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17. Abstract

The Canadian Coast Guard Research and Development Plan lists those research projects planned for fiscal year 2002-2003 by the various branches and regions.

The Plan currently has as its highest single priority the further development of technical solutions to its navigation services and exploring the development of a new orientation to the marine electronic highway, which is focused on using information-based services.

A second major theme is the promotion of sustainable transportation, or safety of the environment, by minimizing the marine footprint on the world's oceans. The CCG is currently developing applications for biologically-based sewage treatment plants on its ships and the improved maintenance/operation of ship's engines.

A third area of concern is recreational boating safety issues. The CCG is reviewing the usage rates of personal floatation devices and initiating further studies into fishing vessel safety, in conjunction with Transport Canada and Fisheries & Oceans.

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Research and Development Plan 2002-2003

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FOREWORD

Research and Development (R&D) is an essential element in the Canadian Coast Guard's strategies to achieve its operational mandate. The Coast Guard is dedicated to ensuring the safe and environmentally responsible use of Canada's waters. Research and Development is one way in which the Coast Guard seeks to become more efficient in its day-to-day operations as well as improving the effectiveness and appropriateness of its levels of service.

Coast Guard will fund a $3.5 million dollar R&D program in the 2002-2003 fiscal year. Additional funds will be provided by industry and international partners.

Strategic Planning is a key element in the Coast Guard R&D program. R&D performed today provides marine expertise in order to influence international standards and to support Canadian industry for the future. Coast Guard research is dedicated to resolving those technology challenges brought-on by the changing nature of commerce worldwide and the evolution of the marine community.

The variety and depth of research themes sponsored by Coast Guard are reflected in the 2002-2003 Research and Development Plan.

As part of its commitment to the economy and the achievement of Canada's goals, the Canadian Coast Guard continues to offer a broad-based planning process involving not only its own staff but also its clients. Likewise the Coast Guard will continue to work and consult closely with Canadian industry, universities and colleges seeking partnerships in knowledge wherever practical. Also the R&D program is closely integrated with the work of other government departments and foreign countries.

Any questions or suggestions regarding this publication should be directed to the Manager, Research and Development, (613) 990-3087.

LOOKING TO THE FUTURE

The R&D program has a long and valued history in the Canadian Coast Guard (CCG). The program was initiated in 1974 in order to meet new CCG operational demands, using technology as one of the primary tools of change. The decision to put an R&D (engineering) program in place was recognized as one of the several mechanisms required to keep the organization forward looking and to respond to challenges in service delivery and efficiency. Today, the adoption of new technologies to meet the challenges of a changing environment remains one of the Coast Guard's four organizational pillars for modernization and growth.

Subsequent to the 1995 merger with the Department of Fisheries and Oceans (DFO), a new series of strategic directions and operational goals were enunciated, to bring the Coast Guard into line with government wide business planning practices. As well, the department's new strategic directions placed emphasis on organizational evolution from a broad-based service delivery group to a more finely-tuned organization exercising leadership and knowledge management. Today, the CCG's leadership role is more broadly understood by industry and other members of the marine community; the evolution of government services to permit a more inclusive role is seen as an effective means of involving interested parties, reducing overall costs, and meeting new challenges for services. Within this organizational context, the issues of safety, environmental protection and support to marine commerce remain as the operational pillars and play determining roles in our capital and operational planning.

CCG's mission is to ensure the safe and environmentally responsible use of Canada's waterways, to support understanding and management of ocean resources, to facilitate the use of our waters for shipping, recreation and fishing, and to provide marine expertise in support of Canada's domestic and international interests.

CCG research addresses a wide range of technological issues brought-on by changing trends in the marine world and international transportation markets; changes in demand for marine services; and to new strategic directions defined by the government. R&D is also directed to a strategic understanding of the broader marine environment, the footprint left by marine activities on our oceans and freshwater resources, and to sustainable transportation objectives. Finally, the R&D program assists in meeting new management strategies relating to changes in levels of service and client advice on the marine program.

The CCG research activity also complements the departmental ocean strategies by supporting a shared knowledge base in theme areas of mutual or overlapping interest.

A wide range of strategies are used to achieve the CCG R&D program goals, including (but not limited to) contracting-out; intellectual property (IP) management; technology transfer through partnerships with other departments, agencies, industry and/or universities; involvement in the government's innovation initiative; the marketing of public service expertise; and international cooperation.

The Coast Guard R&D Program is coordinated through one focal point to assist in the establishment of a master plan, support to the CG business plan and to facilitate the establishment of priorities, project selection criteria, performance measures, reporting and accounting.

At this time, Coast Guard has as its highest overall priority the evolution of its navigation services and the development of a new orientation to the marine electronic highway, which is focused on using information-based services. A second major theme is the promotion of sustainable transportation, or safety of the environment, by minimizing the marine footprint on the world's

oceans. A third area of concern is recreational and boating safety issues. Traditional priorities, which include safety of life, operational efficiency, and support to the domestic marine industry also, remain strong. CG will explore these and other opportunities by sponsoring R&D.

In summary, R&D sponsored work will focus on the following:

Marine Highway:

- development of advanced navigational and ship-related telecommunications and information systems (often satellite-based);
- automatic processing, analysis and automated transmittal of remotely-sensed ice information;
- adoption of AIS and development of alternative technologies to the current physical navigational aid infrastructure;
- presentation of information to the navigator both logically, and in a compatible manner/languages;
- interactive nature of displays on the bridge of the vessel;
- integration of ship's information with shore-side traffic management and commercial shipping operations;
- electronic devices which automatically monitor vessel position and/or services to home-in on persons in the water.

Sustainable Transportation, Environmental Protection and Safety:

- development of improved regulation, standards, training and certification procedures for small craft operators
- research into new engine maintenance management systems, novel power systems/components, and emission control technologies which offer greater efficiency, reduced emissions and reduced maintenance;
- development of "biological" sewage treatment facilities for ships, to handle black and gray water, with zero tolerance regimes as a target.
- development of new technologies which will lead to the mitigation of clean-up costs.

Boating Safety/Others:

- increased wearing of personal floatation devices;
- risk management strategies.

Annually, CG will plan and prioritize R&D projects based on the above key thrust areas to give CG the information it needs to make prudent and strategic investments to provide effective and efficient public services.

Marine Programs

The Marine Programs (MP) Directorate was created in April 2000 as a result of HQ Renewal. It is one of four Directorates within the CCG and encompasses four Branches and an Administrative Services Group, namely Planning and Performance Measurement, Policy and Legislation, Navigation Systems, and Safety and Environmental Response Systems. The R&D projects presented by these groups address the challenges and opportunities identified as essential to meet client demands and changing program structures, policies and levels of service.

Project List Summary

PROJECT NUMBER	PROJECT TITLE	2002/03 (approved)	COMMENT
CG R&D OFFICE			
	No projects specified.		
	CG R&D Office – Total	0	
RISK MANAGEMENT			
FKDE6	Maritime Activity Geomatics and Risk Analysis in the Coastal Zone	275	
	Risk Management – Total	275	
SAFETY & ENV. RESPONSE SYSTEMS – Office of Boating Safety			
FKCT6	Research Project for Increased Wearing of Personal Flotation Devices (PFD)	119	
	Office of Boating Safety – Total	119	
SAFETY & ENV. RESPONSE SYSTEMS – Search and Rescue			
FKDH6	Search Planning Validation	60	
	Search and Rescue – Total	60	
SAFETY & ENV. RESPONSE SYSTEMS - Emergency Response			
FKCA6	Development of Response Strategies for Ori-mulsion (chemical & physical properties)	307	
	Emergency Response – Total	307	

Project List Summary

(Continued)

PROJECT NUMBER	PROJECT TITLE	2002/03 (approved)	COMMENT
MARINE NAVIGATION SERVICES - Aids to Navigation			
FKAG6	Visual & Radar Ranges for Steel & Plastic Buoys	100	
FNAB1	Development of Laser Range Light		Tasked to ITS. See ITS for project description.
FQAO6	Long Life Lamp Development		Tasked to ITS. See ITS for project description.
FQAP6	Long Life Synthetic Mooring		Tasked to ITS. See ITS for project description
FQAS6	Lighted Plastic Buoy Development		Tasked to ITS. See ITS for project description
FQAM6	Evaluation of Large Electric Double-layer Capacitors for Powering Aids to Navigation		Tasked to ITS. See ITS for project description
	Aids to Navigation - Total	100	
MARINE NAVIGATION SERVICES - Icebreaking Program			
FTPA6	Cross-Polarized Radar Trials	50	
	Icebreaking – Total	50	

CG R&D Office

This office, located within the Planning and Performance Measurement Branch, has the responsibility to establish goals, objectives, priorities, and accountability measures for the program that support CCG's Business plan. It is also the program's focal point for resource/business management services, special projects and planning and coordination of the program.

