SUB-COMMITTEE ON STANDARDS OF
TRAINING AND WATCHKEEPING
37th session
Agenda item 3

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VALIDATION OF MODEL TRAINING COURSES

Model course - Operational use of AIS

Note by the Secretariat

<table>
<tr><td colspan="2" align="center">**SUMMARY**</td></tr>
<tr><td>***Executive summary:***</td><td>This document provides a draft model course on training in Automatic Identification Systems (AIS)</td></tr>
<tr><td>***Action to be taken:***</td><td>Paragraph 5</td></tr>
<tr><td>***Related documents:***</td><td>MSC 50/27, STW 17/11 and STW 35/19</td></tr>
</table>

1   The Maritime Safety Committee, at its fiftieth session (MSC 50/27, paragraph 12.10), approved the procedures developed by the Sub-Committee, at its seventeenth session (STW 17/11, annex 5), for validation of model courses related to the implementation of the STCW Convention.

2   The Sub-Committee, at its thirty-fifth session (26 to 30 January 2004), considered the proposal by IFSMA (STW 35/9) and agreed that since the performance standards for Automatic Identification Systems (AIS) have been adopted by the Organization, it would be appropriate to develop a model course to impart training in the operational use of AIS for mariners on board ships. Accordingly, STW 35 instructed the Secretariat to take the necessary steps to develop a new model course for training in AIS, taking into account any decisions of MSC 78 and COMSAR 8 related to long range tracking and identification of ships and to submit it to the Sub-Committee for validation in due course (STW 35/19, paragraph 9.1).

3   The preliminary draft of this model course by the Secretariat was forwarded to members of the validation panel for their comments. Comments on the draft course have been received from the validation panel and have been incorporated as appropriate.

4   The final draft model course is set out in annex.

Action requested of the Sub-Committee

5   The Sub-Committee is invited to consider the above information and decide as appropriate.

***

ANNEX

**MODEL
COURSE
X.XX**

Draft

AUTOMATIC
IDENTIFICATION
SYSTEMS

International Maritime Organization

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

Foreword

TO BE ADDED LATER BY IMO SECRETARIAT

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Secretary-General

Introduction

- **Purpose of the model courses**

The purpose of the IMO model courses is to assist maritime training institutes and their teaching staff in organizing and introducing new training courses or in enhancing, updating or supplementing existing training material where the quality and effectiveness of the training courses may thereby be improved.

It is not the intention of the model course programme 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 instructors are the key components in the transfer of knowledge and skills to those being trained through IMO model course material.

Because educational systems and the cultural backgrounds of trainees in maritime subjects vary considerably from country to country, the model course material has been designed to identify the basic entry requirements and trainee target group for each course in universally applicable terms, and to specify clearly the technical content and levels of knowledge and skill necessary to meet the technical intent of IMO conventions and related recommendations.

- **Automatic Identification Systems**

The Organization has mandated in SOLAS Chapter V the carriage of equipment meeting the requirements of the Universal Shipborne Automatic Identification System (AIS) on all larger ships (as defined in Section 3.1 of this Model Course) to enhance the safety of life at sea, the safety of navigation and the protection of the marine environment. It does this by identifying vessels and other collaborative targets, assisting in target tracking, aiding situational awareness (and thereby collision avoidance) and in simplifying the exchange of safety and security related information between ships and between ships and the shore.

The onboard AIS equipment takes inputs from the ship's navigational sensors and, together with information concerning the ship and its voyage, transmits to surrounding vessels and shore stations. It also receives information from other vessels, shore stations and AIS-fitted aids-to-navigation. The received data is displayed on the ship as alpha-numeric lists on a dedicated display, optionally assisted by showing graphically the position, heading, course and speed of targets. Ideally, AIS targets are displayed on a radar screen or on ECDIS (that can also display radar tracked targets). All radars fitted from 1 July 2008 must be able to display AIS data in this way.

Shore stations use the data for Vessel Traffic Services (VTS) and for national vessel monitoring purposes, including security enhancement. The data is normally displayed with radar at these stations.

The onboard operator has to input accurate information concerning own-ship, some of which is voyage dependent and hence needs to be kept updated. In conjunction with other navigational information, knowledgeable interpretation of the received data can greatly enhance situational awareness, however, AIS is a complex communications/navigation sub-system that is neither self-evident in concept nor in use. Because of this it is important that an officer in charge of a navigational watch (OOW) on a vessel carrying AIS is well trained in its use.

Courses based on this Model Course may be stand-alone and as such will be useful for updating existing watch keeping staff. For seafarers who are training to become an OOW it is good practice to ensure an appropriate level of integration between this model course and Model Course 1.07 (Radar navigation, radar plotting and use of ARPA) and Model Course 7.03 (Officer in charge of a navigational watch).

Training colleges undertaking such a course will need a simple AIS simulator and a radar target tracker (ARPA) simulator with AIS display capabilities. System requirements are discussed under 'Teaching facilities and equipment' in Part A of this model course. A detailed discussion on simulator exercises is given in the final section of Part D.

- **Use of the model course**

To use the model course the instructor should review the course plan and detailed syllabus, taking into account the information provided under the entry standards specified in Part A 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. Also, 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 either delete from the course, or reduce the emphasis on, items dealing with knowledge or skills already attained by the trainees. The instructor should also identify any academic knowledge, skills or technical training which they may not have acquired.

By analysing the detailed syllabus and the academic knowledge required to allow training in the technical area to proceed, the instructor can design an appropriate pre-entry course or, alternatively, insert the elements of academic knowledge required to support the technical training elements concerned at appropriate points within the technical course.

Adjustment of the course objective, scope and content may also be necessary if the trainees completing the course are to undertake duties which differ from the course objectives specified in the Model Course.

Within the course plan the course designers have indicated their assessment of the time which should be allotted to each area of learning. However, it must be appreciated that these allocations are only suggestions 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.

- **Lesson planning**

Having adjusted the course content to suit the trainee intake and any revision of the course objectives, the instructor should draw up lesson plans based on the detailed syllabus. The detailed syllabus contains specific references to the textbooks or teaching material proposed to be used in the course. Where no adjustment has been found necessary in the learning objectives of the detailed syllabus, the lesson plans may simply consist of the detailed syllabus with keywords or other reminders added to assist the instructor in preparing the presentation of the material.

▪ **Meeting the required performance**

The instructor must be satisfied that the trainee has attained each specific learning or training objective. In order to achieve these objectives, it may be necessary for the instructor to repeat the presentation of concepts and methodologies in varying ways. The syllabus is laid out in learning objective format and each objective specifies a *required performance* or, *what the trainee must be able to do* as the learning or training outcome. Taken as a whole, these objectives aim to meet the knowledge, understanding and proficiency specified in the appropriate tables of the STCW Code.

▪ **Implementation**

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

- Equipment

- Suggested references, textbooks, technical papers and other reference material.

Thorough preparation is the key to successful implementation of the course. The Organization has produced a booklet entitled "Guidance on the implementation of IMO model courses", which deals with this aspect in greater detail.

Part A: Course framework

▪ **Aims**

This course provides generic training in the use of AIS. It is designed for officers in charge of a navigational watch on ships that are fitted with such equipment. Its main aims are to increase safety and security and to protect the environment. It does this by giving instruction on the understanding and safe use of such systems, including illustrations of dangerous or improper use. Successful completion of the course enables trainees to acquaint themselves knowledgably with specific AIS equipment fitted on a ship (familiarization), prior to using the equipment in a safe and beneficial manner at sea.

The course takes into account all relevant IMO resolutions and Guidelines on AIS available at the time the Model Course was prepared, including AIS requirements on new radar and navigational displays, mandated by the Maritime Safety Committee to come into force on 1 July 2008. It also takes into account the relevant sections of the revised SOLAS Chapter V which came into force on 1 July 2002. Where appropriate, it also takes note of common implementation practice, as influenced by Administrations, international standards bodies and manufacturers.

▪ **Course objectives**

Trainees successfully completing this course and meeting the required performance standards, will be able to:

• Understand the objectives of AIS.

• Understand how AIS works as a system.

• Understand the benefits and limitations of the system.

• Understand the decision making process that needs to be applied in using such systems.

• Demonstrate competency in entering and checking ship's AIS data.

• Demonstrate competency in the use of AIS as an additional navigational tool to aid situational awareness and collision avoidance.

• Demonstrate competence in sending and responding to safety and security related messages.

• Rapidly familiarise themselves with a particular AIS implementation on a ship, prior to use at sea.

▪ **Entry standards**

The course is designated both for candidates for certification as officers in charge of a navigational watch and for experienced nautical officers and other persons with responsible duties in navigation work, such as pilots.

Those wishing to enter this course should have had training and experience in the use of radar and ARPA and be fully conversant with the Collision Regulations.

▪ **Course certificate, diploma or document**

Every master, chief mate and officer in charge of a navigational watch should have completed a course conforming to this model.

On successful completion of the course and assessments, a document may be issued certifying that the holder has successfully completed a course of training in the operational use of AIS in accordance with the recommendations contained in IMO Model Course X.XX.

▪ **Course intake limitations**

The course intake will be limited by the availability of simulator equipment, particularly an ARPA simulator with AIS display facilities. AIS-specific training does not necessarily require a full-mission bridge simulator but if such a simulator is used, when AIS is being taught as part of a wider course, then experience shows that the effectiveness of practical training is optimised when the intake does not exceed four trainees on such a simulator.

See section on *Teaching facilities and equipment,* below.

▪ **Staff requirements**

The qualifications of the instructor should be in accordance with requirements laid down in section A-I/6 of the STCW Code.

The instructor should be thoroughly familiar with the operation of the equipment to be used in the course.

▪ **Teaching facilities and equipment**

For the theoretical part of the syllabus, a classroom equipped with at least an overhead projector and a flipchart (or equivalent) will be required. A computer driven projector is ideal as this can be used to demonstrate AIS features and use to the complete class, utilising a basic software simulator.

For this course AIS training exercises can be adequately performed on single screen simulators running suitable software. The software should have the following simulation facilities:

• AIS minimum keyboard and display (MKD)

- Tracked target (ARPA) radar display with AIS overlay capability

- Optionally, ECDIS with ARPA and AIS overlay capability

If this course is used stand-alone, either for OOW-qualified seafarers, or for trainees who have already successfully undertaken a course in the use of radar equivalent to Model Course 1.07 (Radar navigation, radar plotting and use of ARPA), then the use of a full bridge simulator (with AIS facilities) is not really necessary, although such facilities, where available, offer a good AIS learning experience.

If this course is combined with other training, such as Model Course 1.07 and Model Course 7.03 (Officer in charge of a navigational watch), full bridge simulator training that includes AIS, particularly displayed on radar, can be extremely useful.

- **Teaching aids (A)**

A1   Instructor Manual (Part D of this Course)

A2   Video tape or DVD player

A3   Video-cassettes or DVDs about the use of AIS. For example, Automatic Identification Systems, available from Videotel Productions, London

A4   Simulator software

A5   Simulator data for an appropriate area

- **IMO references (R)**

R1   Resolution A.917(22), Guidelines for the onboard operational use of shipborne Automatic Identification systems (AIS)

R2   Resolution MSC.74(69), Annex 3, Recommendations on performance standards for a universal Shipborne Automatic Identification System (AIS)

R3   Resolution A.956(23), Amendments to the guidelines for the onboard operational use of shipborne Automatic Identification systems (AIS) (Resolution A.919(22))

R4   SN/Circ.236, Guidance on the application of AIS Binary Messages

R5   SOLAS Chapter V, as amended

R6   SN/Circ. 227, Guidelines for the installation of a shipborne Automatic Identification System (AIS)

R7   Resolution MSC.192(79), Adoption of the revised performance standards for radar equipment

R8   SN/Circ.243, Guidelines for the presentation of navigation-related symbols, terms and abbreviations

R9   Standards, training certification and watchkeeping for seafarers code, STCW Convention, 1995

R10   International safety management (ISM) code and guidelines, 2002

R11   SN/Circ. 244, Guidance on the use of UN/LOCODE in the destination field of AIS messages

R12   SN/Circ.217, Interim guidelines for the presentation and display of AIS target information

R13   SN/Circ.222, Information on regional operating areas and regional operating frequencies available for AIS use

R14   SN/Circ.245, Amendments to the guidelines for the installation of a shipborne Automatic Identification System (AIS)

▪   **Other references (T)**

T1   A. Parkinson, S. Barker and M. Shorthose, "Understanding SOTDMA applied to AIS", Proceedings of the Royal Institute of Navigation AIS03

T2   ITU-R M.1371, Technical characteristics for a universal automatic identification system using time division multiple access in the VHF maritime mobile band, International Telecommunications Union, Geneva

T3   IEC 61108-1 Global navigation satellite systems Part1: GPS, Second edition, 2003, International Electrotechnical Commission, Geneva

T4   I. P. A. Stitt, "AIS and collision avoidance – a sense of déjà vu?", The Journal of Navigation, Volume 57, Number 2, May 2004, pp167-180

T5   IEC61993-2 Class A shipborne equipment of the universal automatic identification system (AIS), 2001, International Electrotechnical Commission, Geneva

T6   IEC 61162-1 Digital interfaces Part 1: Single talker and multiple listeners, 2000, International Electrotechnical Commission, Geneva

T7   International Safety Guide for Oil Tankers and Terminals, 4th Edition, 1996, OCIMP/ICS/IAHP

T8   IEC 62287 AIS Class B equipment for non-SOLAS vessels (under preparation), International Electrotechnical Commission, Geneva

▪ **Bibliography (B)**

Instructors are recommended to visit www. iala-aism.org, the web site of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) to obtain the latest reports and information concerning AIS Aids to Navigation and AIS VTS operations. Trainees should be made aware of the usefulness of this website.

Part B: Course Outline and Timetable

The course comprises lectures, demonstrations and simulator exercises. The outline below identifies the main areas of the course and the approximate time that should be allocated to each activity of teaching. With modern classroom technology these activities can often be merged into a continuous exposition of a particular area of understanding, rather than having to move from room to room.

In particular the lecture can be digitally projected from presentation material (slides, animation and video) directly from a computer that also runs AIS and radar/tracking simulation software, making it easy for the lecturer to alternate between theory and example. Readily available software tools facilitate this. The use of simulators for demonstration and trainee exercises is discussed in the final section of Part D.

Some simulator exercises emphasising particular skills can be performed beneficially in the classroom on individual personal computers (PCs). If possible, exercises on more complex simulators are very useful towards the end of a course to demonstrate that a complete understanding has been obtained and within a team-working environment.

Learning Objective format is used in the Detailed Teaching Syllabus given in Part C; the outline below is a straightforward summary of the course material. The numbering system used below reflects that of the Detailed Teaching Syllabus.

In the following table all lesson times are given in hours for lectures, demonstrations and simulator exercises. Durations given in bold type are the totals for each section.

	Training area	**Lecture**	**Dem**	**Sim Ex**
1	**AIS system concepts**			
	A basic description of AIS at a systems level:	1.3	0.2	
	• AIS objectives of the Organization • System concepts • Comparison of AIS with radar			
2	**AIS data**			
	Detailed description of AIS data at a user level including safety/security related messages, AIS Aids to Navigation and AIS Binary Messages.	0.8	0.2	
3	**AIS ship installations**			
	AIS configuration description, including:	0.8	0.2	
	• Carriage requirements • MKD based configuration • Radar/ECDIS configuration • Overview of operational problems caused by installation issues			

	Training area	Lecture	Dem	Sim Ex
4	**Use of AIS at sea**			
	The safe use of AIS at sea:	3.5	0.5	2.0
	• Bridge procedures • Data input and checking • UN/LOCODES • Use of safety and security related messages • Use of AIS Binary Messages • Use of AIS in areas with security or piracy implications • Use of AIS in oil terminals • AIS alarms • Cautions of use of AIS • Use of AIS to increase situational awareness in for both MKD only and radar/ECDIS installations • Implications of COLREGS • Use of AIS AtoN data • Manual setting of regional operating settings			
5	**Familiarization training**			
	Description of information needed to become quickly familiarised with a ship's particular AIS configuration	0.5		
Total training duration 10 hours		**6.9**	**1.1**	**2.0**

Simulator exercises are suggested in 'Guidance on simulators' in Part D of this Model Course.

