

Report on PRAC's First Annual R&D Forum – May, 2007

1. Introduction and Background:

On May 8th and 9th, 2007, PRAC held its first annual R&D Forum in St. John's, NL. The purpose of the forum was to deliver information about activities in a number of priority R&D areas that PRAC and others are currently focused on, and to encourage discussion about issues, challenges and opportunities for further petroleum R&D initiatives in Atlantic Canada.

Identification of the priority research subjects has been derived from previous discussions, surveys and meetings with a wide range of people from various sectors including industry, government, academia and others. Through this process, six areas of research have been identified as being most critical to the success of Atlantic Canada's offshore industry, as well as having significant potential for being undertaken by highly qualified individuals in the region. These subjects are: geoscience, safety, asset integrity, environment, ice management and gas development. In the past two years PRAC has issued calls for proposals in geoscience and offshore safety, and is working with companies and institutions to facilitate other projects in these subjects. This year PRAC hosted workshops on asset integrity and small field development (an area of great interest to both Nova Scotia and Newfoundland and Labrador), and is considering the possibility of issuing a new call for proposals in asset integrity.

PRAC is not currently funding research in all of the six subjects at this time, however institutions such as C-CORE, and government departments including Fisheries and Oceans and the Geological Survey of Canada are constantly working toward solutions that will have a marked impact on Atlantic Canada. And while PRAC is not always directly involved in some of these research activities, it is important to understand what is and is not being done so that we may be in a position to support critical research in any area of importance to the region.

Through a range of presentations in these various subjects, the R&D Forum provided good insight into what research is being done and what some of the needs are for this region. Included in the Forum agenda were two panel sessions, six technical sessions and a keynote address by NL's Minister of Natural Resources. PRAC hosted a networking reception as well as a dinner with a keynote speech from Schlumberger Canada, and presentation of two awards (excellence in R&D, and distinguished corporate contribution to R&D).

2. Participation:

The forum was attended by 158 people from various sectors including: industry (corporate and small business, numbering 45 delegates); government (municipal, provincial and federal departments including research institutions and petroleum regulators, numbering 43 delegates); academia (NL and NS institutions and private

research companies, numbering 50 delegates), and: others including industry associations, consultants etc. (20 delegates). Attendees were for the most part from Atlantic Canada. A small percentage who traveled from other Canadian cities were either by special invitation (i.e. speakers or other guests), or those closely associated with PRAC activities.

3. Session Summaries:

Opening Panel:

i. Mary Preville, Natural Resources Canada (NRCan) – *Regional Challenges and Needs for the Petroleum Industry in Atlantic Canada*

Ms. Preville provided an overview of the importance of the oil and gas sector, placed in an international context of high oil prices, rig and labour costs, and competition for investment dollars. She detailed the challenges facing Atlantic Canada, including harsh physical environment, high risk, high costs, and uncertainty of return.

From a Federal perspective, the priority areas for research include advancing geoscience knowledge, improving the investment climate, transportation, safety of production, harsh environments, and deep water exploration. Ms. Preville summarized NRCan's research and development funding and described the Earth Sciences and Energy Policy Sectors' programs as well as the Program for Energy Research and Development (PERD). PERD has an annual budget of \$58 million. NRCan manages PERD and operates the program through 13 federal departments and agencies.

PERD established a Frontier in Oil and Gas (FOG) initiative to develop new knowledge and advance technologies in aid of regulatory development, codes and standards and public good to ensure safety and security of energy supply in Canada. The funding is \$8.3 million per year for four years, and will address offshore environmental factors, marine transportation and safety, remediation, and other issues.

Ms. Preville concluded by presenting NRCan's perspective on fostering future work through collaboration among all stakeholders. What is needed is an integrated approach to address challenges, open communication of results and access to all data.

ii. Ruud Zoon, Husky Energy – *East Coast R&D: An Operator's Perspective*

Mr. Zoon summarized the opportunities, objectives and challenges faced by Husky in the region. The R&D opportunities include exploring ways to eliminate the need for glory holes, technology to help reduce drilling costs in deep and hazardous environments, and gas export solutions.

Currently, rig spread day-rate is now over \$1,000,000 Cdn. What is needed is research in ways to reduce costs, such as rig alternatives; technologies to increase speed of the drilling process; and technologies to access multiple targets from the same wellbore.

While there are abundant gas reserves offshore Newfoundland and Labrador, there is no easy solution to bring this gas to market. Challenges facing Newfoundland gas are varied and include the requirement for gas conditioning offshore; how to place a pipeline through the smallest number of jurisdictions; problems inherent with pipelines including iceberg scour and slope stability; and testing unproven technologies including marine based CNG and LNG.