No special projects have been identified.

Contact: Wayne Ellwood (613) 990-3087

Risk Management

The Risk Management office falls within the Policy and Legislation branch. One project is underway to develop a risk model and Geographic Information System (GIS) software to provide CCG SAR with the essential tools for improved SAR program management and effective deployment of SAR resources.

Marine Activity Geomatics and Risk Analysis in the Coastal Zone

Historical incident patterns have limited value for planning for Search and Rescue. Improved data capture and storing would provide sound analytical information for decision-making. A risk model and Geographic Information System (GIS) software would respond to these requirements, providing CCG SAR with the essential tools for improved SAR program management and effective deployment of SAR resources.

The project is developing a comprehensive marine activity and risk model, particularly to address Canadian Coast Guard planning issues but will also serve as a major component of a broader generic coastal mapping model. The model will assist management by displaying georeferenced patterns of activities and incident rates, permitting querying according to various criteria, and illustrating areas of greatest risk to human life. A final report and users' manuals will be published upon completion of the model.

The model will benefit SAR planning requirements by providing sound analytical information for the effective deployment of SAR resources for common high risk activities, frequent, lower-risk incidents or rare catastrophic events. It will also be beneficial for accident prevention activities, congestion evaluations, and oil spill response.

Contact: Brian LeBlanc, (613) 990-5882 *Project Number: FKDE6*

Safety & Environmental Response Systems Branch

This branch conducts R&D projects for the promotion of boating safety, environmental response, search and rescue and marine communications and traffic services. Emerging technologies and innovative techniques are tested and evaluated for these respective program areas.

Office of Boating Safety

Research Project for Increased Wearing of Personal Flotation Devices (PFD)

Recreational boating is a fast growing and popular leisure activity in Canada. There have been significant changes to the regulatory framework governing recreational boating safety in Canada. In addition, there are major non-regulatory initiatives underway within the Office of Boating Safety (OBS) to address concerns with

Canadian recreational boating safety. A substantial effort has been directed towards making Canadian waters as safe as possible for everyone. For example the passing of the *Competency of Operators of Pleasure Craft Regulations*, *Age and Horsepower Restrictions*, the amendments to the *Small Vessel Regulations*, as well as a more highly visible *Enforcement Program* on the water will lead to an increased awareness of boating safety issues by industry, boating organizations and the boating public. These initiatives and the regulatory changes are expected, for example, to increase compliance with the safety equipment carriage requirements of the *Small Vessel Regulations*.

This project was initiated to develop a level of knowledge about the current boater population, themes and messages that will have a positive effect on boater attitudes. Over a 6 year period, OBS will work with behavioural change and social marketing consultants to explore research options to determine strategies to increase PFD wear in any circumstance in Canada. Data will be collected via literature reviews, focus group meetings, surveys, and observational study. Upon analysis of the data, appropriate educational materials and delivery methods aimed at increasing PFD wear will be developed.

The ultimate benefits from this project is a positive impact on recreational boaters' attitudes to wear PFDs; the reduction in the number of lives lost through boating incidents nationally; and reduced SAR costs in SAR incidents.

Contact: Sharon Sellars, (709) 772-2079 *Project Number: FKCT6*

Environmental Response

Development of Response Strategies for Orimulsion/Heavy Oils

As new petroleum products are introduced into Canada, both the Canadian Coast Guard (CCG) and industry must strive to continuously improve their ability to respond to spills of these new products. Orimulsion is a new petroleum product that presents new challenges for response.

Orimulsion is a heavy bitumen that has a higher viscosity than Bunker C, sinks in freshwater and floats, semi-emerged in salt water. Due to the unusual behaviour of this product, response agencies are struggling to find ways of recovering Orimulsion in the marine environment.

This project is set out in a multiyear workplan and addresses 5 subject areas: shoreline recovery, mechanical recovery, biological studies, chemical/physical studies and detection and tracking. Proposals from government and private organizations have been submitted to CCG which have been classified and prioritized under the 5 subject areas. The projects planned for this year are: persistence/recovery from hard rock surfaces and coarse mixed sediments; measure burnability parameters of Orimulsion; feasibility of pumping very viscous bitumens and oils over long distances and significant oil flows; investigate the effects of an Orimulsion spill on low-temperature marine ecosystems; determine the physical properties, chemical composition, and spill behaviour of heavy oils, butumen and Orimulsion (HOBO); and investigate the issues related to the remote detection and measurement of Orimulsion/Heavy Oils in the water column.

The resulting information will benefit CCG, Response Organizations (RO's) and Oil Handling Facilities (OHF's) through improved response strategies to reduce the amount of time and effort spent on recovering Orimulsion and heavy fuel oils and employing newly developed equipment which will improve the efficiency and effectiveness of response operations, thus reducing response costs and ensure a clean and healthy environment.

Contact: Ron MacKay, (902) 368-0204 *Project Number: FKCA6*

Search and Rescue

Search Planning Validation

The detection of small objects at sea has always been a subject of great concern to CCG SAR. The complexity of this operation is augmented by the fact that the drift for common SAR objects is difficult to predict.

In order to establish the drift of a SAR object, CCG utilises a computerised search and rescue program called "CANSARP", and the USCG utilises a similar program, called "CASP". Both organisations are interested in validating the accuracy of the current search planning methods.

In the past year many issues have been dealt with to prepare CANSARP 4.0 for validation testing. CCGC has created a configuration management plan that will control and track all changes to the CANSARP software.

Working with Dalhousie University, the following key criteria are to be considered for the validation of CANSARP 4.0 version: CANSARP V4 produces drift predictions based on real time data; search area can be qualitatively linked to the models and environmental data used; and differences in the case study results between v3 and v4 be explained quantitatively. This will be accomplished by analysing a number of hypothetical drift tracks in all regions to determine if both versions give internally consistent results, with particular attention being paid to drifter tracks exiting/entering new domains and a statistical comparison of v3 and v4 predicted trajectories with observed trajectories in Cabot Strait, Scotian Shelf 96/00, St. Lawrence River, and West Coast experiments using the “bootstrap” technique.

The CANSARP 4 validation will allow the Search and Rescue Coordinators to use the tool more confidently and efficiently to address the safety of mariners and potentially increase response time to a marine incident. More precise validation of SAR drift and planning models will increase the ability to save more lives.

Contact: Jean Maillette, (902) 564-3660 (ext 1342) *Project Number: FKDH6*

Marine Navigation Services

This directorate conducts R&D to support a safe, efficient and accessible waterway by improving operational performance of aids to navigation; reducing maintenance costs and ship-time usage in servicing of short- and long-range aids to navigation; and improving water flow models and water level prediction capability. This directorate also supports icebreaking activities through improved technologies and effectiveness in delivering icebreaking and ice-routing services, thereby enhancing the safety of ice navigation and providing support to marine transportation and to the economy in general.

Aids to Navigation

Visual and Radar Ranges for Steel and Plastic Buoys

Old steel buoys are being replaced by lighter plastic buoys which are easier to handle and will generate efficiencies in maintenance and operational costs. The client users and CCG officers know the visual and radar range for many of the older steel buoys from years of observation. Unfortunately, no data exists for the plastic buoys. For the CCG Levels of Service (LOS) Officers to accurately design a buoyage system, they need to know the visual and radar range of all the buoys currently available in the CCG. The availability of this information to the LOS Officers can ensure consistency in system design across the country.

This new project proposes to develop a computer program, which will calculate the visual and radar range of all the steel and plastic buoys presently used in the CCG. This program will also offer the option of allowing the user to input all the necessary parameters of a new buoy and adding it to the database thereby keeping the CCG current in it’s information. Field tests are also planned to verify the results from the program.

Financial benefits are anticipated because this may eliminate the use of oversized buoys at some navigational aids sites. Also with properly and consistently designed aids to navigation, reduces the possibility of groundings and/or oils spills and stress for the mariner.

