

# **Model Course on Navigation in Polar Waters**

**Theme: Navigational challenges & MET**

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And

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## **Introduction**

### ***Purpose of the model course***

The safety of ships operating in the harsh, remote and vulnerable polar areas and the protection of the pristine environments around the two poles have always been a matter of concern for the shipping industry. During last decades, the increased melting of Arctic sea ice due to the environmental change leads to a longer navigation season for ships, improved accessibility for shipping, and extended use of shipping routes along NEP (Northeast Passage) and NWP (Northwest Passage). Trends and forecasts indicate that polar shipping will grow in volume and diversify in nature over the coming years and these challenges need to be met without compromising either safety of life at sea or the sustainability of the polar environments.

Many relevant requirements, provisions and recommendations therefore have been developed over the years by International Maritime Organization (IMO). In November 2014, IMO adopted the International Code for Ships Operating in Polar Waters (Polar Code), and related amendments to the International Convention for the Safety of Life at Sea (SOLAS) to make it mandatory, marking an historic milestone in the shipping industry to protect ships and people aboard them, both seafarers and passengers, in the harsh environment of the waters surrounding the two poles. The expected date of entry into force of the SOLAS amendments is 1 January 2017, under the tacit acceptance procedure. IMO's Marine Environment Protection Committee (MEPC) adopted the necessary amendments to make the environmental provisions in the Polar Code mandatory under International Convention for the Prevention of Pollution from Ships (MARPOL) in May 2015, with an entry-into-force date to be aligned with the SOLAS amendments.

The Polar Code covers the full range of design, construction, equipment, operational, training, search and rescue and environmental protection matters relevant to ships operating in the inhospitable waters surrounding the two poles.

The purpose of this model course is to assist maritime training institutes and their teaching staff in organizing and introducing the material of training course for seafarers working onboard ship operating in polar waters. It is not the intention of this model course to present instructors with a rigid "teaching package" which they are expected to "follow blindly". Nor is it the intention to substitute audio-visual or "programmed" material for the instructor's presence. As in all training endeavours, the knowledge, skills and dedication of the instructor are the key components in the transfer of knowledge and skills to those being trained through this model course material.

In order to keep the course up to date in future, it is essential that users provide feedback. New information will provide better training in safety at sea and protection of the marine environment. Information, comments and suggestions should be sent to the Office of the International Association of Maritime Universities (IAMU) at Tokyo, Japan.

### ***Structure of the model course***

For ease of reference, the course is divided into five sections.

Part A provides the framework for the course with its scope and objective and notes on the suggested teaching facilities and equipment. A list of useful teaching aids, IMO references and textbooks is also included.

Part B provides an outline of lectures, demonstrations and exercises for the course, together with a suggested sequence for both basic training (Part B1) and advanced training (Part B2). From the teaching and learning point of view, it is more important that the trainee achieves the competence than that a strict teaching hours for each topic is followed. Depending on their experience and ability, some students will naturally take longer to become proficient in some topics than others.

Part C gives the Detailed teaching syllabus also for both basic training (Part C1) and advanced training (Part C2). It is presented in a logical sequence, starting with basic knowledge and information on safety operation, legislative requirements and emergency response. Each subject area is covered by a series of required performances, in other words what the trainee is expected to be able to do as a result of the teaching and training. In this way the overall required performance of knowledge, understanding and proficiency is met. IMO references, textbook references and suggested teaching aids are included to assist the teacher in designing lessons.

Part D contains an Instructor manual. Against each heading in the detailed teaching syllabus the teaching guidelines have been divided into Subject matter details, Recommended presentation and Assessment technique.

It is envisaged that such micro level division of each heading in the teaching syllabus will give the instructor, with varied backgrounds around the world, ample guidelines on developing his/her work plan, as well as the flexibility to adapt keeping in mind the level of the trainees. Furthermore, additional notes as well as simulator exercises for instructors who may have access to a simulator have also been provided.

Part E provides an overall principle, method and comparison relating to the evaluation/assessment which are generally applied in the maritime education and training sectors. Ideally, instructors are recommended to be familiar with the contents and to evaluate/assess the trainees, as appropriate.

### ***Use of the model course***

To use the model course the instructor should review the course outline and detailed syllabus, taking into account the information provided under the entry standards specified in the course framework. The actual level of knowledge and skills and the prior technical education of the trainees should be kept in mind during this review, and any areas within the detailed syllabus which may cause difficulties because of differences between the actual trainee entry level and that assumed by the course designer should be identified. To compensate for such differences, the instructor is expected to delete from the course, or reduce the emphasis on, items dealing with

knowledge or skills already attained by the trainees. They should also identify any academic knowledge, skills or technical training which they may not have been acquired.

Within the course outline the course designers have indicated assessment of the time which should be allotted to each area of learning. However, it must be appreciated that these allocations are arbitrary and assume that the trainees have fully met all entry requirements of the course. The instructor should therefore review these assessments and may need to reallocate the time required to achieve each specific learning objective or training outcome.

### ***Aims***

This course provides training to candidates to be duly qualified with specific duties and responsibilities related to ships operating in polar waters. It comprises a basic training programme and an advanced training programme appropriate to their duties and responsibilities, including knowledge of ice, safety measures, pollution prevention, operational practice and obligations under applicable law and regulations, respectively.

Any of these trainings may be given on board or ashore. It could be by practical training on board or in a suitable shore-based installation.

### ***Presentation***

The presentation of concepts and methodologies must be repeated in various ways by assessing and evaluating the trainee's performance and achievements until it satisfies the instructor, that the trainee has attained the required proficiency under each specific learning objective or training objective. The syllabus is laid out in the form of acquiring knowledge, understanding and proficiency format and each objective specifies what the trainee must know or be able to do as the learning or training outcome. The Instructor manual provides explanations and suggestions for practical, communicative classroom activities to assist the instructor to implement the model course effectively.

### ***Implementation***

Thorough preparation is the key to successful implementation of the course. For the course, to run smoothly and to be effective, considerable attention must be paid to the availability and use of:

- Properly qualified instructors
- Support staff
- Rooms and other spaces
- Workshops and equipment
- Suggested references, textbooks, technical papers, bibliography, and
- Other reference material.

In order to assist the instructor, references are shown against the learning objectives to indicate key textbooks, maritime publications, additional technical material, video material and other teaching aids which the instructor may wish to use when preparing course material.

The following codes are used to categorize the teaching materials cited in the Bibliography for this model course:

- IMO references (indicated by R)
- Teaching aids (indicated by A)
- Textbooks (indicated by T)
- Publications (indicated by P)
- Video material (indicated by V)

### ***Training and STCW 2010 Amendments***

To date, requirements for the training and certification of personnel serving on board ships operating in polar waters were agreed by the Sub-Committee on Human Element, Training and Watchkeeping (HTW), when it met for its second session in February 2015. The draft amendments provide training and certification requirements for officers and crew serving on board ships operating in polar waters in chapter V of the STCW Convention and Code to reflect the training requirements in the Polar Code. The STCW amendments will be forwarded to the Maritime Safety Committee (MSC) for approval and subsequent adoption. The expected date of entry into force of the STCW amendments is 1 January 2018, under the tacit acceptance procedure.

Therefore, the course is developed under the guidance that the contents provided in this course should be consistent with the minimum standard of competence specified in the amendments of STCW Convention and Code agreed by the IMO HTW so far as much as possible, together with additional information provided by the shipping industry.

## **Part A: Course Framework**

### ***Entry standards***

This course is principally intended for seafarers meeting the training requirements related to ships operating in polar waters. Entrants for basic training should have successfully completed a course covering the minimum standards required for certification. Entrants for advanced training should have successfully completed a course covering the minimum standards required for certification. In addition they should have completed approved seagoing experience service or equivalent.

### ***Course certificate***

On successful completion of the course and assessments, a document may be issued by training establishments certifying that the holder has successfully completed the training which meets the level of knowledge and competence for seafarers onboard ships operating in polar waters specified in this course.

### ***Course intake limitations***

It is recommended that the number of trainees should not exceed 20 and practical training should be undertaken in small groups of not more than eight. The teacher to trainee ratio would therefore be 1:20 for classroom teaching and 1:8 for practical instruction.

### ***Staff requirements***

The instructor shall have appropriate training in instructional techniques and training methods. It is recommended that all training and instruction are given by qualified personnel experienced in operating ships in polar waters.

### ***Teaching facilities and equipment***

Ordinary classroom facilities and an overhead projector are sufficient for most of the course. However, dedicated CBT modules to be run on an ordinary PC as well as exercises on a shiphandling simulator, will greatly enhance the quality and result of the course. In such cases sufficient PCs and simulator terminals for use by one or two trainees will be required. In addition, a video player will be required if using videos in the teaching program. Other recommended teaching facilities and equipment are listed in the Bibliography section.

### ***Use of Simulators***

The revised STCW Convention sets standards regarding the performance and use of simulators for mandatory training, assessment or demonstration of competence. The general performance standards for simulators used in training and for simulators used in assessment of competence are given in Section A-I/12. Simulator-based training and assessment is not a mandatory requirement for this course training. However, it is widely recognized that well-designed lessons and exercises can improve the effectiveness of training.

If using simulator-based training, instructors should ensure that the aims and objective of these sessions are defined within the overall training program and that tasks are selected so as to relate as closely as possible to shipboard tasks and practices.

## ***Bibliography***

### **IMO references (R)**

- R1: "Guidelines for ships operating in polar waters"
- R2: "Guidances on arctic navigation in the northeast route"
- R3: "Particularly Sensitive Sea Areas (PSSA)" 2007 edition
- R4: "The International Code for Ships Operating in Polar Waters"
- R5: "Training requirements for officers and crew on board ships operating in polar waters"
- R6: "SOLAS Consolidated Edition", (2014)
- R7: "MARPOL Consolidated Edition", (2011)
- R8: "A Pocket Guide to Cold Water Survival", 2012 edition
- R9: "SAR Convention", 2006 edition
- R10: "Guide for cold water survival"

### **Teaching Aids (A)**

- A1: Nautical Charts
- A2: The instructor manual (Part D of this course)
- A3: Video cassette player and/or film projector
- A4: A video camera (optional)
- A5: Ship handling simulator
- A6: Firefighting installations
- A7: An item of new technology. This could be of any format, for example an educational package available on floppy disc or CD-ROM, or a computer based PowerPoint presentation
- A8: Navigating In Ice, Videotel Code No. 927
- A9: Ice imagery

### ***Publications (P)***

- P1: Captain Duke S., FNI, "*Polar ship operations*", The Nautical Institute
- P2: Norvald K., "*Ice Navigation*", 1<sup>st</sup> edition, Tapir Academic Press, Trondheim (2011)
- P3: "*Ice Navigation in Canadian Waters*", Icebreaking Program, Maritime Services, Canadian Coast Guard, Fisheries and Oceans Canada, Ottawa, Ontario (Revised August 2012)
- P4: "*Communications Instructions For Arctic Navigation 2012 – 2013 on The Northern Sea Route*" Moscow, (2012)
- P5: "Arctic Council Arctic Marine Shipping Assessment 2009 Report"
- P6: "*Arctic Waters Oil Transfer Guidelines*", Transport Canada Prairie and Northern Region, Marine, (1997)
- P7: "*Guidelines for Navigating Ice Covered Seas in Russian Territorial Waters*" Nippon Kaiji Kyokai, Class NK, (October 2009)

P8: *“Winter Navigation on the River and Gulf of St. Lawrence – Practical Notebook for Marine Engineers and Deck Officers”*, 2011 edition

P9: *“Low Temperature Operations Guidance for Arctic Shipping”*, ABS

P10: *“Rules of navigation on the water area of the Northern Sea Route”*, approved by the order of the Ministry of Transport of Russia, (dated January 17, 2013 )

P11: *“Arctic Shipping Position Paper, International Chamber of Shipping”* ICS, (2014)

P12: WMO sea ice nomenclature

P13: *“Admiralty Sailing Directions NP10 Arctic Pilot”*

P14: *“The Mariner's Handbook”*, NP100, UKHO

## Part B: Course Outline

### *Part B1: Course Outline (Basic training)*

<b>COURSE OUTLINE (24 hours)</b>				
	<b>Knowledge, Understanding and proficiency</b>		<b>Hours for lecture</b>	<b>Hours for practice</b>
<b>1</b>	<b>Basic knowledge of ice characteristics and areas where different type of ice can be expected in the area of operation</b>		4	
	1.1	Ice physics, terms, formation, growth, aging and stage of melt	2	
	1.2	Ice types and concentrations		
	1.3	Ice pressure and distribution		
	1.4	Friction from snow covered ice		
	1.5	Implications of spray-icing; danger of icing up, precautions to avoid icing up and options during icing up		
	1.6	Ice regimes in different regions. Significant differences between the Arctic and the Antarctic, first year and multiyear ice, sea ice and land ice		
	1.7	Use of ice imagery to recognize consequences of rapid change in ice and weather conditions	2	
	1.8	Knowledge of ice sky and water blink		
	1.9	Knowledge of differential movement of icebergs and pack ice		
	1.10	Knowledge of tides and currents in ice		
	1.11	Knowledge of effect of wind and current on ice		
<b>2</b>	<b>Basic knowledge of vessel performance in ice and cold climate</b>		5	
	2.1	Vessel characteristics	3	
	2.2	Vessel types, hull designs		
	2.3	Engineering requirements for operating in ice		
	2.4	Ice strengthening requirements		
	2.5	Limitations of ice-classes I		
	2.6	Winterization and preparedness of vessel, including deck and engine		
	2.7	Low-temperature system performance	2	
	2.8	Equipment and machinery limitation in ice condition and low air temperature		
	2.9	Monitoring of ice pressure on hull		
	2.10	Sea suction, water intake, superstructure insulation and special systems		
<b>3</b>	<b>Basic knowledge and ability to operate and manoeuvre a ship in ice</b>		3	
	3.1	Safe speed in the presence of ice and icebergs	1	
	3.2	Ballast tank monitoring		
	3.3	Cargo operations in the polar waters	2	
	3.4	Awareness of engine loads and cooling problems		
	3.5	Safety procedures during ice transit		
<b>4</b>	<b>Basic knowledge of regulatory considerations</b>		2	
	4.1	Antarctic Treaty and the Polar Code	1	
	4.2	Accident reports concerning vessels in polar waters	1	
	4.3	IMO standards for operation in remote areas		