Part C: Detailed Teaching Syllabus

The detailed teaching syllabus indicates the contents of the course and appropriate references and teaching aids.

▪   **Learning objectives**

The detailed teaching syllabus has been written in learning objective format in which the objective describes what the trainee must do to demonstrate that knowledge has been transferred. This format is an appropriate teaching and assessment tool to express:

- The depth of understanding of a subject and the degree of familiarization with a subject on the part of the trainee.

- What capabilities the trainee should really have and be able to demonstrate.

Every instructor is encouraged to teach learning in an 'objective-related' way instead 'material-related'. In this context, all objectives are understood to be prefixed by the words, 'The expected learning outcome is that the trainee is able to . . . '.

To indicate the degree of learning outcome of this course, the learning objectives for the Detailed Teaching Syllabus can be classified in three 'dimensions':

- C   (cognitive)

- A   (affective)

- P   (psycho-motoric)

Within a dimension, they are hierarchised by increasing complexity (C1 to C6, A1 to A5, and P1 to P5) where the complexity (depth, familiarization) is expressed (following B. Bloom and others) by a typical verb as follows:

Cognitive dimension of learning objectives:

C1   Knowledge   describe, outline

C2   Comprehension   explain

C3   Application   apply, perform, operate

C4   Analysis   analyse

C5   Synthesis   synthesise, construct, plan

C6   Evaluation   assess

Affective dimension of learning objectives:

A1   Reception; notice   recognise

A2   Response   respond

A3   Value   value

A4   Organization   organise

A5   Value characterisation   accept, appreciate

Psycho-motoric dimension of learning objectives:

P1   Imitation   imitate

P2   Manipulation   manipulate

P3   Precision   move, mark

P4   Co-ordination   co-ordinate (operations, menus)

P5   Naturalisation   automate, internalise

▪   **References and teaching aids**

In order to assist the instructor, references are shown against the learning objective to indicate IMO references and publications, bibliographies, textbooks and other references, as well as additional teaching aids which the instructor may wish to use when preparing course material. The material is listed in the course framework. The following notations and abbreviations are used:

R   IMO reference

T   Text book and other references

B   Bibliography

A   Teaching aid

Ap.   Appendix

An.   Annex

Ch.   Chapter

p.   Page

Para.   Paragraph

Sc.   Section

The following are examples of the use of references:

"R1 Para.6", refers to paragraph 6 of IMO Resolution A. 917(22);

"A1 Para.D4.3", refers to paragraph 4.3 in Part D of this manual; and

"A1 Sc.DSim", refers to the Simulator Exercises section in Part D of this manual.

▪ **Instructor Manual**

The instructor Manual (Part D) is included to provide additional information to instructors. It is designed to help further in structuring and organising a specific course. At the time of compilation of this model course there were no known text books covering the subject material. For this reason Part D includes extra information on the subject. The instructor is recommended to gain additional technical material from AIS suppliers. Suppliers of simulators are also good sources of technical information.

The instructor should take pains to present the material within 'a-use-at-sea' context. It is not just a matter of imparting technical knowledge. If the instructor has had no sea-going experience in the use of AIS it will be necessary to extrapolate his or her non-AIS experience to incorporate the ideas and disciplines of using AIS.

▪ **Detailed Teaching Syllabus**

All objectives are understood to be prefixed by the words "The expected learning outcome is that the trainee is able to …". The Teaching Aid reference to A1 Sc.DSim, refers to the section on Simulator Exercises in Part D of this model course.

Learning objectives		IMO Reference	Other Refs	Teaching Aid
1	**AIS system concepts** ***Section objective: to understand the objectives of AIS, the system concept and relevant aspects of the technology relevant to its use***			
1.1	Explain the objectives of AIS.	R1 Para.4, R2 Para 1.2		A1 Para D1.1
1.2	Outline the system concepts of AIS.	R1 Para. 5-10	T2	A1 Para D1.2, A3
1.3	Outline the self organising time division multiple access concept of AIS.	R1 An. 2	T1, T2	A1 Para D1.3, A3
1.4	Describe the modes of operation.	R2 Para. 2.1	T2	A1 Para D1.4
1.5	Outline the principles of regional operating settings.		T2, T5	A1 Para D1.5
1.6	Describe the major constituents of an AIS shipborne system.	R1 An.1		A1 Para D1.6, A3

Learning objectives		IMO Reference	Other Refs	Teaching Aid
1.7	Outline AIS Class B systems.		T8	A1 Para D1.7
1.8	Outline the propagation characteristics of AIS transmissions and compare with radar.	R1 Para.9		A1 Para D1.8
1.9	Outline the facility for long-range communication.	R1 Para.48		A1 Para D1.9
1.10	Recognise and accept the IMO requirements and guidelines for AIS.	R1, R2, R3, R4, R6, R7, R8, R11, R12		A1 Para.D1.10
2	**AIS data**			
	Section objectives: to understand the data transmitted and received by AIS			
2.1	Explain the information included in static data and the associated transmission intervals.	R1 Para.11-13	T2	A1 Para.D2.1, A4
2.2	Explain the information included in dynamic data and the associated transmission intervals.	R1 Para.11-13	T2	A1 Para.D2.2, A4
2.3	Explain the information included in voyage related data and the associated transmission intervals	R1 Para.11-13	T2	A1 Para.D2.3, A4
2.4	Explain the functionality of safety and security related messages.	R1 Para.14-15		A1 Para.D2.4, A4
2.5	Explain the functionality of AIS aids to navigation.	R1 Para.50		A1 Para..D2.5, A4
2.6	Explain the purpose of AIS Binary Messages.	R4	T2	A1 Para.D2.5
3	**AIS ship installations**			
	Section objectives: to understand AIS ship installation options and the common operational problems that can arise from poor installation			
3.1	Define the carriage requirements.	R5 Reg.19 Sec.2.4		A1 Para.D3.1
3.2	Describe a typical MKD installation.	R1 An.1		A1 Para.D3.2, A3
3.3	Describe a typical ARPA/ECDIS installation.	R7		A1 Para.D3.3, A3
3.4	Explain common detrimental effects given by poor installation or the retrofitting of interfering systems.	R6		A1 Para.D3.4

4	**Use of AIS at sea**			
	Section objectives: to understand the safe use of AIS at sea			
4.1	Describe the need and use of bridge procedures for AIS.			A1 Para.D4.1
4.2	Describe what static data needs to be entered, recognise the need to check this data and demonstrate competency in the procedures.	R1 Para.12,23		A1 Para.D4.2, A4
4.3	Describe what voyage related data needs to be entered, including the use of UN/LOCODES, recognise the need to check this data and demonstrate competency in the procedures.	R1 Para.12,22,26 R6 An.2, R11		A1 Para.D4.3, A4
4.4	Recognise the need to check dynamic data, describe the need to enter the navigational status of the ship as part of the dynamic data and demonstrate competency in the procedures.	R1 para.12,24,26		A1 Para.D4.4, A4
4.5	Describe the use of safety and security related messages and demonstrate competency in the procedures.	R1 Paras.14-20		A1 Para.D4.5, A4
4.6	Describe the use of AIS binary messages.	R4		A1 Para.D4.6
4.7	Describe the use of AIS in areas that may have security or piracy implications.	R1 Para.21, R3		A1 Para.D4.7
4.8	Explain the special precautions on using AIS in oil terminals.		T7	A1 Para.D4.8
4.9	Outline AIS alarm conditions.		T5	A1 Para.D4.9, A4
4.10	Explain the cautions that should be used when using AIS and demonstrate this understanding.	R1 Para.2, 31-43		A1 Para.D4.10, A3, A4
4.11	Describe how to enhance situational awareness on an MKD based system and demonstrate competency in this understanding.	R1 Para.39-43		A1 Para.D4.11, A3, A4
4.12	Describe the Organization's mandated AIS symbology for use on radar and other navigational displays and how to enhance situational awareness on ARPA/ECDIS based system .Demonstrate competency in these areas.	R8 Ap., R7		A1 Para.D4.12, A3, A4
4.13	Explain and demonstrate the application of the COLREGS when using AIS data.		T4	A1 Para.D4.13

4.14	Explain the display of AIS aids-to-navigation on shipborne AIS equipment and demonstrate competency in recognising such AtoNs.	R8 Ap.		A1 Para.D4.14
4.15	Demonstrate the manual entering of regional operating settings.		T2, T5	A1 Para.D4.15
5.	**Familiarization training**			
	Section objective: to understand the familiarization responsibilities in the use of AIS in order to operate a specific installation			
5.1	Describe a familiarization check-list.	R9, R10		A1 Para.D5

Part D: Instructor Manual

▪ **General**

This manual reflects the views of the course designers on methodology and organization, including the:

- Selection of principal AIS subjects

- Relative importance of these subjects

- Interrelations between these subjects

- Learning objectives

- Necessary teaching tools

- Time allocated to achieving the learning objectives

The guidance given is intended to give the instructor a baseline on which to work out and develop a course that will meet the particular local requirements and the instructor's own experience and ideas. As the course develops the instructor should refine and develop what is successful and discard those ideas which do not work.

Guidance is provided in the booklet entitled 'Guidance on the implementation of IMO model courses' which includes a check list for preparation of courses. Preparation and planning constitute an important factor, which makes a major contribution to the effective presentation of the course.

▪ **Theory, demonstration and exercises**

Theory lectures

The safe use of AIS requires good knowledge and understanding of the concept and basic principles of AIS, taught as classroom lectures. Special emphasis should be laid on giving information about typical ship configurations of AIS, including its common interconnection to other equipment such as GNSS, radar and ECDIS. Guidance on the practical use of AIS should be given, particularly the input and checking of ship related data and the use of AIS to improve situational awareness and as a further aid to assist collision avoidance decisions.

As far as possible, such lessons should be presented within a familiar context and make use of practical examples. They should be well illustrated with diagrams, photographs and charts where appropriate and be related to matter learned or reinforced during simulator exercises. The use of an overhead projector, if possible computer based, will greatly enhance the value of these lectures. Distribution of copies of the presentation screens as trainee handouts contribute to the learning process.

The guidance on specific subject areas included in Part D included many 'bulleted' lists of information. The Instructor may wish to include these in projected 'slides', suitably modified to fit the specific teaching requirements.

Demonstration

During presentation of the theory many of the concepts can be shown as a computer simulation, ideally projected as part of the overhead presentation, but possibly shown on a computer screen, or screens, easily viewable by participants.

Simulator exercises

It is an essential part of the course that sufficient practical experience is gained on suitable simulators. Many aspects can be learnt on single screen simulators running suitable software, simulating an MKD. (The MKD is described in Section 1.6 below). Some time should be spent on a more complex simulator that allows AIS data to be displayed on a radar with tracking facilities (e.g. ARPA), which is also displaying appropriately co-ordinated radar data. Display of this data on an ECDIS simulator would also be useful. For real time navigation exercises of this type, navigation simulators that co-ordinate the radar tracking and AIS data are necessary.

▪ **Evaluation**

The outcome of the training course should be evaluated. Because the course includes theoretical knowledge as well as practical skills and guidance in proper decision-making, the method of evaluation and the criteria for evaluating competency (correctness of method, correctness of outcome, duration, compliance, effectiveness, etc.) should take all these aspects into account. The learning objectives used in the detailed syllabus should provide a sound basis for the construction of suitable tests for evaluating trainee progress. The effectiveness of any evaluation depends upon the accuracy of the description of what is to be measured.

Further guidance on method of evaluation, validity, reliability, subjective testing, objective testing, distracters and guessing (if using multiple choice tests) and scoring is provided in the booklet entitled "Guidance on the implementation of IMO model courses".

▪ **Lesson plans**

The instructor should draw up lesson plans for the individual lessons based on the course objectives and the detailed syllabus taking account any necessary revision of course content to suit the trainee intake. An example of a lesson plan (60 minutes) is shown below. The lesson plans may simply consist of the detailed syllabus with keywords or other reminders added to assist the instructor in making the presentation of the material. The lesson plans may contain specific references to the teaching method, IMO references, bibliography, textbooks and other teaching material proposed for use in the course, instructor guidelines and time (in minutes) allocated to a specific learning objective.

Example of AIS Lesson Plan

2	AIS data	Teaching Method	IMO Reference	Bibliography Textbooks	Instructor guidelines	Time Minutes
2.1	Explain the information included in static data and the associated transmission intervals	Lecture, Dem	R1 Para.11-13	T2 (if additional information is required)	Demonstrate as projected simulator image	10
2.2	Explain the information included in dynamic data and the associated transmission intervals	Lecture, Dem	R1 Para.11-13	T2 (if additional information is required)	Demonstrate as projected simulator image	10
2.3	Explain the information included in voyage related data and the associated transmission intervals	Lecture, Dem	R1 Para.11-13	T2 (if additional information is required)	Demonstrate as projected simulator image	15
2.4	Explain the functionality of safety and security related messages	Lecture, Dem	R1 Para.14-15		Demonstrate as projected simulator image	10
2.5	Explain the functionality of AIS aids to navigation	Lecture , Dem	R1 Para.50		Demonstrate as projected simulator image	5
2.6	Explain the purpose of AIS binary messages and other relevant AIS messages	Lecture	R4	T2 (if additional information is required)		10
					Total	**60 minutes**

▪   **Guidance on specific subject areas**

This section contains guidance to the instructor on the coverage of the AIS subject areas listed in the course outline and the detailed teaching syllabus. The scope and depth of the subject areas are reflected; essentials are pointed out.

Many of the subjects contain objectives which are relevant to different exercises at different levels. Their inclusion in any exercise can reinforce the learning process. A methodology based on the instructor's own experience should be developed bearing in mind that the IMO references help to indicate the required training under each heading.

The paragraph numbering scheme matches the course outline and syllabus, defined in Part C and D, respectively.

1.   AIS system concepts

1.1   The objectives of AIS

Within Reference R1[1], the Organization has defined the objectives of the shipborne Automatic Identification System (AIS), namely:

AIS is intended to enhance:

- *Safety of life at sea*

- *The safety and efficiency of navigation*

- *The protection of the marine environment*

It also states that the purpose of AIS is to:

- *Help identify vessels*

- *Assist in target tracking*

- *Simplify information exchange (e.g. reduce verbal mandatory ship reporting)*

- *Provide additional information to assist situation awareness*

Within Reference R2 the 'top-level' functional requirements for AIS are stated as:

The AIS should improve the safety of navigation by assisting in the efficient navigation of ships, protection of the environment and the operation of Vessel Traffic Services (VTS), by satisfying the following functional requirements:

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[1] Reference R1 as modified by Reference R3 is reproduced in Annex II of this Model Course.

- *In a ship-to-ship mode for collision avoidance* (but see the discussion below)

- *As a means for littoral States to obtain information about a ship and its cargo*

- *As a VTS tool, i.e. ship-to-shore and shore to ship (traffic management)*

Instructors should ideally include the IMO (italicised) definitions as part of the presentation material. Several points may need to be addressed and expanded, depending on the experience and knowledge of the trainees.

