FINAL REPORT: **POSITION PAPER**
INTERNATIONAL ICE NAVIGATOR PROJECT, PHASE II

Prepared For: Canadian Coast Guard
Ship Safety Northern Region

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1.0 INTRODUCTION

1.1 Project Background

Experience from ship operations in the Canadian Arctic indicates that the human factor plays a significant role in marine casualties. Most navigators do not have sufficient experience to deal with the challenges of the Arctic environment and the presence of sea and glacial ice in access channels. Existing regulations, standards and training procedures for Arctic Navigators as specified in the Arctic Shipping Pollution Prevention Regulations (ASPPR), are minimal to non-existent.

The Canadian Coast Guard (CCG) and international agencies under the auspices of the International Maritime Organization (IMO) are launching a Joint Research Project Agreement (JRPA) with the Norwegian Coast Guard (an internationally recognized authority on manning and training standards) to research the implementation of new standards. New standards and requirements for these navigators will reduce casualties and the risk of environmental damage caused by oil spills. The Canadian Coast Guard (CCG) would like to improve the standard required of Arctic navigators and develop an internationally recognized ice navigation course and this forms the rationale and background for the project.

1.2 Project Scope

The project is to be completed in two distinct but overlapping phases which naturally progress from the development of ice navigator requirements onboard Canadian flag vessels operating in Canadian Arctic Waters north of 60°N and a course development framework, to the development of a course syllabus and instructors handbook. This involves the joint efforts of both Canarctic and the Fisheries and Marine Institute of Memorial University, St. John's. The two phases of the project and a summary of responsibilities are illustrated in Figure 1.

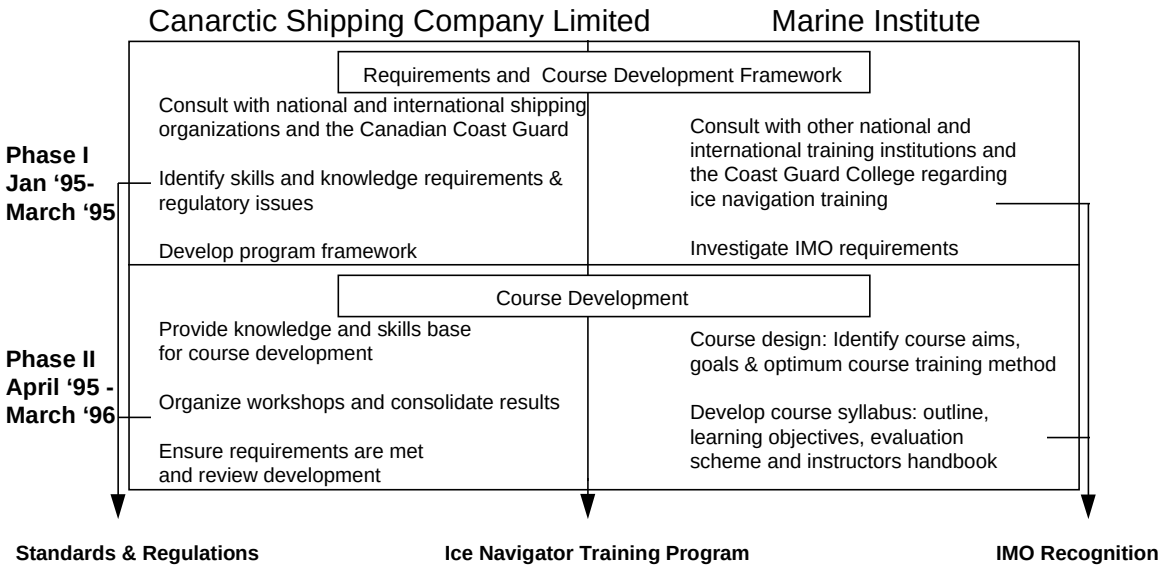

Figure 1. Project Scope and Responsibilities

Phase I has initiated the process to identify the structure for the development of an internationally recognized ice navigation course. Consultation with national and international shipping organizations, training institutions and the Canadian Coast Guard has attempted to identify issues related to the occupation "Ice Navigator", performance requirements, standards, regulations, and course content. In particular, the groundwork has been laid in this document to establish ice navigation standards by utilizing the experience gained in Canadian Coast Guard through previous workshops, the experience of ice navigation by Canarctic, the experience of the Marine Institute in marine course development and the collective experience of those consulted.

The work in this phase to initiate the identification of the required skills and knowledge of an ice navigator and prioritize those requirements in terms of their contribution to the ice navigation task and the ability of training to meet those requirements will form the foundation of the development of performance objectives and standards in Phase II.

1.3 Program Objectives

The objectives of this program are to produce a detailed syllabus of an internationally recognized ice navigator training course by April 1996. The project will provide the necessary background research to allow for the update of ASPPR concerning the training and certification of Arctic navigators, and to summarize the special training requirements of Canadian Arctic Class (CAC icebreaking) vessels that should be represented in the standards.

2.0 Ice Navigator Requirements

2.1 Methodology

2.1.1 Identification and Consultation with Representatives

Extensive Phase 1, Task 1 consultation and research was begun immediately upon the formalization of the Work Plan during meetings in St. John's in January 1995. Two contact lists were initiated.

The first list was national in nature, identifying interested parties in both Canadian marine industry and government. The initial contact list grew, leads were developed, and further sources of interest were found. Most persons contacted were very eager to assist in the development of what was generally conceived as a much warranted movement to ensure safety onboard vessels operating in ice infested waters. Over twenty source contacts had resulted in 17 returns by mid May.

Comments were requested on what skills and knowledge the respondent felt a specially endorsed "Ice Navigator" should possess to safely conduct a bridge watch in Canadian Arctic Waters and a brief questionnaire (Annex 1) was provided to promote thought on the direction the Coast Guard had envisioned in a draft Proposal for Ice Navigator Certification. This included the endorsement scheme as presently utilized in the Tanker Endorsement, identifying two levels of endorsement to a Certificate of Competency.

The second contact list was wholly international. Again, industry, government sources and concerned experts were identified and provided further assistance to broaden the contact base. Countries actively pursued have been: Norway, Denmark, Sweden, Finland, Russia, United States and the United Kingdom. Twenty-one initial contacts were made in total.

Research and consultation assistance in the International sector was centered on the identification of possible standards that may exist already either through regulation, company standing orders or guidance towards any papers or publications that may not have been previously identified.

2.1.2 Literature Search

Coincident with the development and follow-up of the two contact lists, both national and international literature searches were begun. Transport Canada and Canadian Coast Guard Libraries in Ottawa, the Arctic and Antarctic Institute Library, St. Petersburg, Russia and the Scott Polar Research Institute, Cambridge, UK were reviewed, while an international literature search was conducted through CISTI. Relevant material was identified and

collection begun. Valuable assistance was rendered by Lieutenant Commander Stephen Wheeler, USCG, in releasing and obtaining American Naval and Coast Guard resource material. Several of the International contacts were able to provide assistance by providing copies of the written material at their disposal. A bibliography of relevant material was developed.

2.1.3 Working Group Meetings

National working group meetings were conducted on the 4th of May 1995 in Ottawa to take advantage of industry personnel that would be in Ottawa during the spring CMAC meetings.

In conjunction with the Canadian Association of Marine Training Institutions meetings, the Marine Institute conducted sessions concerned with the development of the course syllabus, and solicited further support from the marine training field. Valuable input was received from those in attendance with regard to the direction course development could take to be most effective.

A second working group of marine industry representatives was held to discuss the requirements and standards that an Ice Navigator must attain and meet. After a briefing on the intent and progress to date of the International Ice Navigator Project a series of in depth discussions followed.

A thorough analysis of the base skills and knowledge matrix was completed. Revisions were made to more accurately define roles or material required. Of primary importance in this meeting was the weighting of the various skill and knowledge components, a division of material into two levels and a discussion on the importance of valid seatime requirements.