Contact: Reiner Silberhorn, (613) 998-1411 *Project Number: FKAG6*

Icebreaking

Cross-polarized Radar Trials

A large development effort has been directed at improving Ice Navigation techniques and technology over the past 15 years. In recent years, the development of ECDIS systems, increasing environmental awareness, economic pressures to improve operational efficiency, and environmentally sensitive developments such as the Hibernia project increase the demand for better and more accurate ice detection capabilities.

During the mid 1980's cross-polarized radar was identified as a promising ice hazard detection technology at McMaster University. Since then operational systems were developed, tested, and improved to the point where the technology is now operationally viable. One of the problems facing shipping in ice infested waters is the inability of standard radar to differentiate between first year and older ice. Cross-Polarized Radar (x-pol radar) has proven to be effective, but expensive.

This project will trial a low cost x-pol radar that uses technology that is commercially available but slightly modified. Its performance will be evaluated in a variety of ice conditions and operational situations. The prototype Cross-Polarized radar system was installed aboard the MV Arctic last year. This year an 8 month test period will be initiated. At the end of the trial period, a full evaluation will be made that will also summarize the findings of the trial, usefulness of the X-Polarized radar, suggestions for improvements, and recommendations for follow-on activities.

The availability of the X-Polarized radar technology will provide precise ice information regarding ice conditions. Better route planning and improved operational efficiency will result for CCG Icebreaking Operations and commercial operators.

Contact: Fiona Robertson, (613) 998-1581 *Project Number: FTPA6*

Fleet

This directorate conducts R&D to improve cost-effectiveness and performance of the DFO fleet and the management of policies and standards for improved safety and development of seagoing personnel.

Project List Summary

PROJECT NUMBER	PROJECT TITLE	2002/03 (approved)	COMMENT
FQBK6	Hearing Standard for Seagoing Personnel	150	
FQAG6	Vision Standards for Seagoing Personnel (Physical Activity Requirements)	200	
FQCK6	Dynamic Engine Combustion Analysis (DECA)		Tasked to ITS. See ITS for project detail.
FQAT6	Large Scale Sewage Treatment Plant for Cruise Vessels		Tasked to ITS. See ITS for project detail.
FQAV6	Podded Propellers in Ice		Tasked to ITS. See ITS for project detail.
Approved-in-principle	Evaluation of Arctic Diesel Fuel and Marine Diesel Oil Blends with an without Lubricity Additives in Coated Injector Plungers for a Vasa 32 Diesel Test Engine		Tasked to ITS. See ITS for project detail.
	Fleet - Total	350	

Hearing Standard for Seagoing Personnel

Coast Guard (CG) is studying a number of subject areas relating to medical standards for seagoing personnel and is responsible for demonstrating the bona-fide occupational requirements for the medical standards as set by Health Canada and Transport Canada, Marine Safety. The subject of this research project is on hearing standards. CG ships' officers and crew must often work in harsh, noisy environments. For many of their duties, oral communication and accurate distinction of sounds is essential. For example, those working during Search and Rescue (SAR) and buoytending operations must often distinguish sounds and command in extreme winds, cold, rain and fog. They must be able to detect the variations and directions of sounds such as bells, whistles, alarms and normal and abnormal machinery sounds.

Under contract with the University of Ottawa, research is being carried out in 3 interdependent but mutually exclusive stages. Stage 1 will identify an appropriate hearing test(s) that will address speech perception in noise and sound localization. Stage 2 will validate the selected test(s) in the CCG environment and job functions in all ships' departments through onboard simulations. Stage 3 will establish minimal acceptable auditory norms using the validated test(s) as well as consideration and investigation to the potential use of hearing aids.

As continued downward pressure on CG resources results in fewer ships, personnel and operating funds, the need for the fleet's seagoing personnel to be medically fit grows stronger. This medical fitness test will assist in ensuring safety (self and others); reducing the number of injuries occurring as a result; reducing associated costs.

Contact: Sharon Robertson, (613) 990-2573 *Project Number: FQBK6*

Vision Standards for Seagoing Personnel

This research project addresses the vision standard component relating to medical standards for seagoing personnel set by Health Canada and Transport Canada, Marine Safety. It is crucial that occupational requirements be based on actual, job specific requirements, if one wants to ascertain their true validity.

The first phases of the CG's research into vision standards addressed visual acuity and colour vision. These tests were mainly conducted in a laboratory environment using test subjects taken from the field (pictures of buoys, dials, charts, etc.). The experience learned from this first phase was that greater emphasis has to be placed on developing tests that more closely resemble the tasks performed in the field. Also, a review of the research was carried out to assess the research in terms of defensibility. As a result, it was agreed that a complete task analysis must be carried out to determine what the actual requirements of the job are as they relate to colour vision and visual acuity and to develop a fair and accurate standard.

The second phase, task analysis and risk assessment, is almost complete. A final report will identify the tasks having a substantial visual component supported by complete task descriptions; identify the high-risk, critical, and frequently performed tasks; quantify risk, determine acceptable levels of risk, and identify previously set acceptable job performance levels; categorize the tasks according to the feasibility of testing task performance on board, in simulation, or not at all; and recommend standardized visual function tests potentially capable of significantly predicting performance on the tasks. The final phase will be initiated this year. It will involve designing performance tests, conducting pilot studies, and recommending a vision standards according to minimum levels of visual function required for acceptable task performance.

The establishment of a recognized Bona Fide Occupational Requirement (BFOR's) Medical Standards will result in fewer challenges by the Canadian Human Rights Commission thereby reducing financial and personnel expenditures.

Contact: Sharon Robertson, (613) 990-2573 *Project Number: FQAG6*

Integrated Technical Support (ITS)

This directorate was created in April 2000 and is the technical support arm of the CG. ITS will be responsible for delivering the technical component of the R&D program on behalf of Marine Programs and the Fleet groups where technical expertise is required.

Project List Summary

PROJJECT NUMBER	PROJECT TITLE/ TITRE DE PROJET	2002/03 (approved)	COMMENT
FRBQ6	US Ship Structure Committee (membership)	90	
FQAE6	ANIK-Based Ship-to-Shore Data Communications	100	
FQAN6	Determine Shipboard Multipath Levels & Their Impact on Marine Navigation	25	
FQAL6	Development of Ionospheric Monitoring and Prediction Tools for the CCG	20	
FNAB1	Development of Laser Range Light	70	Tasked by MNS.
FQAO6	Long Life Lamp Development	100	Tasked by MNS.
FQAP6	Long Life Synthetic Mooring	150	Tasked by MNS.
FQAS6	Lighted Plastic Buoy Development	100	Tasked by MNS.
FQAM6	Evaluation of Large Electric Double-layer Capacitors for Powering Aids to Navigation	130	Tasked by MNS.
FQCK6	Dynamic Engine Combustion Analysis (DECA)	50	Tasked by Fleet.
FQAT6	Large Scale Sewage Treatment Plant for Cruise Vessels	200	Tasked by Fleet.
FQAV6	Podded Propellers in Ice	40	Tasked by Fleet.
Approved-in-principle	Evaluation of Arctic Diesel Fuel and Marine Diesel Oil Blends with and without Lubricity Additives in Coated Injector Plungers for a Vasa 32 Diesel Test Engine	Approved-in-principle	Tasked by Fleet.
	ITS - Total	1,075	

US Ship Structure Committee

The Ship Structure Committee (SSC) Headquarters is located in Washington, D.C. The SSC is an international agency with the mandate to further research and development in the area of ship structures. The purpose of the committee is to prosecute a research program to improve the hull structures of ships and other marine structures by an extension of knowledge pertaining to structural design, lifecycle risk management and production methods. Canadian membership is comprised on the Defence Research Establishment Atlantic (DREA) (Canadian Navy); Transport Canada (TC) and Canadian Coast Guard (CCG). Canadian engineering companies are often called upon to provide expertise and perform R&D contracts for the SSC, often under direct management from participating Canadian Agencies.

The purpose of the SSC is to enhance the safety of life at sea, promote technology and education advancements in marine transportation, and to protect the marine environment. This will be done through advocating, participating in, and supporting co-operative research and development in structural design, life-cycle risk management of ship structures, and production technologies. CG will submit project proposals for consideration by SSC. CG will also have the opportunity to attend, free of charge, relevant technical courses sponsored by SSC.