Existing and future developments offshore Newfoundland face a number of challenges posed by the harsh operation environment. Sea states, storms and visibility in the Grand Banks are close to those encountered in other jurisdictions such as the North Sea and off the Western European coast where facilities constructed for the offshore must be built to withstand 100-year storms. Ice also represents a significant challenge. It is the primary reason why Labrador shelf gas has not been developed.

iii. John Hogg, ConocoPhillips Canada – *Petroleum Research Challenges in Frontier Exploration*

Mr. Hogg provided an overview of the petroleum resources of the region as well as the current state of geoscience research in Atlantic Canada. He then compared the state of research in Atlantic Canada with that of the United States, where schools receive more industry funding through Academic\Industry Consortia in addition to strong Federal and State support for petroleum research. Additionally, Norway, the UK and Ireland all have strong government support for petroleum research.

To mitigate this disparity, Mr. Hogg recommends that there be more industry grants to academia, including industry sponsoring graduate research; encouraging researchers to pursue targeted research on the Atlantic offshore or on other topics of interest to industry; encouraging collaborations; and accepting petroleum-related courses taken at other Atlantic universities offered by AAPG, SEG, and others.

In summary, Mr. Hogg suggests that fundamental and applied research is critical to future petroleum exploration efforts and that Atlantic Canada universities can be leaders of this effort. There is a need for focused research to interest exploration, with topics selected in consultation with the industry. There needs to be better communication between industry and researchers, and that industry data donation and research sponsorship will follow results of such collaboration.

Topical Sessions:

These sessions provided a high-level review of research needs and activities in specific technical areas. Speakers broadly addressed current research programs, development and operational challenges, research opportunities and priorities, along with other strategically-important issues.

Geoscience

i. Clinton Tippet, Shell Canada Energy – Value Drivers in ECO Geoscience Research

Despite our best hopes, new discoveries are simply not being made on the east coast of Canada. Common play types and models do not appear to be working and the economics of small fields or more distant (and undiscovered) large fields are not favourable.

It is important to understand industry's process for evaluating exploration risk: decisions are based on economic evaluations of successful prospects versus those that could destroy value; modern evaluation techniques required to understand risk are far more complex; even those prospects which appear to be attractive, may carry too much risk, and; central to the decision-making process is "de-risking" the prospect.

Industry expertise in technical areas such as seismic interpretation is ever-increasing. The impetus to involve academia (through research) appears to be limited to the training of students rather than advancing technology and/or interpretation techniques.

Some of the "value drivers" to consider in evaluating potential prospect areas:

- Detailed provenance studies
- Uplift histories in "hinterland" areas
- Paleogeography
- Deep stratigraphic tests
- Reservoir seal studies
- Analogue basin analyses
- Source rock characteristics
- Multi-component kinetic studies
- Show and seep studies
- Detailed structural studies on timing
- Paleontology constraints

We need to be creative in our thinking and the kind of research we undertake. Innovation has worked in other areas and as long as we keep the "value drivers" in mind, it can work for us.

ii. Michael Enachescu, Memorial University – Petroleum Basin Research at Memorial University

The Pan-Atlantic Petroleum Systems Consortium at Memorial University conducts basin analyses and reservoir characterization offshore Atlantic Canada. Within this consortium, research is being undertaken by a Basin Study Group in applied research in petroleum systems and resource potential of Atlantic Canada basins, and fundamental research in rift tectonics, seismic and sequence stratigraphy, of the Mesozoic rifted margin and Paleozoic basins. Significant donations of software, hardware and data from industry, as well as pan-Atlantic collaborative efforts with other universities have led to MUN being a focal point for geoscience information for offshore NL.

The Basin Study Group teaches and mentors students, conducts research in a number of subject areas, and communicates its results through a variety of means. Dr. Enachescu went through a number of detailed slides showing some of the work he and his group are doing in seismic/stratigraphic interpretation, including in areas such as the Orphan Basin and Flemish Cap. He listed several of the research grants he has obtained from federal and industry sources, as well as two grants received from PRAC. He listed some numbers of students who have graduated through the geoscience program, as well as papers and theses written and awards received.