2.2 Findings

2.2.1 Certification Process

Following the line of action as proposed by the Coast Guard after consultations at the CMAC - Northern meetings in November 1994 a two tier approach (described below) appears to be the most practicable means to achieve an ice navigator standard and to be the most acceptable to industry. The general process was developed from initial March 1993 recommendations of the ASPPR Sub-committee on Training and Certification. The fact that over 60% of the respondents and the working group participants were strongly in favour of and in agreement to that approach and experience with the Tanker Endorsement two tier approach gives credence to the validity of this method.

It is strongly felt that two levels of experience and knowledge are required on the bridge of a ship in ice. An initial introductory level is required which can be more academic in nature but will provide the officer with a background in Arctic operations. This will provide the officer of the watch with sufficient specialized knowledge to conduct the bridge watch safely. The second level is required for the more strategic and command aspects. This level would allow practical experience gained in Arctic ice covered waters to bolster initial academic training received at the first level.

The process can be summarized as follows:

Level One Certification

It is suggested that after an initial period at sea, the junior bridge watchkeeper may have gained enough knowledge to form a foundation on which to build the more specialized knowledge required to deal with the unique considerations required while navigating in Arctic ice regimes. The basic bridge watchkeeping experience would then be supported by specialized training. Level one certification could be granted after successful completion of specified training and/or proof of specific length of supervised experience whilst navigating in ice infested waters. Course material would cover introduction to the specialized aspects of navigation, seamanship and bridge watchkeeping practices in Arctic ice.

Level Two Certification

After a clearly specified period of seatime experience in Arctic ice while holding the level one certification (so that the basic academic information is solidified in the practical environment), the second level of endorsement is reached. The second level would be required for senior deck officers (Chief Officer and Master) to act in the capacity as what has been euphemistically called the Ice Pilot up till now in some trades. A second shorter training course is envisioned that will advance academic material to a senior level and act as a refresher and "updater" for changes in technology or regulation.

This two tier approach allows for a basic level of training and knowledge to be obtained through instruction and course attendance and then to be cemented by actual practical experience. Provision would be made for "grand-fathering" where appropriate.

2.2.2 Specific Skills and Knowledge

The skills and knowledge an Officer of the Watch (OOW) must possess in order to safely conduct a bridge navigational watch in Arctic ice covered waters were established by the polling of individuals personally experienced in navigating in ice infested waters and by reference to various publications available. As expected, a common thread was readily apparent in responses and material. There appeared virtually unanimous agreement on the basics and this was supported by much of the written material that had been collected.

This broad spectrum of skills and knowledge identified by experienced individuals was collated along with material found as a result of the literature search and a tabular presentation matrix was developed (Annex 2). The matrix methodology is similar in approach to that utilized by the Canadian Armed Forces in developing occupational descriptions which accurately break down all classification occupations into the most basic knowledge and skill components.

The matrix breaks down a bridge watchkeeping officer's role or requirements and necessary activities into specific duties or tasks that are required to be carried out while preparing to, and navigating in ice infested waters. As the specific duties have been identified, component skills and knowledge required to perform each duty or task were specified.

To assist with syllabus development, the knowledge and skills required were then divided into three classes (Annex 3): 1, knowledge of ship (operation and capability); 2, environment (geography and ice conditions) and 3, piloting strategies (Voelker et al. 1987).

The component skills and knowledge classified in Annexes 2 and 3 form the framework on which to build a draft proposed International Ice Navigator Endorsement Course.

2.2.3 Weighting and Division of Skills and Knowledge

During the marine industry working group meeting in May 1995, the Skills and Knowledge matrix was revised. A thorough analysis of the base matrix was completed. Revisions were made to more accurately define roles or material required.

Of primary importance in this meeting was the weighting of the various skill and knowledge components. Each subject grouping was analyzed and a time factor assigned to weight it relative to other subject groupings. This allowed the Marine Institute to prioritize material in course development.
Simultaneously, it became apparent that the material must be divided into the two Certification levels that would be required. Each subject group was placed in either the first or second level as required. Material required as a necessary basis for conducting a

safe bridge watch in Arctic ice or would be valued as introductory to give the officer of the watch a basic understanding of the more broad picture about them was included in level one.

Material included in level two was more advanced in nature and would be required at the senior level for strategic planning or broad control. As some time will elapse between the initial certification during seatime accumulation, some basic material was included in the second level course as review and/or updating,

Further work will be necessary to define the level of effort required to teach ice navigation skills versus knowledge in each subject group.

2.2.4 Seatime Accumulation Requirements

Practical ice experience was heavily favoured by most experienced Arctic navigators as the best way to gain the knowledge and skills ultimately required. Considerable practical experience in Arctic ice infested waters is required to keenly develop the practical skills and knowledge ultimately required to safely conduct operations. Periods of experience considered necessary ranged from 3 months to 3 years. The survey indicated that 58.8% of respondents believed that 2 or more years experience in ice infested waters should be a requirement (figure 2) and 76% believed that practical in ice experience was the most valuable method of gaining the required skills and knowledge (figure 3). As such, the seatime requirements between levels should be considerable and of sufficient length to provide high quality experience. As a minimum, the working group felt that at least 50 days Arctic ice experience *over two seasons* should be required. This length of time would ensure that various conditions inherent in Arctic ice regimes would be encountered directly. A single season could conceivably provide extremely limited experience.

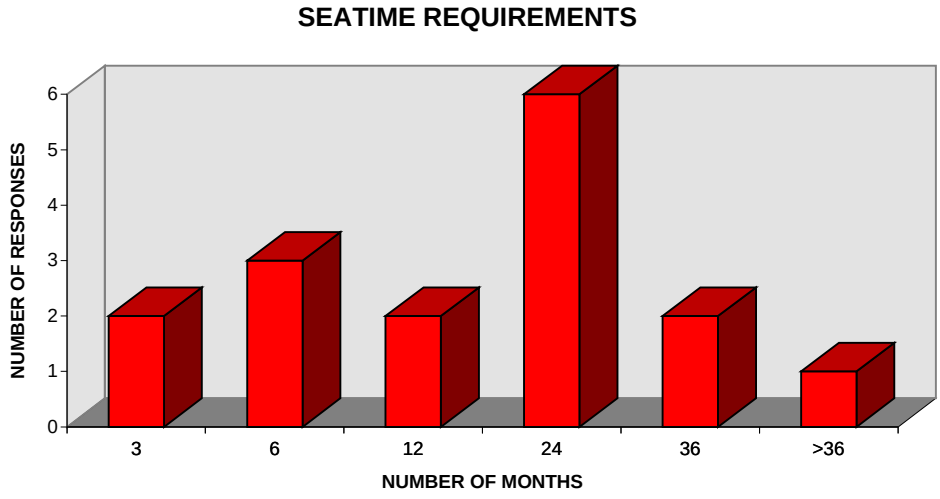

Figure 2

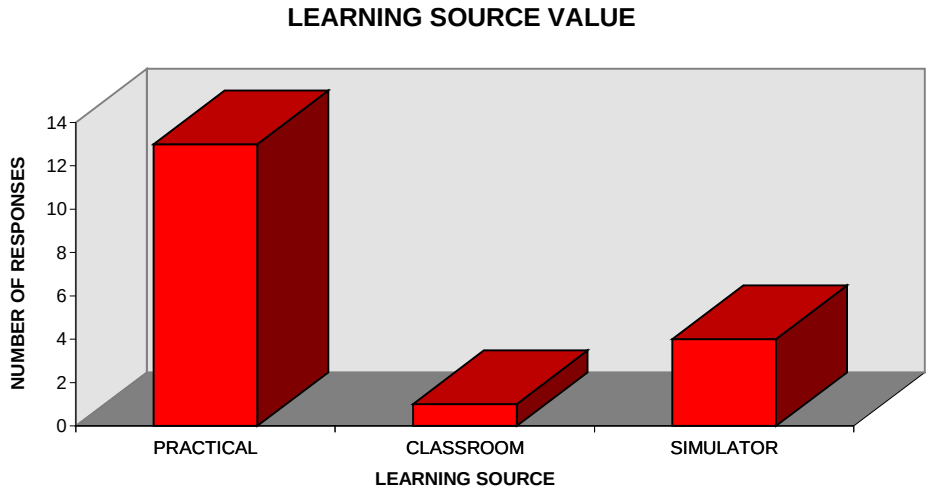

Figure 3

Because of the presence of multiyear, ridged and pressured ice, navigation in Arctic ice regimes is unique. Conditions and local factors found elsewhere, such as in the Gulf of St. Lawrence, vary dramatically from those found in Arctic environs. It is felt that experience required between first and second levels must therefore be accumulated in Arctic ice covered waters as opposed to other ice regimes.