Some comments should be made on the use of AIS for collision avoidance. Importantly, Reference R1 does not use the term 'collision avoidance' when stating the purpose of AIS but uses 'situational awareness'. This emphasis in improving situational awareness should be reinforced continually by the instructor; it is not safe to use AIS as the sole information for collision avoidance decisions. Reference R1, Paras. 39 – 43, amplifies this warning. Section 4.10 below gives additional cautions when using AIS.

Instructors should note that Reference R2 is a recommendation on equipment performance standards. The reference to collision avoidance in Reference R2 emphasises that the equipment needs to be designed to assist this function safely. In actual use AIS data must be used in conjunction with visual and radar data when collision avoidance actions are being determined. The Organization makes it quite clear in Reference R1 that although the potential of AIS is recognised as an-anti collision device it is not yet recommended for this use.

1.2   The system concepts of AIS

AIS is based on automatic communication between 'stations' using very high frequency (VHF) radio communications. The information communicated is primarily concerned with the safe navigation of vessels and also includes information of use to authorities, such as hazardous cargo identification. Communication stations include ships (and in the future small craft – see Section 1.7), shore stations (such as VTS centres), search and rescue (SAR) aircraft, and in the future AIS aids-to-navigation (AIS AtoNs), which will give position and other data concerning navigational marks.

Ships using AIS automatically and continually transmit up-to-date navigational data. This includes:

- Non-changing data such as ship's name and length, (called 'static' data)

- 'Dynamic' data such as current position, speed and course over ground (SOG and COG)

- 'Voyage related' data, which includes destination, estimated time of arrival (ETA) and draught.

The dynamic data is taken from the ship's own data being used for navigation. Position, SOG and COG are normally taken from the ship's Global Navigation Satellite System (GNSS), such as GPS or GLONASS.

The transmitted data is received by all stations in range of the transmitting ship station. Therefore data about that ship is available to these other station, including VTS stations, other vessels and SAR aircraft. This data can be displayed on ships or onshore in a number of ways. In particular it can be shown as additional information on a radar display or ECDIS. In this way ships can be shown by symbols indicating their AIS transmitted position, heading, course and speed. Other information, such as ship's name, can sometimes also be displayed near to the target position. By selecting an individual target further detailed information concerning the target can be displayed in a text box.

Transmissions comprise of bursts of data from each station according to an automatically determined time-ordered sequence. This avoids two stations transmitting at the same time and therefore, in principle, all transmissions could be on the same VHF channel. In practice this would overload a single channel in some busy areas and so two VHF channels are used, doubling the number of stations that could use a single channel system.

The used VHF channels are known as AIS1 and AIS2. Consecutive transmissions from each station normally alternate between the AIS1 and AIS2 frequencies. In most waters Channels 87B (161.975 MHz) and 88B (162.025 MHz) are used for AIS1 and AIS2. Some states have adopted other channels to avoid interference with pre-existing non-AIS services. Shore station commands automatically instruct ship stations the frequencies to use for AIS1 and AIS2, removing any normal need for channel adjustment by the operator.

1.3   Self-organizing time division multiple access

The method of operation where each station uses defined time slots for its transmissions is known as Time Division Multiple Access (TDMA). The time slots for AIS transmissions are all precisely aligned to Coordinated Universal Time (UTC). Global Navigation Satellite Systems are used to give each station precise UTC. One UTC minute is divided up into 2,250 equal slots, allowing 2,250 transmission bursts to be made on each channel per minute.

Individual ships at sea (when not anchored or moored) transmit on average about once every 6 seconds – ie 10 times per minute (the actual rate of transmissions varies for different data, (see Section 2 below). If these were the only transmissions an ideal system could cope with 2,250 x 2/10 = 450 stations in any one area. (The factor '2' in the calculation accounts for the use of both AIS1 and AIS2 channels). Assuming the validity of this rather oversimplified analysis it is seen that the system has the theoretical capacity to cope with 450 ship stations in any one area.

Instructors should note that the above analysis is highly simplified as it does not take all factors into account. It is included to help illustrate the inherent power of time division systems to distribute data continually between a large number of stations, while utilising a small amount of the frequency spectrum (just two VHF channels).

Each station has its own effective area, normally limited by the range of the VHF transmissions. This can be 20-30 miles or more, depending on many factors. These factors are discussed in Section 1.8.

Each AIS station determines its transmission slots by initially 'listening' to the existing traffic to establish which slots are free. It then uses defined algorithms (formulae) to choose suitable slots. This method of selecting the transmission slots is known as self-organising TDMA (SOTDMA). The principles of SOTDMA are illustrated in Figure 1.
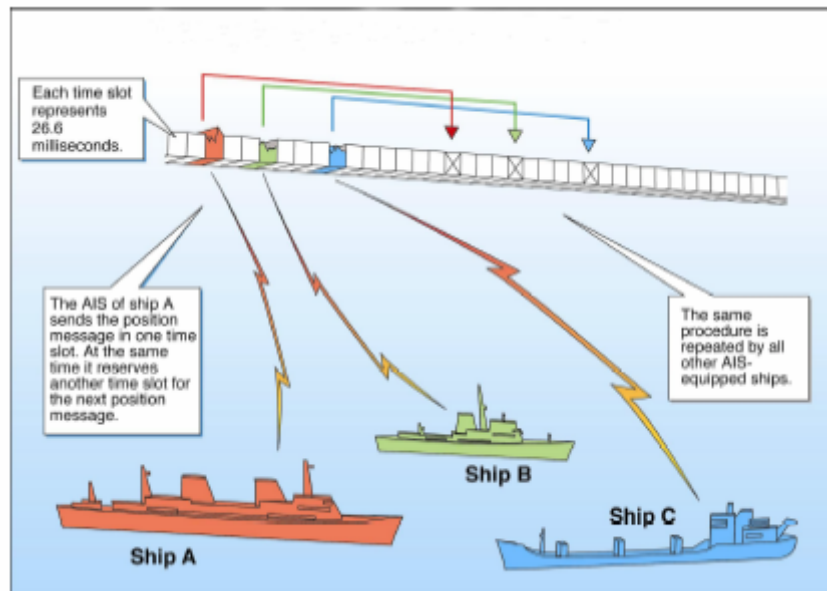

Figure 1 - Principles of SOTDMA

By using the features of SOTDMA together with the inherent properties of the established maritime Frequency Modulated (FM) VHF radio system, AIS has the inbuilt ability to 'degrade gracefully' as the number of stations using the system increases. This means that the range of contacts around a specific ship will increase or decrease according to the local traffic density. Because of this, closer vessels (that are normally the most important to situational awareness) remain in AIS contact even when station overload is reducing overall system performance

If instructors or trainees are interested in learning more about the use of SOTDMA for AIS the use of Reference T1 is recommended. The details included within Reference T1 are not necessary to be included as part of this course.

1.4   Modes of Operation

The self-organizing mode of operation of AIS described above is termed *Autonomous and Continuous*. There are two other modes of operation which may be set by the competent authority. AIS equipment on a ship will automatically switch to these modes on receiving the transmitted electronic instruction from a controlling station. No manual intervention on the ship is required.

The *Assigned Mode* allows the competent authority to assign individual ship stations their data reporting intervals and time slots. This mode can be useful if there are circumstances causing system overload, which may need intervention by the competent authority.

A possible scenario for this is a major SAR operation near a busy port. A SAR aircraft, because of its height, has an extremely long AIS range. Therefore, with a number of these aircraft in operation, together with an influx of emergency AIS-fitted craft, the potential system overload may be averted by the competent authority using Assigned Mode.

When ship stations are switched to the Assigned Mode the ship's system will revert to the (normal) Autonomous Mode after a random interval of between 4 and 8 minutes. (Randomness is introduced in order to reduce the number of ships trying for new time slots at any one time, which could confuse the system). Clearly, if necessary, the competent authority may re-switch ship stations immediately back to the Assigned Mode, until the situation is normalized.

A further mode of operation is known as *Polled.* This allows competent authorities to request specific data directly from ship stations. For instance, ships' static data (which includes the ship's name) and voyage related data is only broadcast in the Autonomous and Continuous Mode every 6 minutes. A VTS station may wish to access this data as soon as the ship comes into AIS range using the Polled Mode, without waiting for an up-to-6 minute delay that would be incurred when using the Autonomous and Continuous Mode.

A competent authority may also use DSC channel 70 to poll information from the shipborne AIS, rather than using the AIS frequencies. DSC may also be used to send AIS1 and AIS2 channel information and other data to the ship. All shipborne AIS equipment includes an inbuilt DSC facility for this mode of operation.

The inclusion of the Polled Mode perpetuates the common name of AIS *Transponde*r being given to AIS equipment. It <u>trans</u>mits information to res<u>pond</u> to an interrogation.

No action is required by ship station operators, whatever the mode set by competent authorities.

1.5   Regional operating settings

When in the range of a shore station the broadcast parameters set to be used by an AIS ship station can be remotely controlled by the shore station. These are known as regional operating settings. The shore station can broadcast the geographical coordinates where the settings are to be used, together with the following parameters:

- The VHF channels to be used for AIS and their transmit/receive sequences

- The transmit power to be used (low or high power)

- The transitional area, during which the ship's AIS is responding to the two adjacent areas according to well defined rules (which do not have to be understood by the user)

The defined geographical region can extend outside the range of a shore station and therefore can effectively control the VHF channels to be used over a very wide area. In particular, this enables the control of frequencies to be effected in regions not using the international AIS frequencies. The AIS can store at least 8 regions and so these areas will be memorised when next in the region but not necessarily in the range of a shore station.

All AIS shipborne units can have regional operating settings manually input by users. This can, for instance, be useful when a ship is entering a large region, well away from shore stations, that has special frequency allocations for AIS. Such settings should only be made when required by the Administration.

As previously stated Channel 70 DSC can also be used to set transmission parameters remotely including area definitions. Manually input areas will be 'overwritten' by automatic channel management data, whether received by normal AIS transmission from a shore station or by DSC. The Organization has invited Governments setting regional frequencies requiring manual switching, to notify the Organization of such areas and designated frequencies, for circulation of that information. Only the Government of Japan has notified the Organization before the requested data of 1 April 2002. The response is contained within the Annex to Reference R13.

1.6   AIS shipborne equipment

In order to meet the system requirements a ship's AIS will effectively consist of the modules illustrated in Figure 2.

An internal GNSS receiver, such as GPS or GLONASS, is required to determine UTC accurately. This is connected by cable to its own GNSS antenna. The GNSS antenna and receiver are part of the shipborne AIS equipment, additional and separate to the ship's other GNSS equipment. If a loss of positional information occurs from the ship's normal GNSS equipment the AIS will transmit position and other GNSS data from this internal GNSS. Normally AIS will use positional and other data from the GNSS that is actually being used to navigate own ship (primary GNSS).
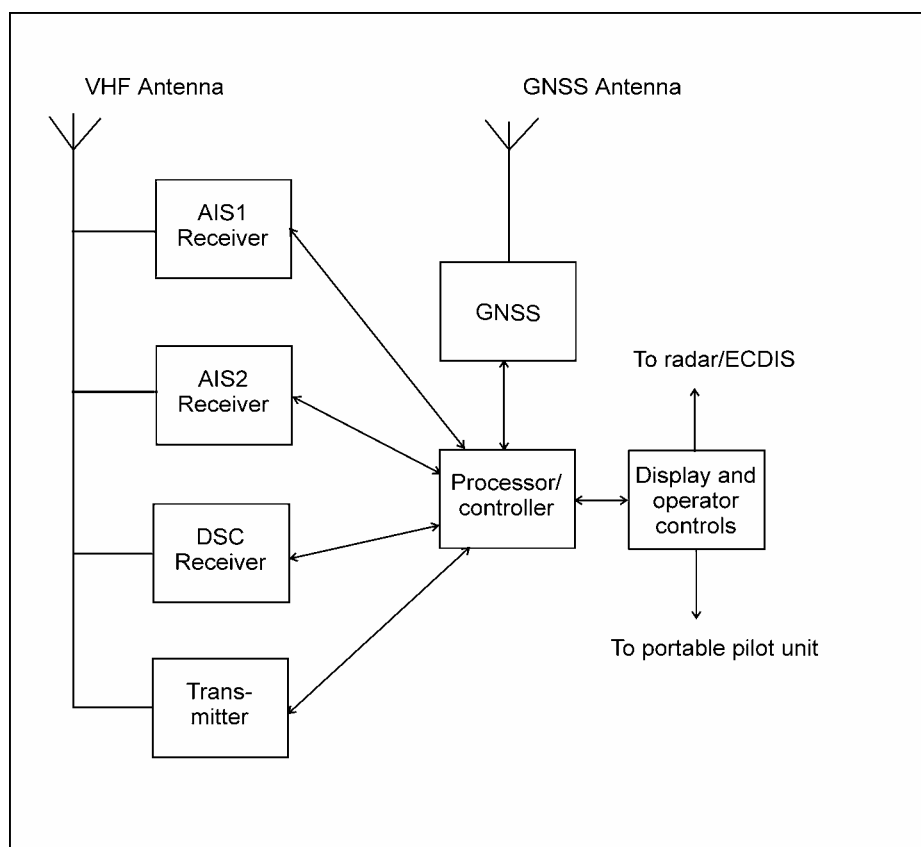

Figure 2 - Modules within AIS

Two VHF receivers are required to be able to receive data on the AIS1 and AIS2 channels simultaneously. In addition one DSC receiver, capable of operating on Channel 70, is required in order to be able to receive polling requests and other data sent over Channel 70. DSC operation is automatic and requires no operator intervention.

A single VHF transmitter is required, capable of operating on all marine VHF channels and responding to Channel 70 DSC interrogations. At any one time AIS data is only being transmitted on one channel; the system automatically selects the correct transmission channel (AIS1, AIS2 or DSC Channel 70). No operator intervention is required.

A single VHF antenna is connected to the AIS unit, which is used by the transmitter and the three receivers. This VHF antenna is separate from the other VHF antennas used on the ship.

A processor sub-system controls the operation and handling of the data concerning the internal GNSS, VHF receivers and VHF transmitter. This also performs all other AIS data handling and computational operations, including the interfaces to the navigational equipment on the ship, the entry of user supplied information and the display of information. These are described in full in later sections of this manual.

The processor sub-system also controls the 'built-in integrity tests' (BIIT) of the unit. These provide monitoring of any failures in the equipment, detecting the availability of data and error checking of both the transmitted and received data.

The shipborne unit includes a display and keyboard. The keyboard is used to control the operation of the unit, normally aided by displayed menus. The keyboard is also used to input user derived information into the unit, such as voyage related data and safety related messages.

The display included with the unit is also often used as the only means of showing AIS received data to the user. Together with facilities to input data manually, this basic configuration is known as a Minimum Keyboard and Display (MKD). The display of an MKD can, as a minimum, consist of only three lines of data, just showing bearing, range and name of ship.

In practice most MKDs display rather more lines of data and may have a simple graphical display showing targets geographically placed, replicating the form of a radar display. Possibly because it is unclear what the word 'minimum' is referring to, manufacturers do not tend to use the acronym 'MKD' in their manuals, referring instead, for instance, to the display and keyboard.

In common use, the term 'MKD' refers to the inbuilt display and keyboard provided on an AIS unit, distinguishing it from the display of AIS targets on a radar screen or ECDIS. This is the meaning used in this course and therefore the use of 'MKD' below does not imply reference to a truly minimum display, (with only 3 lines of data, for instance).

1.7   Class A and Class B AIS

There are two types of AIS, named Class A and Class B. AIS Class A is the one described fully in this course. The Organization has mandated that larger ships, as defined in Section 3.1 below, carry and use Class A AIS.