Dr. Enachescu summarized by saying that many highly-skilled students have been educated as a result of the research projects his group has undertaken, that the research has direct and immediate application for hydrocarbon exploration in Atlantic Canada, and that collaboration with other universities, foreign scientists, industry etc. is invaluable to producing quality results.

iii. Carl Makrides, CNSOPB – CNSOPB Digital Data Management Centre and Geoscience Initiatives

Mr. Makrides described what the Board's Data Management Centre (DMC) is: a repository of digital well, seismic and GIS data which will be available free via the internet. Longer-term plans include expanding the data collection to HS&E, and enabling on-line submissions of data.

A number of reasons for why the DMC was created were given. These include: increasing the efficiency and volume of data access; reducing costs, preserving data, and; facilitating research. A number of data centres exist in the world, and the new DMC is well-placed to provide industry with the same kind of information that can already be obtained in other nations.

Mr. Makrides spoke about a number of areas offshore Nova Scotia which have been assessed for their resource potential, first in 2002 and again this year. Several play types have been identified, some of which have had wells drilled within the past few years. In drilling these wells it was determined that few encountered significant sand zones and that prediction of sand based on seismic data has proven

difficult. Despite this, reserve estimates have decreased only slightly from the 2002 assessment.

Metocean/Geotechnical

i. Freeman Ralph, C-Core – Ice Management and Impact Oil and Gas Developments on the Grand Banks

There are many challenges faced by oil and gas development on the Grand Banks due to ice. These include sea ice and iceberg risk, as well as understanding other geotechnical properties. Additionally, one needs to understand the interaction of ice and the facility type (e.g. GBS, FSPO, Subsea) as well as design features (such as reinforced concrete, hull bow reinforcement, and/or disconnection). Finally, risk mitigation needs to be considered, including iceberg detection/towing, glory holes, and pipeline trenching.

Dr. Ralph identified three main components in ice management studies necessary for the Grand Banks. These are: understanding ice and metocean conditions; providing protection through structural design and integrity; and risk mitigation, including detection of ice and towing of icebergs.

Examination of ice and metocean conditions can include compiling ice load data, analyzing full scale pressure-area data, and studying ice failure mechanics. C-Core also has developed an Ice Structure Interaction model and examines encounter frequency including probability of iceberg collisions, ice management and risk mitigation, and tactical avoidance. All these data are necessary for the development and protection of off-shore petroleum structures.

C-Core also provides studies of methods for protection of petroleum structures. These involve studies of structural integrity, iceberg design loads, disconnection, and examining the efficacy of excavation (i.e. glory holes) or burial (pipelines).

Icebergs pose a unique risk to petroleum production platforms in the waters of Atlantic Canada. Current iceberg management tactics rely heavily on iceberg towing using offshore supply vessels to alleviate the risk of disconnecting a facility from its mooring. This risk is among the most important considerations for facility selection for oil and gas field developments.

Finally, Dr. Ralph indicated areas for future research regarding Ice Management issues, including:

- Iceberg strength
- Continued improvements of ice management on the Grand Banks
- Further development of iceberg drift forecasting capability
- Satellite monitoring in remote areas
- Implementation of Data Fusion into operations

- Implementation of decision-making toolbox into operations
- Continued development of simulation training
- Development of subsea protection alternatives

ii. Dr. Fraser Davidson, Fisheries and Oceans Canada – *Ocean Forecasting for Eastern Canada: Present State, Challenges and Direction: A DFO Perspective*

Dr. Davidson provided an overview of the work being done by DFO. An emerging field in oceanography is the prediction of the state of the ocean from hours, to days, to weeks to decades. Through better understanding of the ocean comes a greater ability to predict its motion, its temperature, its ice cover and its behaviour.

As exploration moves into deeper waters, drill pipes will get longer and more vulnerable to strains, vibration, and damage from ocean currents. Huge drifting icebergs can damage platforms or pipelines unless their course is predicted and action taken. Good ocean information can head off design and operational problems. Should oil spills occur, a good model can predict their path and enable countermeasures.

To build a better model of ocean behaviour in the region, Dr. Davidson is working with Dr. Brad deYoung from Memorial University, Dr. Chris Williams from the National Research Council, and other colleagues to pull together data from multiple sources ranging from ships to satellites to seals carrying ocean-data loggers. By 2008, their Newfoundland Operational Ocean Forecasting System (NOOFS) will provide detailed, three-dimensional sea-state information on-line. This will include past data, “now-casts,” and forecasts for days ahead, showing currents, temperature, salinity, sea height, sea state and ice coverage.

iii. Glen Lochte, Husky Energy – *Geotechnical Needs—Operator Perspective*

Mr. Lochte provided an overview of the geotechnical issues faced by industry in Atlantic Canada. Major issues include characterizing and avoiding obstacles rather than developing new dredging techniques. For example, piling and excavation of the seabed in the Jeanne d’Arc Basin involves many geotechnical unknowns. He explained the technical challenges faced, including excavations, such as with glory holes and pipelines. Mr. Lochte then explained piling techniques and challenges, including obstacles and mitigation techniques. For both excavation and piling, he identified three major research needs:

- Obstacle sensing and characterizing
- Boulder sensing
- Soil strength sensing

Finally, he suggested that boulder location, pre-surveys of the seabed, and surveys of all obstacles was needed to mitigate problems with deep sea excavations and structures.