<b>COURSE OUTLINE (24 hours) continued</b>				
	<b>Knowledge, Understanding and proficiency</b>		<b>Hours for lecture</b>	<b>Hours for practice</b>
<b>5</b>	<b>Basic knowledge of crew preparation, working conditions and safety</b>		4	2
	5.1	Recognize limitations of search and rescue readiness and responsibility, including radio area A4 and its SAR communication facility limitation	2	1
	5.2	Awareness of contingency planning		
	5.3	How to establish and implement safe working procedures for crew specific to polar environments such as low temps, ice covered surfaces , personal protective equipment, use of buddy system, and working time limitations		
	5.4	Recognize dangers when crews are exposed to low temperatures		
	5.5	Human factors including cold fatigue, medical-first aid aspects, crew welfare		
	5.6	Survival requirements including the use of personal survival equipment and group survival equipment		
	5.7	Awareness of the most common hull and equipment damages and how to avoid these	2	1
	5.8	Superstructure-deck icing, including effect on stability and trim		
	5.9	Prevention and removal of ice including the factors of accretion		
	5.10	Recognize fatigue problems due to noise and vibrations		
	5.11	Identify need for extra resources, such as bunker, food and extra clothing		
<b>6</b>	<b>Basic knowledge of environmental factors and regulations</b>		4	
	6.1	Identify particular sensitive sea areas regarding discharge	2	
	6.2	Identify areas where shipping is prohibited or should be avoided		
	6.3	Special areas in MARPOL		
	6.4	Recognize limitations oil-spill equipment	2	
	6.5	Plan for coping with increased volumes of garbage, bilge water, sewage, etc.		
	6.6	Lack of infrastructure		
	6.7	Oil spill and pollution in ice, including consequences		

**Part B2: Course Outline (Advanced training)**

<b>COURSE OUTLINE (40 hours)</b>				
	<b>Knowledge, Understanding and proficiency</b>		<b>Hours for lecture</b>	<b>Hours for practice</b>
<b>1</b>	<b>Knowledge of voyage planning and reporting</b>		6	4
	1.1	Information sources	2	
	1.2	Reporting regimes in polar waters		
	1.3	Development of safe routing and passage planning to avoid ice where possible	4	4
	1.4	Ability to recognize the limitations of hydrographic information and charts in polar regions and whether the information is suitable for safe navigation		
	1.5	Passage planning deviation and modification for dynamic ice conditions		
<b>2</b>	<b>Knowledge of equipment limitations</b>		6	4
	2.1	Understand and identify hazards associated with limited terrestrial navigational aids in polar regions	3	2
	2.2	Understand and recognize high latitude errors on compasses		
	2.3	Understand and identify limitations in discrimination of radar targets and ice-features in ice-clutter		
	2.4	Understand and recognize limitations of electronic positioning systems at high latitude	3	2
	2.5	Understand and recognize limitations in nautical charts and pilot descriptions		
	2.6	Understand and recognize limitations in communication systems		
<b>3.</b>	<b>Knowledge and ability to operate and manoeuvre a ship in ice</b>		8	6
	3.1	Preparation and risk assessment before approaching ice, including presence of icebergs, and taking into account wind, darkness, swell, fog and pressure ice	2	
	3.2	Conduct communications with an icebreaker and other vessels in the area and with Rescue Coordination Centre		1
	3.3	Understand and describe the conditions for the safe entry and exit to and from ice or open water, such as leads or cracks, avoiding icebergs and dangerous ice conditions and maintaining safe distance to icebergs		
	3.4	Understand and describe ice ramming procedures – including double and single ramming passage		
	3.5	Recognize and determine the need for bridge watch team augmentation based upon environmental conditions, vessel equipment and vessel ice class	2	
	3.6	Recognize the presentations of the various ice conditions as they appear on radar		
	3.7	Understand icebreaker convoy terminology, and communications, and take icebreaker direction and move in convoy		1
	3.8	Understand methods to avoid besetment and to free beset vessel, and consequences of besetment		

<b>COURSE OUTLINE (40 hours) continued</b>				
	<b>Knowledge, Understanding and proficiency</b>		<b>Hours for lecture</b>	<b>Hours for practice</b>
	3.9	Understand towing and rescue in ice, including risks associated with operation	2	
	3.10	Handling ship in various ice concentration and coverage, including risks associated with navigation in ice, and turning-backing; avoidance; etc.		2
	3.11	Use of different type of propulsion and rudder systems, including limitations to avoid damage when operating in ice		1
	3.12	Use of heeling and trim-systems; hazards in connection with ballast and trim in relation with ice		
	3.13	Docking and undocking in ice covered waters, including hazards associated with operation and the various techniques to safely and undock in ice covered waters	2	1
	3.14	Anchoring in ice, including the dangers to anchoring system – ice accretion to hawse pipe and ground tackle		
	3.15	Recognize conditions which impact polar visibility and may give indication of local ice and water conditions, including sea smoke, blink and refraction		
<b>4</b>	<b>Knowledge of safety</b>		4	2
	4.1	Understand the procedures and techniques for abandoning the ship and survival on the ice and in ice-covered waters	2	1
	4.2	Recognize limitations on fire-fighting systems and life saving appliances due to low air temperatures		
	4.3	Understand unique concerns in conducting emergency drills in ice and low temperatures	2	1
	4.4	Understand unique concerns in conducting emergency response in ice and low air and water temperatures		

## Part C: Detailed Teaching Syllabus

### *Part C1: Detailed Teaching Syllabus (Basic training)*

COMPETENCE 1	Contribute to safe operation of vessels operating in polar waters
TOPIC 1.1	BASIC KNOWLEDGE OF ICE CHARACTERISTICS AND AREAS WHERE DIFFERENT TYPE OF ICE CAN BE EXPECTED IN THE AREA OF OPERATION
Bibliography	R1,R2,R4,R5,A1,A2,A3,A8,A9,P1,P2,P3,P7,P8,P12,P13

#### TRAINING OUTCOMES:

Demonstrates basic knowledge and understanding of:

1. Ice physics, terms, formation, growth, aging and stage of melt
2. Ice types and concentrations
3. Ice pressure and distribution
4. Friction from snow covered ice
5. Implications of spray-icing; danger of icing up, precautions to avoid icing up and options during icing up
6. Ice regimes in different regions. Significant differences between the Arctic and the Antarctic, first year and multiyear ice, sea ice and land ice
7. Use of ice imagery to recognize consequences of rapid change in ice and weather conditions
8. Knowledge of ice sky and water blink
9. Knowledge of differential movement of icebergs and pack ice
10. Knowledge of tides and currents in ice
11. Knowledge of effect of wind and current on ice

## **TOPIC 1.1 BASIC KNOWLEDGE OF ICE CHARACTERISTICS AND AREAS WHERE DIFFERENT TYPE OF ICE CAN BE EXPECTED IN THE AREA OF OPERATION**

### **Required performance**

#### **1.1.1 Ice physics, terms, formation, growth, aging and stage of melt**

-describe some key elements of the physical properties of ice including: type, formation, concentration, distribution, surface feature, motion process, etc.

-introduce the definitions of ice terminology have been developed and approved by WMO

-explain the process of ice formation, growth, aging and melt

#### **1.1.2 Ice types and concentrations**

-explain new ice, Nilas, young ice, old ice, ice of land origin, medium first-year ice, thin first-year ice

-illustrate the open water, bergy water and ice free

#### **1.1.3 Ice pressure and distribution**

-explain the relationship between the ice pressure and the ice deformation

-describe the ice areas related to its distribution

#### **1.1.4 Friction from snow covered ice**

-introduce the friction between ship hull and snow covered ice

-identify the factors determining the friction from snow covered ice

-describe low friction coatings are important elements in ship performance in snow covered ice

#### **1.1.5 Implications of spray-icing; danger of icing up, precautions to avoid icing up and options during icing up**

-point out that spray-icing of ship may occur when a ship is navigating in ice-covered waters

-explain the reason of spray-icing

-explain the dangers of icing up including impairment of the stability and the safety of a ship

-state the precautions to avoid icing up and options during icing up

#### **1.1.6 Ice regimes in different regions. Significant difference between the Arctic and the Antarctic, first year and multiyear ice, sea ice and land ice**

-describe the ice regime of main areas such as Scandinavia Arctic, East Greenland,

Russian Arctic, Alaska, Canadian Arctic, West Greenland, Antarctic, Great Lakes, Gulf of St. Lawrence, East Newfoundland Waters and South Labrador Sea, etc.

-introduce the significant difference of ice regimes between the Arctic and the Antarctic by comparing first year and multiyear ice as well as sea ice and land ice

-introduce the significant difference of ice regimes between first year and multiyear ice, sea ice and land ice

**1.1.7 Use of ice imagery to recognize consequences of rapid change in ice and weather conditions**

-list the types of ice imagery

-describe the definition and categories of ice chart

-explain the egg code, symbols and colour code used on ice chart

**1.1.8 Knowledge of ice sky and water blink**

-describe the signs which can possibly implicate the approach of ice when steaming through open water and explain the reason of ice sky appearance

-describe the signs which can possibly implicate the approach of open water when steaming through ice-covered waters and explain the reason of water blink appearance

**1.1.9 Knowledge of differential movement of icebergs and pack ice**

-describe the major factors contributing to the movement of icebergs and pack ice

-recognize the differential movement of icebergs and pack ice from given samples

**1.1.10 Knowledge of tides and currents in ice**

-describe the two primary Arctic polar currents, the transpolar Drift and the Beaufort Gyre

-demonstrate the use of the ice chart by given samples

**1.1.11 Knowledge of effect of wind and current on ice**

-describe the general characteristics of wind and current in polar waters

-demonstrate the effect of wind and current on ice such as movement, formation and deformation

COMPETENCE 1	Contribute to safe operation of vessels operating in polar waters
TOPIC 1.2	BASIC KNOWLEDGE OF VESSEL PERFORMANCE IN ICE AND LOW AIR TEMPERATURE
Bibliography	R1,R2,R4,R5,A2,A3,A8,P1,P2,P3,P7,P8,P9

TRAINING OUTCOMES:

Demonstrates basic knowledge and understanding of:

1. Vessel characteristics
2. Vessel types and hull designs
3. Engineering requirements for operating in ice
4. Ice strengthening requirements
5. Limitations of ice-classes
6. Winterization and preparedness of vessel, including deck and engine
7. Low-temperature system performance
8. Equipment and machinery limitation in ice condition and low air temperature
9. Monitoring of ice pressure on hull
10. Sea suction, water intake, superstructure insulation and special systems

## **TOPIC 1.2 BASIC KNOWLEDGE OF VESSEL PERFORMANCE IN ICE AND LOW AIR TEMPERATURE**

### **Required performance**

#### **1.2.1 Vessel characteristics**

- describe the concepts of ice class and polar class
- compare the definitions between category A, B and C
- introduce the main characteristics and limitations of polar vessels such as draft, engine output and machinery

#### **1.2.2 Vessel types and hull designs**

- list the common types of vessels operating in polar waters
- illustrate the main aspects of ship hull design including forward region, midship region and aft region

#### **1.2.3 Engineering requirements for operating in ice**

- describe the requirement of propulsion system including prime movers, electric transmission, mechanical transmission, shafts and shaft-line components, propellers
- describe the requirement of steering system
- describe the requirement of auxiliary systems including cooling, freezing of piping, valves and tanks, waste disposal, fuel oil heating

#### **1.2.4 Ice strengthening requirements**

- point out the general strengthening requirements for polar ships including construction materials
- demonstrate the hull areas to be strengthened

#### **1.2.5 Limitations of ice-classes**

- introduce the basic principle of determining ice-classes
- state the limitations of ice-class influencing the ship operating in polar waters

#### **1.2.6 Winterization and preparedness of vessel, including deck and engine**

- stress the risks to be expected when ship sailing in the winter condition or in the low temperature
- describe the precautions including deck and engine to minimize the risks of commercial losses caused by winterization or in the low temperature

#### **1.2.7 Low-temperature system performance**

- describe the types of low-temperature systems and their functions

-explain the special precautions of low-temperature systems in polar waters

#### **1.2.8 Equipment and machinery limitation in ice condition and low air temperature**

-explain the main limitations of deck systems in ice condition and low air temperature

-explain the main limitations of engine room systems in ice condition and low air temperature

#### **1.2.9 Monitoring of ice pressure on hull**

-describe the importance of ice pressure monitoring for a ship when navigating in ice

-point out it is impossible to carry out the monitoring of ice pressure by way of human hands

-demonstrate the main components of ice pressure monitoring system and the function of each component including sensor, display, alert, etc.