AIS Class B is designed for other vessels, such as leisure and fishing vessels. It is not a mandatory fit. It is designed to co-operate with Class A units but not to provide a burden on the available time-slots so as to interfere with the proper operation of Class A. At the time of writing this Model Course the technical standard for Class B equipment was being prepared by the International Electrotechnical Commission (Reference T8).

The use of data generated by a Class B unit but displayed on a Class A unit is discussed in Section 4.10, below.

1.8   AIS and radar compared

AIS complements radar and use of the two together is of great benefit in improving situation awareness. However, it should always be remembered that AIS is fundamentally a ground stabilised system while radar information is fundamentally relative to the motion of own ship, including sea motion. Systems can automatically convert between the motion states but sometimes this conversion cannot be totally accurate. This can sometimes lead to a real target appearing in somewhat different positions depending on whether its positional data is based on radar or AIS.

The main advantages of radar are as follows:

- Radar is able to 'see' a vast range of targets, all of which can be 'passive' and need no electronic devices on them to generate a 'return'.

- All received data is relative to own-ship and its effective use does not fundamentally require any knowledge of own-ship's geodetic position.

The main disadvantages of radar are:

- Targets of interest are easily obscured in clutter and by line-of-sight shielding.

- Information on targets, apart from their present position and past (relative) track is sparse and open to confusion with other targets. (Is that the buoy I am looking for or is it a stationary small vessel?)

- Movement of targets has to be inferred (even by a tracking radar such as ARPA) from consecutive returns. When a target is turning this causes time delays in the presentation of data. Additionally, the effective centre of the radar return from a large target can also change with target orientation, causing speed and course errors as the target turns.

- Target heading is not strictly given by radar. In some situations the displayed course of a target may not be reflected by its actual heading relative to own-ship. This may give different interpretations of the collision regulations depending on whether radar or visual data is being used to assess heading.

On the other hand the main advantages of AIS are:

- 'Co-operative' targets can give a vast amount of useful data about themselves, including absolute positional, velocity and heading data potentially far superior to that obtainable by radar.

- AIS does not suffer from clutter problems and is relatively capable under conditions where the radar 'line-of-sight' is compromised (shielding by headlands and islands, etc.).

Conversely AIS has these main disadvantages:

- It relies on the cooperation of targets to respond. That is the target must be fitted with an AIS transponder and it must be switched on.

- It relies on the target to provide accurate data.

- It relies on all targets and own-ship continuing to have accurate positional data referenced to a common geodetic datum (WGS84). GNSS failures at a system level, e.g. satellite failure, intentional or unintentional jamming of GNSS signals or a global failure in GNSS, will have varying degrees of severity, including the total failure of AIS.

Propagation of AIS signals

AIS is basically a VHF radiocommunications system, operating on marine-band frequencies. It therefore behaves similarly to VHF radios in terms of communications range under various conditions. Its transmission power differs from standard marine VHF radios, being 2 watts (low power) and 12.5 watts (high power). Typically, VHF marine radio works on 1 watt (low power) and 25 watts (high power).

Simple theory indicates that a power reduction of 50% results in an effective range reduction of 25%. Therefore on the high power mode the range will typically be 25% less than with VHF radio operating at 25 watts. Experience is showing that typically the range of AIS is around 30 nautical miles or more, when the AIS system is not overloaded with an excess of users.

As previously discussed, AIS transmission power of shipborne equipment can be set remotely by the shore station and is a tool that is sometimes used to prevent overload of the system by reducing the effective range. It requires no user action.

The range is not normally affected by weather conditions but it is affected by shielding of the transmitted signal by land masses and buildings. However, this shielding is less significant than is experienced with radar and therefore AIS will often give a signal form a target that is shielded by line of sight, such as around a headland.

The reason for the better performance is because the wavelength of transmission of AIS signals is significantly larger than that used for radar transmissions. This means that useful energy is diffracted and reflected around obstructions. Also radar relies on picking up small reflections from its own transmissions, while AIS is a two way transmission system, giving an inherently better transmission/reception path.

The actual location of the AIS VHF antenna on a ship can affect AIS range significantly. If the antenna is shielded by the ship's superstructure its range will be compromised. This may mean that in some directions AIS range is minimal, perhaps down to a few miles or less, while in other directions good range is still possible. This is further discussed in Section 3.4.

As with radar, under certain unusual atmospheric conditions, VHF range can extend to hundreds of miles (anomalous propagation).

A more quantitative description of propagation effects rapidly grows beyond the scope of the course and is not relevant to most users.

1.9 Long-range communications

All AIS shipborne units have been designed to enable long range communications as an option for long-range security reporting. This is evidenced by a special connector port on the equipment and the likelihood of menu options within the system for such a use.

It was initially envisaged that the facility could be used for the Organization's emerging requirement for Long-Range Identification and Tracking for Ships (LRIT). This is still under discussion by the Organization.

1.10 IMO requirements for AIS

The instructor should check to see whether there have been any updates or additions to the Organization's requirements for AIS, relevant to this course. All IMO references listed in Part A of this manual have all been taken into account during the compilation of the course.

Trainees should be made particularly aware of the existence and content of the Organization's guidelines for the on board operational use of AIS. At the time of writing this Model Course these are embodied within Reference R1, as amended by Reference R3. This amended document is included as an Annex to this Model Course.

2 AIS data

At a basic system level AIS communicates between stations by means of standard (digital) message types. These message types have been internationally agreed within the International Telecommunications Union (ITU) and those interested in this detail are referred to Reference T2. Many of these messages are not directly relevant to the operation of a commercial vessel and deal with such aspects as:

- Allocation of operating frequencies and powers

- Management of the assigned and polled modes

- Search and rescue operations

Other messages contain information of specific interest to the mariner, such as the name, position, course and speed of nearby vessels. Fortunately, the structure and content of the standard message format does not need to be understood by the operator because the AIS shipborne equipment turns relevant received data into understandable and ordered information. Similarly, the organization of operator input information into the correct message type is automatically accomplished by the ship's AIS equipment, prior to transmission.

For this reason it is best to consider information to be organised into five 'user-relevant' groups:

- Static data (ship related information which rarely changes, such as ship's name)

- Dynamic data (data which is continually changing, such as position and speed over ground)

- Voyage related data (data which is specific to the voyage, such as destination port and estimated time of arrival)

- Safety and security related messages

- Other user-relevant AIS messages (AIS has a vast future potential in dealing with other maritime information)

Each group is looked at in more detail in the sub-sections below. It should be understood that not all manufacturers have divided-up their operating menus exactly into the categories defined here. However, this categorization is based around the functional use of AIS and follows that used by the Organization.

2.1   Static data

This data normally has to be entered only once into the AIS system as it consists of data which remains generally constant (i.e. static). It consists of the following entries:

- Maritime Mobile Services Identity Number (MMSI)

- Ship's name

- Call sign

- IMO number

- Type of vessel

- Length and beam

- Location of the position fixing antenna (referred to bow and centreline)

- Height over keel (Not a requirement of the Organization and is not included on all systems).

In the normal autonomous and continuous mode this data is broadcast once every 6 minutes by each ship. It will be seen that this is relatively infrequent, compared to dynamic data, (see Section 2.2 below).

The MMSI is used by the AIS system to identify all messages transmitted by a particular ship. This means that every time a ship transmits data the data is 'headed' by the MMSI. This is important to understand since the user tends to identify ships by name. Since the name is broadcast only once every six minutes and dynamic data is typically broadcast several times a minute there will be a period when the onboard system cannot assign a name (and other static data) to the dynamic information being received. This data can initially only be referenced to the MMSI. In this instance the MMSI is displayed on many systems in the position that the ship's name normally occupies.

The location of the position-fixing GNSS antenna is needed to ensure accuracy in close-quarter situations, when the system is perhaps being used to aid collision avoidance decisions. If the primary position-fix system fails the AIS will use its internal system to generate position. It is therefore necessary to provide the position of both the AIS and primary position fix antennas, often referred to as internal and external antennas, respectively.

Height over keel is included on some AIS units. It is implemented using a special message facility known as an International Format Message (IFM). Not all AIS shipborne units have facilities to transmit this message and so it may not be included as a parameter in the menu structure of a particular AIS unit. (IFMs are covered in more detail in Section 2.6, below).

2.2   Dynamic data

Dynamic data comprises information that is normally changing according to the ship's motion. Most of it is automatically supplied by the ship's navigation system directly to the AIS unit through the digital interface (cable connection) with the ship's navigation equipment, and consists of:

- Ship's position (with accuracy indication and integrity status, if available)

- Time in UTC

- Course over ground (COG)

- Speed over ground (SOG)

- Heading

- Rate of turn (where available)

In addition a manual input has to be made concerning the navigational status of the ship, such as an anchor, underway using engine, etc.

The accuracy of the positional data is indicated as either high or low. High means that the positional accuracy is better than 10 metres, having been obtained by a differential GNSS receiver. Low accuracy indicates accuracy worse than 10 metres, using the autonomous (normal) mode of a GNSS receiver or a terrestrial Electronic Position Fixing Device.

If Receiver Autonomous Integrity Monitoring (RAIM) is in use by the GNSS for the position fix an indication will be given. RAIM is a system which is internal to a GNSS receiver that can determine whether the position fix has been compromised by one or more faulty satellites.

Dynamic data needs to be transmitted at regular time intervals that depend on the dynamics of the vessel, as tabulated below:

Ship dynamics	Reporting Interval (secs)
At anchor or moored and not moving faster than 3 knots	180
At anchor or moored and moving faster than 3 knots	10

With a speed of between 0 – 14 knots	10
With a speed of between 0 – 14 knots and changing course	3.33
With a speed of between 14 – 23 knots	6
With a speed of between 14 – 23 knots and changing course	2
With a speed of greater than 23 knots	2
With a speed of greater than 23 knots and changing course	2

This table, slightly differs from the table in Reference R1, but is the one within Reference T2, which is used by AIS manufacturers for design requirements and by Administrations for type approval of AIS equipment. The modified table recognises that many users are negligent in correctly entering the navigational status of the vessel, particularly with regards to stating that a vessel is at anchor or underway. This is why the modified table includes "At anchor or moored and moving faster than 3 knots".

2.3   Voyage related data

This data must be manually entered at the start of the voyage and kept updated during the voyage as details change. It consists of the following entries:

- Ship's (static) draught

- Destination

- Estimated time of arrival

- Type of ship

- Hazardous cargo type

- Number of persons onboard (Not a requirement of the Organization and is not included on all systems)

The type of ship and hazardous cargo type are entered from a list of options proscribed by the Organization (see Tables A to C of Section 4.3 below).

Many shipborne AIS units have also implemented the 'Number of persons onboard' International Function Message, with the data being normally entered within the voyage related data menu.

Less commonly, a route plan (textual or with lat/long waypoints) may be able to be input as part of voyage related data. (This is another International Function Message, see Section 2.6).

Voyage related data is broadcast from the ship once every 6 minutes.

2.4   Safety and security related messages

All AIS shipborne equipment is capable of receiving and transmitting safety and security related messages. These may be sent to an individual station (e.g. another ship), or broadcast to all stations. The message length is restricted to about 160 characters.

For a message to an individual station (addressed message) there is an automatic response given from that station stating whether the message was fully received or if there was a problem. This is ideally made evident to the sender; although not all AIS equipment does this. For a broadcast message (to all stations) there is no automatic response.

2.5   AIS aids to navigation

AIS may increasingly be used to mark the positions of and supply additional data about AtoNs, such as buoys and landmarks. This can be in conjunction with racons or they could be used as the sole 'electronic marker'. This use of AIS in its infancy and is only briefly covered here since some details may change. Instructors should access the website of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) to ascertain the latest position on the use of AIS AtoNs (www.iala-aism.org).

An AIS AtoN has an AIS transponder associated with it. This transmits a special AIS AtoN message that includes its position and other data about the AtoN using the normal TDMA transmission modes of AIS.

AIS racons have a number of advantages over racons but they suffer from a significant disadvantage. The advantages include:

- Automatic and clear display of precise position on a ground referenced radar and ECDIS

- Auxiliary information about the navigational aid

- Not radar dependent. (Not all new S-band radars after 1 July 2008 will necessarily be compatible with S-band racons – see Reference R7. This will allow the possible introduction of New Technology radar that has the potential of superior sea clutter performance)

The main disadvantage is that the AIS AtoN transmits its ground referenced position and therefore its usefulness depends on own-ship also knowing its own precise position to be of any use. Position of own ship may be lost because of a failure in its primary and back-up GNSS equipment or it may be because of a general failure in GNSS, perhaps due to intentional or unintentional jamming or a major GNSS system failure. The latter could perhaps be provoked by a burst of damaging radiation from space affecting GNSS satellite operation.

Conversely, determination of racon position is entirely a ship-relative procedure and does not fundamentally rely on a position-fix system. Nevertheless, in normal circumstances AIS AtoNs have an edge over racons but to cover all situations it is to be expected that they will normally be collocated with racons.

An AIS AtoN can use GNSS to determine its position, or use any other position fix systems, such as Loran-C or Chayka. Alternatively, it can transmit a surveyed position, which is useful for AtoNs that are truly ground fixed (rather than tethered to the sea bed).

From a technology point of view it is not necessary that an AIS AtoN is physically part of the AtoN. It could be situated some distance away, perhaps on land. This type of implementation is known as a **synthetic AIS AtoN**. This is sometimes a more convenient or economic solution to having the AIS fixed to the AtoN. AtoN position may perhaps be determined by a position-fix system which communicates to the AIS by a data link. Alternatively it may be a surveyed position.

Taking this idea further is a **virtual AIS AtoN**. This is where there is conveniently located AIS that transmits location and 'purpose' data, for a geographical position which is not marked by a visible physical object. Possible uses for this include the continued marking of buoy positions that may be seasonally lifted because of ice. Another is the rapid 'electronic marking' of a recent wreck in advance of being able to lay visual markers.

2.6   AIS Binary messages

The AIS system design allows many additional uses. Some of these are already built into the system, such as AIS AtoN messages but also there is a flexible message facility, known as AIS Binary Messages, which allows other applications to be introduced into the future.

This does not mean that AIS shipborne stations have to be continually upgraded. Firstly, the new messages will not affect existing messages and therefore equipment continues to work even with new messages being received. Secondly, all messages are available on the digital interface of the AIS shipborne equipment, allowing other special-purpose interconnected equipment to use these new messages.

The binary messages are designed to be in two categories – international applications and regional applications. Some international applications have already been agreed on a trials basis by the Organization in Reference R4.

These consist of seven messages, which will remain unchanged for a trial period until mid 2008. Some of these messages have already been incorporated in some manufacturers AIS implementations as discussed in Sections 2.1 and 2.3, above, namely messages for indicating the number of persons on board and the air-draught (height over keel) of the ship.

The display capability of AIS binary messages is not part of the mandatory functions of an MKD and so to the display of most binary messages requires hardware and/or software that is additional to a standard AIS. Also, the use of these Binary Messages is optional.

The use of binary messages may reduce verbal communications, enhance reliable information exchange and reduce the operator's workload. They are not intended to replace other services such as GMDSS and SART. Since binary messages place an additional load on the VHF data link, care must be taken not to impair the main functions of AIS and hence long messages should be avoided.

The seven trial applications are as follows, detailed descriptions of the messages are contained within Reference R4. The instructor should alert trainees to the existence and the capabilities of binary messages but there is no requirement to memorise the following applications.