Environment

i. Dave Burley, CNLOPB – *Petroleum Activities Offshore NL, and Environmental Research and Development*

Mr. Burley gave an overview of some relevant numbers for offshore NL (EL's, SDL's and PL's, wells drilled etc.). He gave a very brief outlook on future potential development and exploration activities for existing projects and possible new areas for drilling (i.e. Orphan Basin, Laurentian Sub-basin, west coast NL and Labrador Shelf). He noted some new initiatives on regulatory issues such as developing more performance-based versus prescriptive regulations, streamlining processes, and developing and/or adopting new guidelines and acts that cover such areas as waste treatment, seismic surveys and species at risk.

Environmental challenges include issues with ice, and optimizing design and operations for existing projects, as well as reducing risk and uncertainties for new small field developments. He noted challenges posed by currents in deepwater (Orphan Basin) and the Laurentian Sub-basin.

Research can also be conducted on: the effects of seismic surveys on marine life; the feasibility of electromagnetic survey techniques, and; effects of production discharges such as produced water and oil on marine life.

Mr. Burley ended by pointing out that many areas offshore NL lack sufficient baseline marine biological information. This constrains the usefulness of SEA's, increases the risk of missing potential sensitive marine areas, and put increased expectations on potential exploration activity, which in turn can be a disincentive to exploration.

ii. Andre d'Entremont, Chevron Canada Limited – *Environmental Research for Deepwater Areas Offshore NL*

Mr. d'Entremont highlighted some of the research priorities and programs undertaken by Chevron during its activities throughout the world. These include collecting baseline data on birds, mammals, currents and benthic communities, researching the effects of discharges on coral colonies, and of seismic activities on marine life.

In 2005 a study was conducted in the Orphan Basin to better understand the ecosystem in which the company would be conducting its operations. Through this endeavour the company was also interested in advancing the understanding of these more challenging areas to explore, to enhance relations with the local scientific community and to address some knowledge gaps discovered from previous environmental assessments. During the study a significant amount (and kinds) of data were collected, providing new and very useful information for the researchers.

Mr. d'Entremont described some of the equipment and techniques used during the study, and provided a visual example of the impact of water pressure on semi-solid objects. He showed a number of pictures of marine species not previously seen at the depths or location of the study.

iii. Mr. Geoff Hurley, Hurley Environmental Ltd. – Adaptive Monitoring and Research in the Nova Scotia Offshore

Mr. Hurley described four elements of the environmental management process. These include:

1. Environmental Management Framework – research feeds into many aspects of environmental stewardship in petroleum operations. Ultimately this leads to good corporate policy which focuses on protecting the environment, maintaining open and honest dialogue with stakeholders, minimizing environmental footprints, complying with applicable laws and regulations, and continually improving environmental performance.
2. Environmental Planning and Project Design – a philosophical shift from little emphasis on prevention and most emphasis on clean-up, to the reverse. This requires participation from senior managers in various elements of a project (engineering, safety etc.) and includes such design features as: sensitive areas (fishing, marine protected areas etc.), drill waste, re-injection of acid gas, produced water discharge or re-injection, and pipeline routing and integrity.
3. Environmental Effects Monitoring – three objectives include: verifying EA predictions, early warning of unexpected environmental effects, and adapting mitigation and monitoring procedures.

Mr. Hurley showed several slides demonstrating predicted versus observed/unexpected environmental effects.

4. Environmental Research – the objective is to address gaps in knowledge of the environmental impacts of e&p activity and threshold levels (i.e. noise), and the effectiveness of environmental assessment/EEM tools. By increasing our knowledge in these areas, industry will be better able to: assess the potential impact of proposed operations, design optimum mitigation and monitoring procedures, assist in regulatory decision-making, and address concerns of stakeholders.