#### **1.2.10 Sea suction, water intake, superstructure insulation and special systems**

-describe the characteristics and arrangement of the sea suction, water intake, superstructure insulation and special systems

-state the operational precautions of sea suction, water intake, superstructure insulation and special systems in low temperature

-point out that means must be provided to clear the sea bays if they do become blocked by ice

COMPETENCE 1	Contribute to safe operation of vessels operating in polar waters
TOPIC 1.3	BASIC KNOWLEDGE AND ABILITY TO OPERATE AND MANOEUVRE A SHIP IN ICE
Bibliography	R1, R2, R3, R5, A1, A2, A5, A8, A9, P1, P2, P3, P6, P8, P14

TRAINING OUTCOMES:

Demonstrates basic knowledge and ability to:

1. Safe speed in the presence of ice and icebergs
2. Ballast tank monitoring
3. Cargo operations in the polar waters
4. Awareness of engine loads and cooling problems
5. Safety procedures during ice transit

## **TOPIC 1.3 BASIC KNOWLEDGE AND ABILITY TO OPERATE AND MANOEUVRE A SHIP IN ICE**

### **Required performance**

#### **1.3.1 Safe speed in the presence of ice and icebergs**

- demonstrate preparedness to change speed at any given moment
- identify the factors that determine a safe speed
- point out the factors which determine the minimum escort distance and the maximum escort distance

#### **1.3.2 Ballast tank monitoring**

- explain the need of constant monitoring for ballast tank under cold weather
- identify the safety considerations for ballasting and deballasting operations under cold weather
- demonstrate the appropriate procedure for ballast tank monitoring under cold weather

#### **1.3.3 Cargo operations in the polar waters**

- describe the safety precautions during operation
- describe the appropriate pre-transfer preparation and operations
- describe the contingency procedures during operation in ice
- demonstrate the appropriate communications during operation

#### **1.3.4 Awareness of engine loads and cooling problems**

- identify the limitation of engine loads for ship operating in ice condition
- identify the cooling problems for engines operating in ice condition
- describe the preventive measures could be taken

#### **1.3.5 Safety procedures during ice transit**

- describe the preparation works onboard ship before entering ice-covered area including: prepare fenders, set optimal trim/draft, retract the pit sward
- identify the hazards in connection with ballast and trim in relation to ice

- point out the general manoeuvring characteristic for ships operating in ice
- describe the role of the ice pilots and ice navigators and responsibilities on the bridge
- explain why the vessel should be in manual steering mode when operating in ice
- write a standing order for operating in ice
- explain the importance of plotting the vessel's position at short intervals
- describe the extra look-out for drifting ice both visually and on radar
- compare the radar navigation in ice covered waters and sea water
- explain the bearing errors at high latitudes
- demonstrate the ability to watch out with search light
- explain the benefit of slightly lowering anchors in the hawse pipe in freezing spray conditions
- state how to monitor icing up
- state how to monitor stability of the vessel during ice transit
- discuss de-icing methods used on the ship's structure, tanks and machinery
- describe the appropriate methods to determine the type and thickness of ice floating by radar
- state the appropriate practices for entering the ice edge including: finding an area of lower ice concentration to enter the ice; determining the correct approach angle when entering ice; determining the correct way of adjusting speed and power-output, prior to ice contact as well as upon contact with ice; estimating ice thickness by observing the edges of pieces as they turn against the ship's side
- state the rules shall be followed when ship is operating in ice by daylight and at night
- describe the preparatory work and appropriate actions to be taken for close quarter situations in fairway including: engaging a bend, following a track in reduced visibility, encountering with ice bridges and reversing in ice
- describe the preparatory work and appropriate actions to be taken for passing another vessel, anchoring and towing operations, pilot transfer, berthing, unberthing and

mooring operations

-point out frequencies and services of the marine communications and traffic services in the area of operation

-recognize the visual and aural signals that will be used by the ice breaker

-demonstrate the proper communications with authorities, ice pilots, icebreakers and other vessels

-understand the different requirements and methodologies in supporting and reporting among various icebreaking support agencies or authorities

-list the data regarding own vessel usually requested by icebreaker for assistance

-understand instructions from the ice-breaker under escort

-state the precautions need to be taken when under escort

-understand the build-up of the convoy and the levels of priority

COMPETENCE 2	Monitor and ensure compliance with legislative requirements
TOPIC 2.1	BASIC KNOWLEDGE OF REGULATORY CONSIDERATIONS
Bibliography	R1,R2,R3,R4,R6,R7,A1,A2,A3,A4,P1,P2,P3,P4,P6,P10,P12,P14

TRAINING OUTCOMES:

Demonstrates basic knowledge and understanding of:

1. Antarctic Treaty and the Polar Code
2. Accident reports concerning vessels in polar waters
3. IMO standards for operation in remote areas

## **TOPIC 2.1 BASIC KNOWLEDGE OF REGULATORY CONSIDERATIONS**

### **Required performance**

#### **2.1.1 Antarctic Treaty and the Polar Code**

- describe the background and the basic contents of Antarctic Treaty
- introduce the main structure and content in the POLAR CODE
- state the requirements laid down in the various part to the POLAR CODE

#### **2.1.2 Accident reports concerning vessels in polar waters**

- describe the basic format and contents of the accident reports by using specific samples
- introduce the reporting procedure of the accident reports

#### **2.1.3 IMO standards for operation in remote areas**

- list the general contents and structure in Guidelines For Ships Operating In Polar Waters (IMO A.1024 (26)) and Guidelines For Ships Operating In Arctic Ice-Covered Waters(MSC/Circ.1056)
- describe the terms of contingency plans for passenger ships operating in areas remote from SAR facilities in Enhanced Contingency Planning Guidance For Passenger Ships Operating In Areas Remote From SAR Facilities (MSC.1/Circ.1184)
- introduce the Guidelines On Voyage Planning For Passenger Ships Operating In Remote Areas (IMO A.999(25)) and Guide For Cold Water Survival(MSC.1/Circ.1185)
- describe the stability requirements during the operation of the ship in 2008 IS CODE
- introduce the relevant provisions of the SOLAS, MARPOL, STCW and SAR conventions for operation in remote areas

COMPETENCE 3	Apply safe working practices, respond to emergencies
TOPIC 3.1	BASIC KNOWLEDGE OF CREW PREPARATION, WORKING CONDITIONS AND SAFETY
Bibliography	R1, R2, R4, R5, R6, R9, A1, A2, A5, A9, P1, P2, P3, P4, P9, P14

TRAINING OUTCOMES:

Demonstrate a knowledge and understanding of:

1. Recognize limitations of search and rescue readiness and responsibility, including radio area A4 and its SAR communication facility limitation
2. Awareness of contingency planning
3. How to establish and implement safe working procedures for crew specific to polar environments such as low temps, ice covered surfaces , personal protective equipment, use of buddy system, and working time limitations
4. Recognize dangers when crews are exposed to low temperatures
5. Human factors including cold fatigue, medical-first aid aspects, crew welfare
6. Survival requirements including the use of personal survival equipment and group survival equipment
7. Awareness of the most common hull and equipment damages and how to avoid these
8. Superstructure-deck icing, including effect on stability and trim
9. Prevention and removal of ice including the factors of accretion
10. Recognize fatigue problems due to noise and vibrations
11. Identify need for extra resources, such as bunker, food and extra clothing

## **TOPIC 3.1 BASIC KNOWLEDGE OF CREW PREPARATION, WORKING CONDITIONS AND SAFETY**

### **Required performance**

#### **3.1.1 Recognize limitations of search and rescue readiness and responsibility, including radio area A4 and its SAR communication facility limitation**

- recognize limitations of search and rescue readiness and responsibility
- review the distribution of radio areas
- state the facility limitation of SAR communication in A4 area

#### **3.1.2 Awareness of contingency planning**

- describe the importance and function of the contingency planning
- understand the basic contents of the contingency planning
- describe the contingency planning procedure during operation in ice

#### **3.1.3 How to establish and implement safe working procedures for crew specific to polar environments such as low temperatures, ice covered surfaces, personal protective equipment, use of buddy system, and working time limitations**

- introduce the types of safe working procedures for crew specific to polar environments such as low temperatures, ice covered surfaces, personal protective equipment, use of buddy system, and working time limitations
- describe the special precautions for crew working under specific polar environment
- understand the limitations for crew working under specific polar environment

#### **3.1.4 Recognize dangers when crews are exposed to low temperatures**

- define the frostnip and frostbite
- understand the factors leading to hypothermia
- understand snow blindness
- point out the protective clothing for working under low temperatures
- describe the cold weather health and safety

#### **3.1.5 Human factors including cold fatigue, medical-first aid aspects, crew welfare**

- identify the dangers of cold fatigue at sea

-point out the appropriate medical-first aid for cold injuries

-describe crew welfare onboard ship operating in polar waters

**3.1.6 Survival requirements including the use of personal survival equipment and group survival equipment**

-identify the emergency equipment onboard ship for polar waters

-demonstrate the operation procedures for emergency equipment

-identify the contents of personal survival equipment and group survival equipment for polar waters

-demonstrate the use of personal survival equipment and group survival equipment

-introduce the appropriate procedures for the maintenance of survival equipment

**3.1.7 Awareness of the most common hull and equipment damages and how to avoid these**

-compare own ship's class to polar class and ice classes

-describe ice class characteristics for given vessel

-explain the terms 'ice belt' and 'ice draft'

-state the location of ice strengthening area for own vessel

-state the trimming requirements of own vessel regarding ice class

-understand the types of steel used in the vessel construction

-introduce the effects of the brittleness of ship components due to sub-zero temperatures

-explain the influence of ice class of own vessel on operational performance

-describe the voyage limitations for different ice classed vessels considering hull strength

-recognize potential problems and counter measures for deck equipment due to sub-zero temperatures

-describe the most common hull and machinery damages in ice operations, their cause and ways to avoid them

**3.1.8 Superstructure-deck icing, including effect on stability and trim**

- identify the potential hazards for superstructure-deck icing
- describe the preventive measures used to maintain deck equipment in operational readiness in sub-zero conditions
- describe the appropriate safe considerations for the crew confronting with the superstructure-deck icing condition

**3.1.9 Prevention and removal of ice including the factors of accretion**

- identify the equipment for ice prevention and removal
- identify the resources onboard ship for ice prevention and removal
- demonstrate the operations such as winterization and bridge window heating

**3.1.10 Recognize fatigue problems due to noise and vibrations**

- explain the specific effect of noise and vibrations on ships operating in polar waters
- describe the fatigue problems due to noise and vibrations on ships operating in polar waters
- introduce preventive measures to mitigate the effect of noise and vibrations

**3.1.11 Identify need for extra resources, such as bunker, food and extra clothing**

- describe need for extra resources
- list extra resources in accordance with various situations
- introduce the methods of determining the quantity of extra resources
- introduce the appropriate usage of extra resources

COMPETENCE 4	Ensure compliance with pollution prevention requirements and prevent environmental hazards
TOPIC 4.1	BASIC KNOWLEDGE OF ENVIRONMENTAL FACTORS AND REGULATIONS
Bibliography	R1,R2,R3,R4,R6,R7,A1,A2,A3,A4,P1,P2,P3,P4,P6,P10,P12,P14

TRAINING OUTCOMES:

Demonstrates basic knowledge and understanding of:

1. Identify particular sensitive sea areas regarding discharge
2. Identify areas where shipping is prohibited or should be avoided
3. Special areas in MARPOL
4. Recognize limitations oil-spill equipment
5. Plan for coping with increased volumes of garbage, bilge water, sewage, etc.
6. Lack of infrastructure
7. Oil spill and pollution in ice, including consequences

## **TOPIC 4.1 BASIC KNOWLEDGE OF ENVIRONMENTAL FACTORS AND REGULATIONS**

### **Required performance**

#### **4.1.1 Identify particular sensitive sea areas regarding discharge**

- define the Particular Sensitive Sea Areas (PSSA)
- describe the requirements for vessels operating in a PSSA
- state pollutants whose discharge is prohibited

#### **4.1.2 Identify areas where shipping is prohibited or should be avoided**

- describe the environmental hazards associated with shipping in polar waters
- identify the areas where shipping is prohibited or should be avoided

#### **4.1.3 Special areas in MARPOL**

- identify special areas in MARPOL
- describe the specific requirements for special areas

#### **4.1.4 Recognize limitations of oil-spill equipment**

- identify oil-spill equipment coping with oil spill
- describe the limitations of oil fence boom when there is strong wind and flow, with drifting force increase
- recognize the effectiveness for the oil spill dispersant in ice

#### **4.1.5 Plan for coping with increased volumes of garbage, bilge water, sewage, etc.**

- state the considerations for the discharge of sewage within polar waters
- describe the requirements for the treatment of garbage, bilge water, sewage, etc. in MARPOL

#### **4.1.6 Lack of infrastructure**

- describe the current situation regarding lack of infrastructure
- introduce the counter-measures for lack of infrastructure

#### **4.1.7 Oil spill and pollution in ice with consequences**

- introduce oil spill risk and impact in polar waters
- describe the various pollution consequences in polar waters
- describe the oil spill contingency planning
- describe the oil spill response procedure

***Part C2: Detailed Teaching Syllabus (Advanced training)***

COMPETENCE 1	Plan and conduct a voyage in polar waters
TOPIC 1.1	KNOWLEDGE OF VOYAGE PLANNING AND REPORTING
Bibliography	A1, A9, P1,P2,P3,P13,P14

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

1. Information sources
2. Reporting regimes in polar waters
3. Development of safe routing and passage planning to avoid ice where possible
4. Ability to recognize the limitations of hydrographic information and charts in polar regions and whether the information is suitable for safe navigation
5. Passage planning deviation and modification for dynamic ice conditions

## **TOPIC 1.1 KNOWLEDGE OF VOYAGE PLANNING AND REPORTING**

### **Required performance**

#### **1.1.1 Information sources**

- review the principles and stages covered in both strategic and tactical passage planning
- identify potential navigational hazards that are different in the polar regions must be considered when planning a polar passage
- recognize additional sources of data related to a complete ice condition picture along the route
- utilize the navigational data, charts, sailing directions and pilot books
- utilize the historical surface current, ice and weather data, weather and ice imagery and information
- utilize the local guidelines and directives and information provided by the local ice service, ice operation centres and communication sources

#### **1.1.2 Reporting regimes in polar waters**

- stress that local reporting systems are in place extensively in both the Arctic and Antarctic regions
- describe the basic information and reporting procedure of some polar specific regional reporting systems