2.2.5 Current Regulatory Provisions

Presently, the regulatory requirements for carriage of Ice Navigators onboard ships in ice infested waters has been minimal. Though the desirability of having experienced ice navigators onboard ships transiting ice infested waters has been recognized, little detailed thought has been given to the skills and knowledge that an ice navigator should possess, even internationally. For example, the Russian Regulations for Navigation on the Seaways of the Northern Sea Route require the Master (or person that performs his duties) of a vessel transiting the Northern Sea Route to be "experienced in operating the vessel in ice" (USSR Ministry of Defense, Annex 4, 1991). No quantitative or even qualitative measure or comparison is given.

ASPPR touches upon a very basic requirement for ships navigating within Arctic Shipping Safety Control Zones stating that an "Ice Navigator" is required onboard. The Ice Navigator so required must be qualified to act as master or officer in charge of a deck watch and "have served in the capacity of master, officer in charge of a deck watch or *helmsman* for a total period of at least *five days*...where the ship...was in ice conditions that required the ship to make extraordinary maneuvers or to be assisted by an icebreaker." (ASPPR 26. (1), (2), and (3), 1993)

There are two exceptions where more experience is required. The first requires a ship of Arctic class 3 carrying oil in quantity under specific conditions to have the person in charge of a deck watch with *not less than 30 days experience* in ice-covered Arctic waters while using specialized satellite and airborne ice radar imagery (ASPPR 6. (6)(F)).

The second exception requires Arctic Class 3 ships carrying oil in quantity in the approaches to Cameron Island between 16 and 30 September to carry both an ice navigator and a master onboard, each with *not less than 100 days experience* in ice covered Arctic waters onboard Arctic Class 3 or higher class ships (ASPPR (7)(b)).

2.2.6 Regulatory Changes Required

Results obtained so far from ice experienced mariners indicates that seatime requirements must be considerable to ensure sufficient skill and knowledge of operations in Arctic ice covered waters is obtained. As such, the seatime requirements between levels should be considerable and of sufficient length to provide high quality experience. As a minimum, the working group felt that at least 50 days Arctic ice experience *over two seasons* should be required. This length of time would ensure that various conditions inherent in Arctic ice regimes would be encountered directly. A single season could conceivably provide extremely limited experience.

Because of the presence of multiyear, ridged and pressured ice, navigation in Arctic ice is unique. Conditions and local factors found elsewhere vary dramatically from those found in Arctic environs. It is felt that experience required between first and second levels must therefore be accumulated in Arctic ice covered waters as opposed to other ice regimes.

Provision for validation of required seatime can be made by revision of EXN 25 testimonial forms to include the Master's authorization of actual days served in charge of a navigational bridge watch "in Arctic ice covered waters".

A more structured and defined series of provisions will most likely be required within ASPPR to fully implement the intent of the Ice Navigator Endorsement Course. As the initial target has been identified as Canadian Flag ships, regulatory changes should be rather straight forward. The requirement for the Ice Navigator certification onboard Canadian Flag ships operating within Canadian Arctic waters (Shipping Safety Control Zones) should first be established. This will include the minimum requirements to be met in both in Arctic ice seatime and knowledge attainment as well as making provision for "grand fathering" if necessary.

Level One certificate endorsement should be required of officers in charge of a bridge watch in Arctic Shipping Control Zones or within Arctic Ice Regimes and Level Two should be required of at least one senior officer.

A reasonable grace period will also be required in order to allow for issue of certificates under "grand fathering" provisions and to allow for the national training institutes to get up to speed to meet the demand.

2.3 Summary of Findings and Recommendations

Specific skills and knowledge are required of an OOW in Arctic ice covered waters in addition to the more traditional material required in other trading areas.

Endorsement of Certificates of Competency should be required in two levels to ensure bridge watchkeeping personnel have sufficient skills and knowledge to safely conduct operations in Arctic ice covered waters.

Level One Endorsement should be required of any officer in charge of a bridge watch while in Arctic Shipping Control Zones or within Arctic Ice Regimes.

Level Two Endorsement should be required of at least one senior officer while in Arctic Shipping Control Zones or within Arctic Ice Regimes.

Skills and knowledge subject areas were weighted by time for Level One and Level Two to assist with syllabus creation.

Due to the unique conditions in the Arctic, the recommended 50 days seatime required for endorsements must be acquired in Arctic ice covered waters, preferably over two seasons.

ASPPR must be amended to require bridge watchkeeping officers onboard ships operating within Arctic Shipping Control Zones and Arctic Ice Regimes to hold appropriate Ice Navigator Endorsements.

ASPPR must be amended to stipulate the amount of seatime in Arctic ice covered waters required to obtain Level Two Endorsement.

• 3.0 National and International Ice Navigation Course Development

3.1 Background

There is no formal Ice Navigator training program in Canada. All of the Maritime training Institutes within Canada were contacted to determine the current state of activity in this area and to outline any immediate plans for the future. The Coast Guard College at Sydney, NS, appears to have the most significant ice related training content. This content is delivered from the point of view of the requirements for operating an ice-breaker. There are also short sections on ice-navigation as part of larger courses in existing diploma programs. All of the colleges indicated a willingness to participate in the definition of a "standard" for Ice Navigator training and are expecting to be contacted with further information prior to meeting to discuss this topic coincident with the CMAC conference in May, 1995.

With respect to international initiatives, the only significant training programs found to date have been from Chile and Argentina. The outlines of these programs were reviewed, but they are clearly not suitable for adoption without significant adaptation. A great deal of this material focuses on the political and regulatory framework of the Antarctic. Efforts are being made to determine if northern hemisphere countries such as Russia, Norway, Finland and Sweden are currently offering any training or certification in this field.

A search of the literature and various maritime databases has yielded a large number of references to related articles and papers. In addition, there are at least six texts directly related to ice navigation. Despite the depth and breadth of reference material available, the search has so far failed to find any direct reference to training or education for ice navigators.

Initial discussions with individuals involved with the International Maritime Organization (IMO) have suggested that the route to having a course accepted as a model course involves discussions at various levels with all stakeholders. Widespread communication of the course content and design will ensure maximum "buy-in" by member states. It is recognized that certification for training is outside the mandate of the IMO, and that member states would have to offer their own certification or credit for certification given elsewhere.

The details and supporting documentation for this summary can found in the pages that follow.

3.2 Review of National Status of Ice Navigator Training

In order to establish the status of ice navigation training in Canada, all of the maritime training Institutes across the country were contacted. The flowchart in Annex 5 outlines the approach taken in the telephone survey. The list of contacts is shown in Annex 4. The absence of any significant training initiatives at any of the schools makes any tabulation of the results uninformative. When asked about course content, the CCG manual "Ice Navigation in Canadian Waters" was suggested as a good starting point in defining the scope of the curriculum. It should be noted that there are sections on ice navigation related topics in some of the courses that form part of diploma programs (see Annex 6).

Canadian Coast Guard College, by virtue of training officers for ice-breakers, is involved in somewhat more ice navigation activity than the other colleges. However, discussions revealed the training to be targeted specifically for CCG personnel and focused on operational issues associated with running an ice-breaker and escorting other ships. This training is not of sufficient breadth to form the basis for the proposed Ice Navigator training program and would not easily be transposed to reflect the skills and knowledge requirements of the merchant marine. When the proposed time frame of two weeks was mentioned, the CCG contact indicated that this seemed excessive from his point of view. (It should be noted in the International section that the existing course durations are 2 - 3 weeks.)

All of the individuals contacted indicated their willingness to be consulted during the development of the Ice Navigator training program. It was agreed that as much detail as possible would be circulated prior to the CMAC conference in May in order to provide for input from all faculty and staff, as appropriate. The Institutions' CMAC representatives could then reflect this wider range of viewpoints during discussions to be arranged coincident with CMAC regarding the development of this curriculum. To this end, a draft cover letter has been prepared (see Annex 7) to send out to all contacts. This will be sent out subsequent to the next project steering group meeting, at which time the exact details of the content of the mail out can be verified.