Priority areas for environmental research offshore Nova Scotia include:

Through the Environmental Studies Research Fund (ESRF)

- Impact of seismic activity
- Impact of operations on seabirds
- Waste management

Through Nova Scotia's Offshore Energy Environment Research (OEER) Association

- Tidal power
- Impact of seismic activity on invertebrates

iv. Steve Campana, Department of Fisheries and Oceans – *Seismic Exposure Investigation of Fish*

This is a pilot study planned for the summer of 2007. Objectives of this study are to:

- Monitor the behaviour, movement and survivability of several species of fish before, during and after seismic operations
- Determine the short and long-term effects of seismic surveys on fish hearing and physiology
- Describe and model the relevant features of the seismic sound field

Dr. Campana noted some similar studies conducted elsewhere in the world, and highlighted some of the key differences with his study which included tagging certain fish to follow them throughout the entire scope of the study. His presentation described how the fish will be tagged and how transceivers will be placed to capture readings as fish swim within range. He noted the study area and showed pictures of the kinds of species they will study. The project and methodology are designed to be portable (can be used in other jurisdictions and for a wide range of fish species). Future plans include going back to the study area to assess the distribution of previously-tagged fish, to measure and model sound fields, and to conduct full-scale field tests.

Safety

i. Dr. Paul Amyotte, Dalhousie University – *Offshore Safety: Research Strengths In The Atlantic Region*

Dr. Amyotte provided background regarding safety-oriented researchers and research in Newfoundland and Nova Scotia. There is great collaboration among all the safety-oriented researchers in both provinces, all of whom have worked together at one stage or another. They are drawn from academia, government, and industry. The two main research goals Amyotte identified include addressing knowledge gaps by providing the basic knowledge required for informed debate and better decision-making by designers, regulators, operators, etc.; and initiating and conducting innovative activities with high potential for impact. Both goals address the overarching mission to improve safety of personnel at sea. This is a clear and compelling goal - and has been a great source of strength for the research team that has rallied to this program.

The research team includes people with expertise in:

- Human factors, such as the effects of vessel motions on situational awareness, task interruptions, and motion sickness.
- Occupational safety, examining the roles of corporate safety culture and policy, and behavioural factors.
- Process accidents, including fire and explosion modeling; accident escalation, mitigation and control; and inherent safety principles.
- Training, where team members collaborate with the Marine Institute's Centre for Marine Simulation and their Offshore Safety & Survival Centre to ensure that what is learned through the research work finds its way quickly to the people who need it.
- Performance of evacuation systems and the effects of environmental.

Dr. Amyotte then provided examples of these various research areas, including his own interest in performance of evacuation systems. He went through a number of detailed slides illustrating the breadth and depth of the research undertaken in Atlantic Canada. He summarized his presentation by reiterating the strengths of offshore safety research in Atlantic Canada, which addresses a unique mission aimed at people; provides a broad scope of activities encompassing experimental, computational and simulation efforts aimed at developing innovative hardware and software solutions to practical problems; has regional, national and international relevance, a diverse funding base, and a high level of intra- and inter-institution collaboration; and, most significantly, is composed of a dedicated core of professional researchers in academia, government and industry.

ii. Stewart Strong, PetroCanada – Review of Offshore Health & Safety Related R&D Focus Areas and Initiatives

Mr. Strong, representing the Canadian Association of Petroleum Producers as Chair of the Atlantic Canada Safety Sub-Committee, presented an overview of CAPP's research and development focus, as well as provided details regarding CAPP Safety Sub-Committee initiatives.

There is significant value in the Communities of Interest (COI) initiative and further progress is required to build on success to date. Other Community of Interest areas need to be identified, and there needs to be regular communication and engagement sessions. PRAC is shifting to a more industry focused organization, with the planned vision including PRAC to be the member focal point for facilitating research of general application in Atlantic Canada.

Mr. Strong then gave an overview of the CAPP Safety Sub-Committee initiatives, including:

- OHS Legislative Amendments / Regulatory Reform
- Escape, Evacuation and Rescue (EER) Performance Standard
- CSA OHS Standards Development
- Helicopter Underwater Escape Breathing Apparatus (HUEBA) Implementation

- CAPP Safe Lifting Practices
- CAPP East Coast Medical Assessment for Fitness to Work Offshore Standard Practice
- CAPP Standard Practice for the Training and Qualifications of Personnel
- CAPP Hydrocarbon Leak Prevention Guide

Finally, Mr. Strong mentioned the Atlantic Canada Safety Sub-Committee Emerging Issues of Process Safety Management, which is in direct response to the BP Texas City Refinery Explosion and Fire.