#### **1.1.3 Development of safe routing and passage planning to avoid ice where possible**

- explain the overall characteristics of an intended route by evaluating the historical data, the ice conditions, the routine navigational hazard information from charts and sailing directions or pilots
- stress that the likelihood of individual course and track could change as a result of ice conditions changing or availability of support
- explain the track and course line is in safe water and has sufficient safe water either side to alter for changing ice conditions
- explain track should be selected based on lowest ice concentrations
- practice the development of safe routing and passage planning to avoid ice where

possible

**1.1.4 Ability to recognize the limitations of hydrographic information and charts in polar regions and whether the information is suitable for safe navigation**

-explain the limitations of hydrographic information in polar regions

-explain the limitations of charts in polar regions

-recognize whether the information is suitable for safe navigation

**1.1.5 Passage planning deviation and modification for dynamic ice conditions**

-describe three dynamic ice conditions, opening, closing and simply moving

-explain the passage planning might deviate or modify subject to whether the ice is opening, closing or simply moving due to wind and current

-practice the passage planning deviation and modification for dynamic ice conditions

COMPETENCE 1	Plan and conduct a voyage in polar waters
TOPIC 1.2	KNOWLEDGE OF EQUIPMENT LIMITATIONS
Bibliography	R1,R2,R4,R5,R6,R9,A2,A8,P1,P2,P3,P13,P14

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

1. Understand and identify hazards associated with limited terrestrial navigational aids in polar regions
2. Understand and recognize high latitude errors on compasses
3. Understand and identify limitations in discrimination of radar targets and ice-features in ice-clutter
4. Understand and recognize limitations of electronic positioning systems at high latitude
5. Understand and recognize limitations in nautical charts and pilot descriptions
6. Understand and recognize limitations in communication systems

## **TOPIC 1.2 KNOWLEDGE OF EQUIPMENT LIMITATIONS**

### **Required performance**

#### **1.2.1 Understand and identify hazards associated with limited terrestrial navigational aids in polar regions**

- identify the hazards and disadvantages associated with terrestrial navigational aids
- explain the equipment limitations associated with terrestrial navigational aids
- discuss the operation precautions associated with terrestrial navigational aids

#### **1.2.2 Understand and recognize high latitude errors on compasses**

- explain errors on compass in high latitudes
- utilize manual of gyro compass for use in high latitudes
- discuss the operation precautions while using compass in polar waters

#### **1.2.3 Understand and identify limitations in discrimination of radar targets and ice-features in ice-clutter**

- understand the difficulties to recognize different radar targets
- understand the ice-features in ice-clutter
- demonstrate the correct operation of radar in polar waters

#### **1.2.4 Understand and recognize limitations of electronic positioning systems at high latitude**

- explain the limitation of electronic positioning systems at high latitude
- state the different positioning systems used in polar waters
- demonstrate the correct operation of positioning systems in polar waters

#### **1.2.5 Understand and recognize limitations in nautical charts and pilot descriptions**

- explain the limitation in nautical charts and pilot descriptions
- demonstrate the appropriate use of nautical charts and pilot in polar waters

**1.2.6 Understand and recognize limitations in communication systems**

-explain the limitations in communication systems

-describe major communication systems in polar water

-demonstrate the correct use of communication systems in polar waters

COMPETENCE 2	Manage the safe operation of vessels operating in polar waters
TOPIC 2.1	KNOWLEDGE AND ABILITY TO OPERATE AND MANOEUVRE A SHIP IN ICE
Bibliography	R1, R2, R3, R5, A1, A2, A5, A8, A9, P1, P2, P3, P6, P8, P14

TRAINING OUTCOMES:

Demonstrates knowledge and understanding of:

1. Preparation and risk assessment before approaching ice, including presence of icebergs, and taking into account wind, darkness, swell, fog and pressure ice
2. Conduct communications with an icebreaker and other vessels in the area and with Rescue Coordination Centres
3. Understand and describe the conditions for the safe entry and exit to and from ice or open water, such as leads or cracks, avoiding icebergs and dangerous ice conditions and maintaining safe distance to icebergs
4. Understand and describe ice ramming procedures – including double and single ramming passage
5. Recognize and determine the need for bridge watch team augmentation based upon environmental conditions, vessel equipment and vessel ice class
6. Recognize the presentations of the various ice conditions as they appear on radar
7. Understand icebreaker convoy terminology, and communications, and take icebreaker direction and move in convoy
8. Understand methods to avoid besetment and to free beset vessel, and consequences of besetment
9. Understand towing and rescue in ice, including risks associated with operation
10. Handling ship in various ice concentration and coverage, including risks associated with navigation in ice, and turning-backing; avoidance; etc.
11. Use of different type of propulsion and rudder systems, including limitations to avoid damage when operating in ice
12. Use of heeling and trim-systems.; hazards in connection with ballast and trim in relation with ice
13. Docking and undocking in ice covered waters, including hazards associated with operation and the various techniques to safely and undock in ice covered waters
14. Anchoring in ice, including the dangers to anchoring system – ice accretion to hawse pipe and ground tackle
15. Recognize conditions which impact polar visibility and may give indication of local ice and water conditions, including sea smoke, blink and refraction

## **TOPIC 2.1 KNOWLEDGE AND ABILITY TO OPERATE AND MANOEUVRE A SHIP IN ICE**

### **Required performance**

#### **2.1.1 Preparation and risk assessment before approaching ice, including presence of icebergs, and taking into account wind, darkness, swell, fog and pressure ice**

-describe the preparation work before approaching ice-infested waters

-identify the risk factors for navigating in ice-infested waters

-discuss the methods for risk assessment before approaching ice-infested waters

#### **2.1.2 Conduct communications with an icebreaker and other vessels in the area and with Rescue Coordination Centres**

-practice the appropriate procedures to communicate with an icebreaker and other vessels in the area and with Rescue Coordination Centres

-practice the appropriate procedures to establish the communication with Rescue Coordination Centres

#### **2.1.3 Understand and describe the conditions for the safe entry and exit to and from ice or open water, such as leads or cracks, avoiding icebergs and dangerous ice conditions and maintaining safe distance to icebergs**

-demonstrate the correct way of adjusting speed and power-output, prior to ice contact as well as upon contact with ice

-demonstrate the utilization of leads, opening and fragments in ice navigation

-explain how to avoid colliding with ridges, growlers and multi-year ice in polar regions

-discuss the methods to determine the safe distance to icebergs

-describe the preparation and precautions for navigation near ice shelves, ice islands and tabular icebergs

#### **2.1.4 Understand and describe ice ramming procedures – including double and single ramming passage**

-explain the knowledge related to ice ramming such as terms, risks analysis and assessment

-understand and describe the ice ramming procedures

-identify the factors that determine if ramming is advisable, once halted in ice

**2.1.5 Recognize and determine the need for bridge watch team augmentation based upon environmental conditions, vessel equipment and vessel ice class**

-demonstrate the general bridge watch arrangement for polar waters

-state the extra watch arrangement regarding different situations

-demonstrate the watch with search light

-demonstrate to write a standing order for operating in ice

-describe the dynamic positioning operation in ice

**2.1.6 Recognize the presentations of the various ice conditions as they appear on radar**

-explain the differences of echo images under various ice conditions

-demonstrate the echo images under specific ice conditions

-discuss the measures to appropriately identify the various ice conditions according to the echo images

**2.1.7 Understand icebreaker convoy terminology, and communications, and take icebreaker direction and move in convoy**

-explain the icebreaker convoy terminology

-understand the communications procedures during icebreaker convoy

-exercise how to take icebreaker direction and move in convoy

**2.1.8 Understand methods to avoid besetment and to free beset vessel, and consequences of besetment**

-describe appropriate precautions to avoid getting beset

-describe correct procedures to free beset vessel

-explain the various consequences of besetment

**2.1.9 Understand towing and rescue in ice, including risks associated with operation**

- explain the procedure for towing and rescue in ice
- identify the risks during towing and rescue operations in ice
- discuss the precautions to mitigate the risk impact during towing and rescue operations in ice

**2.1.10 Handling ship in various ice concentration and coverage, including risks associated with navigation in ice, and turning-backing; avoidance; etc.**

- identify the dangers for operation of vessel regard to shoaling, transiting, turning backing, avoiding, freeing, etc.
- describe correct procedures to handle ship in various ice concentration and coverage
- describe the hazards of stern movement and turning for vessels with reference to rudders and propellers
- explain the influence of the thickness of the ice on the ship's turning circle
- compare the dangers of turning manoeuvres (long turn vs. short turn star-manoevre)

**2.1.11 Use of different type of propulsion and rudder systems, including limitations to avoid damage when operating in ice**

- identify the system strength and capacity limitation for propulsion system and rudder
- demonstrate the proper use of given propulsion system and rudder

**2.1.12 Use of heeling and trim-systems.; hazards in connection with ballast and trim in relation with ice**

- identify the hazards in connection with ballast and trim in relation with ice
- demonstrate the appropriate use of heeling and trim systems during operation

**2.1.13 Docking and undocking in ice covered waters, including hazards associated with operation and the various techniques to safely and undock in ice covered waters**

- explain the appropriate procedures for docking and undocking in ice covered waters

- identify the hazards for docking and undocking operations in ice covered waters
- describe the various techniques for safe docking and undocking operations in ice covered waters
- discuss the precautions during docking and undocking operations in ice covered waters

**2.1.14 Anchoring in ice, including the dangers to anchoring system – ice accretion to hawse pipe and ground tackle**

- explain the appropriate procedures for anchoring in ice
- identify the dangers to anchoring systems during anchoring operation
- describe various techniques for anchoring operation in ice
- discuss the precautions during anchoring operation in ice

**2.1.15 Recognize conditions which impact polar visibility and may give indication of local ice and water conditions, including sea smoke, blink and refraction.**

- explain various conditions that may impact polar visibility
- describe how to indicate local ice and water conditions, including sea smoke, blink and refraction.

COMPETENCE 3	Maintain safety of the ship's crew and passengers and the operational condition of life-saving, firefighting and other safety systems
TOPIC 3.1	KNOWLEDGE OF SAFETY
Bibliography	R1,R2,R4,R8,R10,A3,A6,P1

TRAINING OUTCOMES:

Demonstrates knowledge and understanding of:

1. Understand the procedures and techniques for abandoning the ship and survival on the ice and in ice-covered waters
2. Recognize limitations on fire-fighting systems and life saving appliances due to low air temperatures
3. Understand unique concerns in conducting emergency drills in ice and low temperatures
4. Understand unique concerns in conducting emergency response in ice and low air and water temperatures

## **TOPIC 3.1 KNOWLEDGE OF SAFETY**

### **Required performance**

#### **3.1.1 Understand the procedures and techniques for abandoning the ship and survival on the ice and in ice-covered waters**

- describe the procedures and techniques for abandoning the ship
- list resources for survival on the ice and in ice-covered waters
- describe actions to be taken to improve the situation in a survival craft or in the water during the survival phase
- explain the survival techniques on the ice and in ice-covered waters

#### **3.1.2 Recognize limitations on fire-fighting systems and life saving appliances due to low air temperatures**

- list the life saving and firefighting equipment used in low temperatures
- identify the limitations on fire-fighting systems and life saving appliances due to low air temperatures
- describe appropriate precautions for fire-fighting and life saving operations in polar waters

#### **3.1.3 Understand unique concerns in conducting emergency drills in ice and low temperatures**

- explain unique concerns in conducting emergency drills in ice and low temperatures
- exercise emergency drills in ice and low temperatures
- understand the precautions during emergency drills in ice and low temperatures

#### **3.1.4 Understand unique concerns in conducting emergency response in ice and low air and water temperatures**

- explain unique concerns in conducting emergency response in ice and low temperatures
- exercise emergency response in ice and low temperatures

-understand the precautions during emergency response in ice and low temperatures

## **Part D: Instructor Manual**

### ***Part D1: Instructor Manual (Basic training)***

#### **1.1 Basic knowledge of ice characteristics and areas where different type of ice can be expected in the area of operation**

##### **-Subject detail matter**

Basics of ice including polar waters, ice physics, terms, formation, growth, aging, stage of melt, types, concentrations, pressure, distribution, friction from snow covered ice, ice sky, water blink and so on should be briefly introduced. Besides that, the implications of spray-icing, danger of icing up, precautions to avoid icing up, options during icing up and the ice regimes in different regions, differential movement of icebergs and pack ice, tides and currents in ice, effect of wind and current on ice and so on should be presented. Finally, the use of ice imagery to recognize consequences of rapid change in ice and weather conditions should be delivered.

The terms of ice include but not limited to New Ice, Young Ice, Grey Ice, Grey-White Ice, First-Year Ice, Young Ice, Old Ice, Multi-year Ice, Floe, Fast Ice, Drift Ice/Pack Ice, Ice Cover, Concentration, Consolidated Ice, Compact Ice, Shear Zone, Ridged Ice, Rafting, Glacial Ice, Iceberg, Ramming, Keel, etc. should be interpreted correctly.

Ice may be cleared from an area by winds and/or currents, or it may melt in place. Where the ice field is well broken (open ice or lesser concentrations), wind plays a major part as resulting wave action will cause considerable melting. Where the ice is fast or in very large floes, the melting process is primarily dependent on incoming radiation. Air and water temperatures and some types of precipitation also have a significant effect on ice melt. Snow cover on the ice acts initially to slow ice ablation, because it reflects almost 90 percent of incoming radiation back to space.

The mean areal density, or concentration, of pack ice in any given area is expressed in tenths. Concentrations range from: Open water (total concentration of all ice is < one tenth); Very open pack (1-3 tenths concentration); Open pack (4-6 tenths concentration); Close pack (7-8 tenths concentration); Very close pack (9-10 to <10-10 concentration); Compact or consolidated pack (100% coverage).