Application 1 - Meteorological and hydrological data (IFM11)

This gives data from shore stations and can include:

- Wind speed and direction (average and gusts)

- Air temperature, humidity, dew point

- Air pressure and tendency

- Water level and trend

- Current speed and direction on surface and at different levels

- Sea state, wave and swell height, direction, and swell period

- Water temperature, ice presence and salinity

- Precipitation type

Application 2 - Dangerous cargo indication (IFM12)

This message is designed to be used as a response to a request for Dangerous Cargo Indication from a competent authority. The message content includes the harbour where the necessary documents can be found, the category of main dangerous goods and their quantity.

Application 3 - Fairway closed (IFM13)

This message is used to inform ships about temporarily closed fairways or sections in ports. It includes the location and extent of the area and the time period of closure.

Application 4 - Tidal window (IFM 14)

This message is used to inform vessels about tidal windows which allow the safe passage of a fairway. The message includes predictions of current speed and current direction.

Application 5 - Extended ship static and voyage related data (IFM15)

This message is used to report the height over keel and is already included on some shipborne AIS implementations. See Section 2.1 above.

Application 6 - Number of persons onboard (IFM16)

This message is used to report the number of persons onboard, usually on request by a competent authority. See Section 2.3 above.

Application 7 - Pseudo-AIS targets (IFM17)

This message can be used by shore stations to transmit targets that are tracked by the VTS station. The maximum number of targets that can be contained in a single message transmission is 7. In principle a number of messages can be transmitted to cover more targets but to avoid overloading the AIS VHF link there should be no more than necessary to provide the necessary level of safety.

Instructors should be aware that this is a changing situation and should make sure that any relevant developments in the use of AIS are included in their courses. The actual IFM number is not important as the applications should be accessed by user friendly menus.

3   AIS ship installations

3.1   Carriage requirements

The requirements for the carriage of AIS have been defined by the Organization in SOLAS Chapter V (Reference R5), namely AIS shall be fitted to:

- All ships of 300 gross tonnage and upwards engaged on international voyages.

- All ships of 500 gross tonnage and upwards not engaged on international voyages.

- Passenger ships irrespective of size.

3.2   MKD installation

A simplified system diagram of an example AIS installation is shown in Figure 3. Connections to ARPA and ECDIS are optional and are discussed in the next Section.
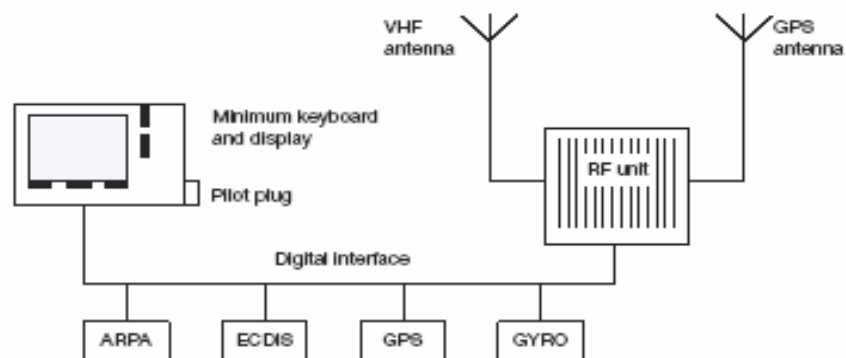

Figure 3 - AIS example shipborne system

Reference R14 states that the AIS should ideally be connected via an uninterruptible power supply (UPS) to the ship's power supply (as defined in SOLAS Chapter II-1), to ensure operation through temporary losses of the prime electrical supply.

The example configuration includes:

- A display and keyboard module used for viewing and inputting AIS data. This is the so-called Minimum Keyboard and Display but as discussed earlier it normally exceeds the minimum requirement laid down by the Organization.

- An electronics module or RF Unit, which is sometimes called the transponder module. This interconnects with the display and keyboard module, the AIS VHF and GNSS antennas, and the navigation systems of the ship.

- VHF and GNSS antennas for the sole use of AIS. These are sometimes combined into a single antenna module.

- A 'pilot plug'. This is the connector that enables the interconnection of a Personal Pilot Unit (PPU) to the AIS, allowing pilots to have special operation of the equipment. It is important that this connector position is accessible from the normal position of the pilot.

Different configurations are possible. For instance, the display and keyboard module can be combined with the RF unit. The complete unit may then be termed the transponder. The confusion with nomenclature should be noted but it is not a serious issue.

The AIS needs to connect with the GNSS being used for the navigation of the ship. In particular, this feeds the AIS with:

- position, in latitude and longitude, referenced to the WGS 84 datum;

- speed over ground (SOG);

- course over ground (COG); and

- the time (UTC) that these measurements were made at.

In addition, providing the GNSS receiver meets the latest performance standards (for example, Reference T3) the AIS will also be fed with: information concerning the accuracy of the position fix, using the inbuilt Receiver Autonomous Integrity Monitoring (RAIM) facility of the GNSS.

The AIS also needs to connect with the heading indicator of the ship. This will normally be from the gyro-compass, although on smaller vessels (ships less then 500 gross tonnage) this could be from a transmitting magnetic compass.

If rate of turn (ROT) information is available from the heading device it should be made available to the AIS. On ships without such a device the direction of turn may optionally be derived from heading information given by the compass, an external converter unit or the AIS itself. (ROT indicators are only mandated on ships of 50,000 gross tonnage and upwards).

AIS units are typically designed to accept all navigation inputs through the digital interface (plug and cable connection) known as IEC 61162 (Reference T6). (This reference is very technical and is not recommended that instructors consult this reference for the purposes of teaching this Model Course). When such an interface is not available a suitable conversion unit must be fitted. These conversion boxes, when incorrectly set up, have been the cause of a number of inaccurate AIS data transmissions. This is discussed further in Section 3.4.

Because of the difficulties of inputting manual information on an MKD (mainly because of the small keyboard) a number of ship installations use a connected Personal Computer (PC) for this purpose.

3.3   AIS data displayed on radar and ECDIS

Although increased situational awareness is obtainable from an MKD based installation, far better improvements can be made by displaying AIS data on an AIS compatible radar or ECDIS. Recognising this, the Organization has mandated that from 1 July 2008 all new radar installations must be able to display AIS targets according to standards laid down by the Organization (Reference R7). Reference R8 contains new standards for navigational displays installed after 1 July 2008, which include display symbology requirements for radar, ECDIS and any other navigational display (such as an MKD) when showing AIS graphical data.

The ability to show AIS on radar or ECDIS is entirely due to whether the radar/ECDIS has been designed or modified for this use. If so, the connection can be readily made by a qualified installation engineer to any AIS (MKD) unit, as in Figure 3.

There are a number of advantages of displaying AIS targets on radar, namely:

- Radar is used as the main electronic aid to assist collision avoidance decisions. A common radar/AIS display enables quick and easy assimilation of both sources of data.

- Radar screens are 'large' and of good quality and normally situated in a prime position.

- The presentation setup of radar and AIS targets becomes identical. On an MKD the AIS may consist of just a list of targets or be displayed on a plan display that may have a different set-up to that of the radar, e.g. Head-up/North-up, different maximum range settings, range ring settings, etc.

- All the radars tools used for improved situational awareness (e.g., range and bearing markers) are available for use on AIS targets and have an identical mode of operation, reducing mental fatigue.

- Overlaying radar and AIS data enables better operator decisions on whether a radar observed target and an AIS target are the same object (target association).

- AIS target filtering according to the rule of the Organization can be applied to reduce screen clutter. This is discussed further in Section 4.12.

- Automatic target correlation may be implemented. In the future this could be useful in reducing a confusing excess of data. (At present such techniques are unproven and care should be taken in using them).

Providing facilities are also available for displaying 'raw' radar and radar target tracks on an ECDIS, many of the above benefits are equally applicable to the display of AIS targets on ECDIS. This is further discussed in Section 4.12 below.

3.4   Installation issues

It is clearly stated in the Organization's AIS installation guidelines (Reference R6) that 'the functionality of the MKD should be available to the mariner at the position from which the ship is normally operated'. (It is useful for trainees to be aware of this reference but they do not need a detailed knowledge of its contents). Regrettably, this guideline has not always been followed by installers, with the excuse that there is insufficient room to fit the equipment in such a position.

Poor positioning of the display unit leads to the following issues:

- Situational awareness is compromised because the effort involved in keeping the OOW updated will reduce the use of AIS derived information.

- Safety and security related messages may be missed.

- If the equipment develops a fault it will not be quickly spotted and may transmit misleading data for an extended length of time.

- If the 'pilot plug' is also located on the display equipment this too is likely to be in an unsuitable location, causing difficulties in interfacing to a pilot's portable equipment, (see Section 3.2 above).

Consideration should be given to the repositioning of poorly sited MKDs, which should always be performed by a qualified installation engineer.

When AIS was first introduced there were many technical problems caused by faulty installations of AIS shipborne equipment. Users should be aware of the type of faults that can arise from poor initial installation or refit, in order to initiate corrective action by the installer. It should be noted that some faults can be caused by the installation or refit of other navigation or radiocommunication systems subsequent to the fitment of AIS.

Typical faults, together with their likely causes are listed below. It is not an exhaustive list but covers many common examples:

	Observed symptoms	Likely causes
1.	I am hearing repetitive clicks or noises when using VHF radio.	a) A VHF radio antenna is too close to the AIS VHF antenna. If the VHF radio is being affected it is likely that AIS reception is also being degraded leading to some loss of target data. b) The AIS antenna has been connected with inferior cable. Because of the digital nature of the signal the Organization recommends a high quality cable, defined in Reference R6.
2.	Ships often appear without a ship's name or with the MMSI number in the name position. The name appears after a few minutes.	This is normal and does not signify a fault. See Section 2.1.
3.	As symptom 2. above but the fault tends to persist.	This indicates that the AIS receiver has been desensitised, often because of the causes in 1.a) or b) above or because the AIS VHF antenna is too close to a radar or satellite communications antenna. It could also indicate an AIS receiver fault.
4.	I have noticed or I have been told by shore stations or other vessels that my heading transmissions are in error.	Retrofit of AIS on ships with older heading indicators requires a digital converter to be fitted to the heading device. This requires a fixed offset to be set-up at the converter. Sometimes this is incorrectly set by the installation engineer or has been inadvertently changed by bridge staff. The normal display on the heading device continues to read correctly and so it appears to the user that everything is working normally.

5.	I have noticed or I have been told by shore stations or other vessels that there are errors in my static data.	These may not have been correctly set on installation. Refer to the manufacturer's handbook to edit these parameters. To change static parameters may need a password. The parameters should only be modified with the Master's permission.
6.	Since having AIS installed some of my other navigation instruments are malfunctioning.	It is likely that the installation engineer has made a wiring or set-up error. If the fault is significant try alleviating the situation by switching off the AIS and/or other navigation.
7.	I get a permanent or occasional AIS error message saying 'AIS: UTC clock lost'.	This indicates a possible poor installation of the internal GNSS antenna or an antenna cable fault or a malfunctioning of the internal GNSS receiver.
8.	I have noticed that I rarely see AIS targets beyond a range rather less than 20 miles, (in all or certain directions relative to the ship's heading).	This indicates an AIS VHF antenna sitting problem. It is being obscured by the ship's superstructure in some or most directions. A qualified installer needs to re-site the antenna to have a clear line-of-sight in all directions.

4   Use of AIS at sea

It is imperative that the user of an AIS system at sea should be familiarised with the operation of the actual equipment that is installed on the ship before use at sea. This is necessary to comply with the Organization's Standards, Training, Certification and Watchkeeping Code (STCW) and the relevant parts of the International Safety Management Code (ISM).

Section 5 of this Model Course contains guidance on what should be covered within this familiarization. Also, Annex I suggests guidance to manufacturers and Companies as to what should be provided for familiarization training.

Because of the differences in operation between different manufacturer's AIS units and AIS overlay facilities on radar and ECDIS these guidance notes are not able to cover details of operation of specific implementations. Instructors should be fully familiar with the detailed operation of the AIS units or simulators used on their specific courses.

AIS should always be in operation when ships are underway or at anchor. SOLAS Chapter V (Reference R5) states that "Ships fitted with AIS shall maintain AIS in operation at all times except where international agreements, rules or standards provide for the protection of navigational information".

If the master believes that the continual operation of AIS might compromise safety or security of the ship or where security incidents are imminent, the AIS may be switched off. This is further covered in Section 4.7. In ports AIS operation should be in accordance with port requirements. Oil terminals, in particular may have special requirements, see Section 4.8.

4.1   Bridge procedures

It is important that the use of AIS is covered in the ship's bridge procedures. These should cover at least the following aspects:

- Frequency of checks of own ship data accuracy, including static, voyage related and dynamic data.

- Procedures for the update of voyage related and navigation status data.

- Cautions concerning the making of critical decisions (such as collision avoidance) based solely on AIS data.

- Procedures covering the abnormal operation, or failure of AIS and cautions concerning the impact such failures might have on navigational safety.

- Any special requirements concerning the receipt, transmission or data content for AIS binary messages (see Section 2.6).

Users of AIS should familiarise themselves with the ship's bridge procedures before use of the system at sea and comply with their requirements.

The transmission of erroneous information implies a risk to other ships as well as own-ship and therefore great care should be taken in checking for errors as in the following Sections 4.2-4.4.

4.2   Input and checking of static data

Static data consists of the following:

- Maritime Mobile Services Identity Number (MMSI)

- Ship's name

- IMO number (where available)

- Call sign

- Type of vessel

- Length and beam

- Location of the GNSS antennas (external and internal)

- Height over keel (if facility exists)

These parameters are sometimes protected from being inappropriately changed by means of password access. When not protected by a password it is more likely that inadvertent or misappropriate changes could occur. For this reason it is recommended that the static data on unprotected systems are checked by the OOW at the start of every watch. On a password protected system checks need occur rather less frequently, provided the password remains secure. In this case it is recommended that checks are made at least once per voyage or once per month, whatever is shorter.

It is recommended that checks of static data are made by comparison with a master list, kept close to the display/keyboard used for AIS control, e.g. the MKD. If a change appears to be necessary the Master should be informed and appropriate permission obtained.

The ship's name should be entered without a prefix such as MV, unless advised by the flag state of the ship. This is to ensure that the vessel lists of shore stations are easily searched alphabetically by shore station and VTS operators.

The data entry of the antenna positions and the ship dimensions are inter-related. Figure 4 shows the dimensions required to be entered. The system works out the ship length and beam by adding dimensions A to B and C to D, respectively.
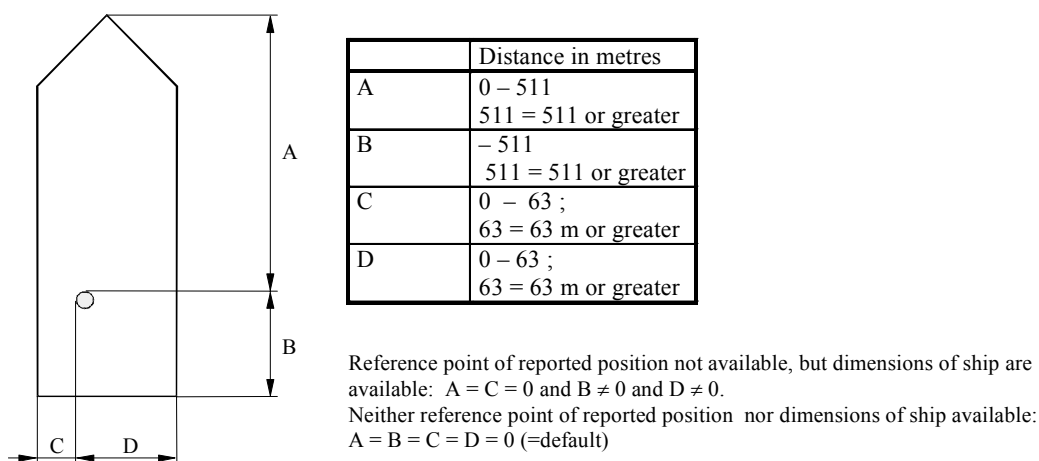
	Distance in metres
A	0 – 511 511 = 511 or greater
B	– 511 511 = 511 or greater
C	0 – 63 ; 63 = 63 m or greater
D	0 – 63 ; 63 = 63 m or greater

Reference point of reported position not available, but dimensions of ship are available: A = C = 0 and B ≠ 0 and D ≠ 0.
Neither reference point of reported position nor dimensions of ship available:
A = B = C = D = 0 (=default)

Figure 4 - Vessel dimensions and GNSS antenna position

A ship of 100 metres in length by 10 metres in beam, with an antenna mounted 20 metres from the stern, offset form the centre line by 2 metres to port would have parameters as follows:

A = 80,   B = 20, C = 3,   D = 7

Special care should be taking when any of the static parameters change, for instance the GNSS antenna position or the ship's name. Make sure that both the check-list and the contents of the AIS memory are correctly altered.