Asset Integrity

i. Dr. Faisal Kahn, Memorial University – Risk Based Integrity Management and Asset Integrity Management

Dr. Kahn reported on Risk Based Integrity Management and Asset Integrity Management activities at Memorial University. Activities include asset integrity engineering and risk-based integrity management. Projects have led to the development of a semi-quantitative model for risk-based inspection planning which has been successfully applied to both a Thermal power plant and an Ethylene Oxide plant. Additionally, a new quantitative Risk-Based Integrity Modeling has been developed and applied to process pipelines, autoclave, and separator. Additionally, the group has developed a new methodology for Risk Based Inspection and Maintenance Decision Making, which is in line with API 580/581 and ASME guidelines.

Future work includes such areas of study as:

- Application of quantitative RBIM to Offshore Oil and Gas operation
- Asset Management through Risk based design
- Integration of safety and integrity in holistic asset management framework
- Integrity Models for rotary equipment integrity assessment and maintenance planning
- Bringing facility risk from unit/system level to component level
- Integration of human factor elements to risk based integrity management

ii. Dr. Farid Taheri, Dalhousie University – State of Oil- and Gas-Related R&D in Dalhousie University

Dr. Taheri presented an overview of oil and gas related research and development at Dalhousie. He went through a number of slides identifying the faculty and detailing their work. Dalhousie is a university with extensive diverse expertise pertinent to various aspects of the Asset Integrity in oil industry. Research is robust and researchers have access to state-of-the-art resources. However, there is a need for consistent and sustainable research funding so that the university could further tailor its expertise to respond to oil & gas industry's demands.

iii. Dr. Mark Fleming, Saint. Mary's University – *Human Factors and Asset Integrity*

Dr. Fleming provided an overview of human factors with regards to Asset Integrity. Human behavior can be modeled through understanding of factors including the individual, the organization, and the job – all three of which affect performance. The oil and gas industry in Atlantic Canada should take lessons from other industries on how to mitigate asset integrity failures due to performance. Asset Integrity improvement can be defined by five stages: uncertainty, awakening, enlightenment, wisdom, and certainty.

Dr. Fleming went on to describe the current stage of human factors research needs, which include review of existing indicators, refining existing and developing new indicators, and finally, evaluating indicators using case studies and outcome validation. He further went on to define the characteristics of High Reliability Organizations, which include:

- Preoccupation with failure
- Employees report errors and problems
- Develop deep understanding of problems and issues
- Decentralized decision making
- Seek employee concerns

All these factors must be kept in balance, because it is a fine line between protection and production, bankruptcy and catastrophe.

Gas Development

The session was opened by Carey Ryan (PRAC), who provided a summary of drilling activity and oil and gas reserves/resources in Atlantic Canada. Mr. Ryan noted some of the gas development opportunities in the region including onshore production in New Brunswick, coal bed methane in Nova Scotia and gas production in western Newfoundland. Challenges to bringing these and other gas resources to production include high exploration risk, proximity to markets environmental risk management.

i. Paul Durling, Corridor Resources – *The McCully Gas Field: An Onshore Natural Gas Development in Southern New Brunswick*

Mr. Durling provided a brief introduction to Corridor Resources and their exploration interests in Atlantic Canada. The bulk of his presentation focused on Corridor's McCully natural gas project in southeastern New Brunswick near Sussex. He described the structure and stratigraphy of the McCully field, and gave a summary of drilling, testing, stimulation and production activities over the past two years.

The McCully field has been producing approximately 2 MMcfd of natural gas for several years for a single customer (and project partner), the Potash Corporation of

Saskatchewan. Larger scale of development of the field's Hiram Brook formation was well advanced including the construction of a gas plant and 54km pipeline which will tie in production from the field to the MNP pipeline which is expected to see first gas mid-year 2007. Net proven and probable reserves are estimated at 143 Bcf, with 3P estimates of gas in place amounting to 1281 Bcf. The resource potential of the deeper Frederick's Brook formation (shale) and Dawson Settlement formation is being investigated with the potential to add additional reserves to the project.