3.3 Review of International Status of Ice Navigator Training

Subsequent to the review of national initiatives, the level of international activity in ice navigator training was sought. As a starting point, V.M. Santos-Pedro's 1994 paper, The Case for Harmonization of (Polar) Ship Rules, indicated that "the benefits of formal training are generally reserved to crews of government ships. An exception is the training offered by Argentina and Chile to Antarctic crews." No further examples of formal training programs have been located to date. An effort is being made, particularly with respect to Russia, Norway, Sweden and Finland, to find examples of training programs

based on the northern hemisphere. The two training programs referenced by Mr. Santos-Pedro are briefly outlined in the following sections.

3.3.1 Chilean Course on Navigation in Antarctic Waters

Regulations were put in place in September, 1991 to require any Chilean ships bound for Antarctic territory to be under the command of a master who has completed the course of "Navigation in Antarctic Waters". Details of this course were circulated to the member states of the IMO. A brief synopsis of this course follows, while the full text of the course description is available for reference.

Duration of course:	3 weeks (40 hrs/wk)
Entry requirements:	deck officer certification (or diploma)
Evaluation:	one or two theoretical knowledge tests and/or practical exercises. minimum 60% passing grade 90% attendance required
Certification:	Certificate from the General Directorate of the Maritime Territory

A brief summary of the learning objectives and the time allocations provides an indication of the nature of the course, the emphasis given each area, and by extrapolation the profile of the "Ice Navigator" in this context. The text of the objectives is directly from the information circulated by IMO, with the addition of accepted terminology for the statement of learning outcomes.

Antarctic Meteorology (20 hours)

[The successful student will demonstrate] general knowledge of the physical configuration of the Antarctic and of the meteorological and glaciological phenomena which occur in the Antarctic and which affect the southern continents and seas.

Maritime Administration in Antarctica (8 hours)

[The successful student will be able to] explain, as provided in national and international regulations, the practice of the National Maritime Authority in Antarctica.

Antarctic Legislation (14 hours)

[The successful student will be able to] explain the national policy and position with regard to Chilean Antarctic territory.

Antarctic Treaty (10 hours)

[The successful student will be able to demonstrate a knowledge of] the Antarctic Treaty and other conventions and to explain their principal implications.

Tides and Currents in Antarctica (10 hours)

[The successful student will be able to] explain in detail the phenomena of tide and currents in the Antarctic.

Antarctic Environment (10 hours)

[The successful student will be able to] recognize the principal characteristics of Antarctic ice phenomena and events.

Antarctic Pilotage (47 hours)

[The successful student will be able to] perform a reliable pilotage in the Chilean Antarctic territory. (It should be noted that although a significant number of hours is allocated to "*Antarctic Pilotage*", it is understood that this portion of the course involves field exercises at sea.)

3.3.2 Argentinean Course on Navigation in Sea-ice

The National School of Navigation in Argentina, a branch of the World Maritime University, has offered a course in Navigation in Sea-ice for a number of years. Details of this course were circulated to the member states of the IMO in 1993 after a section was added on marine pollution (in the context of amendments to Annexes I and V of MARPOL 73/78). A brief synopsis of this course follows, while the full text of the course description is available for reference.

Duration of course: 2 weeks (35 hrs/wk)
Entry requirements: sea-going masters and officers

A brief summary of the learning objectives provides an indication of the nature of the course and, by extrapolation, the profile of the "Ice Navigator" in this context. The text of the objectives is directly from the information circulated by IMO, with the addition of accepted terminology for the statement of learning outcomes.

The Natural Environment

[The successful student will demonstrate] a general knowledge of the Antarctic and of its natural setting.

Synoptic Climatology and Antarctic Meteorology

[The successful student will be able to describe the climatic conditions] of the region of South America, the Antarctic peninsula and adjacent areas.

Marine Glaciology

[The successful student will be able] to give a general description of the formation of ice at sea [and the] effect of wind on drifting marine ice and influence of tides and currents on its movement.

Antarctic Treaty - SCAR - Legislation - ...

[The successful student will be capable of] correct conduct in the "political environment", given the prevailing international situation.

Classification of Ships for Ice

[The successful student will demonstrate a] knowledge of technical facilities, their capabilities and limitations for operating in the Antarctic.

Navigation and Navigational Safety in the Antarctic

[The successful student will be able to demonstrate the theory required to] operate at sea by means of useful and practical concepts and recommendations specific to the area.

Operations and Maneuvering in Ice Areas ...

[The successful student will be able to demonstrate] the necessary theoretical knowledge for carrying out sea-going operations in the ice field.

Operations with Ice-breakers

[The successful student will be able to demonstrate a knowledge of the] general theory of the operation of ice-breakers in Antarctica.

Survival in the Antarctic

[The successful student will be able to state the] recommendations and theoretical minimum standards to enable the survival of on-board personnel in emergency situations in the Antarctic.

General Discussion
To provide an opportunity for the interchange of experience and knowledge in order to reaffirm the general objective of the course.

3.4 Conclusions on Current International Initiatives

Based on our brief review of the Chilean and Argentinean courses, it seems that the programs have been specifically developed to highlight Antarctic issues with reference to the regulatory, political and environmental regimes. That being said, there are a number of sections focused on ice physiology and navigation and operations in ice-infested waters which would form a part of any ice navigator program. Both groups are being approached to determine if they can offer suggestions on program design and successful techniques for training in these areas.

It is anticipated that the course under development will have more emphasis on pollution prevention, given ASPPR's involvement in stimulating this action and the government's current emphasis on environmental concerns.

3.5 Additional Review Activities

A literature review and search of various maritime databases has provided hundreds of references to related articles and papers. It has also turned up at least six texts which have at least a section which focuses on navigation in ice-infested waters. These texts are listed in listed in the bibliography (marked with *). Despite the volume of reference material located, there is no direct reference to training or education for ice navigators. As a result, the question of curriculum design and the most appropriate techniques remain to be discovered through consultation with members of the maritime education community and the mariners and companies involved in shipping in Arctic waters.

Initial discussions with individuals involved with the International Maritime Organization (IMO) have suggested that the route to having a course accepted as a model course involves discussions at various levels with all stakeholders. Widespread communication of the course content and design will ensure maximum "buy-in" by member states. It is recognized that certification for training is outside the mandate of the IMO, and that member states would have to offer their own certification or credit for certification given elsewhere. Sample IMO model curricula have been obtained and further exploration of the most expeditious route to an internationally accepted course is being pursued.

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Wells, D. G., and D. M. Nazarenko. *A Study of Icebreaker Escorts and the Proposed Ice Regime Shipping Control System*. Ottawa: Norland Science and Engineering, 1992.

Wheeler, LCDR S. M. *Polar Class Ice Piloting Manual (draft).* Washington: United States Coast Guard, 1995.

ANNEX

1. International Ice Navigators Standards Industry Questionnaire

2. International Ice Navigator Role Specification

3. Skills and Knowledge Subject Classes

4. Extract from Regulations for Navigation on the Seaways of the Northern Sea Route

5. Flowchart of phone survey for Canadian maritime Institutes

6. Draft of letter to initiate next phase of dialogue with other Institutes in preparation for CMAC in May, 1995.

7. List of contacts at Canadian maritime institutes, shipping companies, and international shipping operators

8. Copy of ice navigation related section from Marine Institute course in navigation.

ANNEX 1

INTERNATIONAL ICE NAVIGATOR STANDARDS INDUSTRY QUESTIONNAIRE

In order to improve the standard required of Arctic navigators, the Canadian Coast Guard is proposing standards and regulations for an International Ice Navigator Endorsement in conjunction with the proposed Canadian Ice Regime Shipping Control System implementation. It is envisioned that the certificate endorsements will initially be necessary for Bridge Watchkeeping personnel on Canadian Flag vessels navigating within any Canadian Arctic Shipping Safety Control Zone. With further International input it is hoped that the standards will eventually be approved by IMO for world wide use.