4.3   Input and checking of voyage related data

Voyage related data consists of:

- Destination and ETA at master's discretion

- Ship's draught

- Ship type

- Hazardous cargo type, if required by competent body

- Total number of persons onboard (optional – not all AIS equipment has this capability)

- Route plan (optional – at the time of writing this Model Course most AIS equipment does not have this capability)

This data can be input and checked by entering the appropriate menu structure on the AIS display. The OOW should input the data at the start of the voyage and update the data whenever changes occur. It is recommended that voyage related data is checked for validity by the OOW at the start of a new watch.

It is essential that the master gives clear guidance concerning both the hazardous cargo type and the requirement for destination and ETA and that these are followed. Under certain security circumstances these may be omitted (see Section 4.7). Disobeying these rules could compromise the security of the ship or contravene port or flag State requirements.

The AIS field for destination allows for 'free text' of up to 20 characters. This results in numerous variations in the spelling of the same port, making it difficult for other ships and shore authorities to identify the port uniquely.

The Organization therefore recommends in Reference R11 the use of the destination field for entering both the port of departure and the next port of call using the United Nations code for ports known as UN/LOCODE.

4.3.1   UN/LOCODE

The recommended format is to indicate the port of departure at the first six positions of the data field followed by a separator and then the code for the next port of call.

In order to identify that it is a LOCODE, to separate the locations and to indicate the 'from' and 'to' ports, a '> 'symbol should be used as a separator. As an example:

A ship is leaving Dubai bound for Rotterdam. Use of the UN/LOCODE would represent this voyage as:

AE DXB>NL RTM

If the next port of call is unknown, '?? ???' should be entered instead of the UN/LOCODE in the corresponding place in the data field. For example:

AE DXB>?? ???

If the port of departure does not have a designated UN/LOCODE then 'XX XXX' should be entered instead of the UN/LOCODE in the corresponding place in the data field. For example:

XX XXX>US PBI

If the next port of call does not have a designated UN/LOCODE the commonly accepted English name of the destination port should be entered, preceded by '===' (3 'equals' signs.). If no such

name is known the locally used name should be entered. In this case there may not be enough space available to indicate the port of departure. For example:

   ===Orrviken.

If only the general area of destination is known the name or accepted abbreviation of the area preceded by '===' (three 'equals' signs) should be entered. For example:

   NL RMT> === US WC

indicating a destination on the United States West Coast.

4.3.2   Other voyage related data

The ship's draught should be entered in metres and is defined as the 'maximum present static draught'. This means that the entry needs to be updated according to the water salinity and any loading changes during the voyage. In particular, it is necessary to update this parameter when a sea-going ship enters or leaves a freshwater canal or river system.

Although 'ship type' could be taken to be static information it is normally included in voyage related data as it is defined according to a table issued by the Organization that covers both ship type and cargo. This table is effectively contained within the menu structure of an AIS is order to simplify entries, without the need to refer to separate table.

The format of the original table in Reference R6 can be confusing and so an alternative tabulation is given here. Basically, the entry requires two numbers, referred here as the first and second digit. These digits are determined according to one of the three tables below. Table A is used for most commercial vessels not engaged in special operations. Table B is used for other vessels engaged in special activities, such as fishing, leisure, military and towing. Table C is for special craft engaged in 'official' activities, such as law enforcement, search and rescue and port operations. These Tables do not need to be memorised.

Table A - Commercial vessels not engaged in special activities			
1st Digit	Meaning of 1st digit	2nd Digit	Meaning of 2nd digit
0	Not used	0	All ships of this type
1	Reserved for future use	1	Carrying DG, HS, or MP IMO hazard or pollutant category A
2	WIG (Wing-In-Ground)	2	Carrying DG, HS, or MP IMO hazard or pollutant category B
3	Other ships See Table B	3	Carrying DG, HS, or MP IMO hazard or pollutant category C
4	HSC (High Speed Craft)	4	Carrying DG, HS, or MP IMO hazard or pollutant category D

5	Special craft See Table C	5	Reserved for future use
6	Passenger Ships	6	Reserved for future use
7	Cargo Ships	7	Reserved for future use
8	Tanker(s)	8	Reserved for future use
9	Other types of Ship	9	No additional information

DG = Dangerous Goods   HS = Hazardous Substances   MP = Marine Pollutants

Table B - Other ships engaged in special activities		
1st Digit	2nd Digit	Meaning of 2nd digit
3	0	Fishing
3	1	Towing
3	2	Towing and lengthy of the tow exceeds 200m or breadth exceeds 25m
3	3	Engaged in dredging or underwater operations
3	4	Engaged in diving operations
3	5	Engaged in military operations
3	6	Sailing
3	7	Pleasure craft
3	8	Reserved for future use
3	9	Reserved for future use

Table C - Special craft engaged in 'official' activities,		
1st Digit	2nd Digit	Meaning of 2nd digit
5	0	Pilot vessel
5	1	Tug
5	2	Search and rescue

5	3	Port tender
5	4	Vessel with anti-pollution facilities or equipment
5	5	Law enforcement vessel
5	6	Spare - for assignments to local vessels
5	7	Spare - for assignments to local vessels
3	8	Medical transport (as defined in the 1949 Geneva Convention and additional protocols
3	9	Ships according to Resolution 18 (Mob-83)

The total number of persons onboard is often required when passing through waters subject to Mandatory Ship Reporting. It is therefore a useful addition to have available on AIS. If available, this is transmitted in the form of a International Function binary message in response to an AIS transmitted request. No special action has to be taken by the operator as the transmission is performed automatically.

On some ships installations it may become possible for the route plan of the ship to be transmitted by the AIS. This may become typical on a ship where the AIS is configured as part of an Integrated Navigation System (INS) and the route plan can be automatically extracted from the INS stored data into the AIS.

The transmission of route plans is an International Function binary message. It can be addressed to one station (typically shore based) or broadcast to all stations. To use this facility the operating manual of the AIS (or the INS) should be consulted. It is possible that in the future some coastal states may require vessels to use this facility when entering their ports or waters.

4.4   Input and checking of dynamic data

Most dynamic data is automatically fed into the AIS from the ship's navigational instrumentation, with the exception of the navigation status of the ship. (On some AIS equipment the navigational status is treated as if voyage related data). Dynamic data consists of the following:

- Ship's position (with accuracy and integrity, if available)

- Time in UTC

- Course over ground (COG)

- Speed over ground (SOG)

- Heading

- Rate of turn (where available)

- Navigation status

Although the automatic inputs (all except navigation status) require no operator action the data being transmitted should be regularly checked to see that it replicates the data being used to navigate the ship. This is performed ideally at least once during a watch. In practice this can be difficult on some MKDs as it involves entering a password protected area. This protected area can be the same as that used for changing static data and hence care must be taken when using such systems not to change any static parameter.

The navigational status of a ship needs to be entered from a fixed list of possibilities, which is normally offered to the user as a 'drop-down' list. The options are as follows, although more may be added by the Organization in the future:

- Underway using engine

- At anchor

- Not under command

- Restricted in ability to manoeuvre

- Constrained by draught

- Moored

- Aground

- Engaged in fishing

- Underway by sail

Changes in navigational status should be made concurrently with any necessary changes in exhibited lights and shapes.

4.5   Short safety and security related messages

This 'text' message service on AIS should only be used for safety and security related messages, either to a specified ship or shore station destination or broadcast to all stations. Its use is not confined to emergency situations but should be relevant to the safety of navigation or general security, e.g., an iceberg sighted or a buoy not on station. Misuse of this facility for personal messages or the use of obscene language will lead to action on perpetrators by Administrations.

The detailed operation of this facility will be described in the operating manual of the AIS and care should be taken in selecting correctly an 'all-ships' broadcast or an (MMSI) addressed transmission to a specific ship or shore station.

The message length is limited by the system to be no more than 156 characters for an addressed message and 161 characters for a broadcast message. Specific equipment may have fewer characters available for use. Messages should be kept as short as possible in order not to overload the AIS channels.

Operator acknowledgement may be requested by a text message. With addressed messages the receiving equipment will automatically acknowledge the receipt of a message to the sending equipment, although on some systems this may not be clearly indicated either on the initiating or responding unit.

It is important to realise that even if the receiving equipment has indicated that the message was successfully received it does not mean that the message has been read or understood by anybody on the receiving vessel. The only firm way of ensuring that a message has been received is to receive an operator acknowledged message, either via AIS or on another communications channel.

Most AIS equipment makes it easy to respond to a received addressed message, for instance by automatically inserting the sender's MMSI to the reply.

Short message of this type are only an additional (but sometimes convenient) means of broadcasting maritime safety and security information. It does not remove any of the requirements of the Global Maritime and Distress and Safety System (GMDSS). Nevertheless it is important that received messages are displayed, considered and responded to, appropriately.

The facility is somewhat hampered by the poor text entering facilities on MKDs and is best performed on a standard computer type keyboard, if this facility is provided.

According to SOLAS regulation V/31 (Danger Messages):

> *"The master of every ship which meets with dangerous ice, a dangerous derelict, or any other direct danger to navigation, or … is bound to communicate the information by all the means at his disposal to ships in his vicinity, and also to the competent authorities …"*

Normally this is done by VHF voice communication but "by all means" implies the additional use of the AIS short message application, which has the advantage of reducing difficulties in understanding, especially when noting down the correct position.

When entering any data manually, consideration should be given to the confidentiality of this information, especially when international agreements, rules or standards provide for the protection of navigational information.

4.6   Use of AIS binary messages

At the time of writing this Model Course there was no real use being made of Binary Messages, apart from the 'number of persons on board' and the 'height over keel' messages. As has been explained previously some manufacturers of AIS equipment have included these as if they were voyage and static data categories, respectively.

Section 2.6 above describes the AIS binary messages contained within Reference R4.

The instructor should determine whether the use of these and other messages have become more common and include them in the course, if applicable.

4.7   Use of AIS in areas that may have security or piracy implications

AIS should always be in operation when ships are underway or at anchor. If the master believes that the continual operation of AIS might compromise the safety or security of the ship or where security incidents are imminent, the AIS may be switched off. If the ship is operating in a mandatory ship reporting system, unless it would further compromise the safety or security, the master should report this action and the reason for doing so to the competent authority.

Actions of this nature should always be recorded in the ship's logbook, together with the reason for doing so. The master should restart the AIS as soon as the source of danger has disappeared. Ship's own data will be transmitted after a two minute initialisation period.

All AIS units have a security mechanism that detects the disabling of the AIS. This consists of a memory function that records all periods when the AIS installation is non-functioning or is switched off. The memory is not accessible by the user and is not affected by power-outs. As a minimum it records the last 10 times when the equipment was non-functioning for more than 15 minutes. This information includes UTC and the duration of the 'off' periods.

This memory may be accessed by a competent authority in order to check that the AIS has not been switched off without due reason.

Some MKD systems do not have a power on/off switch. It may be necessary to remove the 'front panel' fuse in order to switch off these systems, unless there is a separately installed AIS power switch. Before removing the fuse in this manner check the equipment manual or with the supplier that there are no dangerous voltages exposed.

4.8   Use of AIS in oil terminals

Oil transfer regulations contained within the International Safety Guide for Oil Tankers and Terminals - ISGOTT (Reference T7) state that radio transmissions from a ship loading or discharging tankers must be limited to 1 watt maximum. It should be realised that low power operation of an AIS is normally set at 2 watts. Some systems have a 1 watt manual setting for use within oil terminals.

If this setting is not provided the master should order the AIS to be switched off during loading or discharging operations, unless port regulations override this.

This consideration should also be made when berthed in other hazardous environments where explosive gases may be present.

4.9   AIS alarms

AIS provides a number of alarms to alert operators of failures. As a minimum the alarms described in the following table are given, together with how the system reacts to the failure. Also included are some brief guidance notes for operators:

Alarm's description text	Reaction of the system	Notes for operator
AIS: Tx malfunction	Stops transmission	The system should be able to continue to receive data but will not transmit.
AIS: Rx VSWR exceeds limits	Continues operation.	This can indicate a possible fault in the VHF antenna or cabling, which could be affecting reception and transmission.
AIS: Rx channel 1 malfunction	Stop transmission on affected channel	The update rate of both own ship's transmission and received target data will be halved.
AIS: Rx channel 2 malfunction	Stop transmission on affected channel	The update rate of both own ship's transmission and received target data will be halved.
AIS: Rx channel 70 malfunction	Stop transmission on affected channel	Will only be a problem where DSC is being used by shore stations.
AIS: General failure	Stop transmission	The system may also lose reception capability.
AIS: MKD connection lost	Continue operation with "DTE" set to 1	This can inform other AIS stations that the transmitting AIS cannot view received data. Some systems do not include this information in the listed target data.
AIS: External EPFS lost	Continue operation, apply sensor fallback	Check primary EPFS/GNSS system for correct operation. The system will get position, etc from the internal GNSS.
AIS: No position sensor in use	Continue operation, set position accuracy to 0	No position data is available for transmission.
AIS: No valid SOG information	Continue operation using default data	NO SOG data is available for transmission.
AIS: No valid COG information	Continue operation using default data	No COG data is available for transmission.
AIS: Heading lost/invalid	Continue operation using default data	No heading data is available for transmission
AIS: No valid ROT information	Continue operation using default data	This only applies when ROT has been configured. No ROT data is available for transmission.

Alarms will be repeated every 30 seconds, until acknowledged. The OOW should report failures to the master. In mandatory reporting areas the competent authority should be immediately informed of the AIS failure, with the authority of the master.

All failures need to be attended to by a service agent at the earliest opportunity.

4.10   General cautions when using AIS

Sections 4.10 to 4.14 contain vital information concerning the safe onboard use of AIS when using the system to increase situational awareness. The instructor should ensure that ample time is given to this part of the course to ensure that trainees can demonstrate that they have assimilated all the information.

Whether AIS target data is displayed on an MKD, radar or ECDIS there are a number of important aspects to be considered before using such data. These are listed below:

1)   Not all vessels or floating hazards will be transmitting AIS data and therefore AIS can never give a full 'picture' of the situation. Although both radar and visual means of determining the presence and position of targets is never 100% reliable, AIS data is inherently incomplete.

       AIS data may be absent for the following reasons:

   - Vessels may not be fitted with AIS as they fall outside of the carriage requirements of SOLAS. This applies to most fishing vessels and leisure craft, which form by far the largest majority of vessels. Warships may also not transmit AIS data.

   - The AIS on board some ships may not be functioning due to a fault or because it has been intentionally or unintentionally switched off.

