapping System adapted for ice fields has been integrated into the operational routines at Ice Forecast Central. Features of the system developed for ice purposes have been successfully adapted for other applications and marketed by the principal contractor (Systemhouse Inc.) in subsequent sales.

- Models for predicting the mean daily drift of iceberg ensembles and iceberg deterioration rates have been developed for incorporation in the AES Ice Services Program.

Icebergs pose a major threat to developments, particularly offshore from Newfoundland. A good prediction of the short-term movement of a threatening iceberg is valuable when selecting counter-measures, and when towing. A model developed at Dalhousie University predicts within an error range, the future course of an iceberg based on the statistics of its past movement. Results are better than those from a deterministic model, and the error formulation has now been incorporated in a commercially available predictor (NORDCO). The accuracy of the model is now being improved, particularly by incorporating better data from other studies and new instrumentation measuring local winds and currents.

A major accomplishment in environmental forecasting has concerned the development of a parametric wind-wave forecast model which has now been installed in the Canadian Meteorological Centre in Montreal. In operational trials this model shows a capability equal or superior to that of the present human judgement forecasting method, and final tuning of the model is now underway prior to its adoption as a primary forecasting methodology. The principal contractor (Meteorological and Environmental Planning Limited) has adapted and successfully marketed a Beaufort Sea version of the system.

In order to support marine weather forecasting, a marine data system has been developed for generating empirical marine weather forecasts. Forecast equations of surface winds have been developed for east coast and Beaufort Sea marine areas. These will be investigated for their ability to provide higher quality data for operating ice and sea state forecast systems. The principal contractor (ACRES Consulting Services Ltd.) is marketing their capability in data base systems.

One of the major problems encountered by offshore drilling operations in the presence of icebergs is the inability to predict their movement. Real-time measurements of currents in the upper 100 m. of ocean are required over large areas during forecast periods. Acoustic doppler systems have

been purchased and evaluated as real-time current measuring devices. Two systems were obtained: one boom-mounted portable system capable of being transferred between vessels and one permanently installed on the CSS DAWSON research vessel at BIO. The "over-the-side" system is limited in use because of restricted operation in rough seas and ice-infested waters, but is readily available to researchers since it is not dependent on the availability of the DAWSON. The first application of the portable system was in offshore oil-spill tests conducted by the Canadian Offshore Oil Spill Research Association (COOSRA - an industry group) in September 1983 to monitor surface currents in the spill vicinity. Several cruises have been taken to test the system against conventional current meter moorings: to date, results have been positive, showing that acoustic profiling is an efficient and cost effective method for large scale ocean current surveys.

The Bayfield Laboratory (F&O), with the help of Energy R&D resources administered by Transport Canada, developed on unmanned profiling system to measure current speed, temperature and conductivity under an ice cover. The unit was first field tested in conjunction with the Laboratory's research of the freshwater plume extending under the ice in Hudson and James Bays and the possible effects of the planned hydroelectric power developments. The unit was then complemented with a gyro-orientation capability to obtain a time-series of continuous vertical profiles under the shorefast Arctic ice, near the north magnetic pole. The profiler has been extensively utilized in the Barrow Strait region to study the oceanic heat flow to the under side of the ice surface and its relation to water mass movement, in support of transportation of oil and gas through the Northwest Passage.

The Institute of Ocean Sciences (IOS, F&O-OSS) has been contracting major evaluations of the quantity and quality of historical information and available marine data for application to environmental operating conditions, regulatory guidelines and mitigation of adverse effects of hydrocarbon development in the Arctic Ocean. Twelve publications have been prepared to date, covering biological, chemical, physical oceanographic and marine climatological data sets. Two examples illustrate their application.

A report on geochemical fluxes of hydrocarbons, metals, sediments and nutrients in the coastal Beaufort Sea provided the basis for an evaluation by F&O-OSS of industrial impact concerns presented to the Beaufort Sea Environmental Impact

Assessment Panel.

A semi-quantitative method of assessing industrial impacts on marine mammals was prepared in the format of an Initial Environmental Evaluation (IEE) Kit. By calculation of vulnerability (industrial zone of influence, animal's distribution and timing) and prediction of ecological significance (choice of population dynamic characteristics), a quick evaluation of environmental issues is possible which permits others to scrutinize the assumptions, data sources, and calculations. This approach is currently being applied by F&O-OSS to Arctic and West Coast evaluations.