Canarctic Shipping Company Limited, along with the Marine Institute of Memorial University has been contracted by the Coast Guard to determine the ice navigator requirements, to develop an accompanying training course and to provide background research to allow for the update of the Arctic Shipping Pollution Prevention Regulations concerning the training and certification of Arctic navigators.

Your input is being solicited in order to determine the standards that should be met. Canarctic would appreciate any input you may have by reference to operational experience, international regulations, relevant literature or company operational policies related to ice navigator skills, knowledge and duties that you may access to. Relevant extracts, copies or source locations for documentation would be beneficial.

(The attached questionnaire is intended to promote thought on the subject. Please feel free to produce additional copies of the questionnaire for further distribution.)

In conjunction with the national initiative, an International Workshop is being planned to be held coincident with the November 1995 CMAC meeting in Ottawa. Would you have interest in attending such a workshop? ____Yes. ____No.

Thank you for your interest and the few moments of your time *(to complete this questionnaire*). If possible responses are requested to be returned by 28 February 1995 to the above Facsimile number. If you have any questions or require clarification, please feel free to call me.

1. Rate the value of the following skills to a junior and senior Ice Navigator:

	Junior Officer					Senior Officer				
	1	2	3	4	5	1	2	3	4	5
Ice chart interpretation	•	•	•	•	•	•	•	•	•	•
Visual ice recognition	•	•	•	•	•	•	•	•	•	•
Radar interpretation	•	•	•	•	•	•	•	•	•	•
SAR/SLAR interpretation	•	•	•	•	•	•	•	•	•	•
Knowledge of Arctic Ice regimes	•	•	•	•	•	•	•	•	•	•
Knowledge of CASPPR/IRSCS and appropriate regulations	•	•	•	•	•	•	•	•	•	•
Passage planning in ice	•	•	•	•	•	•	•	•	•	•
Meteorology effect on ice	•	•	•	•	•	•	•	•	•	•
Engineering considerations	•	•	•	•	•	•	•	•	•	•
Operations with Icebreakers	•	•	•	•	•	•	•	•	•	•
Ship maneuverability in ice	•	•	•	•	•	•	•	•	•	•
Ice types related to hull structure and potential damage	•	•	•	•	•	•	•	•	•	•

(1-least valuable, 5-most valuable)

2. What other skills should an ice navigator have, apart from those that are required through the present certificate of competency structure?

3. What other knowledge should an ice navigator possess, apart from that required by the present certificate structure?

4. What tasks, above and beyond “normal” watchkeeping duties would an ice navigator be expected to carry out?

5. Should the skill and knowledge be based on:

	(1-least valuable, 5-most valuable) 1	2	3	4	5
Practical experience	•	•	•	•	•
What length of service in ice should be required? ____months/years? (delete as appropriate)					
Classroom instruction	•	•	•	•	•
What duration of classroom instruction should be required? ____days/weeks/months? (delete as appropriate)					
Simulator training	•	•	•	•	•
How many hours simulator experience should be required? ____hours					
Examination	•	•	•	•	•
Other method (please explain)	•	•	•	•	•

6. Should there be one level of endorsement or two levels as in the Tanker Endorsement? _____One. _____Two.

7. Are you aware of any promulgated or recommended standards for ice navigators that may exist, and if so where? Can you forward copies or extracts?

8. Are you aware of any relevant papers and discussions or publications that may exist, and if so, where? Can you forward copies or extracts?

9. Any other comments.

Please return completed form and any further comments to:

David Snider
Operations Development Co-ordinator
Canarctic Shipping Company Limited Facsimile (613) 234-9747

ANNEX 2

INTERNATIONAL ICE NAVIGATOR ROLE SPECIFICATION

DUTIES/TASKS	SKILL	KNOWLEDGE	WEIGHT	FACTOR
			LEVEL 1	LEVEL 2
Vessel Preparation		Detailed knowledge of ballast and trim and relation to ice cargo stowage requirements effects of extreme cold on water, steam lines etc. hull obstructions and hull coatings requirement for FF & LS eqpt to be used lack of repair facilities in Arctic regions	2.0	1.0
Interpret Ice Imagery		Knowledge of Ice physics ice types and properties ice formation and growth ice motion relative to wind and tidal current meteorological effect on ice and ice climatology		
	Skilled in estimation of ice type and concentration	Knowledge of ice types		
	Skilled in visual ice condition interpretation	Knowledge of visual ice signs day and night		
	Skilled in interpretation of ice imagery	Knowledge of international ice coding Knowledge of advantages and disadvantages of various ice imagery systems		
	ice chart interpretation	Knowledge of ice chart symbology ice chart "ice egg" reporting relationship to ice regimes and understanding	8.0	2.0
	radar image interpretation	Knowledge of radar/ice use of gain and clutter adjustments understanding effects of analog vs. digital display understanding effects of 3cm vs. 10cm use of range switching shadow interpretation		
	SAR/SLAR/RADARSAT interpretation	Knowledge of Synthetic Aperture Radar Side Looking Airborne Radar Radarsat high resolution Synthetic Aperture Radar		

Conduct Emergency Procedures	Skilled in use of shipboard damage control eqpt Skilled in directing personnel in reacting to emergency situations	Knowledge of shipboard DC Knowledge of effects of Arctic environment on FF & LS equipment and practices pollution prevention and control practices Awareness of arctic survival techniques	1.0	3.0
Tactical Passage Planning	Skilled at immediate situation appraisal and decision making though effective risk analysis Skilled at Bridge Team operation	Knowledge of differences in nature of piloting strategy development open water transit (<10% ice coverage) in ice transit icebreaking transit icebreaker assisted transit Knowledge of Bridge Team Management practice roles and tasks of team personnel contingency planning	3.0	1.0
Navigate Ship In High Latitudes	Skilled in use of electronic fixing aids Skilled in the use of magnetic compass	Knowledge of limitations of various fixing aids particular attention to GPS/chart datum relation Knowledge of limitations to terrestrial methods	2.0	0.5
Operate Ship IAW all Applicable National and International Regulations	No applicable skill	Knowledge of, understanding and focus on relevant sections of: Arctic Shipping Pollution Prevention Regulations Arctic Waters Pollution Prevention Regulations Shipping Safety Control Zones Order Ice Regime Shipping Control System Awareness of International Regulations	2.0	1.0
Conduct Operations with Icebreakers	Skill at manouevreing and operating in company with other ships	Detailed knowledge of icebreaker operating methods signals and communications emergency procedures safe distances and speeds convoy operating methods	1.0	3.0
TX/RX all Applicable reports	Skilled in use of HF radio, Satellite comms	Detailed knowledge of reporting requirements of IRSCS after action reports NORDREG/ECAREG Canada Shipping Act Ice reports SOLAS req'd Ice reports Detailed knowledge of: Ice Advisories and forecasts International Ice Patrol	2.0	2.0

		ice coding, terminology and reporting ("ice egg")		
Maneuver Ship in Ice Infested Waters	Skilled in all aspects of ship handling in ice	Knowledge of ship handling in ice own ship capability and technology awareness of international ship ice class equivalencies how to maneuver in ice		
	approaching and entering ice	approaching ice safe speed in ice entering ice transit in ice	3.0	1.0
	prevention of becoming beset	avoiding action preventing being beset hazards of astern movements		
	freeing beset ship	freeing own ship freeing beset ship in company being freed by an icebreaker		
	berthing and unberthing ship	berthing/unberthing ship condition alongside	1.0	3.0
	towing and being towed	anchoring towing handling damaged ship		
Strategic Passage Planning	Skill at broad situation appraisal and decisionmaking through effective risk analysis Skilled in strategic navigational planning	Knowledge of risk analysis methodology Detailed knowledge of passage planning methods appraisal planning execution monitoring Knowledge of passage planning resources available publications charts ice imagery and forecasts international resources Knowledge and understanding of environmental impact cultural/social impact	0.5	2.0
	Skilled in application of Ice Regime Shipping Control System	Detailed knowledge of Ice Regime Shipping Control System	1.0	3.0

ANNEX 3

SKILLS AND KNOWLEDGE SUBJECT CLASSES

Knowledge of Ship (operation and capability)