Ice pressure and distribution depends on the different ship-ice interaction scenarios. Ice pressure on hull comes from the actual ship-ice interaction situation which consists of several different cases. The main situation may be divided into two – local pressure and total pressure.

The frictional force comes from ice floes sliding along the hull and also at the contact as the edge is pushed downwards. The friction coefficient between snow and a ship's hull varies with the consistency and wetness of the snow; wetter snow has a higher friction coefficient than dry snow.

Icing up can hinder shipboard activity and, in extreme cases, it can seriously impair vessel

operations and stability. The accumulation of ice on a ship's superstructure can raise the centre of gravity, lower the speed and cause difficulty in manoeuvring. Icing up can also create various problems with cargo handling equipment, hatches, anchors, winches, and the windlass. Icing up on vessels can result from freshwater moisture such as fog, freezing rain, drizzle, and wet snow, or from salt-water including freezing spray and wave wash. The precautions to avoid icing up and options during icing up include slowing down in heavy seas, head for warmer water or a protected coastal area, lower and fasten cargo booms, cover deck machinery and boats, make the ship as watertight as possible, if the freeboard is high enough, fill all empty bottom tanks containing ballast piping with seawater, and under severe icing conditions, manual removal of ice may be the only method of preventing a capsizing.

Ice imagery of various types is invaluable as data sources for ice and weather condition analysis. Each type of imagery offers its own advantages and disadvantages. Ice imagery tends to be of satellite imagery and ice chart. Ice charts indicate the ice conditions determined from assimilating a wide variety of data sources. These sources could include optical, infrared and radar satellite imagery, visual observations from ships or aircraft and air craft-mounted radar. The source data may be identified on the chart. Ice trajectory or ice forecast charts indicate the predictions of sea ice conditions usually up to 48 hours ahead and take into consideration forecast tidal current and expected wind-driven current effects on sea ice.

Ice blink is a fairly reliable sign and the first indication that an ice field is in the vicinity. When steaming through open water, it may be possible to detect the approach of ice by the sign of ice blink. Water sky is dark patches on low clouds, sometimes almost black in comparison with the clouds, indicate the presence of water below them. When the air is very clear this indication is less evident. It may be possible to detect the approach of open water by the sign of water sky.

Mariners should beware of leads in pack ice, which may suddenly end at an iceberg. Because icebergs project deep into the water column, they are affected more by ocean currents and less by winds than the surrounding sea ice. This may result in differential motion and the creation by the iceberg of an open water track through the pack ice.

For the most part, tidal rise and fall is minimal in the Arctic regions. Areas of greatest tidal current are on the southeastern coast of Baffin Island in the Canadian Arctic, at the entrance to the White Sea in the Russian Arctic and along Spitsbergenbanken. Tidal activity in Antarctic waters is generally weak, with some exceptions, within channels of the Antarctic Peninsula.

Winds and currents cause the ice to undergo various forms of deformation. Wind causes ice floes to move generally downwind at a rate that varies with wind speed, concentration of the pack ice, and the extent of ice ridging or other surface roughness. As sea ice is partially submerged in the sea, it will also move in response to near surface currents and tides. As a result, the net movement of the ice is a complex product of both winds as well as currents and consequently is difficult to forecast.

Ice of land origin is formed on land by the freezing of freshwater or the compacting of snow as

layer upon layer adds to the pressure on that beneath. Sea ice forms by the freezing of seawater and accounts for 95 percent of all ice encountered. First-year ice is ice of not more than one winter's growth, ranging from 30 centimetres to over 2 metres thick. Multi-year ice is easier to identify than second-year ice, primarily because the hummocks and melt-ponds become increasingly pronounced. In addition, there is normally a well-established drainage pattern connecting the melt ponds, and floes tend to have a higher freeboard than first-year ice. Where the ice is bare, the colour of multi-year ice may appear bluer than first-year ice.

#### **- Recommended presentation**

Present the theoretical lecture in conjunction with materials related to ice, difficulties due to ice, effects of wind, tide and current on ice, precautions, ice imagery reading, etc. Case study and small group discussion should be preferable during delivery of ice imagery. Utilize teaching aids such as polar nautical publications and charts, ice weather data in polar waters and operational guidelines and related national and international regulations and conventions in polar waters to demonstrate the acquisition of information therein.

#### **- Assessment technique**

It's recommended that the assessment should be conducted by both theoretical and practical means. Ice, difficulties due to ice, effects of wind, tide and current on ice, precautions are suggested to be included in theoretical examinations. Practice is established to demonstrate that knowledge, understanding and proficiency through a variety of teaching aids such as polar nautical publications, ice charts, and ice weather data in polar waters.

### **1.2 Basic knowledge of vessel performance in ice and low air temperature**

#### **-Subject detail matter**

Ice class means the notation assigned to the ship by the Administration or by an organization recognized by the Administration showing that the ship has been designed for navigation in sea-ice conditions. Ice class includes ice strengthened ships, ice going ships, and icebreakers.

Polar class means the class assigned to a ship based upon IACS Unified Requirements, and are given in the following table. It is the responsibility of the owner to choose which class is most suitable for their ship.

Category A ship means a ship designed for operation in polar waters in at least medium first-year ice, which may include old ice inclusions. Category B ship means a ship not included in category A, designed for operation in polar waters in at least thin first-year ice, which may include old ice inclusions. Category C ship means a ship designed to operate in open water or in ice conditions less severe than those included in categories A and B. The main characteristics and limitations of polar vessels such as draft, engine output and machinery should be introduced according to different categories.

The design of structure for ice-strengthened ships requires the knowledge of the magnitude of ice loads, which are influenced by: hull shape, displacement, power, speed, ice confinement, and ice

type. The ice load experienced by a ship's hull will vary between hull areas. The bow shapes for ice-strengthened ships may be described by the stem, flare, buttock, and water-line angles. The selection of a midbody shape must consider its effect on resistance, manoeuvrability, construction cost, and the required deadweight. The stern design on ice-strengthened ships is controlled mainly by the number of propellers, which is a function of the required power and operational requirements. The stern must, to the greatest extent possible, provide protection to the rudder(s) and propeller(s). For ice-strengthened ships, the specific engineering requirements for operating in ice compared to non-ice-strengthened ships should be considered in the following systems: propulsion system including prime movers, electric transmission, mechanical transmission, shafts and shaft-line components, propellers, steering system, and auxiliary systems including cooling, freezing of piping, valves and tanks, waste disposal, fuel oil heating. For example, the propulsion system for ice-strengthened ships must be reliable, flexible with a view to redundancy, maintainable, and have high power-to-weight and power-to-space ratios; rudder stops are to be provided and the design ice force on rudder shall be transmitted to the rudder stops without damage to the steering system; auxiliary systems required to operate the main electric power generators shall also be separate and independent, to reduce common fault failures.

The navigating officers on board a vessel in ice must be aware of the type of steel used in the construction of their ship. The shell expansion plan will be on board and it will show clearly the steel qualities used. If a ship has no low temperature steel, it is important to avoid impacts with hard ice when the air temperatures are very low, or the vessel has been exposed to very low temperatures for a long period prior to navigating in ice. The ice-strengthened ship's hull must be designed, and arranged, to withstand the ice loads imposed globally and locally, and its bow, bow intermediate, midbody and stern normally are designed only to force ice.

The main limitations of ice-classes include: the ice classes of different classification societies are always aimed at a certain sea area; even there are strengthening requirements of structure and engine in classification rules, but not include other equipment fitted on ship, such as deck and superstructure installations; the ice-classes are aimed at common situations of ice and climate, the actual situation is variable.

The basic principle of determining the ice classes depends on whether the hull and machinery are constructed such as to comply with the requirements of different ice classes. But mariners should be particularly aware of the limitations and effects, such as:

- ice class is valid only with defined draught;
- lower loading capacity (deadweight) and freeboard because of heavier hulls;
- heavy hull leads to a great metacentric height, which in its turn will give the ship intense and rapid rolling movements in open waters.

when ship sailing in the winter condition or in the low temperature, the risks to be expected include loss of material performance, machinery malfunction, ice on deck and superstructure, malfunction of fluid system, frostnip and frostbite, etc.

The precautions including deck and engine to minimize the risks of commercial losses caused by

winterization or in the low temperature includes:

- Piping systems should be drained where possible or, where draining is not possible, the pipes should be heat traced and insulated.
- Valves and connection stations should be placed in a protective enclosure to protect them from the environment.
- Safety critical systems such as fire pipelines should be drained, heated, insulated and/or positioned to remain effective at the minimum anticipated temperature. Portable fire extinguishers that are susceptible to freezing should not be placed in a location where freezing is likely.
- The ships electrical power supply should be designed to accommodate the extra load from heating and heat tracing systems, including the emergency generator's capacity. In an event where the ship must switch to emergency power, providing heat for the crew is essential for survival but other stations, such as the machinery space workshop, should be heated as well.
- The spaces where crews are accommodated or expected to perform routine tasks should be ventilated and heated to maintain safety and human performance.
- 

Low-temperature system is a sea water or fresh water pipe system for cooling main engine and auxiliary engine. To ensure low-temperature system performance, the following measures should be taken.

- Maintain essential seawater by using inlets situated as low and as far aft as possible near the centreline.
- Use sea boxes that have the following characteristics: should be fitted on each side of the ship; should be as deeply submerged as possible; should have an area open to the sea of five to six times the total area of pump suction served by the seabay; should be fitted with a strainer plate at the ship's side having perforations approximately 20 mm diameter to prevent ingestion of ice particles. Should be fitted with a low steam pressure connection to clear strainers; should be vented to atmosphere by a valved pipe with a cross-sectional area at least equal to that of the cooling sections.
- Use diversion arrangements to introduce warm cooling water to seawater inlets and strainers.
- Provide means to manually clear sea inlets of ice blockage by introducing low compressed air or steam.
- Allow ice and slush ice, introduced in the system, to float freely away from pump intakes without undue stirring.
- Allow temporary or permanent use of ballast water for two purposes: back flushing sea boxes; and cooling the engines as a short-term solution unless a large quantity is available and re-circulated.

The main limitations of deck systems in ice condition and cold climate include: freezing of anchor chain, windlass, fire hydrant and deck pipes, foam fire extinguisher. And main limitations of engine room systems in ice condition and cold climate include: ice and slush to enter sea bays or sea inlet boxes, blocking sea-water flow to the cooling system, water freezing in pipes, valves, and tanks resulting in structural damage.

Ice pressure monitoring for a ship navigating in iced area is very important for hull safety, it is impossible, however, to carry out the monitoring of ice pressure by human hands. Ice pressure monitoring system includes Sensor, Display, Alert, Etc.

- The characteristic of the sea suction, water intake, superstructure insulation and special systems are capable of being cleared of accumulation of slush ice. For the arrangement of these systems, special attention should be paid to: high and low inlet grilles can be provided as far apart as possible.
- The suction is separated from the sea inlet grilles by a vertical plate weir. Any ice entering the box can float to the top and is unlikely to be drawn back down to the suction level.
- De-icing return(s) can be arranged to feed steam or hot water to the sea inlet box top, where frazil ice may have accumulated, or directly to the cooling system suction where a blockage may have occurred.
- Ballast water recirculation through the cooling water system allows ballast tanks to be used as coolers, alleviating any need to use blocked sea inlet boxes. Means should be provided to clear the systems manually of blockage by ice.

#### **- Recommended presentation**

Present the theoretical lecture in conjunction with materials related to ice class/polar class, winterization and preparedness of vessel, equipment and machinery limitation in ice condition and low air temperature, etc. Case study and small group discussion should be preferable during the lecture delivery. Utilize teaching aids such as operational guidelines and related national and international regulations and conventions in polar waters to demonstrate the acquisition of information therein.

#### **- Assessment technique**

It's recommended that the assessment should be conducted by both theoretical and practical means. The ice class/polar class, limitations of equipment and machinery in ice condition and low air temperature, preparedness are suggested to be included in theoretical examinations. Practice is established to demonstrate that knowledge, understanding and proficiency through a variety of teaching aids such as ship models, pictures and videos.

### **1.3 Basic knowledge and ability to operate and manoeuvre a ship in ice**

#### **-Subject detail matter**

Manoeuvre a ship in ice is unique to all other ship operations. Due to its remoteness, navigational mistakes can be fatal for both the operators and the environment. Operations in ice regions necessarily require considerable advanced planning and many more precautionary measures than those prior to a typical open ocean voyage. The crew, large or small, of a polar-bound vessel shall be thoroughly indoctrinated in the fundamental polar operations, utilizing the best information resources available. Seafarers who are not familiar with vessels operating in ice conditions may not fully appreciate the risks involved and in consequence may not be adequately prepared.

Winter climatic conditions in polar areas can bring many unusual problems for mariners having little or no experience in such conditions. Moreover, ships and their equipment are not always designed or capable to face various ice conditions. Therefore, ice navigation calls for special knowledge and precautions even in ice-strengthened ships. The preparation of a vessel for polar operations is of extreme importance and the considerable experience gained from previous operations should be drawn upon to bring the ship to optimum operating condition.

These factors have substantially reduced the risk of ice damage, provided that the mariner acts in accordance with sound operating practice in relation to: safe speed in ice conditions; ballast tank monitoring and awareness of engine loads and cooling problems.

In this section, the general concerns for operation of ships in ice will be introduced and discussed and it can be adapted to most of the ice-covered waters. The appropriate practices for ship handling considering the ice conditions are quite important when ship is operating in ice without assistance. The hazards connected to operation of ships will be described according to different working scenario such as ice transit, cargo operation and oil transfer. The navigator shall familiar with the preparatory work and appropriate actions to be taken involving close quarter situations, passing another vessel, anchoring and towing operations, pilot transfer, berthing, unberthing and mooring operations. Moreover, there are many preparation works shall be done before one travels into waters with ice including operational preparations, technical preparations and installation of useful equipment.