Other opportunities were briefly described including the extension of McCully to include the Elgin block, and planned exploration drilling on Prince Edward Island's Green Gables property. Corridor has been waiting for government approval to proceed with exploration activity on the well-known Old Harry field in the Laurentian Channel.

ii. Mike Paulin, IMV Projects Atlantic – Pipeline Design, Construction and Operation in Harsh Environments

IMV Projects is a multi-disciplinary EPCM company offering a wide range of services to the petroleum sector. Mr. Paulin described some of the harsh environment pipeline projects in which his company has been involved internationally, particularly in the Arctic, and many of the design, construction and operational issues they have encountered. His presentation expanded on some of the design issues such as ice scour and ice keel protection, permafrost and thaw settlement, upheaval buckling potential, strudel or hydraulic scour, limit state strain design, and trenching and backfilling. Construction and installation offers a number of challenges in Arctic conditions and the more important of these were also described (e.g. platform approach and tie-in, ice incursions while dredging or pipe laying, trenching issues, shore crossing, leak detection, etc.).

Mr. Paulin highlighted some of the science and technology that has gone into overcoming these challenges. He also identified remaining technical gaps that are areas for potential advancement. Among these are a number of specific gaps impacting pipeline design, construction and operation. He provided some further detail on opportunities related to pipeline trenching, the well intersection method for transporting product from a producing well to shore, leak detection systems and Arctic pipeline repair.

iii. Tony King, C-CORE – Challenges for Offshore Labrador Gas Development

Discovered natural gas reserves on the Labrador Shelf exceed 4 tcf from limited exploration but the development of these reserves faces significant technical challenges, particularly the risks to subsea facilities and offshore pipelines from iceberg scours. Tony King reviewed work that has been done to assess these risks beginning with early work conducted in 1983, followed by an updated risk assessment in 2002 and more recent work. In each case the studies involved

modeling to examine the distribution of iceberg scour depths along possible pipeline routes and the number of iceberg keel impacts with the pipeline on an annual basis.

The recent work benefited from the development of a comprehensive ice scour data base that included 6,556 scour features and 121,710 scour profiles using data from surveys conducted in 1985 (side scan) and 2003 (multibeam) as well as ice thickness, iceberg sighting data and iceberg drift modeling. A comparison of the results of the three risk analyses for one of the pipeline routing options demonstrated the reduction in predicted risk as a result of improved data, better modeling capabilities and greater understanding of iceberg scour mechanisms. The 1983 work suggested 4 pipeline direct contacts per year; the 2002 risk assessment reduced the number of contacts to 1 in 20 years. The drift-based Monte Carlo iceberg grounding model used for the most recent work indicated 1 contact in more than 300 years.

Mr. King completed his presentation by identifying a number of areas where further research and development is required for assessing the risks from iceberg scour on the Labrador Shelf. These included:

- Additional repetitive scour mapping
- Multi-year ice characteristics
- Iceberg size, frequency, drift forecasting
- Ice island frequency, size
- Iceberg detection and management
- Inner shelf bathymetry
- Trenching technology
- Geotechnical and geohazards
- Risk to subsea structures/protection
- Maximum iceberg draft (pipeline/subsea)
- Export issues and technologies

iv. Craig Young, Centre for Marine CNG – *Marine CNG: Atlantic Canada's Gas Delivery Solution*

The Centre for Marine CNG Inc. based in St. John's, NL is the world's first marine CNG research and development facility. It is focused on the efficient, safe and competitive transportation, storage, handling and usage of compressed natural gas; and facilitating the development of standards for vessels, storage systems, training, and procedures. Mr. Young described the differences between CNG and LNG, and provided an overview of the typical CNG value chain involving gas production, compression, transportation and containment, offloading and gas storage.

He compared the capital costs of three gas transportation options – pipeline, CNG and LNG – to make the point that CNG involves fewer assets and that those assets are transferable from project to project. He then looked briefly at the application of CNG from the Grand Banks to markets in NL, the Maritime Provinces and

Northeastern US. The application of CNG in the NS offshore area was also described. It was pointed out that CNG is not a competitor to LNG but rather has a number of niche applications in many areas of the globe.

At present there are a number of barriers that affect the application of CNG technology on a no commercial basis including perceived technological risk, gas supply agreements, tariff agreements and the current focus on LNG. The Centre's role is to act as an advocate for the adoption of the technology by working with key stakeholders to address barriers and to undertake focused R&D activities related to CNG.

v. Sandy MacMullin, Nova Scotia Department of Energy – *Offshore Nova Scotia: Encouraging Exploration Development*

Mr. MacMullin provided a brief review of exploration and development activity in the Nova Scotia offshore area during the past 40 years. During the period there have been three distinct exploration cycles with a total of 127 wildcat exploration wells drilled resulting in 23 significant discoveries. Of these SDAs, 8 are included in the two the development projects to date (Sable and Cohasset/Panuke) and one planned (Deep Panuke). There remain 15 undeveloped SDAs.