Besides the direct access to research results and reports, CG benefits by participating in an international forum and having access to a network of stakeholders and researchers who share in the objectives of safer and more efficient ship structures. Members also gain in visibility and participation in the development of the research program.

Contact: Daniel J. Gauvin, (613) 998-1666 *Project Number: FRBQ6*

Lighted Plastic Buoy Development

One of the objectives of the Marine Aids Modernization Project is to develop a buoy system that operates without servicing or maintenance, for a period up to five years. This includes all components of the aids to navigation buoy system: hull materials, paints, moorings, power supplies, lanterns and sound signals. The main benefit resulting from the implementation of a year-round buoy equipment system is in the reduction of ship time required to service and transport buoys. Savings also result from a reduced requirement for servicing and refurbishing of buoys at CCG bases. As a result several research initiatives are underway.

In 1990, the CCG began investigating the use of plastics as a potential replacement material for the steel predominantly used in buoy construction. Today a significant number of small unlighted plastic buoys are in service across the country. This success has yet to translate in the use of plastic buoys to replace the larger steel lighted buoys. There are many structural and strategic problems to overcome before larger plastic buoys can become a reality. Although a number of large lighted plastic buoys exist on the market, further testing and evaluations are required to develop a thorough understanding of the benefits and limitations of the large lighted plastic buoys and encourage industry to meet CCG's operational specifications.

This project will be carried out in three phases. Phase 1 will develop a set of performance specifications specifying CCG's operational requirements. Phase 2 will be the development of testing specifications and procedures to help determine whether the buoys are in full compliance with the CCG performance specifications. Phase 3 will test and evaluate commercially available large lighted plastic buoys. A final report of the findings and recommendations is expected in March 2003.

Large lighted plastic buoys could bring significant savings to the CCG by eliminating the need for sandblasting and painting and servicing by large buoy tenders.

Contact: Ernie Koteles, (613) 990-3044 *Project Number: FQAS6*

Long Life Synthetic Mooring

Under the umbrella of the five-year buoy project is the study of synthetic mooring. There are a significant number of locations where the mooring chain does not stay on location for more than two years due to extreme bottom or sea conditions and many other buoys are being risk managed in years 4 and 5.

Since 1994, CCG has been field testing a new mooring system for difficult sites on the East Coast. This mooring system goes under the Trade Name of the Hurricane Mooring System (HMS), which was developed and supplied by Strait Moorings International (SMI) Inc. of Shediac, N.B. The company has significantly improved the original system to better match the requirements of CCG buoy moorings and handling practices. Unfortunately, the performance data collected to date on the test installations is inconclusive. Further research is required to develop a thorough understanding of residual strength and design technique of these moorings.

Last year, a series of break tests were conducted of the HMS, a cost and reliability comparison between the HMS and conventional chain moorings, examination of factors such as UV exposure and silt ingress that may cause some reduction in rope strength and comparison of design safety factors of the HMS with conventional mooring systems. A final report of the findings is being finalized.

Based on the recommendations anticipated in the final report of the HMS evaluation, work over the next two years will consist of developing a Long Life Synthetic Mooring (LLSM) Selection Guide based on the existing Chain Mooring Selection Guide (MSG) and measuring moorings forces in-situ with load cells. The latter work will allow CCG to compare the load behaviour of SMI's HMS with Chain moorings, as well as providing synchronized load and environmental data (wind, wave, current) to calibrate the two MSGs (Chain and LLSM).

Synthetic moorings can save money and ship time for the CCG. They are also environmentally friendly as they cause less sea bottom disturbance compared to chain moorings.

Contact: Douglas R. Jones, (613) 998-1387 *Project Number: FQAP6*

Long Life Lamp Development

Previous studies have shown that the best way of achieving a five-year performance of light-source for marine aids applications is through refinements to the incandescent lamps/flashers/ lampchangers configurations currently being used. However, with limitations for possible improvements by this means and with breakthrough developments taking place in other light sources (such as light emitting diodes (LEDs)) it is important to evaluate alternatives, as they become available.

LEDs are a product of the technological revolution arising from the latest development advancement in semiconductor technology. LEDs for lighting application are readily solarized. They consume the equivalent amount of energy as conventional incandescent lamps but last up to 100,000 hours (100 times longer) and they are virtually maintenance free.

Phase 1 of this project will develop comprehensive testing specifications and procedures to help determine the benefits and limitations of the LED lanterns for general use in the CCG. Phase 2 will test and evaluate the currently available LED lanterns and prepare a final report on the findings and recommendations.

The implementation of LED lanterns will financially benefit the CCG in terms of reducing maintenance costs, ship time and fuel consumption. The LED lanterns have shown that they can last up to five years in service without maintenance.

Contact: Reiner Silberhorn, (613) 998-1411 *Project Number: FQAO6*

Development of a Laser Range Light

The Canadian Coast Guard (CCG) wants to reduce its costs in providing the services offered to navigation users. Laser technology has progressed in recent years and now offers compact efficient visible sources at reasonable costs. Currently, range lights require two lands sites at a significant distance from each other. The use of a laser range light would allow the CCG to offer the same level of service from a single site with much reduced real estate requirements and even increase the level of safety offered to the public.

The two-colour laser system is a significant step forward in laser development in CCG and should generate a product that meets the performance requirement of a lighted range system. The colours, red or green,

seen by the users will automatically give the port and starboard deviation from the center of the channel without any code interpretation. Only the degree of deviation will be given by a code which will consist of pulses of light transmitted at different repetition rates with respect to the angle of deviation. The prototype field tests from 1996 to 1998 yielded good results. Also, a more simplified two-colour laser range was developed and installed in Hay River in 2000 is also providing good results. Field trials of a laser range system are also being conducted in the Portneuf area in the Québec region. By 2002/03, the CCG will have had the opportunity to evaluate 3 versions of the laser range development.

This is the final year of the project. Maintenance and evaluation of the laser range light will be undertaken. The evaluation will report on the operational and service capabilities, cost effectiveness; reliability and acceptance by the user community.

The Coast Guard operates approximately 650 lighted ranges. It can be calculated that the elimination of one structure, through the use of a single-station laser range would result in an annual savings of 650 x $9000/2 = $2,950,000. Of course, it would not be every light range system that could be converted to a single laser range light but this shows that laser range development represents a good opportunity for savings. Another benefit for implementation of the laser range development is that they are powered by solar energy making them environmentally friendly.

Contact: Ernie Koteles, (613) 990-3044 *Project Number: FNAB1*

ANIK Based Ship/Shore Communications

The Canadian Coast Guard/Department of Fisheries and Oceans (CCG/DFO) has an ever expanding requirement for ship-to-shore integrated digital communication services to meet it's day to day operational activities. This requirement has drastically increased in the last several years due to the addition of shipboard computers and networks, as well as data driven navigation systems and equipment. The service presently uses a number of services such as INMARSAT, Msat, and cellular telephone to provide the necessary connectivity. However, these existing ship/shore systems are generally inefficient for various reasons; including inadequate bandwith, poor geographic coverage, unreliable radio frequency channels, and/or cost.

The Department has undertaken a number of studies in the past in order to determine requirements and possible solutions. These efforts are aimed at ensuring short and long range capacity, scalability and compatibility will meet CCG/DFO operational requirements across the fleet.

Over a three-year period (2001/01 to 2002/2003) this project will investigate and develop ways to increase the efficiency and speed of transferring information between CCG/DFO vessels and land based facilities using various satellite systems as the transfer medium. Field trials of a hybrid system utilizing the Direct Broadcast Satellite Nimik as the downlink and Msat as the uplink are underway. Other associated equipment of a different configuration will be procured this year for further testing and evaluation. Several configuration changes of the shore-based equipment will also be evaluated. A post-trials performance evaluation and design review will be done in the final year of the project that will address any observed deficiencies during the operational trials.

The benefits accruing from an improved integrated digital communications infrastructure include: reduced long-range communication costs; efficient handling of information, less time for personnel, higher reliability; maintenance and logistics savings through commonality of equipment; and improve internal communications among colleagues and their families.

Contact: Richard O'Laney, (613) 998-9258 *Project Number: FQAE6*

Determine Shipboard Multipath Levels and Their Impact on Marine Navigation

The differential GPS (DGPS) corrections generated by Canadian Coast Guard (CCG) reference station sites provide accurate and reliable corrections to the mariner user. The corrections are checked in real time as follows: 1) The DGPS reference station checks the magnitude of each satellite's corrections; 2) The DGPS

integrity monitor checks the magnitude of each satellite's residuals; 3) The DGPS integrity monitor checks the resulting horizontal position error.