#### **- Recommended presentation**

Present the theoretical lecture in conjunction with materials related to safe speed in the presence of ice and icebergs, ballast tank monitoring, cargo operations in the polar waters, awareness of engine loads and cooling problems and safety procedures during ice transit. Utilize teaching aids such as polar nautical publications and charts, ice charts, ice report, ice imagery, ice weather data in polar areas and operational guidelines and manuals in polar areas to demonstrate the acquisition of information therein. Ideally, the ship handling simulator in ice could be used to improve the training results.

#### **- Assessment technique**

The equipment, charts and nautical publications required for the voyage are enumerated in oral or written form. Practice is established to demonstrate that information obtained from a variety of sources is interpreted correctly and properly applied. The basic knowledge and ability to operate and manoeuvre a ship in ice are required in oral or written form. Practice is established to demonstrate the application of those safety procedures during ice transit and cargo operation, identification factors determining the safe speed under different scenarios, application of appropriate procedures for ballast tank monitoring.

## **2.1 Basic knowledge of regulatory considerations**

### **- Subject matter details**

The Antarctic Treaty came into force on 23 June 1961 after ratification by the twelve countries then active in Antarctic science. The Treaty covers the area south of 60°S latitude. Its objectives are simple yet unique in international relations. They are:

- to demilitarize Antarctica, to establish it as a zone free of nuclear tests and the disposal of radioactive waste, and to ensure that it is used for peaceful purposes only;
- to promote international scientific cooperation in Antarctica; to set aside disputes over territorial sovereignty.

Polar Code is to provide for safe ship operation and the protection of the polar environment by addressing risks present in polar waters and not adequately mitigated by other instruments of the Organization. It consists of Introduction, parts I and II. The Introduction contains mandatory provisions applicable to both part I and part II. Part I is subdivided into part I-A, which contains mandatory provisions on safety measures, and part I-B containing recommendations on safety. Part II is subdivided into part II-A, which contains mandatory provisions on pollution prevention, and part II-B containing recommendations on pollution prevention.

The principles and reporting procedures for accident reports concerning vessels in polar waters should be introduced according to the national and international regulations. IMO standards for operation in remote areas such as SOLAS, SAR, IS CODE and related guidelines and resolutions should be adequately presented.

### **- Recommended presentation**

Present the theoretical lecture in conjunction with materials related to legislative requirements and procedures according to national and international regulations. Case study and small group discussion should be preferable during the lecture delivery.

### **- Assessment technique**

It is suggested that theoretical exams should be taken.

## **3.1 Basic knowledge of crew preparation, working conditions and safety**

### **-Subject detail matter**

The remoteness of polar waters makes search and rescue or clean-up operations difficult and costly. When ice is present, it can impose additional loads on the hull and affect propulsion system. The obligation of ships to go to the assistance of vessels in distress is enshrined in international conventions so as to improve the SAR cooperation in polar waters. Moreover, it is important for mariner navigating in polar waters to understand the facility limitations of the SAR communication and establish awareness of contingency planning.

Equipment necessary to meet the basic needs of the crew and to insure the successful and safe completion of the polar voyage should not be overlooked. A minimum list of essential items

should consist of polar clothing and footwear, including but not be limited to 100% u/v protective sunglasses, food, vitamins, medical supplies, fuel, storage batteries, antifreeze, explosives, detonators, fuses, meteorological supplies, and survival kits containing sleeping bags, trail rations, firearms, ammunition, fishing gear, emergency medical supplies, and a repair kit.

The vessel's safety depends largely upon the thoroughness of advance preparations, the alertness and skill of its crew, and their ability to make repairs if damage is incurred. Spare propellers, rudder assemblies, and patch materials, together with the equipment necessary to effect emergency repairs of structural damage should be carried. Examples of repair materials needed include quick setting cement, oakum, canvas, timbers, planks, pieces of steel of varying shapes, welding equipment, clamps, and an assortment of nuts, bolts, washers, screws, and nails. Ice and snow accumulation on the vessel poses a definite capsizing hazard. Mallets, baseball bats, ax handles, and scrapers to aid in the removal of heavy accumulations of ice, together with snow shovels and stiff brooms for snow removal should be provided.

All activities in polar waters are conducted near the limit of technological opportunities and human abilities. Therefore, it is important for mariners to obtain the basic knowledge about human factors such as cold fatigue and crew welfare so as to improve the safe navigation in polar waters.

#### **- Recommended presentation**

Present the theoretical lecture in conjunction with materials related to Search and Rescue operations and contingency plan in polar waters, safe working procedures for crew specific to polar environment, personal protective and survival methods and equipment, common hull and equipment damages, superstructure-deck icing, prevention and removal of ice, human factors including fatigue problems and need for extra resources. Utilize teaching aids such as polar nautical publications, ice weather data in polar waters and operational guidelines and related national and international regulations and conventions in polar waters to demonstrate the acquisition of information therein.

#### **- Assessment technique**

The equipment, regulations, publications required for the voyage are enumerated in oral or written form. Practice is established to demonstrate that knowledge and information obtained from a variety of sources is appropriately understood and properly applied. The basic knowledge of crew preparation, working conditions and safety are required in oral or written form. Practice is established to demonstrate the application of those safety information and regulations during ice transit for crew preparation, working conditions and safety.

### **4.1 Basic knowledge of environmental factors and regulations**

#### **-Subject detail matter**

A PSSA is an area that needs special protection through action by IMO because of its significance for recognized ecological, socio-economic, or scientific reasons and because it may be vulnerable to damage by international shipping activities. Any discharge into the sea, of oil, oily mixtures, noxious liquid substances, garbage or harmful substances from vessels of any type or size is prohibited in PSSA in total of 14 currently.

The designation of an area as a Special Area under Annexes I, II or V, or a SO<sub>x</sub> emission control area under Annex VI of MARPOL 73/78, or application of special discharge restrictions to vessels operating in a PSSA.

Any discharge of oil or oily mixtures from cargo tanks, including cargo pumps, from petrol tankers and from engine-room bilge areas, mixed with cargo waste is prohibited in PSSA.

Dumping at sea of the following types of garbage from ships of any type of size: 1) Plastics, synthetic fishing lines and nets, plastic garbage bags; 2) loose stowage materials, packing materials and coverings; 3) paper, rags, glass, metal, bottles, ceramics or similar materials is prohibited in PSSA.

Identify areas where shipping is prohibited or should be avoided in polar waters, there are some criteria should be considered. These criteria can be divided into three categories: ecological criteria; social, cultural, and economic criteria; and scientific and educational criteria.

The special areas in MARPOL means a sea area where for recognized technical reasons in relation to its oceanographical and ecological condition and to the particular character of its traffic the adoption of special mandatory methods for the prevention of sea pollution by oil is required. The Antarctic area is a special area.

When the oil spill accident happened, it would make huge damage to the environment, at present, the main oil-spill equipment for coping with such accident include oil fence boom, oil spill clean-up skimmers, work boats, boom storage reels, oil absorbents, and oil spill dispersant, etc. Nevertheless, these equipment have its limitations in ice-waters. For example, oil fence boom, oil spill dispersant, because of low temperature in ice water, the spill oil viscosity will increase, meantime, it will cause the diffusion velocity decrease, finally, the function of oil spill dispersant will lose effectiveness.

Specific plan for coping with increased volumes of garbage, bilge water, sewage etc. should be developed and carried on board ship operating in polar waters, taking into accounts the voyage duration, ship type, and storage capacity.

Mariners should always keep in mind that polar waters are typically remote areas and the infrastructure such as port reception facilities and equipment of pollution emergency response are insufficient. The cumulative impact of such limiting factors can make marine spill response operations near impossible for long periods of time in polar waters.

There are several characteristics of the polar environment and polar wildlife species that exacerbate the potentially negative consequence of an oil spill to polar waters. Oil persists longer in polar conditions because it evaporates more slowly or may be trapped in or under ice and is thus less accessible to bacterial degradation. Population recovery after an incident may be slowed because many species have relatively long life spans and slower generational turnover.

**- Recommended presentation**

Present the theoretical lecture in conjunction with materials related to prevention of pollution requirements and procedures according to national and international regulations. Case study and small group discussion should be preferable during the lecture delivery.

**- Assessment technique**

It is suggested that theoretical exams should be taken.

## ***Part D2: Instructor Manual (Advanced training)***

### **1.1 Knowledge of voyage planning and reporting**

#### **-Subject detail matter**

As in traditional passage planning, the process in polar waters begins with a strategic overview plan and follows on with a tactical plan that is updated and changed as conditions require. Prior to developing the passage planning in polar regions, potential navigational hazards that are different in the polar waters should be clearly and accurately identified, such as the remote area of operation, lack of nearby support, geographic and extreme weather differences, possible presence of multi-year and glacial ice, limitations on navigational equipment and communications. Information and data recourses referred to should include the navigational data, charts, sailing directions and pilot books, the historical surface current, ice and weather data, weather and ice imagery and information and the local guidelines and directives and information provided by the local ice service, ice operation centres and communication sources.

It is of great importance to stress that local reporting systems are in place extensively in both the Arctic and Antarctic regions. The basic information and reporting procedure of some polar specific regional reporting systems, such as NORDREG (Canadian Arctic), GREENPOS (Greenlandic Arctic), CHILREP (Chilean Antarctic) and AUSREP (Australian Antarctic) are required to be described.

The overall characteristics of an intended route in polar waters can be determined by evaluating the historical data, the ice conditions and the routine navigational hazard information from charts and sailing directions or pilots. However, the navigator must be always aware that the likelihood of individual course and track could change as a result of ice conditions changing or availability of support. When developing safe routing and passage planning to avoid ice where possible, it should be met that the track and course line is in safe water and has sufficient safe water either side to alter for changing ice conditions, and track should be selected based on lowest ice concentrations.

The accuracy of hydrographic information and charts in polar waters depends upon the data available and the hydrographic information and charts represent the conditions at a particular time and that the weather and ice can change significantly in short time. In particular, polar charts are not as reliable as is expected in more regularly travelled areas of the globe. Chart datum may differ from chart to chart and may be outside the norms of internationally accepted standards. The accuracy and date of the surveys, as well as the density of soundings forming the basis for the survey, should also be verified.

At all times, the mariner should enter ice only if necessary, selecting open water routes if at all possible. However, operating a vessel within ice-infested waters requires consideration of additional factors in the continuing decision-making process in the same continual feedback manner as any passage plan. The primary additional factor is, of course, the ice and the weather conditions are open with relatively little ice or close. The typical dynamic ice conditions involve opening, closing and simply moving. The decision-making process for the passage planning

deviation and modification varies from dynamic ice conditions, together with the considerations of own vessel's speed, ice class, draft and manoeuvrability etc.

#### **- Recommended presentation**

Present the theoretical lecture regarding the principles of passage planning, the potential navigational hazards, the basic information and reporting procedure of some polar specific regional reporting systems, the general principles when developing safe routing and passage planning to avoid ice where possible, and the hydrographic information and charts in polar regions regarding the limitations thereof. Utilize teaching aids such as polar nautical publications and charts, ice chart, ice report, ice imagery, historical surface current, ice and weather data in polar waters and materials related to operational guidelines and directives in polar waters to demonstrate the acquisition of information therein.

#### **- Assessment technique**

The equipment, charts and nautical publications required for the voyage are enumerated in oral or written form. Practice is established to demonstrate that information obtained from a variety of sources is interpreted correctly and properly applied. The basic information and reporting procedure of some polar specific regional reporting systems are required in oral or written form. Practice is established to demonstrate the application of those general principles when developing safe routing and passage planning to avoid ice where possible, the identification of the limitations of hydrographic information and charts in polar waters, and the application of decision-making process for the passage planning deviation and modification subject to one of dynamic ice conditions.

### **1.2 Knowledge of equipment limitations**

#### **-Subject detail matter**

Navigational equipment and communication systems have limitation in polar waters, subject to the hazards associated with limited terrestrial navigational aids, high latitude errors on compasses, limitations in discrimination of radar targets and ice-features in ice-clutter, limitations of electronic positioning systems at high latitude, limitations in nautical charts and pilot descriptions and limitations in communication equipment.

Terrestrial aids to navigation can be categorized into fixed type and floating type. Terrestrial navigational aids mainly refer the buoy, including the actual buoy and virtual buoy. In addition, the conspicuous landmark can be used as the navigational aids for position fixing. Both fixed and floating terrestrial aids to navigation are spares in the polar waters and may be totally non-existent in many areas.

Magnetic variations in high latitudes may lead to unreliable readings from magnetic compasses. The magnetic compass can be erratic in the Arctic and is frequently of little use for navigation. The magnetic compass depends on its directive force upon the horizontal component of the magnetic field of the earth. As the north magnetic pole is approached in the Arctic, the horizontal component becomes progressively weaker until at some point the magnetic compass becomes

useless as a direction measuring device. If the compass must be used the error should be checked frequently by celestial observation and, as the rate of change of variation increases as the pole is approached, reference must be made to the variation curve or rose on the chart. Gyro-compasses may become unstable in high latitudes. Ships should ensure that systems for providing reference headings are suitable for intended areas and modes of operation, and that due consideration has been given to the potential effects noted above. For operations in polar waters, ships should be fitted with at least one gyro-compass and should consider the need for installation of a satellite compass or alternative means such as Fiber Optic Compass.