   - Navigational markers may not be fitted with AIS. In fact at the time of writing virtually no navigational markers have an AIS capability.

   - Floating debris, including semi-submerged containers, which may be visible on radar or by sight, will not be transmitting AIS data.

2)   The data being transmitted by some vessels may be in error. The early experience of AIS is that such errors are common but it is hoped that by the use of better onboard checking procedures (as suggested by this Model Course) they will reduce. Data errors can occur with any AIS transmitted data as in the following examples:

   - Navigational status errors are extremely common and result from a lack of bridge procedures or when existing procedures are not being followed. (A spot check of ships in the vicinity of a major European port in February 2004 showed that nearly 50% of AIS fitted ships had navigational status errors – mainly showing underway when moored, or vice versa).

   - Fixed heading errors can be caused by the heading offset not being set correctly, see Section 3.4.

- The data from vessels fitted with Class B AIS must be treated with caution. The dynamic data updates will be less frequent than with Class B systems, therefore possibly creating apparent positional jumps. Also Class B data is more likely to be compromised by poor installation and by connection to inferior navigation equipment.

- Bidirectional ships are prone to having 180 degree heading offsets caused by failure to reset the heading offset when the direction of travel is reversed. Such ships are often ferries operating in restricted waters and this confusion can lead to potential accidents. It is important that AIS users on these ships take great care to set the offset correctly and for other AIS users to recognise this type of error.

- Position errors can come from a variety of causes including: a faulty GNSS receiver; incorrect transmission of position data to other than the WGS 84 datum (this is possible when older GPS receivers are connected to the system); apparent position shifts when the GNSS receiver changes constellation or for other reasons; wrongly input GNSS antenna position parameters.

- Wrongly entered static data remain a common occurrence. It includes incorrect name, call sign and dimensions. A particularly damaging error can come from incorrect entering of the MMSI. If two ships in the same area are broadcasting the same MMSI then the apparent position of the ships can swap.

3) A faulty own-ship installation may be preventing data being received consistently, see Section 3.4.

4) As with radar, just because a target can be seen on a ship's AIS display does not mean that the opposite is true, i.e. the target may not be able to see your own ship on its AIS display.

5) Because of a SAR operation or for other emergency reasons the shore station may limit the time slots used by ships by using Assigned Mode (see Section 1.4). This will increase the times between consecutive updates of position and other dynamic data, therefore introducing perceived dynamic data errors.

6) Unlike radar, AIS is totally dependent on the correct and continued operation of GNSS. GNSS at a system level can fail or its accuracy can be compromised by a number of possible causes:

- A failure at system level, which could affect many or all satellite transmissions

- A major security situation could result in GNSS becoming unavailable or its accuracy being severely degraded through the application of Selective Availability (SA)

- Intentional or unintentional jamming could seriously degrade GNSS coverage over a wide area

Nevertheless, providing the possibility of all the above is recognized, AIS does provide very useful information to increase situational awareness and safety.

Users should be additionally aware that the dynamic data on a target includes the following information on its positional data accuracy:

- The reported accuracy of position (high – better than 10 metres or low – worse than 10 metres).

- Whether the position fix device includes RAIM information.

With the additional knowledge of these parameters on own-ship, assessments of the likely positional accuracy of surrounding targets can be made.

In summary it is useful for the instructor to give the following cautions, given by the Organization in Reference R1:

- AIS is an additional source of navigational information. It does not replace, but supports, navigational systems such as radar tracking and VTS.

- The use of AIS does not negate the responsibility of the OOW to comply at all times with the Collision Regulations.

- The user should not rely on AIS as the sole information systems, but should make use of all safety-relevant information available.

- The use of AIS on board ship in not intended to have any special impact on the composition of the navigational watch, which should continue to be determined in accordance with the STCW convention.

In particular, the Organization highlights these cautions in Reference R1

- **Not all ships carry AIS.**

- **The OOW should always be aware that other ships, in particular leisure craft, fishing boats and warships, and some coastal stations including VTS centres, might not be fitted with AIS.**

- **The OOW should always be aware that AIS fitted on other ships as a mandatory carriage requirement might, under certain circumstances, be switched off on the master's professional judgement.**

4.11   Use of AIS data on MKD-based systems

While the use of AIS data on a radar or ECDIS display has undoubted benefits, useful improvements in situational awareness can be obtained by careful use of an MKD-based system.

For instance, any ship that is manoeuvring in an unclear manner when observed visually or by radar, and for which collision avoidance action may become necessary, could be attempted to be identified on the MKD by range and bearing to assess its AIS parameters. Such identification may, for instance, show that the ship is constrained by draught, towing or not under command. Also, the AIS may show that the ship is proceeding to a local destination, perhaps unexpected by the observing ship.

In appropriate circumstances and subject to the possibility of mistaken identity, the call-sign and ship name could be determined from AIS and a VHF call made to the ship in an attempt to clarify its intentions. However, even with the more positive identification of vessels that AIS provides it is not recommended that manoeuvring agreements are made that do not comply with the Collisions Regulations (COLREGS). On suitable occasions it may be useful to confirm intentions of collision avoidance manoeuvring that do comply with the COLREGS. It should never be absolutely assumed that the vessel being called on VHF is the AIS/radar observed target and the situation needs to be continually monitored.

Some Administrations require a VHF exchange for collision avoidance manoeuvring in defined circumstances. The more positive identification that AIS offers is of clear benefit.

The AIS may offer different ways of ordering listed targets in order to assist identification but typically they will be ordered by range from own-ship. Most offer a graphical display, which may be constrained to a north-up orientation or may include other display modes such as head-up. If the radar and the MKD are set to the same orientation display mode it can ease the association of AIS and radar targets.

The small screens used in MKDs may, however, confuse the situation if there are many targets in the vicinity, particularly when the display is set to display longer ranges. Some MKDs offer target filtering to reduce screen clutter, based on such parameters such as target range, CPA/TCPA or AIS target class (A or B). These will be accessible from the MKD menu structure If the radar and MKD are not set to the same orientation mode extreme caution must be taken not to associate targets mistakenly. Wrong association can also occur because of confusion in the comparison of ranges on the MKD and radar.

The symbology used on graphical displays MKDs will probably replicate or be an approximation to the symbology that the Organization has mandated for use on radar and other navigation displays be used on radar and ECDIS displays when displaying AIS (See Section 4.12).

Because graphical displays are not compulsory on an MKD and actual implementations differ, further description of the use of graphical displays is not covered here. Some of the information in the next section on the use of AIS on radar and ECDIS displays may be relevant to particular implementations.

Operators should be aware of potential dangers in using proprietary MKD display modes. These can display targets, for instance, as a visual approximation of the 'view from the bridge window'. Such displays can perhaps give a greater impression that this is the complete scene, despite the incompleteness of AIS data discussed in Section 4.8 above.

It is important that the cautions identified in Section 4.10 are always observed when using AIS.

4.12   Use of AIS data on a radar or ECDIS display

The real benefits of AIS accrue when viewing AIS targets on a radar or ECDIS display. These benefits have been outlined in Section 3.3 of this Model Course. However, it is important that the AIS cautions identified in Section 4.10 above are always observed, even when displayed on a radar or ECDIS.

It would be useful for the instructor to explore briefly the ever-advancing convergence in radar and ECDIS. Some radar displays are capable of displaying Electronic Navigational Chart (ENC) data and many ECDIS displays can show 'raw' radar and tracked target vectors. Navigational displays are beginning to emerge that blur even more the differences between radar and ECDIS but have options for set-up that allow a 'classical' radar or ECDIS display. The Organization has set requirements for Navigational Displays, which come into force for equipment newly installed on or after 1 July 2008.

However, there remains controversy about making collision avoidance decisions on an ECDIS and this should be explained to trainees. Much of the debate reduces down to three areas:

- Following the COLREGS, collision avoidance decisions are based on movement through the water and not over ground. ECDIS is a ground referenced system.

- It is unlikely that the displayed range for making collision avoidance decisions will be the same as the displayed range needed for route monitoring.

- Chart data can clutter the screen and also lead to information overload. This could be detrimental to assessing the correct action for collision avoidance.

The convergence of the technologies for radar and ECDIS displays perhaps provides counters to these issues:

- Target and ownship vectors can be selected as 'through-the-water' parameters, i.e. STW, CTW, even though displayed on a 'ground-fixed' chart background'.

- Multiple displays are necessary. Each should have their set-up optimised for a specific function, e.g. collision avoidance, route monitoring.

- When used for collision avoidance only the bare minimum of chart data should be displayed, consistent with the need to take the right action, bearing in mind the constraints of charted data (such as depth, buoyage, traffic separation schemes, etc.).

For 'classical' navigation systems, used on most ships today, it is recommended that radar (with AIS capability) is used as the prime electronic aid to assist collision avoidance decisions. In many situations useful information can also be obtained by temporarily displaying radar and AIS target data on ECDIS.

The great advantages that can be obtained by displaying AIS on radars and ECDIS have led the Organization to mandate that all radar should be capable of displaying AIS targets for equipment newly installed on or after 1 July 2008. The requirements for these radars have been detailed by the Organization in Reference R7.

Manufacturers of early implementations of radars with AIS display facilities followed the Organizations earlier (Interim) Guidelines for the presentation and display of AIS target information, which were published in 2001 (Reference R12). Systems built to meet the interim Guidelines will differ somewhat to those built to the requirements of Reference R7. The following description is based around the later requirements of reference R7and the requirements for the presentation of AIS data given in Reference R8.

There are strict requirements on the symbology to be used for the display of AIS targets on radar and ECDIS.

Certain target definitions need to be first understood:

Sleeping target   This indicates the position and orientation of a vessel transmitting AIS data.

Activated target   When a target is activated it is treated in a similar way to radar tracked targets. The display additionally shows:

- A speed and course over ground vector

- A heading vector

- A turn direction 'flag', if the data is available

- An optional turn path predictor, (providing ROT is available)

- The target's past track if this facility is switched on

Dangerous target   A target (activated or not) that is calculated to violate user-set CPA and TCPA limits.

Selected target   When a target is selected its detailed information is displayed in a window on the display. This will include CPA and TCPA data as well as AIS target data.

Lost target   A target representing the last valid position of an AIS target before the reception of data was lost. It will be shown as such until the alarm is acknowledged or the target signal reacquired.

The Table given in Figure 5 is compiled from the Organization's definitions for such symbols (Reference R8). To reduce display 'clutter' a means to filter the presentation of sleeping AIS targets is provided, e.g. by target range, CPA/TCPA or AIS target class (A or B). The user parameters selected for target filtering should be carefully considered to ensure that critical information is not excluded, while preventing too much irrelevant data confusing the user's awareness of the situation. Simulator scenarios that help train users to determine good filter settings should be carefully considered by the instructor.

Activation/deactivation of targets may be achieved by individual selection or optionally by user defined zones or when meeting user defined parameters such as target range, CPA/TCPA limits or AIS target class.

The display of AIS targets may be switched off or on. When 'off' the processing of AIS information is kept operational so that targets instantly reappear when switched back on.

On low range displays activated targets will be displayed as true scale outlines.

On some systems it may be possible to select more than one target. If so there will be a clear identification of the data which is applicable to each selected target.

Topic	Symbol	Description
AIS Target (sleeping)		An isosceles, acute-angled triangle should be used. The triangle should be oriented by heading, or COG if heading missing. The reported position should be located at centre and half the height of the triangle. The symbol of the sleeping target should be smaller than that of the activated target.
Activated AIS Target Including Dangerous Target		An isosceles, acute-angled triangle should be used. The triangle should be oriented by heading, or COG if heading missing. The reported position should be located at centre and half the height of the triangle. The COG/SOG vector should be displayed as a dashed line with short dashes with spaces approximately twice the line width. Optionally, time increments may be marked along the vector. The heading should be displayed as a solid line thinner than speed vector line style, length twice of the length of the triangle symbol. Origin of the heading line is the apex of the triangle. The turn should be indicated by a flag of fixed length added to the heading line. A path predictor may be provided as curved vector. For a "Dangerous AIS Target", bold, red (on colour display) solid triangle with course and speed vector, flashing until acknowledged.
AIS Target – True Scale Outline		A true scale outline may be added to the triangle symbol. It should be: Located relative to reported position and according to reported position offsets, beam and length. Oriented along target's heading. Used on low ranges/large scales.
Selected target		A square indicated by its corners should be drawn around the activated target symbol.
Lost target		Triangle with bold solid cross. The triangle should be oriented per last known value. The cross should have a fixed orientation. The symbol should flash until acknowledged. The target should be displayed without vector, heading and rate of turn indication.
Target Past Positions		Dots, equally spaced by time.

Figure 5 - AIS Target symbology

Target Alarms

If the calculated CPA or TCPA of an activated AIS target is less than the set limit a CPA/TCPA alarm will be given and the particular target will be indicated with a dangerous target symbol. The set CPA/TCPA limits apply both for radar and AIS targets. The user can select whether the limits apply just to activated AIS targets or to both activated and sleeping targets. As a default it applies to only activated targets.

When a target that has not previously been activated enters a user set zone or is first received in that zone an alarm will be given and the target is identified with the relevant symbol.

There is a lost AIS target alarm that can be enabled or disabled. If:

- The AIS lost target alarm function is enabled.

- The target meets the user-set lost target filter criteria.

- A message is not received for a set time, depending on the nominal reporting time of the AIS target.

then:

- The last known position will be clearly indicated by a lost target symbol and an alarm given.

- The lost target symbol will be extinguished if the alarm is acknowledged or replaced by the previous symbol if the signal is received again.

Target association

A prime benefit of using a radar display to show AIS targets is the relative ease of being able to make decisions on whether an AIS target is likely to be the same object as a radar target. The radar target could be a tracked target or could just be a 'raw' radar return (paint). This is called target association, also known as target correlation. The fact that two independent systems are confirming the presence of a target obviously increases confidence.

Conversely, if target association is not possible it acts as a warning that great care should be applied if the 'isolated' radar or AIS target is significant to the safe navigation of own-ship. When there is no obvious association it is prudent to establish why this is the case. If there is only AIS return and no observed radar target the causes may be:

- The target is obscured to the radar 'line-of-sight'. This may be a headland, island or buildings, or a nearby large ship. The target could be in a blind sector of the radar, obscured by the ship structure or because radar sector blanking has been set.

- The radar is set-up in a manner that is not optimising target detection, e.g. gain and clutter controls may not be ideally adjusted.

- The target is obscured by sea or rain clutter.

- Propagation conditions are such that AIS has a better range than the radar return from the target.

- The radar is faulty.

- The target vessel is transmitting erroneous positional data preventing target association.

If there is only a target indication on radar and not on AIS:

- The target may not be fitted with AIS.

- The target's AIS may be faulty or switched off.

- Propagation conditions are such that radar has a better range for this target than AIS.

- Own ship's AIS has a fault, which may be caused by poor installation.

- The target is transmitting erroneous positional data preventing target association.

It is seen that AIS and radar complement each other. In particular AIS may give a valid target indication when there is no radar or visible indication of a target.

The positive association of radar and AIS targets has to be done with great care. In crowded waters a false association becomes more likely but it can also occur at any time. AIS (or radar) targets that are erratically behaving should be treated with great care. For instance AIS target positional jumps are frequently reported, which can be due to the target's GNSS changing satellite constellation. (These can also occur when two vessels have entered the same MMSI into their static data).

Despite this, the correct association of radar and visual targets with AIS is more positive on a radar or ECDIS display than it can be with an MKD based system. This helps in identifying call signs for possible VHF communication. It is, however, important that the cautions on using VHF for collision avoidance discussed in Section 4.10 above are observed.