Knowledge different ship ice classes, capabilities in ice and technology
- international ice class equivalencies

Knowledge of Emergency Procedures in the Arctic Environment
- shipboard DC
- requirement for FF & LS eqpt to be used
- lack of repair facilities in Arctic regions
- pollution prevention and control
- awareness of Arctic survival techniques

Detailed knowledge of
- ballast and trim and relation to ice
- cargo stowage requirements
- effects of extreme cold on water, steam lines etc.
- hull obstructions and hull coatings

Knowledge of advantages and disadvantages of various ice imagery systems

Knowledge of
- ice chart symbology
- ice chart "ice egg" reporting
- relationship to ice regimes and understanding

Knowledge of radar/ice
- use of gain and clutter adjustments
- understanding effects of analog vs. digital display
- understanding effects of 3cm vs. 10cm
- use of range switching
- shadow interpretation

Knowledge of
- Synthetic Aperture Radar
- Side Looking Airborne Radar
- RADARSAT high resolution Synthetic Aperture Radar

Environment (geography and ice conditions)

Knowledge of limitations of various fixing aids

Knowledge of limitations to terrestrial methods

Knowledge and understanding of
- environmental impact
- cultural/social impact

Knowledge of Ice physics
- ice types and properties
- ice formation and growth
- ice motion relative to wind and tidal current
- meteorological effect on ice and ice climatology

Knowledge of ice types

Knowledge of visual ice signs day and night

Detailed knowledge of:
- Ice Advisories and forecasts
- International Ice Patrol

Detailed knowledge of ice coding and reporting terminology/“ice egg” format

Piloting Strategies

Knowledge of ship handling in ice
- how to manouevre in ice
- approaching ice
- safe speed in ice
- entering ice
- transit in ice
- avoiding action
- preventing being beset
- hazards of astern movements
- freeing own ship or freeing beset ship in company
- being freed by icebreaker
- berthing/unberthing ship
- condition alongside
- anchoring
- towing
- handling damaged ship

Knowledge of differences in nature of
- piloting strategy development
- open water transit (<10% ice coverage)
- in ice transit
- icebreaking transit
- icebreaker assisted transit

Knowledge of risk analysis methodology

Knowledge of Bridge Team Management practices
- roles and tasks of team personnel
- contingency planning

Detailed knowledge of strategic planing methods
- appraisal
- planning
- execution

monitoring

Knowledge of planning resources available
- publications
- charts
- ice imagery and forecasts
- international resources

Knowledge of icebreaker operations
- signals and communications
- emergency procedures
- safe distances and speeds
- convoy operating methods

Detailed knowledge of reporting requirements of
- IRSCS after action reports
- NORDREG/ECAREG
- Canada Shipping Act Ice reports
- SOLAS req'd Ice reports

Knowledge of, and understanding relevant sections of
- Arctic Shipping Pollution Prevention Regulations
- Arctic Waters Pollution Prevention Regulations
- Shipping Safety Control Zones Order
- Ice Regime Shipping Control System

Awareness of International Regulations

ANNEX 4

Extract from
"Regulations for Navigation on the Seaways of the Northern Sea Route"

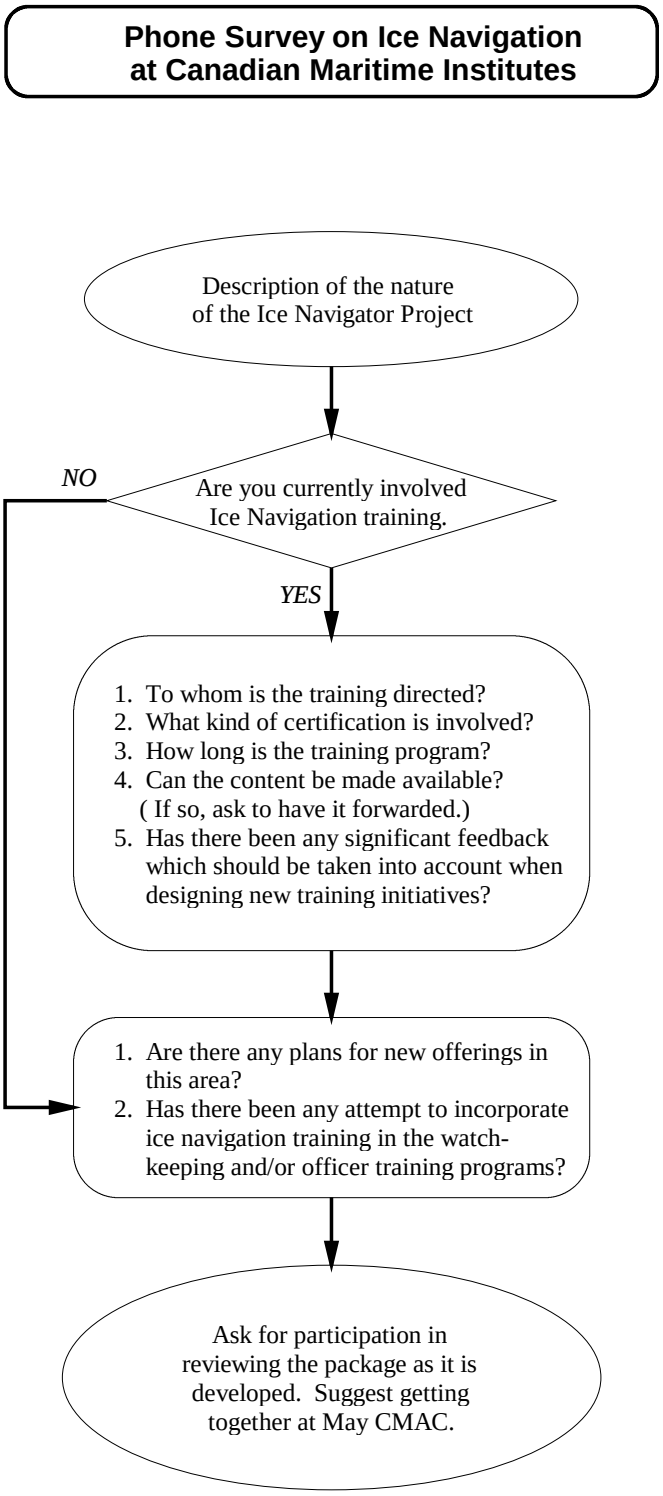
"4. REQUIREMENTS FOR VESSELS AND COMMAND PERSONNEL

To navigate the Northern Sea Route, a vessel shall satisfy special requirements while the Master, or the person that performs his duties, shall be experienced in operating the vessel in ice.

In case (sic) where those persons have no such experience, or when the Master requests so, the Administration (Marine Operation Headquarters) may assign a State Pilot to the vessel to assist in leading it through the Northern Sea Route."

ANNEX 5

Marine Institute Phone Survey



ANNEX 6

Draft letter to initiate next phase of dialogue with other Institutes in preparation for CMAC in May, 1995

???????????
???????????

April ?, 1995

Dear ????:

As discussed in our phone conversation, the Marine Institute is working with Canarctic Shipping Ltd. to develop an Ice Navigator course for the Ship Safety Northern Region of Canadian Coast Guard. Upon completion, this course will be made available to all maritime training institutes in Canada. We look forward to discussing our work to date with you coincident with the CMAC conference in May.

Attached you will find a conceptual framework for the course along with some of the outstanding issues as identified to date. It is our hope that the appropriate individuals at your Institute will review this documentation and provide input based on their experience and knowledge of this area. If it were possible to receive written comments prior to the meeting in May, we would be in a better position to optimally structure the discussions at that time. In any case, we would appreciate it if your representative(s) to CMAC have the input from all of the individuals at your Institute who are in a position to contribute to this project.

In addition to the above, the ASPPR Subcommittee on Training and Certification recommended that basic ice navigation training be considered for inclusion in watchkeeping certification programs. We would like to see this issue discussed at the May meeting as well, since it may impact on the proposed Ice Navigator training in the long term (e.g. provision of prior knowledge of ice navigation basics). To this end, the attached document also asks a number of questions regarding the inclusion of ice navigation fundamentals in the watchkeeping certification programs.