Radar can be a great asset in ice navigation during periods of limited visibility, but only if the display is properly interpreted. Ice makes a poor radar target beyond 3 to 4 nautical miles and the best working scale is in the 2 to 3 nautical mile range. Radar signal returns from all forms of ice (even icebergs) are much lower than from ship targets, because of the lower reflectivity of radar energy from ice, and especially snow, than from steel. Detection of ice targets with low or smooth profiles is even more difficult on the radar screen, although the radar information may be the deciding factor when attempting to identify the location of these targets under poor conditions, such as in high seas, fog, or in heavy snow return. For example, in close ice conditions the poor reflectivity and smooth surface of a floe may appear on the radar as a patch of open water, or signal returns from sea birds in a calm sea can give the appearance of ice floes. In an ice field, the edge of a smooth floe is prominent, whereas the edge of an area of open water is not. The navigator must be careful not to become over-confident in such conditions. In strong winds the wave clutter in an area of open water will be distributed uniformly across the surface of the water, except for the calm area at the leeward edge.

Problems encountered with position fixing arise from either mistaken identification of shore features or inaccurate surveys. Low relief in some parts of the Arctic makes it hard to identify landmarks or points of land. Additionally, ice piled up on the shore or fast ice may obscure the coastline. For this reason radar bearings or ranges should be treated with more caution than measurements in southern waters. Visual observations are always preferable. Sometimes it is possible to fix the position of grounded icebergs and then to use the iceberg for positioning further along the track, if performed with caution. Large areas of the Arctic have not yet been surveyed to the same standards as areas further south, and even some of the more recently produced charts are based on reconnaissance data. To decrease the possibility of errors, three lines (range, or less preferably bearings) should always be used for positions. Fixes using both sides of a channel or lines from two different survey areas should be avoided. Because of potential problems, fixes in the Arctic should always be compared with other information sources, such as electronic positioning systems. Reliance on one information source should be avoided.

With respect to the polar waters, due to a lack of modern hydrographic surveys, the quality of charts, including paper charts, Electronic Navigational Charts (ENC) and Raster Navigational Charts (RNC) can be poor. Many charts contain areas that are inadequately surveyed, or are based on old surveys where only spot soundings were collected, or where data was collected only along a single track. Mariners must be aware of these limitations. There are two areas of concern regarding the use of charts in the Arctic. These are consideration of the different projections used

versus southern waters and the accuracy of the surveys. While up-to-date charts and nautical publications are always critical to safe navigation the Arctic requires a special understanding and the mariner should use all sources of updates, including Notices to Mariners and broadcast Notices to Shipping, to be sure paper charts, electronic charts and nautical publications are up to date.

Current maritime digital communication systems were not designed to cover polar waters. VHF is still largely used for communication at sea, but only over short distances (line of sight) and normally only for voice communication. HF and MF are also used for emergency situations. Digital VHF, mobile phone systems and other types of wireless technology offer enough digital capacity for many maritime applications, but only to ships within sight of shore-based stations, and are, therefore, not generally available in polar waters. AIS could also be used for low data-rate communication, but there are very few base stations, and the satellite-based AIS system is designed for data reception only. Non-GMDSS systems may be available and may be effective for communication in polar waters. Operator should use the following equipment and system well and proficiency, such as radios, INMARSAT, Mobile Satellite (MSAT) / SkyTerra Communications Satellite System and Iridium Satellite System, etc.

#### **- Recommended presentation**

Demonstrate the pictures respectively for the trainees to get general impression about terrestrial navigational aids. Interpret the different principles of magnetic compass and gyro compass for correct use and awareness on compass, electronic positioning systems, communication systems in polar waters. Introduce the production of different nautical charts and publications via paper and digital type.

#### **- Assessment technique**

Practice is established to demonstrate the limitations on terrestrial navigational aids in Arctic waters and Antarctic areas. Information obtained from publications is interpreted correctly and correct use the compass, radar, electronic positioning systems, nautical charts according to the manual and ISM checklist onboard.

### **2.1 Knowledge and ability to operate and manoeuvre a ship in ice**

#### **-Subject detail matter**

Non-ice strengthened vessels now frequently trade to areas which several years ago were closed to normal navigation during winter months. This is a direct result of several factors: improved icebreaker assistance, improved ice observation; and an improved advisory service in programming vessels through ice-affected areas. It is of importance for mariners to recognize that preparation and risk assessment should be adequately conducted before approaching ice including presence of icebergs, taking into account wind, darkness, swell, fog, and pressure of ice.

These have substantially reduced the risk of ice damage, provided that the master has enough sea experiences navigating in ice-covered areas as well as sufficient training relating to: risk assessment, SAR coordination, damage control procedures, bridge resources management and berthing and unberthing operation, etc. It is of great importance for senior officers to recognize the presentation of the various ice conditions as they appear on radar, the limitations of proportion the

rudder systems and appropriate use of heading and trim systems. Sound practice and procedure for communication with an icebreaker and other vessels in the area and with Rescue Coordination Centres should be introduced.

Operations in ice-prone regions necessarily require considerable advanced planning and many more precautionary measures than those taken prior to a typical open sea.

Special cautions for using rudder and propeller should be highlighted when considering the safe entry and exit to and from ice or open water, such as leads or cracks, avoiding icebergs and dangerous ice conditions and maintaining safe distance to icebergs.

It is recognized that ice ramming including double and single ramming passage is particularly effective when attempting progress through ice that is otherwise too thick to break continuously. However, ramming must be undertaken with extreme caution because the impact forces caused when the vessel contacts the ice can be very high. If the ramming is restricted to low speeds, the risk of damage will be greatly reduced.

Mariners should be borne in mind that the correct recognition of the presentations of the various ice conditions as they appear on radar is key practice to ensure ship safe navigation in ice. Conventional marine radars are designed for target detection and avoidance. Enhanced marine radars provide a higher definition image of the ice that the vessel is transiting through and may help the user to identify certain ice features. In the enhanced marine radar, the coastline is more clearly defined; icebergs are visible at greater distances, as are the smaller bergy bits and growlers. In the standard radar, sea clutter affects the ability to see smaller targets near the vessel. X-band radars will produce clearer images of the ice at short ranges, such as under 4 nautical miles, when set to a short pulse. The shapes of ice floes, the ridges and rafted ice and open water leads are also more distinct in an ice navigation radar, particularly when using the short radar pulse length.

As ships escorted by icebreaker(s), convoy terminology and communication procedures should be appropriately applied. Ships should normally follow the icebreaker direction and move accordingly in convoy, but the master's responsibility should never be released. When ship is operating in ice, carefully manoeuvring should be taken to avoid as well as to free the vessel from besetment as the consequences of besetment may cause fatal damage to ship's hull.

When towing and rescue in ice occur, risks associated with operation should be clearly identify before towing and rescue in ice. Towing vessels should constantly monitor the gap between the vessels to ensure that ice does not become lodged between the vessels and cause damage to either. Other risks include ice piling up in front of and between the vessels. This type of broken ice build-up can drive the vessels apart placing undue strain on the towing lines.

Similarly, when handling ship in various ice concentration and coverage, risks associated with navigation in ice, and turning-backing, avoidance, etc. Changes in course will be necessary when the vessel is in ice. Care must be taken even when turning in an open water area, as it is easy to underestimate the swing of the ship and to make contact with ice on the ship's side or stern. If it is

not possible to turn in an open water area, the Master must decide what type of turning manoeuvre will be appropriate. Masters will have to weigh the dangers of backing in ice to accomplish the star manoeuvre, against any navigational dangers of a long turn in ice. Care must be taken while backing on each ram that the propeller and rudder are not forced into unbroken ice astern.

For docking and undocking in ice covered waters, hazards associated with operation such as the damages to the wharf by contact with the vessel, or by forcing ice against pilings as well as the damages to ship hull by forcing unbroken floes of hard ice against the unyielding facing of a solid berth, should be clearly recognized before. The prudent thing is to move the ship off the dock before the situation deteriorates because the ice conditions can change quickly when alongside a wharf and, for this reason, it is desirable to keep the engine(s) on standby at all times.

Anchoring in the presence of ice is not recommended except in an emergency, but if such anchoring is necessary, only the minimum amount of cable should be used and the capstan/windlass should be available for immediate use. The engines must be on standby, or kept running. It is of great importance to recognize dangers to anchoring system including ice accretion to hawse pipe and ground tackle.

Operating in restricted visibility is inevitable in, or near, ice-covered waters, either because of precipitation, fog or darkness. Travel through ice may, however, continue at night or in fog, which is common during the open water period, and visibility is often reduced by blowing snow during the winter and by indicating sea smoke, blink and refraction.

#### **- Recommended presentation**

Present the theoretical lecture in conjunction with materials related to various ice operation procedures according to different ice conditions, limitations for equipment to avoid damages and bridge team management in polar waters. Case study and small group discussion should be preferable during the lecture delivery. Utilize teaching aids such as polar nautical publications and charts, ice weather data in polar waters and operational guidelines and related national and international regulations and conventions in polar waters to demonstrate the acquisition of information therein. Ideally, the ship handling simulator in ice could be used to improve the training results.

#### **- Assessment technique**

It's recommended that the assessment should be conducted by both theoretical and practical means. The principles, procedures, safe precautions and methods are suggested to be included in theoretical examinations. Practice is established to demonstrate that knowledge, understanding and proficiency through a variety of teaching aids such as nautical publications, navigation aids and ship handling simulator.

### **3.1 Knowledge of safety**

#### **- Subject matter details**

As in most extreme situations at sea, abandonment and evacuation of the parent ship should be a

last resort. Leaving behind the resources and protection of the ship for survival craft must be carefully considered given the remote nature, time for SAR resources to respond and arrive on scene and the extremes of weather that will impact the crew in survival craft. When abandoning the ship, the Master must consider that the crew will be evacuating to either open water, mixed open water and ice, or on ice. The environment into which the crew is entering may make choice of survival craft a consideration. Survival skills and precautions on the ice and in ice-covered waters which are ice-specific should be particularly introduced according to Guide For Cold Water Survival (MSC.1/Circ.1185).

The requirements and ways to avoid freezing, snow accumulation and ice accretion of fire-fighting systems and life saving appliances exposed to the environment due to low air temperatures should be available when required.

Evacuation drills, rescue boat drills, fire drills, damage control drills should be varied so that different emergency conditions are periodically simulated as per the requirements, taking into account unique concerns in ice and low temperatures. For example, evacuation drills include abandonment into the water, on ice, or a combination of the two; in rescue boat drills, each member of the crew should be given instructions which should include problems of cold shock, hypothermia, first-aid treatment of hypothermia and other appropriate first-aid procedures.

Unique concerns in conducting emergency response such as hull damage, oil spill, main engine failure, collision, grounding, besetment, man overboard, fire, explosion in ice and low air and water temperatures should be identified.

**- Recommended presentation**

Present the video regarding the procedures and techniques for abandoning the ship, drills, emergency response, and application of life saving and firefighting equipment, practice and training can be established to demonstrate the procedure. Present the theoretical lecture regarding the unique concerns thereof.

**- Assessment technique**

It's recommended that the assessment should be conducted by both theoretical and practical means. The principles, procedures, safe precautions and methods are suggested to be included in theoretical examinations. The equipment required for the practical exams. Practice is established to demonstrate that knowledge, understanding and proficiency through a variety of teaching aids such as real equipment and mockups.

## **Part E: Evaluation**

The effectiveness of any evaluation depends to a great extent on the precision of the description of what is to be evaluated. The detailed teaching syllabus is thus designed, to assist the instructors, with descriptive verbs, mostly taken from the widely used Bloom's taxonomy.

Evaluation/Assessment is a way of finding out if learning has taken place. It enables the assessor (instructor), to ascertain if the learner has gained the required skills and knowledge needed at a given point towards a course or qualification.

The purpose of Evaluation/assessment can also be used is:

- To assist trainee learning.
- To identify trainees' strengths and weaknesses.
- To assess the effectiveness of a particular instructional strategy.
- To assess and improve the effectiveness of curriculum programs.
- To assess and improve teaching effectiveness.

### ***Types of evaluation/assessment***

The different types of evaluation/assessment can be classified as:

#### ***Initial/Diagnostic assessment***

This should take place before the trainee commences a course/qualification to ensure they are on the right path. Diagnostic assessment is an evaluation of a trainee's skills, knowledge, strength and areas for development. This can be carried out during an individual or group setting by the use of relevant tests.

#### ***Formative assessment***

Is an integral part of the teaching/learning process and is hence is a - Continuous assessment. It provides information on trainee's progress and may also be used to encourage and motivate them.

Purpose of formative assessment is to provide feedback to trainees, motivate trainees, diagnose trainees' strengths and weaknesses and help trainees develop self-awareness.

#### ***Summative assessment***

It is designed to measure trainee's achievement against defined objectives and targets. It may take the form of an exam or an assignment and takes place at the end of a course.

Purpose of summative assessment is to pass or fail a trainee and grade a trainee.

#### ***Evaluation for Quality Assurance***

Evaluation can also be required for quality assurance purposes. Purpose of assessment with

respect to quality assurance is to provide feedback to Instructors on trainee's learning, evaluate a module's strengths and weaknesses and improve teaching.

### ***Assessment Planning***

Assessment planning should be specific, measurable, achievable, realistic and time bound (SMART). Some methods of assessment that could be used depending upon the course/qualification are as follows and should all be adapted to suit individual needs.

- Observation (In Oral examination, Simulation exercises, Practical demonstration).
- Questions (written or oral).
- Tests.
- Assignments, activities, projects, tasks and/or case studies.
- Simulations (also refer to section A-I/12 of the STCW code 2010).
- CBT.

### ***Validity***

The evaluation methods must be based on clearly defined objectives, and they must truly represent what is meant to be assessed, for example only the relevant criteria and the syllabus or course guide. There must be a reasonable balance between the subject topics involved and also in the testing of trainees' KNOWLEDGE, UNDERSTANDING AND PROFICIENCY of the concepts.

### ***Reliability***

Assessment should also be reliable (if the assessment was done again with a similar group/learner, would you receive similar results). We may have to deliver the same subject to different group of learners at different times. If other assessors are also assessing the same course/qualification as us, we need to ensure we are all making the same decisions.