F & O has demonstrated the special potential for application of the Mixed Function Oxygenase (MFO) enzyme technique to monitoring strategies for oil pollution. The overall value of the technique has been established for use with both water column and bottom dwelling fishes. The analysis of a variety of other parameters confirmed that MFO enzyme induction provides the most sensitive index of oil pollution exposure in fish.

A study entitled "Offshore Oil and Gas Production Waste Characteristics, Treatment Methods, Biological Effects and their Applications to Canadian Regions" was completed in November 1983 for the Environmental Protection Service (EPS) of Environment Canada. The study results were presented and discussed in a series of seminars in March 1984 in St. John's, Halifax, Ottawa and Calgary: participants included both government and industry representatives. The report provided input to the Environmental Assessment Review Process for offshore developments and identified required regulatory and research requirements for the offshore.

A survey of five abandoned well sites in the Hibernia region, showed that under current exploratory drilling practices and regulations no debris is left of sufficient size to be of physical concern to the commercial fishery. Traces of chemicals from drilling operations were detected in the biota and sediments in the immediate vicinity of the well sites. Their significance is the subject of an ESRF evaluation, which may lead to further research.

A review contracted for by the Environmental Protection Service (EPS-EC) has concluded that current abandonment practices for artificial islands in the southern portion of

the Canadian Beaufort Sea have had no significant effect on the physical, chemical or biological environment. No effects have been observed on timing of break up and yearly seaward extent of landfast ice, consequent population distribution of marine animals, and hunting and trapping practices. The potential hazard of abandoned islands to navigation could be alleviated by such means as accurate charting, permanent navigation aids, or scalping particularly in designated navigation corridors, as contemplated in recent policy guidelines under the Navigable Waters Protection Act.

PROGRAM 6.8 - ELECTRICAL R&D

OBJECTIVE:

To enhance the role of electricity through support of the Canadian Electrical Association and through research in transmission and measurement of electricity.

The federal contribution of $2.8 million to CEA for 1983 represented about 39% of the total CEA R&D program funding for that year. The leverage on federal funds in relation to total CEA program commitments, including co-sponsors' funding, is about 4 to 1.

The CEA has been placing increased emphasis on transferring its R&D results by increasing the involvement of manufacturers in R&D performance, by licensing Canadian supplies, and by publicising results through conferences and technical information systems.

The "1983 Annual Report of CEA R&D Activities" highlights a dozen technologies with large market potential being developed with Canadian manufacturers.

Six conferences and symposia were organized through the CEA R&D committees in 1983 to promote R&D results, and meetings were held with representatives of the U.S. Electric Power Research Institute (EPRI) and other agencies to discuss research programs and trends. The CEA R&D Program also provides Canada's national link with the International Electric Research Exchange through which electrical R&D information is exchanged with participants from Europe, Japan, Mexico and Brazil in addition to the United States.

A major international symposium on "Distribution Fusing" was organized by the CEA and attended by 150 delegates in 1983. The project on current-limiting fuses was initiated in 1975 by the CEA Distribution R&D Committee and resulted in the establishment by Kearney National of a North American manufacturing facility at St. Leonard, Quebec. The results of this research were selected as one of the 100 most significant worldwide technological advances in 1982. The IREQ developers of the technology were presented with the I.R. 100 Award and a month-long exhibit featuring their work was held at the Museum of Science and Industry in Chicago.

In 1983, 66 final reports were published on completed CEA R&D projects. These reports are now included in the COMPENDEX database which is a computerized version of Engineering Index Monthly, published by Engineering Information, Inc. This database is available through several suppliers, including CAN/OLE, provided by CISTI at NRC. CISTI also receives copies of the reports for its library.

The Q-Glaze insulator, developed by Ontario Hydro through a CEA project, has been commercialized and is being manufactured in Canada. The Q-Glaze insulator is a porcelain insulator manufactured with a semi-conductive glaze which prevents sparking and hence reduces radio and television interference. It is now a standard requirement in one major utility and is being field tested by all other major utilities in Canada.

The partial discharge analyzer which was developed under a 1976 CEA contract is now being manufactured under licence and its application is being extended to cover all types of electrical machines. The device is able to provide an in-service monitoring capability on the quality of insulation in large electrical machines. This makes it possible to have early warning of deterioration and so to be able to anticipate the need for repairs or replacements during planned outages rather than suffer from unpredicted failure. Interest in this device is being shown by other countries.