The latest cycle began in 1998 with 27 exploration and delineation wells drilled between then and 2004 resulting in only two discoveries. Exploration licenses grew from 10 in 1999 with work commitments of \$120 million, peaked at 57 in 2003 (work commitments of \$1.57 billion) and then declining to 22 in 2007 (\$917 million in work commitments). Corresponding to this decline has been an increase in license relinquishments and forfeitures. The key message from this background is that the lack of exploration success is a major concern for the province as is the expected decline in offshore revenues. The problems affecting exploration interest were outlined as were the opportunities that remain in the Nova Scotia offshore area.

In order to realize Nova Scotia's petroleum potential exploration risk must be reduced. Mr. MacMullin outlined a series of initiatives being undertaken or planned by the province in an effort to attract offshore investment. These fall under the broad headings of increased geoscience data and analysis, implementing new upstream policies to attract activity, continuing to improve the regulatory system, and increased marketing efforts. Specific steps in each of these four areas were described.

The Way Forward

The closing panel, chaired by Dr. Carl Breckenridge of Dalhousie University, addressed the question, "Where do we go from here?"

Dr. Soheil Asgarpour presented an overview of PTAC, and illustrated areas where PRAC could emulate PTAC's success.

Mr. Andy Noseworthy of ACOA gave a presentation entitled "Atlantic Petroleum R&D, Where Do We Go from Here?" In his presentation Mr. Noseworthy expressed the opinion that research and development represents a regional strength and critical building block in the development of the Atlantic Canadian economy. In the oil and gas sector R&D is essential, both for the development of new exploration and development technologies that can facilitate activity in the region, as well as provides a solid foundation for the region's offshore supply and service sector.

There are challenges and opportunities. For example, petroleum research and development is a rapidly evolving area, and international competition is intense and growing; however, Atlantic Canada has world class R&D facilities and capabilities. The local supply sector is mainly focused on basic materials supply and service support, not R&D; however, the Atlantic region has highly innovative companies that are adaptable.

Strengthening the region's R&D capacity and addressing industries needs is not an easy task, however, with effective communications and frank exchange, it can be done. Finally, energy R&D requires significant resources, yet locally there is recognition by government and industry that relevant projects must be supported.

Challenges in the future include developing a strengthened R&D community focused on industry priorities; seamless communications on industry needs and local research capacity between all players; a meaningful network among governments, the academic community and all elements of the industry on the way forward; transition from existing technologies to innovative solutions and innovative products that are in response to local and international demand; and, finally, continued priority of R&D funding by governments and industry.

Dan Walker, President of Oceanic Consulting Corporation, spoke on "Public-Private Partnership for Industry Lead Research: A Case Study in Vortex Induced Vibration (VIV)," a research project in collaboration with Oceanic, the National Research Council and Memorial University. This industry-supported research placed Oceanic in the forefront of VIV modeling research, and Oceanic now provides industry with a leading-edge capability to evaluate and improve mitigation techniques. This success has allowed Oceanic to build a niche in VIV suppression research, extend capability to VI Motion suppression research and facilitate fundamental research in VIV at Memorial and the NRC.

Mr. Walker described the steps Oceanic took on its path to success: work with industry to understand current challenges; use local contact as the front door to global market; consider the global market as the playground; take risks by

stretching capability; establish solid management models, and; most importantly, industrial research must be on time, on budget and on the mark.

The role of PRAC in this process could be to coordinate intelligence; provide startup funding for research, and; identify common interests and synergies, both in the research community and in industry. Finally, the community as a whole needs to increase communication, both internally and externally, as well as break down barriers, create integrated marketing strategies, reduce or mitigate fragmentation, and think globally for solutions.

4. Conclusions

The Forum provided a very good opportunity for people to learn more about R&D activities taking place in Atlantic Canada in a number of subject areas. As well, it demonstrated the breadth of R&D expertise which exists in the region within academia, government and private industry.

PRAC has and continues to work with industry and the research community in many of the R&D initiatives discussed during the Forum, and while significant progress is being made in these areas, much more can and needs to be done. PRAC staff intend to incorporate the suggestions and ideas brought forward in its development of a renewed strategic plan for R&D with the continued assistance of its various partners. Clearly there are some very specific suggestions for R&D (alternatives to glory holes, analogue basin analyses, simulation training etc.) which shall be given consideration for future project development. However in addition to project ideas, the Forum highlighted the need to greater cooperation and communication amongst all stakeholders, and the role PRAC can (and does) play in the facilitation of these activities.