To be reliable an evaluation procedure should produce reasonably consistent results no matter which set of papers or version of the test is used.

If the Instructors are going to assess their own trainees, they need to know what they are to assess and then decide how to do this. The *what* will come from the standards/learning outcomes of the course/qualification they are delivering. The *how* may already be decided for them if it is an assignments, tests or examinations.

The instructors need to consider the best way to assess the skills, knowledge and attitudes of our learners, whether this will be formative and/or summative and how the assessment will be valid and reliable.

- All work assessed should be valid, authentic, current, sufficient and reliable; this is often know as VACSR - valid assessments create standard results.
- Valid – the work is relevant to the standards/criteria being assessed:
- Authentic – the work has been produced solely by the learner;

- Current – the work is still relevant at the time of assessment;
- Sufficient – the work covers all the standards/criteria;
- Reliable – the work is consistent across all learners, over time and at the required level.

It is important to note that no single methods can satisfactorily measure knowledge and skill over the entire spectrum of matters to be tested for the assessment of competence.

Care should therefore be taken to select the method most appropriate to the particular aspect of competence to be tested, bearing in mind the need to frame questions which relate as realistically as possible to the requirements of the officer's job at sea.

### ***Calculations***

The ability to perform calculations and to resolve such problems can be tested by having the candidates carry out the calculations in their entirety. Since a large variety of technical calculations is involved and the time necessary for their complete solution is considerable, it is not possible to completely test the abilities of candidates within a reasonable examination time.

Resort must therefore be made to some form of sampling technique, as is the case with the assessment of knowledge, comprehension and application of principles and concepts in other subject fields.

In examinations conducted on a traditional essay-type basis, the sampling technique that is applied in respect of calculation requirements is to attempt to cover as much of the subject area as possible within the examination time available. This is frequently done by using questions involving shorter calculations and testing in depth on one or two topics by requiring the completion of more complex calculations. The employment of this 'gross sampling' technique reduces the reliability of the examination as compared with what can be achieved with a more detailed sampling technique.

A greater breadth of sampling can be achieved by breaking down calculations into the various computational steps involved in their solution. This technique can only be applied to calculations in which the methodology is standardized. Fortunately, most calculations follow a standard format; where alternative methods of solution exist, the examination can be developed so as to allow candidates an appropriate freedom of choice. Such freedom of choice must be a feature of examinations of all types, in any event.

In order to develop a series of 'step test items', covering an entire calculation, it is necessary to identify each intermediate step in each calculation involved by all methods which are accepted as being correct in principle. These questions, after they have been reviewed for clarity and conciseness, form the standard 'step test items' in that calculation topic.

This approach allows questions to be posed which sample the candidate's knowledge and ability to perform parts of various calculations, which process takes up less time than having him perform entire calculations. The assumption is made that if the candidate can or cannot correctly complete a calculation step leading to the solution, then he can or cannot successfully carry out the entire

calculation. Such detailed sampling allows a larger number of questions to be answered by the candidate within the time allotted for the examination, thus allowing a broader sampling of the candidate's knowledge and abilities, thereby increasing the reliability of the examination.

It must be pointed out that because of the greater number of test items used more time will be spent by candidates in reading the questions and in appreciating the precise step which each question involves.

However, the ability to answer correctly questions that are based on each intermediate step leading to the solution does not necessarily indicate competence in the application of the calculation methodology nor in the interpretation of the intermediate or final results. Further questions must therefore be developed which are of a "procedural" and principle nature.

Such 'step test' and 'procedural' items may be drawn up as 'essay-type' items, supply type items or multiple-choice items. Marking or scoring is easier if multiple-choice test items are used, but in some cases difficulties may arise in creating plausible distracters.

Detailed sampling can allow immediate identification of errors of principle and those of a clerical nature. It must be emphasized that this holds true, in general, only if the test item is based on a single step in the overall calculation. Multiple-choice items involving more than one step may, in some cases, have to be resorted to in order to allow the creation of a sufficient number of plausible distracters, but care must be exercised to ensure that distracters are not plausible for more than one reason if the nature of the error made (and hence the distracter chosen) is to affect the scoring of the test item.

### ***Compiling tests***

Whilst each examining authority establishes its own rules, the length of time which can be devoted to assessing the competence of candidates for certificates is limited by practical, economic and sociological restraints. Therefore a prime objective of those responsible for the organization and administration of the examination system is to find the most efficient, effective and economical method of assessing the competency of candidates. An examination system should effectively test the breadth of a candidate's knowledge of the subject areas pertinent to the tasks he is expected to undertake. It is not possible to examine candidates fully in all areas, so in effect the examination samples a candidate's knowledge by covering as wide a scope as is possible within the time constraints and testing his depth of knowledge in selected areas.

The examination as a whole should assess each candidate's comprehension of principles, concepts and methodology; his/her ability to apply principles, concepts and methodology; his/her ability to organize facts, ideas and arguments and his abilities and skills in carrying out those tasks he will be called upon to perform in the duties he is to be certificated to undertake.

All evaluation and testing techniques have their advantages and disadvantages. An examining authority should carefully analyse precisely what it should be testing and can test. A careful selection of test and evaluation methods should then be made to ensure that the best of the variety

of techniques available today is used. Each test shall be that best suited to the learning outcome or ability to be tested.

### ***Quality of test items***

No matter which type of test is used, it is essential that all questions or test items used should be as brief as possible, since the time taken to read the questions themselves lengthens the examination. Questions must also be clear and complete. To ensure this, it is necessary that they should be reviewed by a person other than the originator. No extraneous information should be incorporated into questions; such inclusions can waste the time of the knowledgeable candidates and tend to be regarded as 'trick questions'. In all cases, the questions should be checked to ensure that they measure an objective which is essential to the job concerned.

### ***Scoring tests***

The assessment of seafarers is concerned with judging whether they are competent, in terms of meeting sufficient specified learning objectives, to perform the tasks required by the qualification they are seeking. That is, they should be tested against predetermined criteria rather than against the performance of other examinees or the norm for the group as a whole, as is the case in many examinations.

To achieve that end in subjective tests, an analytical scoring scheme should be drawn up in which a complete model answer, which would attract full marks, is produced for each question. The model answer is then analysed for the definitions, facts, explanations, formulae, calculations, etc., contained in it and marks are allocated to each item, the aim being to make the scoring as objective as possible. A subjective element will still exist in the original allocation of marks to the various sections and, to some extent, in the scoring of incomplete or partially correct sections.

Either credit scoring or deductive scoring may be used. In credit 'scoring, marks are awarded, in accordance with the scoring scheme, for each correctly completed part of the answer, no marks being credited for incorrect parts or omissions. With deductive scoring, marks are deducted for errors and omissions from the total mark for the question or part question (where a question has been divided into two or more sections). When applied to essay questions, the two methods should produce virtually the same score. Deductive scoring is usually confined to the marking of calculations.

Deductive scoring can be weighted to take account of the relative seriousness of different types of error. Errors are commonly classed and weighted as follows:

1. errors of principle; for example, using the formula for righting moment in a calculation of list; deduct 50% of the mark for the question or part question;
2. major errors; for example, extracting data for the wrong day or time from a publication; deduct 30% of the mark for the question or part question; and
3. clerical errors; for example, transposition of numbers from tables or question paper, careless arithmetic; deduct 10% of the mark for the question or part question for each error.

In the case of clerical errors, only one deduction for a single error should be made. No deductions are made for incorrect answers which follow through from the original error.

If deductions exceed the total mark for a question or part question it is given a zero score; negative scores are not carried over to other parts.

The different types of error can be taken into account in credit scoring schemes by suitably weighting the marks allocated to method, to the extraction of data and to clerical accuracy at each step of the calculation. The steps need to be smaller and more detailed than the division into parts used in deductive marking. As a result, the marks lost for errors of principle tend to be smaller in credit scoring than in deductive scoring.

A small percentage of the total mark, to be credited only for the correct final answer, is sometimes included in a credit scoring scheme. The answer must lie within stated accuracy limits to qualify for that credit. In deductive schemes, an answer that has otherwise been correctly calculated but which falls outside the accuracy limits is treated as a clerical error.

Where tests are to be marked locally at more than one test centre, a well-defined scoring scheme, which will give the same score when applied to the same paper by different markers, is essential for the uniform and fair treatment of candidates. To aid in any subsequent review of marks, possibly resulting from an appeal, the marker should make brief marginal notes on the paper to indicate the reasons for deductions.

Guidance on the treatment of answers produced by pocket calculators is needed. Examination rules usually warn candidates that all working must be shown to gain full marks for a question. The marks to deduct when insufficient working is shown but a correct answer is produced, or when all working is correctly shown but the answer is wrong, need to be known by the marker.

In papers in which all questions are to be answered, the marks may be weighted to reflect the importance or difficulty of individual questions or the length of time which will be needed to answer them. When this is done, it is usual to indicate: the mark for each question on the question paper. Optional questions should all be of similar standard and carry equal marks, so that the standard of the complete test is the same regardless of the questions chosen.

Use can be made of a compulsory and an optional section in the same paper. Questions on which it is felt that all candidates should be tested can be placed in the compulsory section and suitably weighted, while the remainder of the paper offers a choice of questions each of similar standard.

A problem that arises with optional papers is how to deal with cases where more than the required number of questions is answered. Various solutions are adopted by different examining boards. Many mark all questions and discard the lowest marked question or questions. Although that fact is not generally advertised as it may encourage candidates to attempt extra questions. Others take the requisite number of answers in the order in which they are on the question paper and ignore

the remainder.

A similar problem arises in papers in which candidates are required to answer a given number of questions and including at least some stated number from each of several sections.

The pass mark should be set at the lowest score for which sufficient skills and knowledge are demonstrated for competency in each subject. In practice, that score is difficult to determine exactly for an individual paper and could vary slightly from one examination to another. Such an arrangement would be difficult to administer and would be considered unfair by candidates, so the pass mark is fixed and published in the examination regulations. It is, therefore, essential when preparing papers to maintain as constant a standard as possible, such that the pass mark is an appropriate measure of competency.

The following instructions are typical of those produced for guidance of examiners on the marking of examinations.

In order to achieve uniformity in marking between the Examiners in various centres and to facilitate the review of papers, the following guidelines are to be used at all centres:

1. When several candidates write the same examination, papers, other than multiple choice, should be marked question by question, that is to say, question 1 of paper 1 should be marked for all applicants before proceeding to question 2, etc. This gives more uniform marking.

2. All questions should be marked even if it becomes apparent that the candidate cannot achieve the pass mark.

3. Neatness and Orderly Layout of Work:

Where work is not properly laid out or is not neat, marks should be deducted without regard to correctness of the answer. The number of marks deducted should vary according to the quality of the work up to a maximum of 10% where the correct answer is obtained.

4. Important Engineering and Technical Terms:

Where, in general calculations or general questions, an incorrect term is used and such a term is incidental to the work, the Examiner should exercise his judgment as to whether or not marks should be deducted, but in any case, a deduction should not exceed 10% of the allotted marks. This does not apply to direct answers involving definitions or in answers involving the naming of parts.

5. Types of Errors:

Errors can be divided into 3 types:

(a) P - error in principle; 50% of marks allotted for the whole or part of the question should be deducted.

(b) C - clerical error; 10% of the marks allocated should be deducted for each such error.

(c) M - major error, 30% of the marks allotted for the question or part of the question should be deducted.

NOTE: Large mark questions should be considered in their main sections and percentages of the sections deducted. Candidates should be given the benefit of any doubt which may exist.

#### 6. Drawings:

Too much importance should not be attached to elaborate drawings. Often a simple sketch with captions is very explanatory and indicative of a good understanding.

#### 7. Incomplete Answers:

Where a problem or distinct section of a large problem is only partly worked and a step of principle remains to be made, marks allotted should not exceed 50% of the total marks or the split marks allotted as the case may be.

#### 8. Making papers

When marking papers, examiners should enter appropriate marginal notes in brief showing why marks have been deducted, using abbreviations in Paragraph 5. The actual error should be ringed and marked with a brief statement of the reason for the error, e.g., 'wrong answer'. A paper should be so marked that any reviewing Examiner can see at a glance just what happened, including a marginal note to indicate award of a 'benefit of doubt'.

In the case of marginal failure, the paper concerned should be carefully reviewed. This review is not to be regarded as having the purpose of passing the candidate; it is to ensure that the foregoing marking standards have been correctly applied and are consistent with those of other responses to the same examination. It may result in either an increase or a decrease in marks assigned.

This review having been completed, the examiner should issue a fail result if it is still below the pass mark.

#### 9. Use of Calculators

When a pocket, non-programmable calculator is used by a candidate in an examination, all necessary formulae and transpositions must be shown for full marks to be allotted. In the case of a correctly set out answer, or partial answer, which has an incorrect final result, 30% of the whole or part should be deducted on the major error rule.

### ***Advantages and disadvantages of oral and practical tests***

Some aspects of competency can only be properly judged by having the candidate demonstrate his ability to perform specific tasks in a safe and efficient manner. The safety of the ship and the protection of the marine environment are heavily dependent on the human element. In general, all proficiencies require a practical demonstration which in some cases can be performed within training or in service. It is important that any practical testing used to evaluate competence is valid. This means that where this is to be conducted during a training course, the assessor needs to create an environment that has the key features of the work environment on ship present.

It is generally considered advisable that at least some of the testing of knowledge and

understanding of candidates for certificates of competency should be conducted orally.

The ability of candidates to react in an organized, systematic and prudent way can be more easily and reliably judged through an oral/practical test incorporating the use of models or simulators than by any other form of test.

One disadvantage of oral/practical tests is that they can be time-consuming and can require expensive equipment and facilities. Each test may take up about 1 to 2 hours if it is to comprehensively cover the topics concerned. Equipment must also be available in accordance with the abilities that are to be tested. Some items of equipment can economically be dedicated solely for use in examinations.