If the corrections exceed a predefined threshold, the reference station does not broadcast the correction. The integrity monitor checks the magnitude of the residuals, and if any of these exceed a predefined threshold, the reference station stops sending corrections for the offending satellite. Finally, if the integrity monitor's position error is outside of tolerance, the marine users are immediately notified to stop using the corrections. With these integrity checks combined with the quality installation, and redundant equipment, one can be assured that the corrections being transmitted by CCG reference station sites are reliable. However, this does not guarantee that the resulting marine user's position will also be reliable due to problems at the marine user's end. The two major error sources on the marine user's end are differential ionospheric errors and multipath. Differential ionospheric errors are being examined under a separate R&D project to determine its magnitude and stochastic behaviour. This project will study marine multipath. Multipath can produce range errors that exceed 100 m, thereby biasing the navigation solution.

Phase 1 will determine the magnitudes and stochastic behaviour of the shipboard multipath and determine the impact of the resulting multipath signal on the ship's position. Phase 2 will be conducted if significant multipath errors are found in Phase 1. This phase will determine the response of the CCG's marine user receivers to the multipath signals determined in phase 1. If the results of phase 2 show that the CCG GPS receivers cannot mitigate the multipath then Phase 3 will be performed. Phase 3 will analyse various methods of mitigating multipath on CCG ships.

The benefit of improving the reliability/integrity of DGPS positioning will increase the reliability/ integrity of floating aids to navigation to be accurately placed using DGPS. This would reduce the cost of re-visiting aids to navigation due to incorrect placement.

Contact: Sam Ryan, (613) 998-1528 *Project Number: FQAN6*

Development of Ionospheric Monitoring and Prediction Tools for the CCG

This is a companion project to the work on multipath. The ionosphere causes two major effects on DGPS navigation. The first is increased positional errors, caused by the spatial de-correlation of the ionoshphere. The magnitude of the positional errors is proportional to the baseline length and the ionospheric activity. The second is ionospheric scintillation, which can cause ionospheric storms. Several analysis centres around the world provide ionospheric storm advisories on both a global and regional scale. However, it is not known how well the ionospheric storm advisories correlate with the increased DGPS positional errors and scintillation effects. This research project proposes to determine this correlation.

Assuming that a suitably strong correlation is found between the advisories and the DGPS effects, a look-up table will be generated which would match the type and location of the ionospheric storm with the location and magnitude of the resulting DGPS positional errors and scintillation effects. The look-up table would form the basis for ionospheric warnings, which would be transmitted to the mariner via the RTCM Type 16 message of the DGPS broadcast.

The first stage of the project was completed in March 31, 2001. The results were very promising but more research is required before the warning service could be tested in operation. Stage 2 will be completed by March 31, 2002 and consists of three activities: accuracy of correlations; accuracy of predictions; and regional predictions. Assuming positive results from the second state, the final stage will trial the operation of the ionospheric warning service at one of the DGPS control monitor sites. After the testing period and refinements to the look-up table and warning procedures, a decision on whether to add these warnings to the DGPS navigation service will be made.

Providing warnings when the DGPS positional errors may be greater than normal will increase the integrity/reliability of buoy positioning and DGPS navigation service and improve the safety of navigation for the general marine community.

Contact: Sam Ryan, (613) 998-1528 *Project Number: FQAL6*

Evaluation of Large Electric Double-layer Capacitors for Powering Aids to Navigation

Large electric double-layer capacitor technology is new. Information about this new technology was first released at the 2nd World Photovoltaic Conference in Vienna, Austria in July 1998. NTT has deployed the equipment to boost the photovoltaic power supply system for telecommunication equipment. The performance of the equipment is encouraging. CCG would like to probe the possibility of using large electric double-layer capacitors for powering minor aids to navigation and reduce its overall reliance on batteries.

In the first year of the project, CCG developed requirements for capacitors and associated electronic equipment and tested the equipment with the smaller solar systems and in a stand-alone system (i.e. without batteries). This year, the equipment will undergo a one-year trial at selected sites that pose no harmful effects to the aids service and to the existing equipment.

Savings can vary between $2M and $20M over a 40 year horizon, depending on the speed at which the cost of capacitors decrease with increased applications. CCG also expects a reduced number of maintenance trips by ships and helicopters and in the number of batteries to be used.

Contact: Sunny Leung, (613) 998-1390 *Project Number: FQAM6*

Dynamic Engine Combustion Anaylsis (DECA)

In the early 1980s, Canadian Coast Guard recognized the need to re-engineer its maintenance effort for the fleet. Technology has played a key role in the development and implementation of computerized maintenance management systems for the fleet. These systems form the backbone of any maintenance effort and with the breakthrough of open system architecture and connectivity, the user can now integrate third party systems such as CAD, graphics viewers and predictive maintenance technologies. Maintenance techniques such as vibration and lubricating oil analysis and trending as cost effective means has been implemented. The performance parameters are tracked and analyzed to predict equipment degradation and impending failures thereby signaling maintenance is required.

Another important maintenance effort for the CCG is in the performance of the fleet's four-stroke, medium speed diesel engines. One of the best indicators of diesel engine performance is to measure the cylinder pressure displayed as a function of cylinder volume during the combustion process. However, improvements are needed to increase accuracy and reveal the whole story of the combustion process. Research efforts has lead to the development of the Generation II Firing Pressure Remote Transmitter (FPRT II) prototype using fiber optic tranducers to accurately project cylinder pressure versus crankshaft angle data for a four-stroke, higher speed diesel applications.

CCG, in partnership with Transport Canada - Transportation Development Centre (TDC), will continue this year to study the reliability and accuracy of the FPRTII in marine applications. A detailed technology trial on board the George R. Pearkes is underway. A sixty channel system will monitor cylinder pressures, EGTs, turbocharger performance as well as other important ancillaries with the objective of improved maintenance decision making and reduced fuel consumption and better emission control.

The ability to monitor engine performance will improve operational efficiency. An operator will be able to determine the engine's condition non-intrusively and use performance-based engine maintenance over time-based maintenance. As well, a well balanced engine burns less fuel and burns fuel more completely, thereby reducing emissions caused by incomplete combustion.

Contact: Al DaCosta, (613) 998-1776 *Project Number: FQCK6*

Large Scale Sewage Treatment Plant – Feasibility Study

Over the last several years, awareness of pollution from ships has grown. Pressure is rising to deal with waste from both commercial (non-passenger) traffic, rising cruise line business, and a burgeoning recreational boating population.

Several international protocols have been established, both under International Maritime Organziation (IMO) and through domestic legislation, to address the levels of allowable discharges of solid, chemical and oily wastes from large commercial ships, as well as the areas in which wastes can be discharged. In the Arctic, the 1997 Arctic Waters Pollution Prevention Act (and pursuant regulations) effectively created a zero discharge regime for solid, chemical and oily wastes. In more southerly (inland) waters, less rigorous regulations for oily wastes are applied under the Canada Shipping Act and the Great Lakes Pollution Prevention Regulations. Oil concentrations of up to 5 ppm are tolerated. In other inland waters, the territorial seas, and on the high seas, even less rigorous standards apply.

This project proposes to install a biological waste treatment system on an "R" class CCG icebreaker to test and evaluate the technology for a large scale system. Data collected from the operational tests will be used to show that the system is feasible; i.e. it is practical, effective and compliant with the most rigorous standards.

The new technology would effectively provide a single process to deal with discharge overboard that comply with the existing Arctic regimes and the impending IMO regime for sewage discharges.

Contact: Jacques Mondy, (418) 648-3208 *Project Number: FQAT6*

Podded Propellers in Ice

Transport Canada's initiative in the Harmonization of Polar Shipping Rules is leading to a Polar Code being accepted by the International Maritime Organziation (IMO) based on proposed Unified Requirements of the International Association of Classification Societies (IACS). Amongst other things, these requirements give guidance for the design of machinery for operation in the polar regions. While these proposed regulations do discuss load requirements in podded systems, they do not include the loads on the pods themselves. Also, the loads on podded propellers are simply taken as loads on open propellers, no account is given to operation in off centreline pod orientations.