CEA research has led to a modified burner for use by Ontario Hydro which provides a 47% reduction in nitrogen oxide emissions at major Ontario Hydro coal-fired generating plants. This environmental improvement was obtained at a capital cost of $12 million, about one-third of the cost of available commercial systems.

The inhouse electrical R&D Program at NRC on Dielectrics and Electrical Measurement provides information and expertise for the electrical utilities and manufacturers, and is designed in conjunction with these customers. An international expertise in cable dielectrics has been established at NRC through the Program. Work on Precision Electrical Measurement has resulted in the development and patenting of instrumentation for standards laboratories which has been licensed to Canadian manufacturers. In 1983-84, instrument sales from these licenses totalled about $900,000, with roughly 96% being exported. Examples include a direct current comparator potentiometer and an AC/DC thermal transfer standard, both now manufactured by Guideline Instruments Ltd. of Smith's Falls, Ontario.

OFFICE OF ENERGY R&D - COORDINATION PROGRAM

The Ocean Engineering Information Centre (OEIC) of Memorial University, Newfoundland, transferred 616 new documents on Canadian cold ocean engineering to the computerized Arctic Science and Technology Information Service (ASTIS) of the Arctic Institute of North America, at the University of Calgary. In addition, 2614 existing ASTIS documents were coded as also being available at OEIC. Thus, 24% (3230 documents) of the ASTIS database can now be accessed by Canadian users at two locations in Canada which represent major foci of cold ocean engineering research. The Arctic Petroleum Operators Association (APOA) has expressed strong support for this work on behalf of the frontier industry, the prime users of ASTIS.

List of Acronyms

AES: Atmospheric Environment Service (Environment Canada)

AGC: Atlantic Geoscience Centre (GSC-EMR)

AOL: Atlantic Oceanographic Laboratory (F&O at BIO)

AOSTRA: Alberta Oil Sands Technology and Research Authority

APOA: Arctic Petroleum Operators' Association

ASTIS: Arctic Science and Technology Information Service (Arctic Institute of N. America, Calgary University)

BIO: Bedford Institute of Oceanography, Dartmouth, N.S.

BRUTIV: Bottom Referencing Underwater Instrumented Vehicle

CAN/OLE: Canadian Online Enquiry System (of CISTI)

CCG: Canadian Coast Guard (TC)

CEA: Canadian Electrical Association

CERI: Canadian Energy Research Institute

CHS: Canadian Hydrographic Service

CISTI: Canada Institute of Scientific and Technical Information

CMG: Computer Modelling Group (Calgary)

COGLA: Canada Oil and Gas Lands Administration

COMPENDEX: Computerized Engineering Index (Engineering Index Monthly, Engineering Information Inc.)

COOSRA: Canadian Offshore Oil Spill Research Association

DIAND: Dept. of Indian Affairs and Northern Development

DOLPHIN: Deep Ocean Logging Profiler Hydrographic Instrumentation and Navigation

EC: Environment Canada

EIS: Environmental Impact Statement

EMR: Energy, Mines and Resources

EOR: Enhanced Oil Recovery

EPB: Earth Physics Branch, EMR

EPRI: Electric Power Research Institute

EPS: Environmental Protection Service (of EC)

FEARO: Federal Environmental Assessment Review Office

F&O: Fisheries and Oceans

GSC: Geological Survey of Canada (EMR)

IEE: Initial Environmental Evaluation

IERE: International Electric Research Exchange

IOS: Institute of Ocean Sciences, B.C.

IREQ: Institut de Recherche d'Hydro Quebec

LASE: Large Aperture Seismic Experiment

MAST: Marine Statistics Software Package

MEDS: Marine Environmental Data Service

MFO: Mixed Function Oxygenase

NRC: National Research Council

OBS: Ocean Bottom Seismometer

OEIC: Ocean Engineering Information Centre (Memorial University, Nfld)

OERD: Office of Energy Research and Development

OSS: Ocean Science and Surveys (F&O)

PERD: Panel on Energy R&D

PGC: Pacific Geoscience Centre (EPB-EMR)

PILP: Program for Industry/Laboratory Projects (NRC)

PWC: Public Works Canada

RALPH: Not an acronym

TC: Transport Canada

TDC: Transportation Development Centre (TC, Montreal)

USGS: United States Geological Survey