I appreciate your time and assistance in facilitating this request. If you have any questions or concerns regarding this initiative, please don't hesitate to contact me directly for clarification. We look forward to your comments and to our discussions in May.

Regards,

Andrew Fisher, M.Eng., P.Eng.
Director of Programs, School of Maritime Studies

ANNEX 7

List of Canadian Maritime Institute Contacts

Capt. Roman Piechocki
Associate Dean
Pacific Marine Training Institute
BC Institute of Technology
265 West Esplanade
North Vancouver, BC
V7M 1A5

phone: 604-985-0622
fax: 604-985-2862

Capt. Tom Kearsey
Principal
Nautical Institute
NS Community College
P.O. Box 1225
226 Reeves Street
Port Hawkesbury, NS
B0E 2V0

phone: 902-625-0193
fax: 902-625-0193

Mr. Alan Woodford
Academic Director, Marine Programs
Georgian College
P.O. Box 600
1150 8th St. East
Owen Sound, ON
N4K 5R4

phone: 519-376-0682
fax: 519-376-5395

Mr. Brian Keefe
St. Lawrence College
Windmill Point
Cornwall, ON
K6H 4Z1

phone: 613-933-4693
fax: 613-937-1523

Mr. Robert Pelletier
Directeur
Institut Maritime du Quebec
203 chemin des Iles
Levis, Quebec
G6V 7M5

phone: 418-835-1621
fax: 418-835-0192

Mr. Jim Calvesbert
Superintendent of Navigation and
Logistics Training
Canadian Coast Guard College
1190 West Mount Rd
P.O. Box 4500
Sydney, NS
B1P 6L1

phone: 902-564-3660
fax: 902-562-6113

International Shipping and Operations Contacts

COUNTRY	COMPANY	FIRST CONTACT	PHONE	FAX
Argentina	Direccion Nacional Del Antartico	Dr Juan Vincente Sola	44-0072/6313	
Denmark	Royal Arctic Lines	Claus Pavar -VP Ops	299-2-24-20	24-50
Finland	Kvaerner Masa Yards	Goran Wilkman	358-0-194-2540	194-2527
Finland	Neste Oy	Capt Pekka Inkinen	358-0-4501 ?	358-0-450-4777
Finland	Neste Oy	Juhani Laapio	358-0-450-4350	358-0-450-4777
Finland	Neste Oy	Olli Kaljal-planning mgr	358-0-450-4729	450-4555
Norway	Fiskeritenkniske Hogskole College of Marine Studies	Norvald Kjerstad	47-701-25-228	22-248
Norway	Trondheim	Soren Peter Kjelden	47-73-52-83-20	73-51-70-22
Russia	Intaari -SPB	Dimitri Golev	011-7-812-352-37-57	352-16-41
Russia	RF MOT NSR Admin	Capt Boris Matveev	via Golev	
Russia	Russian Federation Ministry of Transport	Capt Vladimir Mikhailichenko	011-7-095-926-1696	926-9128
Sweden	National Maritime Administration -Sweden	Anders Backman	46-11-19-12-15	46-11-10-31-00
United Kingdom	BP Shipping -	Doug Brown	442-22-5571	442-22-4327
United Kingdom	Scott Polar Research Institute	Dr. Gareth Rees	011-44-223-336-559	336-549
United Kingdom	Scott Polar Research Institute	Kristian Teleki	44-1223-336558	336-549
United States	AMOCO - tulsa	Denis Blanchet	918-660-3214	660-3274
United States	ARCO Exploration and Production - Plano, TX	Emilio Corona	214-509-6529	509-3280
United States	ARCO Marine, Inc - Long Beach	David Sucharski	310-590-4527	983-3310
United States	EXXON Company - Houston	Philip J. Grossweiler	713-656-7033	656-7100
United States	Ocean Ship Holdings - Houston	Calvin Bancroft	713-579-3700	579-3329
United States	Texaco Marine Services	Merv Hutton	409-723-6665	723-6797
United States	USCG	Capt Alan Summy	202-267-1450	267-4425
United States	USCG	LCdr Stephen Wheeler	202-267-1453	267-4425

Canadian Shipping and Operations Contacts

COMPANY	FIRST CONTACT	PHONE	FAX
Arctic Operations International	Capt Dave Johns	604-752-5060	752-5060
BC Department of Transport - Marine	Gavin Brown	604-387-1391	389-6066
Bedford Institute of Ocean Sciences	Al Adams	902-426-7294	426-1890
CA Crosbie Shipping	Fred Taylor	514-849-6194	849-0238
Canmar	Alex Hotchkiss	403-298-2875	298-2883
CCG	Ian Marr -	613-993-0007	
CCG - Icebreakers	Ivan Cote	613-990-9957	991-4820
CMSG	Earl Simpson	905-227-7544	991-4820
Company of Master Mariners	Dave Jenkins (CCG)	613-991-3137	993-8196
Enerchem	Joe Pascale	514-395-4525	395-4576/77
Fednav	Stephen Chan	514-878-6500	878-6689
Institute of Ocean Sciences-Sidney	Capt Ray MacKenzie	604-363-6546	363-6724
JD Irving, Kent Line	George Hill	506-632-1666	632-0116
Marine Atlantic	Don Saturley	709-772-5725	
Nautical Institute - BC Branch	Jim Arnott	604-985-0622	985-2862
Nautical Institute - Newfoundland Branch	Dennis Drown	709-753-9173	738-1905
Norland Science and Engineering	Doug Hagen	613-236-5876	238-1734
Northern Transportation Company Limited	Paul Preville	403-423-9201	424-1935
PMTC of BCIT	Roman Piechocki	604-985-0622	985-2862
Rigel Shipping	Brian Ritchie	506-533-9000	532-6300
Soconav	Carole Brown	514-281-0141	845-2175
Transport Degagnes	Paul Cote	418-692-1000	692-6044
Transportation Safety Board of Canada	Capt Eric Snow	819-953-1572	953-1583

ANNEX 8

NAVIGATION 3100: ***Copy of ice navigation related section from Marine Institute course in navigation***

TYPE AND PURPOSE: This advanced course in navigation prepares for a pre-scheduled MOT 041 exam. In addition it develops the student's knowledge to analyze and solve problems connected with the safe and economic conduct of a passage. The aim of this course is to develop an understanding of chartwork and pilotage up to and beyond that required for the Watchkeeping Mate Certificate of Competency.

CALENDER ENTRY: Navigation Procedures; Advanced Chartwork; The Compass; Pilotage; GPS; and Navigation Passage Making/Planning

PREREQUISITES: Navigation 2300
12 Months Approved Sea Time

SCHEDULE:

Duration:	13 weeks
Lectures:	4 hours/week = 52 hours
Laboratories:	4 hours/week = 52 hours

TEXTS:

Coolen, Edward. J. (1987). Nicholls's Concise Guide to Navigation (Volume 1). Glasgow, Great Britain: Brown, Son & Ferguson, Ltd. ISBN 0 85174 539 3

Blance, A. G. (Ed.). (1983). Norie's Nautical Tables. Cambridgeshire, England: Imray Laurie Norie and Wilson. ISBN 0 85288 091 x

Bowditch, N. (1984). American PracticalNavigator. (Volumes 1 & 2). Washington, D.C.: Defense Mapping Agency Hydrographic Center.

Canadian Coast Guard. (1985). Recommended Code of Nautical Practices and Procedures Ottawa, Ontario. Transport Canada. (TP 1018).

Canadian Hydrographic Service. (January, 1988). Chart No.1: Symbols and abbreviations used on Nautical Charts. Ottawa, Ontario.

COURSE AIMS: This course will develop the student's ability:

1) To demonstrate a thorough knowledge of the responsibilities and role of a ship's navigator.
2) To solve chartwork and pilotage problems beyond that required for the Watchkeeping Mate Certificate of Competency.
3) To recognize the hazards involved with navigation in ice.
4) To better understanding the role of the navigator in ice infested waters.
5) To list the precautions to be taken in restricted visibility.
6) To describe the components, operation, and limitations of the gyro and magnetic compass.
7) To explain the operation of GPS.
8) To solve parallel, plane, and Mercator sailing problems.
9) To analyze problems associated with the safe and economic conduct of a passage.