The research proposed here will give information on the loads on a podded propeller operating in ice. It involves the design and testing of scale models of a podded propeller in ice, using the expertise and facilities of the National Research Council's Institute for Marine Dynamics (IMD), in St. John's, Newfoundland. The propellers will be instrumented to record contact and "milling" loads exerted on the propeller system as it is passed through an ice sheet. This will include measuring shaft and strut loads, the loads on one individual blade while operating in ice, and the in-plane loads exerted on the stern bearing of the pod.

The current research is exploratory. It will not yield immediate financial benefit, although the knowledge generated will be useful in the definition of future product, resulting in improved life cycle service and reduced breakage. Podded propellers are also more efficient and will permit small installed horsepower for Arctic type vessels, resulting in savings in fuel and maintenance.

Contact: Stephen J. Jones, (709) 772-5403 *Project Number: FQAV6*

Evaluation of Arctic Diesel Fuel and Marine Diesel Oil Blends with and without Lubricity Additives in Coated Injector Plungers for a Vasa 32 Diesel Test Engine

As a final precautionary step, before continually or occasionally using lower lubricity fuels with lubricity additives in a CCG heavy duty icebreaker engine over lengthy time periods, it is proposed that the lubricity additive(s) be tested in a stationary generator set engine in the Arctic with low lubricity Arctic diesel fuels. This step of testing in a full size medium speed diesel engine is proposed so that any potential longer term engine problem during testing would not jeopardize a CCG heavy icebreaker during a major mission. Discussions have been undertaken with the Nunavut Power Corporation (NPC) for potential utilization again of their Vasa 32 engine for a 5,000 hour durability test purposes. This in line nine cylinder engine is coupled to a stationary generator set. The engine/generator is used for electric power and heat generation in the Arctic community of Iqaluit.

As in past tests, it is proposed that the lubricity additive that has the best performance to date in the bench rig test – Ball on Three Disk (BOTD) tester be tested in the NPC Vasa 32 engine (12 cylinder-V configuration). This study would utilize coated injector plungers. This would ensure that the lubricity additives would also be able to minimize wear for the coated injection components. It is proposed that the separate fuel system previously developed be used for each of the two cylinders on the Vasa 32 engine. The remaining ten cylinders would use P50 without any lubricity additives. The acquired data throughout the test period would be analyzed and tabulated for the reporting process. The fuel injection system wear components (fuel injection system pump and nozzles of the two high temperature fuel cylinders and two reference cylinders) would be disassembled, photographed, analyzed and a comparison made.

This project will benefit all of CCG's diesel engine application areas through reduced maintenance costs. This project is also being funded by and supported in-kind by a number of Canadian and US industries including a number of the major additive manufactures.

Contact: Patrice St-Pierre, (613) 991-2482 *Project Number: Approved-in-principle*

REGIONS

Project List Summary

PROJECT NUMBER	PROJECT TITLE	2002/03 (approved)
NEWFOUNDLAND		
FKCT6	Research Project for Increased Wearing of Personal Flotation Devices (PFD	See HQ OBS list. $119K will be transferred from HQ OBS.
	Newfoundland – Total	See HQ OBS list
MARITIMES		
FMDG2	Field Tests for Magnetic Joint & Current Buster	140
	Orimulsion Project (Year #2)	$307K will be transferred from HQ ER.
	Maritimes – Total	140
QUÉBEC		
GPJN3	Revision of non-commercial buoy types	87
FMCC3	Erosion-Sedimentation Model of the St. Lawrence River	150
GMJE3	St. Lawrence River Ice Manager - Integrated Ice System	50
GMJF3	Squat Study for the Purpose of Re-Evaluating Underkeel Clearance Specifications	383
GMJG3	Computer-Assisted Ice Observation System in Helicopters	50
GMJJ3	User-friendly Software Forecasting the Trajectory of Oil Spills in Case of Environmental Intervention	80
FJNF3	Lighted Spar Buoy	100
	Québec – Total	900
CENTRAL & ARCTIC		
	Central & Arctic – Total	0
PACIFIC		
FPAK5	DGPS & GIS Integration for Aquaculture	25
FPAM5	ROV for NWPA Inspections & Investigations Related to Aquaculture	27.5
	Pacific – Total	52.5

Newfoundland

With regional headquarters located in St. John's, Newfoundland, this region selects R&D projects to assist in their challenge to adapt to trends in operational demands, strategic changes in levels of service, and evolving expectations from clients. The R&D priority in support of their overall effectiveness of service delivery operations for this year relates to boating safety.

Research Project for Increased Wearing of Personal Flotation Devices (PFD)

Newfoundland will carry out this project on behalf of the Office of Boating in Ottawa. The project description can be found under Marine Programs, Safety and Environmental Response.

Maritimes

With regional headquarters located in Dartmouth, Nova Scotia, this region selects R&D projects to assist in their challenge to adapt to trends in operational demands, strategic changes in levels of service, and evolving expectations from clients. This year the priority technological opportunities in support of their overall effectiveness of service delivery operations relate to oil spill response and preparedness.

Field Tests for Magnetic Joint & Current Buster

The Canadian Coast Guard operates a number of offshore sweep systems from a variety of vessels, both CCG and vessels of opportunity. The present inventory consists of "state of the art" V sweep systems that allow maximum swath width during operations, thereby collecting oil from the largest possible area. However, two factors hinder optimal performance. The current sweep systems operate at a speed of one knot or less and there is always the tendency of the boom to pull away from the hull resulting in loss of product.

Last year CG undertook two research projects towards the development of an effective on water recovery system. They are combined this year into one project to maximize ship time. The first project, entitled Enhanced Sweeping Methods, completed test trials on a small system known as the Current Buster designed for the near-shore by a Norwegian boom manufacturer. A larger version known as the Ocean Buster is a high speed sweep system designed for the off-shore and has the potential to achieve sweeping speeds as high as four knots. The boom will be tested with the second project underway entitled Magnetic Ship Joint for Sweeping Systems. A Canadian inventor has developed a flexible magnetic seal joint capable of assuring a positive seal between ships' hull and the boom. This project will study the behaviour of the flexible magnetic sealing joint with various sweep systems. A final report will outline the effect on on-water off-shore and near-shore recovery enhancement.

If this system is successful in maintaining a seal between the ship hull and sweep interface that is incorporated with an effective high speed sweep system, the total system would be among the most effective on water recovery system in the world today. CCG could effectively conduct on water recovery at a rate of more than 4 times the current ability and significantly reduce the cost in shore-line response. Furthermore, ships will be able to maintain maneuverability, thus enabling work in limited areas, without compromising efficiency and performance.

Contact: Nancy McNeil, (902) 426-9022 *Project Number: FMDG2*

Orimulsion Project (Year 2)

Maritimes will manage this project on behalf of the Emergency Response branch in Ottawa. The project description can be found under Marine Programs, Emergency Response.

Québec

With regional headquarters located in Quebec City, Québec, this region selects R&D projects to assist in their challenge to adapt to trends in operational demands, strategic changes in levels of service, and evolving expectations from clients. The priority technological opportunities in support of their overall effectiveness of service delivery operations relate to: ice information management, marine traffic management, aids to navigation, erosion/sedimentation mechanisms, and SAR and environmental response.

Revision of Non-commercial Buoy Types

Until about ten years ago, floating buoy systems in the pleasure craft channels of Canada utilized steel buoys. The steel navigation buoys have been gradually replaced by a number of plastic buoys of various types and shapes. These synthetic buoys were often either the same shape or size as the former steel buoys.

Based on recent reviews of the level of service in pleasure craft channels, we believe that we could improve client services and possibly reduce program costs by introducing new sizes and/or models of buoys that are made of synthetic materials and better suited to their intended purpose. The arrival in recent years of new products on the market supports this view. Finally, these same reviews indicated that the performance of the steel buoys remaining in the system could also be improved through the development of equipment that would improve their basic performance.

This project will review the conclusions of the level-of-service reviews (conducted in the pleasure craft channels) and precisely define the specific weaknesses of the system in pleasure craft channels (maintenance, clearance, weight, shape, visibility, colour of buoys).

The application of new technology and features would ensure maximum effectiveness and efficiency of aids to navigation equipment and the level of service to recreational clients. CCG will save in operational costs through reduced transits to sites for the installation/removal, maintenance and repair of buoys.