The Organization's performance requirements for AIS displayed on radar allow the possibility of radars with an automatic mode of target association. These are likely to rely on user input parameters to make the association, e.g. criteria based on how close the targets are, and their differences in such parameters as heading, speed and course. The user should use such automated features with great care until more research and experience is gained in their use.

The combination of visual, radar and AIS data, in conjunction with charted information give the main ingredients to acquire good (navigational) situational awareness.

The early guidelines for the display of AIS information on radar displays included the requirement that AIS target symbols should have priority over other target presentations, including ARPA, ATA and EPA. This should be borne in mind when using such equipment. The later equipment standard gives the operator the choice of whether radar tracking or AIS targets are given priority, although AIS target/data remains a default setting.

AIS aids-to-navigation are viewable on radar, ECDIS and some MKDs. They are discussed further in Section 4.14.

4.13   AIS and the COLREGS

The COLREGS as written at present do not explicitly mention AIS. This is likely to be the situation for an extended period, until there is good practical experience available that suggests the COLREGS should reference AIS.

It is useful, however, for the instructor to identify and discuss with trainees those regulations which could be interpreted to be applicable to the use of AIS.
The discussion can be based around the instructor's knowledge of the COLREGS, backed up by any relevant discussion papers that the instructor may have access to. For instance, the discussion in Reference T4 may stimulate thinking in this area, although additional or different**'** **interpretations'** of the COLREGS, applicable to the use of AIS, may also be possible.

4.14   Use of AIS aids to navigation

An AIS AtoN will be displayed on a radar or ECDIS using the symbology in the table below:

Topic	Symbol	Description
AIS Based AtoN Real Position of Charted Object		Diamond with crosshair centred at reported position. (Shown with chart symbol. Chart symbol not required for radar.)
AIS Based AtoN Virtual position		Diamond with crosshair centred at reported position.

The additional information that is transmitted by the AIS AtoN and that will be included in the information box when the AIS AtoN is 'selected' on radar or suitable MKDs, includes the following:

- Type of AtoN

- Name of AtoN

- Position of AtoN

- Position accuracy indicator

- RAIM indicator

- Type of position fix, e.g. GPS, Chayka, surveyed

- Off-position indication

- Dimension of the AtoN, including GNSS antenna position

- Whether it is a virtual AtoN

Both synthetic and virtual AtoNs will be labelled as virtual. If a floating 'real' navigation aid is associated with the AIS AtoN (synthetic AtoN), such as a buoy, the real position and the AIS reported position may not exactly tie-up. This may mean that the floating object has moved from its intended position.

4.15 Regional operating settings

Before entering the waters of a particular competent authority it may be necessary to enter AIS transmission parameters manually, according to the requirements of the competent authority, (see Reference R13).

This will be performed by entering the appropriate menu of the AIS and either entering new parameters or editing existing parameters of stored regional operating settings.

It should be realised that in most circumstances this is an automatic function and the manual inputting of parameters is only required in special circumstances, which will be communicated by the competent authority.

No understanding is necessary of the meaning of the technical parameters (a brief discussion is included in Section 1.5) but the data should be entered exactly as instructed by the competent authority, following the operation manual of the particular onboard AIS. The parameters that can be entered or edited are as follows:

Channel number A

Channel A bandwidth

Channel number B

Channel B bandwidth

Transmit/receive mode

Power

Longitude 1

Latitude 1

Longitude 2

Latitude 2

It is recommended that instructors prepare a representative parameter list that has to be entered and checked into a simulator by trainees after giving them suitable detailed instructions to undertake this task. The instructor will need to consult the simulator handbook to understand how to perform the detailed action and determine representative parameters.

5 Training and familiarization

Successful completion of a training course based on this model course is not the only training needed to operate AIS. In addition suitable familiarization training should be given on the actual equipment that is to be used.

This course objective emphasises the importance of proper familiarization training. A generalised course in AIS cannot explain the functionality and use of any specific equipment configuration on a ship. It would be worth the instructor explicitly referencing the relevant parts of STCW (Reference R9) and the ISM code (reference R10), concerning familiarization training.

It should be explained that the principles and practices learnt within this course will enable familiarization training to be rapidly assimilated, particularly if such familiarization training conforms to the recommendations given in the Annex I of this model course.

The trainees should be made aware of the contents of Annex I and that installers, manufacturers and Companies are recommended to base their familiarization training around these recommendations.

Many seafarers often move between ships and will become familiar with many manufacturers' implementations. This can lessen the time for familiarization. However, it gives some dangers as similar looking equipment may be differently configured.

Also, staff returning to a ship after a period away, may find that the configuration has been updated. It is therefore important that a new or returning user always undergoes a familiarization procedure. The user should check that the items in the appropriate checklist below are included within the familiarization.

AIS familiarization checklist

On joining a ship the user should check the availability and whereabouts of the familiarization training course and then undertake training prior to operating the equipment at sea. In the absence of such material the user should become acquainted with the points described in the succeeding paragraphs, before using the AIS equipment at sea. This will probably also involve asking questions to experienced users on board.

A. General operation

- Determine whether there are bridge procedures for using AIS. If there are these should be read and understood.

- From the bridge procedures or from senior bridge staff establish the required frequency of static, dynamic and voyage related data checks.

- From the bridge procedures or by asking senior bridge staff establish the master's requirements for when AIS should be switched off and when voyage related data should be restricted.

- From the bridge procedures or from senior bridge staff establish whether there are any special requirements concerning the sending and receipt of Binary Messages.

- Determine the availability and whereabouts of the AIS User Manual. Use this to understand more detailed functionality that may not be covered by familiarization training.

- Understand what equipment is connected to the AIS, in particular the primary GNSS (and the secondary, if fitted), the heading device and whether ROT information is available for the AIS.

- Understand whether radar, ECDIS or other navigational displays can show AIS data or whether the AIS installation is an MKD only system.

- On a radar (or other navigation display based system) determine what AIS functions are available on the radar and what have to be accessed at the AIS unit (the MKD). For instance where can the checking of own ship's data be performed, where are short safety related messages displayed and where can they be sent from, where is voyage related data entered?

Detailed operation

- Understand how to adjust the displays for brightness, contrast and colour, if available.

- Understand how to access and control the main operating menu and its submenus.

- Understand how to check static data.

- Understand how to check dynamic data including how to enter and check navigational status.

- Understand how to enter and check voyage related data.

- Understand how to view incoming safety related messages and send such messages.

- Understand how to view AIS received data, including AIS AtoNs in all the available modes of presentation.

- Understand the provided alarms and indicators and the means of acknowledging the alarms.

On systems which provide the facilities:

- Understand how to activate and deactivate targets.

- Understand how to set CPA and TCPA alarm limits.

- Understand how to filter displayed targets.

- Understand how to switch between radar, AIS and combined modes of display.

- Understand the operation of the automatic association facility and the user inputs required for effective operation.

- Understand how to deal with binary messages.

- **Guidance on simulator exercises**

It is essential that trainees get practical experience on this course by using AIS simulators. Such simulators can be relatively simple - a single screen with 'windowed' displays, representing the working of AIS on an MKD and radar, being sufficient. Ideally such simulators should also cover AIS displayed on ECDIS.

Although full-mission bridge simulation can be a good learning experience, they are expensive to procure and run. They are not an essential requirement for teaching the use of AIS.

Even colleges with full-mission simulators find that time can be spent more effectively by having the majority of exercises on single screen classroom simulators, leaving the full-mission simulator for final exercises, particularly to bring in team interaction scenarios and multi-input scenarios.

It is important that the simulator is properly configured to comply with IMO's requirements for AIS, whether on an MKD, radar or ECDIS. This matter should be discussed with the supplier of the simulator system.

Simulator exercises should be set appropriately to the facilities available to the college. Great care should be used in designing these exercises, as it important that they give the trainee experience in dealing with normal, abnormal and emergency condition in a manner as close as possible to real life. Even so, the exercises will be simulating many abnormal or emergency situations which would be unlikely to occur in any normal voyage.

Some colleges are situated close to navigable waters and use a 'live AIS system' for both demonstration and training purposes. Such systems can be useful for demonstration but the following should be borne in mind:

- It should ideally be a 'receive-only system' so that it does not transmit misleading data or contribute to bandwidth saturation.

- Many commercial AIS units cannot be configured to a 'receive only' mode of operation.

- If the system transmits it should always be set up in a way that meets the Administrations requirements concerning its MMSI and other transmitted data.

- A transmitting system should not be configured by trainees without full supervision. The supervisor should fully understand the requirements placed upon its use by the Administration.

Fictitious versus real sea areas

Exercises should produce the greatest impression of realism in limited 'real time'. To achieve this, the scenarios can often be best located in fictitious sea areas, for the following reasons:

- Situations, functions and actions for different learning objectives that occur in different sea areas can be integrated into one exercise and experienced in real time.

- It eases the exchange of scenarios and exercises between maritime educational institutions.

On the other hand it can be difficult to get convincing and sufficient data in fictitious sea areas, for instance when using Electronic Navigational Chart (ENC) data on ECDIS. Therefore the best data available for the particular simulation exercise should be chosen, fictitious or real.

Specific types of sea area

It is advisable to make use of simulation in three types of sea area for which typical characteristics and attributes, navigational situations and requirements, navigational functions and operators' actions can be identified:

- Sea passages.

- Shallow waters, pilotage waters and fairways.

- Harbour areas.

Compilation of typical situations and actions

In order to design exercises, it is advisable to compile characteristic sets of data containing learning objectives, situations and actions which the trainee has to perform. Much effort should go into producing realistic simulations of abnormal and emergency situations.

Monitoring of exercises

The actions of the trainees should be closely monitored and recorded. Also, a summary should be made for the purposes of debriefing.

Debriefing

Debriefing of the exercises is essential. The time spent on debriefing should typically occupy between 15% and 30% of the total time used for simulator exercises. Times in excess of this can be useful in some circumstances. The instructor should refer to the summary made during the exercise to raise important points and to direct the discussion among trainees. The following facilities may be used in debriefing:

- Playback of relevant sequences in the video recording.

- Playback of possible simulator recording facilities, which can include plots of own ship manoeuvres, surrounding vessels, etc.

Recommended exercises

Part B (Course Outline and Timetable) recommends the time allocated to the elements of teaching, including simulator exercises. The following table details suitable simulator exercises into an example logical sequence:

	Simulator Exercise	Time (Hours)	Syllabus Reference
	MKD based system		
1.	Enter and check representative ship's static data	0.2	2.1, 4.2
2.	Enter and check voyage related data, including adding UN/LOCODES	0.2	2.2, 4.2
3.	Enter and check navigational status and check dynamic data	0.1	2.3, 4.3
4.	Manually associate MKD target list with radar targets, (at least one target should have incorrect AIS data to prevent association)	0.2	4.10, 4.11,
5.	Repeat a similar exercise to 4. above using the plan (graphical) display on the MKD, if available	0.2	4.10, 4.11
6.	Respond appropriately to a received safely or security related message and send a safety related message to both a etc	0.2	2.4, 4.5
	Radar/ECDIS based system		
7.	Recognise all symbology, including AtoNs	0.1	4.12, 4.14
8.	Activate/deactivate appropriate targets and set appropriate target filters	0.2	4.12, 4.14
9.	Set appropriate CPA/TCPA limits and identify dangerous targets	0.1	4.10, 4.12, 4.13
10.	Manually associate radar and AIS targets, (using tracked targets and 'raw' radar examples). Not all radar targets should have AIS data. Some AIS targets should have incorrect data.	0.2	4.10, 4.12, 4.13, 4.14
11.	Deal correctly with lost targets	0.1	4.9, 4.10, 4.12, 4.13, 4.14
12.	Manually set regional operating settings	0.2	1.5, 4.15
	Total simulator exercises	**2.0**	

Annex I

Familiarization Training

The supplier of an AIS system and its display facilities (radar and ECDIS), should work with the Company to provide material suitable for familiarization training of mariners who will be using the equipment as part of their OOW duties. The level of training required is dependent on the complexity of the system. It is expected that users who have satisfactorily completed an AIS course based on this Model Course will only need to take a short period of on-board familiarization training, based on the material defined in this Annex. Such familiarization training must meet the standards required by ISM.

This Annex has been written in order to provide a guide as to the contents that should be contained within familiarization training that would normally be effective for a new user who has previously taken an AIS training course based on this Model Course. The Model Course is designed to train the mariner in understanding the principles, benefits, dangers and good seamanship in using AIS. It cannot, of course, explain the functions, limitations, controls, displays, alarms and indications of any specific bridge. This must be left to familiarization training for the specific implementation.

Emphasis should be on producing familiarization training that can be completed in the shortest practicable time. This will help maximise the probability that the training will be properly undertaken. For most systems this should perhaps take no longer than 10 minutes, for the average OOW, provided the OOW has completed an AIS training course based on this Model Course. Such familiarization training can take a number of forms. The following are illustrative examples but other effective methods of training are acceptable:

- Computer based training on the ship.

- Remote computer based training (e.g., on personal or notebook computer of new user).

- Training mode on fitted equipment.

- Training video supported by self-training manual.

- Stand-alone self-training manual.

- Manual or training giving guidance to enable experienced users to teach new users on the actual equipment.

- Shore-based course.

The topics that need to be covered are listed below. It is not necessary to follow the order of this list but the topics should be covered in a logical way. It is not a detailed manual of operation and therefore it is not appropriate for every small detail to be included. Reference to the relevant section of the Operators' Manual should be made for descriptions of more detailed operations or of secondary, less essential functionality.

Familiarization training framework

A.   **General operation**

- Determine whether there are bridge procedures for using AIS. If there are these should be read and understood.

- From the bridge procedures or from senior bridge staff establish the required frequency of static, dynamic and voyage related data checks.

- From the bridge procedures or by asking senior bridge staff establish the master's requirements for when AIS should be switched off and when voyage related data should be restricted.

- From the bridge procedures or from senior bridge staff establish whether there are any special requirements concerning the sending and receipt of AIS binary messages.

- Determine the availability and whereabouts of the AIS User Manual. Use this to understand more detailed functionality that may not be covered by familiarization training.

- Understand what equipment is connected to the AIS, in particular the primary GNSS (and the secondary, if fitted), the heading device and whether ROT information is available for the AIS.

- Understand whether radar, ECDIS or other navigational displays can show AIS data or whether the AIS installation is an MKD only system.

- On a radar (or other navigation display based system) determine what AIS functions are available on the radar and what have to be accessed at the AIS unit (the MKD).   For instance where can the checking of own ship's data be performed, where are short safety related messages displayed and where can they be sent from, where is voyage related data entered?

Detailed operation

- Understand how to adjust the displays for brightness, contrast and colour, if available.

- Understand how to access and control the main operating menu and its submenus.

- Understand how to check static data.

- Understand how to check dynamic data including how to enter and check navigational status.

- Understand how to enter and check voyage related data.

- Understand how to view incoming safety related messages and send such messages.

- Understand how to view AIS received data, including AIS AtoNs in all the available modes of presentation.

- Understand the provided alarms and indicators and the means of acknowledging the alarms.

On systems which provide the facilities:

- Understand how to activate and deactivate targets.

- Understand how to set CPA and TCPA alarm limits.

- Understand how to filter displayed targets.

- Understand how to switch between radar, AIS and combined modes of display.

- Understand the operation of the automatic association facility and the user inputs required for effective operation.

- Understand how to deal with AIS binary messages.

Annex II

Guidelines for the onboard operational use of shipborne Automatic Identification Systems (AIS)

(Resolution A.917(22) as amended by resolution A.956(23))

TO BE ADDED LATER BY IMO SECRETARIAT

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