MAJOR TOPICS:

1.0 Navigation Procedures
2.0 Advanced Chartwork
3.0 The Compass
4.0 Pilotage
5.0 GPS
6.0 Navigation Passage Making/Planning

COURSE OUTLINE:

1.0 Navigation Procedures
- 1.1 Position Fixing
- 1.2 Current and Leeway
- 1.3 Tides

2.0 Advanced Chartwork
- 2.1 Three-bearing Problem
- 2.2 Circles of Position
- 2.3 Errors of Position
- 2.4 Chart Corrections
- 2.5 Navigation Safety

3.0 The Compass
- 3.1 Magnetic Compass
  - 3.1.1 Construction
- 3.2 Gyrocompass
  - 3.2.1 Properties of a Free Gyroscope
  - 3.2.2 Components of a Gyro Compass
  - 3.2.3 Errors

3.2.4 Compass Repeater Systems/Automatic Pilot

4.0 Pilotage
- 4.1 Pilotage
- 4.2 Navigation in Restricted Visibility
- 4.3 Navigation in Ice

5.0 GPS
- 5.1 Principle
- 5.2 Differential GPS
- 5.3 Accuracy
- 5.4 Summary

6.0 Navigation Passage Making/planning
- 6.1 Passage Planning
- 6.2 Sailings

LEARNING OBJECTIVES:
THE EXPECTED LEARNING OUTCOME IS THAT THE STUDENT WILL BE ABLE TO:

1.0 Navigation Procedures

1.1 Basic Chartwork Review

- Demonstrate an ability to properly use charts produced by the major projections in common use.
- Demonstrate a thorough knowledge of the Canadian buoyage system and CHART #1.
- Use publications at the disposal of the navigator .
- Take and plot visual bearings.
- Fix a vessel's position by various means including electronic navigation aids.
- Determine compass error by various means including taking amplitudes or azimuths of celestial bodies.

1.2 Current and Leeway

- Demonstrate an ability to estimate a vessel's position allowing for the effects of wind and/or tide.
- Demonstrate an ability to lay off safe courses allowing for wind and/or tide.

1.3 Tides

- Demonstrate a thorough knowledge of tidal theory.
- Demonstrate an ability to calculate the heights and times of reference and secondary ports.
- Determine tidal stream rates and times from tide tables.
- Demonstrate an ability to calculate the time at which a required height of tide (or depth of water) is reached.

2.0 Advanced Chartwork

2.1 Three-bearing Problem

- Demonstrate an ability to determine course made good and fix a vessel's position using the 3- bearing method.

2.2 Circles of Position

- Calculate a vessel's position using the circles of position method.

2.3 Errors of Position

- Describe the errors associated in taking and laying off bearings.
- Select the most suitable objects for observation when taking bearings and ranges.
- Determine displacement of fix when the same error is present in two bearings.
- Define "circular error" when taking horizontal sextant angles.
- State when a "circular error" occurs.
- Determine "most probable position".
- State the action to be taken when a "cocked hat" has resulted.
- Enumerate on the errors associated with "chart distortion".

2.4 Chart Corrections

- Explain the importance of maintaining up-to-date charts.
- Demonstrate an ability to correctly apply permanent, preliminary (P) and temporary (T) chart corrections.
- Explain the procedure for recording chart corrections.
- Explain the procedure for the reporting of uncharted objects to the relevant authorities.

2.5 Navigation Safety

- Expand on the purpose and use of traffic separation schemes and routing systems.
- Demonstrate a knowledge of the function, purpose, and use of vessel traffic services.
- List the precautions to be taken when relying on buoys.
- Obtain information from radio navigational warning systems.
- Use information from radio navigational warning systems.

3.0 The Compass

3.1 Magnetic Compass

3.1.1 Construction

- Describe the construction of a dry card compass.
- Describe the construction of a liquid compass.
- Enumerate the various factors which determine the optimum siting of a magnetic compass.
- Explain the care and maintenance of a magnetic compass.

3.2 Gyrocompass

3.2.1 Properties of a Free Gyroscope

- Define gyroscopic inertia.
- Explain the precession of a free gyroscope.

- Explain "tilt" in relation to latitude and azimuth.
- Describe "tilt" in relation to latitude.
- Explain "drift" and "tilt" in relation to the earth's rotation.

3.2.2 Components of a Gyro Compass

- Explain how a free gyroscope is converted to a gyro compass.
- Describe the different methods of control of a gyro scope.
- Explain gravity and sensing control using a liquid ballistic.

3.2.3 Errors

- Describe latitude, course, and speed errors, and their associated corrections.
- Enumerate the advantages and disadvantages of a gyro compass versus a magnetic compass.

3.2.4 Compass Repeater Systems/Automatic Pilot

- Explain the principle and operation of a gyro repeater system.
- Explain the basic principles and operation of automatic pilot systems.
- List the steps required to prepare a gyro compass and repeaters for use.

4.0 Pilotage

4.1 Pilotage

- List the preparations for pilotage, including the use of available charts and publications.
- Identify the navigational aids in pilotage situations.
- Use navigational aids in pilotage situations.
- Enumerate on-bridge practices and procedures in pilotage situations.
- List the common failures in piloting.
- Identify the obligations and responsibilities of the ship's navigational personnel when the pilot is employed.
- Describe the importance of maintaining a record of a vessel's progress.

4.2 Navigating in Restricted Visibility

- Describe the precautions to be taken when navigating in restricted visibility.
- Utilize knowledge of the Collision Regulations and the publication "Recommended Code of Nautical Practices and Procedures" in conducting and planning passages in restricted visibility.
- List the common navigational errors associated with navigation in restricted visibility.

4.3 Navigation in Ice

- Demonstrate a thorough knowledge of the publication ©Ice Navigation in Canadian Waters[a].
- Describe the role and importance of the ice navigator .
- State the precautions to be taken while navigating in ice infested waters.

- State the importance of proper communications with engine room personnel when a vessel is operating in ice.
- Recognize the hazards associated with navigation in ice including radar detection of ice, operating in ice, weather, and visibility.
- Collate information on ice conditions .
- Explain the function of the International Ice Patrol.
- Describe the signs of pack ice and open water.
- List the services available from the Canadian Coast Guard to assist vessels navigating in ice.
- State the requirements of ships operating in ice.

5.0 GPS

5.1 Principle

- Describe the operational characteristics of GPS.
- Describe the method of GPS Position Fixing.
- Describe the satellite orbits and methods of satellite transmissions.
- Describe receiver operation.
- State position accuracy.

5.2 Differential GPS

- Enumerate on the principles of differential GPS.
- State the accuracy of differential GPS.

5.3 Accuracy

- Differentiate between DOP, PDOP, HDOP, VDOP, and TDOP.
- List the fixed and variable errors which affect position accuracy.
- Explain ionospheric delay.
- Define clock error.
- Explain tracking error.
- Define Multi-path error.

5.4 Summary

- List the advantages and disadvantages of GPS and DGPS.
- Compare GPS and DGPS with other navigation systems.

6.0 Navigation Passage Making/Planning

6.1 Passage Planning

- Explain the necessity for passage planning.
- Describe the principles contained in the publication © A Guide to the Planning and Conduct of Sea Passages[a].
- Use the principles contained in the publication © A Guide to the Planning and Conduct of Sea Passages[a].
- Describe the procedure in planning an approach to a particular coast.

- Plan the execution of a passage.
- Appraise the criteria for the selection of a specific route having regard to economy of time and fuel, minimization of weather damage, navigational safety, the constraints of loadline areas, and the prevailing winds and currents expected.
- Monitor the progress of a passage.
- Describe the principles involved when making landfall in thick and clear weather and also in selecting a suitable anchorage.

6.2 Sailings

- Demonstrate the ability to solve parallel, plane, and Mercator sailing problems.
- Solve problems which combine the various sailing methods by nautical tables and/or formula.

EVALUATION:	Term Tests	20%
	Mid-term Examination	30%
	Assignments	10%
	Final Examination	40%
	Total	100%
Pass Requirement:	M.O.T. Examinations	100% - 70%