Contact: Sylvie Pelletier, (418) 648-7450 *Project Number: GPN3*

Erosion/Sedimentation Model of the St. Lawrence River

The potential impact of maritime navigation and the maintenance of the St. Lawrence Waterway have been the subject of numerous comments and concerns, following Environment Canada's publication of a background paper on the condition of the St. Lawrence in 1996, and the submission of an impact study during the course of a project to deepen the waterway. These events lead to the creation of a navigation co-operation committee which brings together representatives of government, the maritime industry and the community who have a mandate to find means of limiting the impact of navigation on the environment. The main concerns raised by the committee are bank erosion, the destruction of fauna habitats and dredging-related impacts. In conjunction with the committee's work, the purpose of this project is to develop a software which is capable of modeling the influence of navigation and maintenance of the waterway on bank erosion of the St. Lawrence between Cornwall and Cap Gribane at the end of the North Traverse. The knowledge gained from these projects will enable various departments to be better informed to respond to concerns expressed by interest groups and the general public.

In addition, the numerical model will be used in the International Joint Commission (IJC) study to review the criteria for Lake Ontario-St. Lawrence River water-level regulation. It will be used to simulate erosional processes in the fluvial portion of the St. Lawrence.

This project is undertaken in partnership with National Research Council's Canadian Hydraulics Centre (CHC), Environment Canada and the Science Directorate of Fisheries and Oceans Canada. Their expertise combined will develop a software which includes a mathematical sedimentation-transportation model and a graphic interface. The model will provide CCG with a tool for the analysis and understanding of the phenomena of erosion, sedimentation and lapping (ship-generated waves) in the St. Lawrence.

The numerical model will be of benefit to the CCG in that CCG will be better informed to manage dredged sediments, assess environment impacts of navigation and maintenance of the waterway and respond to concerns raised by interest groups and the general public regarding certain CCG activities or development projects.

Contact: Pierre Rouleau, Eng., (418) 648-7493 *Project Number: FMCC3*

St. Lawrence River Ice Manager

The introduction of the St. Lawrence River Ice Manager (SLRIM) has helped improve user confidence in the maintenance of a safe and effective waterway between Québec City and Montreal all year long. SLRIM helps ice breaking officials by providing an evaluation of ice conditions and obtaining punctual information on prevailing or forecast ice conditions. With more key information at their fingertips, CCG icebreaking services and escorts are more effectively deployed and advisory services are improved.

Operational trials over the past few years have identified the strengths and weaknesses of the system. To improve its smooth operation research efforts continue.

This year, improvements to the SLRIM are aimed at completing and optimizing deployment of the remote surveillance site on curve no. 1 of Lac St-Pierre. Experience has shown that curve no. 1 at the entrance to Lac St-Pierre is a critical site for the formation of ice jams. Installing an instrument to measure the thickness and speed of the ice at this location would significantly improve the ability of the SLRIM to detect ice stoppages on Lac St-Pierre. By comparing this information with that gathered at the two sites located downstream – curve no. 2 (two cameras and one radar) and island 3 (a camera) – ice breaking officials could identify and quickly locate any possible ice stoppages.

The SLRIM is already yielding major benefits for CCG operations and users. It has reduced the frequency of regular CCG icebreaker and helicopter trips to maintain surveillance conditions, reduced fuel consumption, reduced the frequency and risk of ice jams and subsequent flooding.

Contact: Réginald Corriveau, (418) 648-5620 *Project Number: GMJE3*

Squat Study for the Purpose of Re-evaluating the Underkeel Clearance Specification for the St. Lawrence River

The loading capacity of ships travelling the St. Lawrence is directly related to three elements: (1) the maintained (dredged) depth of the channel with respect to the chart datum; (2) the elevation of the flat body of water with respect to the chart datum; and (3) the various dynamic factors and phenomena which are included in the underkeel clearance calculation (squat, roll and pitch, etc.). Squat, which is defined as the measurement of the sinking (or the equivalent) of the ship when in movement, is one of the components in the underkeel clearance (UKC). This squatting, which varies mainly due to the speed and width of the ship, the static draft and water depth, is evaluated based on a theoretical formula which has never been validated under actual conditions of use and the accuracy of which can vary from one ship to another. This formula constitutes the basis of the UKC standard which has been in force since 1992 on the navigable channel of the St. Lawrence between Montreal and Quebec City. The UKC standard, which was implemented for reasons of safety and environmental protection, is managed and enforced by the Maritime Communications and Traffic Services (MCTS) of the Canadian Coast Guard (CCG).

Climatic changes predicted for the short- and medium-term suggest that the water level of the river could dip more frequently beneath the average than it has in the past 40 years. At a time when dredging is the subject of many environmental concerns, a better knowledge of the ship squat phenomenon, with a view to optimizing the column of water available for navigation, could be an interesting alternative to dredging should the maintained depth of the navigable channel need to be increased to ensure competitiveness of ports along the St. Lawrence.

An earlier study has concluded that the squat evaluation obtained by the formula currently in use could be too conservative for some types of ships, particularly those with high drafts. The recent development of GPS "On the Fly" (OTF) technology, has shown the potential to measure squat phenomenon accurately and will be used in this study to validate the current theoretical equation under actual operational conditions.

This study proposes to re-evaluate the underkeel clearance standard in force on the St. Lawrence in three phases. Phase 1 (2001-2002) consists of a feasibility study and preliminary testing that will result in a detailed work plan and confirmation of the methodology and instruments selected. Phase 2 (2002-2003) will be the planning and collection of data based on the findings in Phase 1. Phase 3 (2003-2004) will be devoted to determining vessel squat and making a comparison with the current UKC standard.

Optimizing UKC offers several benefits. It will help CCG ensure safe shipping to preserve the coastal regions and oceans and produce potential fuel savings for the marine industry. The findings of the study could also lead the CCG to revise downward the squat factor in the application of the UKC standard, the marine industry could increase load capacity of its ships without further deepening the navigation channel. This would help maintain or improve the competitiveness of Canadian ports along the St. Lawrence.

Contact: Pierre Rouleau, Eng., (418) 648-7493 *Project Number: GMJF3*

Computer-Assisted Ice Observation System in Helicopters

The ice breaking and escort operations are first accompanied by helicopter and plane ice reconnaissance patrols to gain a current picture of the condition of the ice and which routes navigators should follow.

The ice observer with Environment Canada collects the data manually and provides a brief oral summary to the CCG's Regional Ice Centres, the Canadian Ice Service (Environment Canada) located in Ottawa and the ice breaker commanders. Unfortunately, the visual information (the map) is forwarded at a later time and as such does not meet the requirements of the ice centres and the maritime clientele. The application of new technology such as a laptop computer connected to a GPS device would certainly simplify the data gathering activity, make it more accurate and expedite reporting to the CCG Ice Centres and Environment Canada.

A prototype system, a pen computer, was created in 1999. The system has demonstrated to be effective but requires improvements and further validation. The environmental response group has shown an interest in the system for its ability to locate and monitor oil spills and to quickly evaluate the amount of oil spilled.

This year the system will be upgraded based on user comments and information gained from the validation trials of ICEgg version 3.0. The upgrades will include the capability of the system to interface with other ice models.

The upgraded system will result in improved quality, accuracy and production of ice maps and oil spills as well as the capability to forward data quickly to the CCG regional ice centres, the Environmental Intervention Centre and the Canadian Ice Service Centre in Ottawa to make expedient decisions to deploy services.

Contact: Réginald Corriveau, (418) 648-5620 *Project Number: GMJG3*

User-Friendly Software Forecasting the Trajectory of Oil Spills in Cases of Environmental Intervention

Since 1988, the personnel of the Physical Modeling Section, Division of Ocean Sciences, Sciences Sector, has been doing operational oil spill forecasts in cases of environmental interventions. In 1995, the salvage

activities of the Irving Whale barge resulted in the development of software to replace the manual portion of forecasting the spill. This reduced the team's response time. However, several sections need improvement so that it can be used by persons who have not been initiated to numerical modelization. The model has also gained significant interest by emergency response organization to enhance efficiency in their response capabilities.

The project will be completed over three stages. Stage one is to integrate better current patterns, use better current interpolation to calculate spill and build a user-friendly interface in the software to produce results over a shorter time frame. Stage two will add the possibility to edit thematic layers to the modeling visual display. For example, air observation, working teams position, specially sensitive areas. Stage three involves training the users in the CG Québec region and additional modifications to the interface to facilitate their work in an actual situation.

The improved model will be used as part of normal CG operations in the Québec region thereby maximizing resources and improving response time.

Contact: Martin Blouin, (418) 648-4557 *Project Number: GMJJ3*

Lighted Spar Buoy

Every year, the Quebec Region faces pressure from the marine industry to leave the lighted buoys in place as long as possible in the fall and to put them back as soon as possible in the spring. Furthermore, the requirement to go to the same place twice a year to change the spar buoy for the lighted one (and the reverse) involves considerable CCG resources.

The challenge is to develop a spar buoy in polyethylene or some other material requiring as little maintenance as possible and designed to provide the best resistance to ice without major damage. We must also aim for the best visual clearance (air draught) and the best possible vertical stability in winter conditions. The buoy should be able to lie under the ice for long periods. It should also have some feature making it easy to set up and retrieve. There will also be a challenge to develop a lighting system visible from a great distance and as little obstructed as possible by the snow, icing or the ice accumulated after long immersion under water. The buoy must also have an acceptable radar detection threshold. The internal components will have to be sturdy enough to resist the impact of floating ice as well as extreme temperatures (air temperature: -40^{o} Celsius).

The development of 2 different spar prototypes will have to be considered. The first will be developed to endure light to medium ice conditions and should therefore have a lighting system incorporated into the buoy. The aim would be to have a single annual visit either to check the spar or completely replace it. This prototype would help extend the service period for users.

The second prototype will be designed for more severe ice conditions and would not have a permanent lighting system. The challenge will be to have a buoy with a body capable of resisting damage as much as possible and a better air draught than we have presently. The aim is to incorporate a seasonal lighting system in the spring and increase its visibility during the day by adding floats or any other form of day mark.

The buoys will be tested and assessed over a period of two years to determine if they meet expected operational needs.

The lighted spar will reduce the stress associated with the beginning and the ending of the season as well as maintenance and operational costs if the buoy is used as an annual buoy in certain places .

Resource person: Allan Blanchard, (418) 649-6999 *Project : FJNF3*

Central and Arctic

With regional headquarters located in Sarnia, Ontario, this region selects R&D projects to assist in their challenges to adapt to trends in operational demands and strategic changes in levels of

service and evolving expectations from clients. The priority technological opportunities in support of their overall effectiveness of service delivery operations relate to: SAR and environmental response, icebreaking and support to environmental standards for the protection of the fragile Arctic environment.

Due to the change in personnel this year, no proposals have been submitted.

Pacific

With regional headquarters located in Vancouver, B.C., this region selects R&D projects to assist in adapting to local trends in operational demands, strategic changes in levels of service and evolving expectations from clients. This year the priority technological opportunities in support of their overall effectiveness of service delivery operations relate to waterways maintenance and protection.

DGPS & GIS Integration for Aquaculture

Personnel in the Navigable Waters Protection Division (NWPD) – Aquaculture are required to conduct pre-development and post-development site inspection reports on all works that require a formal approval, as well as those works determined to be exempt under the Act if they have been constructed in waters charted by the Canadian Hydrographic Service (CHS). The primary purpose of these inspections are to ensure that the works are in accordance with plans submitted by the proponent, i.e. location of cautionary buoys, shellfish growing racks and strings and the size and orientation of fish pens. Additionally, site inspections provide the opportunity to accurately determine the position of the subject works for charting purposes and updating of NWDS database.

Current practices can be time and labour intensive. Many waterways cannot be readily crossed to facilitate taking measurements with a conventional measuring devices (e.g. hip chain). Similar difficulties are encouraged when measuring distances from structure to structure. Lastly the process of entering data collected in the field into the NWDS database is a time consuming process. The acquisition of a state of the art positioning system in the form of a differential global positioning system (DGPS) and data logger to the officer's field equipment will allow accurate measurement of aquaculture tenure sites, cautionary buoy locations and provide a means to log data in the field and submit it directly into the GIS program.

For a trial period of one year, the system will be used to take measurements during site inspections. The data collected will be compared to conventional collection methods. In a similar manner, the Laser Range Finding equipment would be interfaced to the DGPS to augment the collection of data. Comparisons of DGPS positions relative to those positions obtained by normal GPS would be recorded and post processed using Provincial, Active Control Site data to correct the non Differential position. The position data would be post processed to provide UTM positions that would be usable for plotting on 1:50000 scale topographic maps and all CHS field sheets. By using geographically referenced aerial photos the capability of overlaying the field data directly onto the photos would provide a secondary method of monitoring the changes that occur over a number of years.

The resulting benefits will be larger amounts of data collected at a lower cost per inspection, greater ability to monitor the long term affects at each site, and the ability to provide site data when responding to complaints about interference to navigation.

Contact: Robert Gowe, (604) 775-8866 *Project Number: FPAK5*

Remotely Operated Vehicle (ROV) for NWPA Inspections and Investigations Related to Aquaculture

Navigable Waters Protection Division (NWPD) personnel are required to conduct investigations under Part II of the Act 'Obstacles and Obstructions' where navigation has been impeded or rendered more difficult or dangerous, as well as those works determined to be exempt under the Act if they have been constructed in

waters charted by the Canadian Hydrographic Service (CHS). The primary purpose of these investigations is to ensure that the obstructions do not pose a substantial interference to the safe navigation of vessels. Additionally, site inspections are necessary to investigate complaints arising from intrusions into the navigable waterway by works that were developed unlawfully.

Current methods of conducting underwater investigations can be time and labour intensive as well as dangerous for divers. Acquisition of a state of the art submersible remotely ROV to the officer's field equipment would allow a safe, reliable and portable method of investigating sub-surface sites and provide a video record of the underwater investigation.

The purpose of this project is to determine how the ROV can enhance the collection of information and support to the Canadian Environmental Assessment Act (CEAA) screening process by providing a visual record of conditions prior to and following the occupation of a site. At the end of the one year trial period, a comparison of measurements will be modelled against existing data collection methods and the costs associated with conventional dive operations. In a similar manner, scanning sonar images of the sites would be referenced to the ROV images to augment the collection of evidence. Comparisons of DGPS sonar positions relative to those positions obtained by the ROV will be recorded and logged into the NWDS database providing a visual record of changing conditions at the various sites.

The ROV offers the benefit of increased productivity, decreased cost to investigations and decreased health and safety risks to personnel.

Contact: Robert Gowe, (604) 775-8866 *Project Number: FPAM5*

NEW SEARCH AND RESCUE INITIATIVES FUND (NIF)

The New Search and Rescue Initiatives Fund (NIF) is a unique undertaking by federal and participating provincial, municipal and private Search and Rescue (SAR) organizations. It's objective is the saving of lives by enhancing SAR prevention and the provision of SAR services. NIF is not specifically oriented to R&D projects but, rather, was established by the federal government to provide funding to new initiatives which enhance the effectiveness of SAR by all participants, especially those outside government.

NIF is managed by the National Search and Rescue Secretariat (NSS) reporting to the Lead Minister for Search and Rescue (the Minister of National Defence).

Within CCG, it is managed as a separate program within the Safety and Environmental Response Directorate (SERS). For the CCG R&D Program, NIF funded research projects are reported when a research project is sponsored by CCG.

For 2002/03, one project is reported that involves some data collection from Bedford Institute of Oceanography (BIO) to support research into CANSARP validation.

Project List Summary

PROJECT NUMBER	PROJECT TITLE	2002/03 (approved)
2002038	Ingestion of Grand Bank Surface Current Data into CANSARP	49.5
	NIF - Total	49.5

Ingestion of Grand Bank Surface Current Data into CANSARP

Surface currents for the Grand Banks can be predicted from advanced computer models developed at BIO/DFO. The models have been implemented on the BIO Ice-Ocean Forecasting System. The system generates 48-hour forecast of surface currents and other ocean variables for the Grand Banks everyday. This real time and near real time data is the most critical type of information required for CANSARP and the SAR system.

The project proposes to develop an interface for transferring the data to the CANSARP environment and modify several modules of CANSARP 4. It is this data that will assist CCG's project officer, Jean Maillette, in his work to validate CANSARP 4. The description for his work is found on page 5.

Together, BIO and CCG are working to bring new data to CANSARP in order to improve their ability to predict search areas for the Grand Banks and north east coast of Newfoundland.

Contact: Charles Tang, DFO Maritimes, (902) 426-2960 *Project Number: 2002038*