

# Competence related to the use of Remotely Sensed Earth Observation Data on Board Vessels

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DET NORSKE VERITAS AS

### FOREWORD

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Any comments may be sent by e-mail to *rules@dnv.com* 

## CHANGES

#### General

This is a new document.

#### Acknowledgement

This Standard of Competence is the result of a close cooperation with the European Space Agency (ESA) and Global Maritime Services Ltd (GMS). Other organisations such as Polar Imaging, Meteorologisk Institutt Norge and Offshore Monitoring, have contributed through providing detailed input which proved crucial.

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#### 1 Introduction

#### **1.1 Introduction**

The standard aims to provide guidance for establishing a competence foundation for people who are expected to use earth observation data and/or products as an end-user, to be supplemented by e.g. operational / supplier manuals. The standard aims to identify a base set of competencies.

Specific details related to ship-specific arrangements / systems cannot be captured in a standard of a general nature.

The increasing use of earth observation data on board vessels provides many opportunities and can supply much valuable information. Current use of data in meteorology and ice information is part of an increasing number of useful services. Officers on board navy and merchant vessels will become more familiar with working with earth observation data and it is important that their competence allows them to judge the quality of the data provided.

#### 1.2 Scope

This Standard of Competence was created while focusing on bridge watchkeeping officers and masters on board vessels that (will) use earth observation data or related products in their daily operations. The target population is assumed to be competent to navigate a vessel using today's navigating equipment and has a thorough understanding of interpreting charts and tables, meteorology and voyage planning.

The standard identifies a suggested minimum level of knowledge and skills for people involved in the use and interpretation of earth observation data. This standard can be used in the following ways:

- As a reference to familiarise or assess people in relation to the topic area.
- As a reference for global competence and defining training requirements.
- As a guide to training providers, who are to develop courses according to the requirements of the standard and needs of the industry.
- As a reference document for e.g. certification of personnel.

Even though the emphasis lies on the use of data on board vessels the major part of the standard can be considered a foundation for any end-user.

The scope of the standard excludes specialist competencies for specific activities or operations. In the future, appendices to the standard could be developed for specific activities, equipment and/or target groups. However, the foundation as captured in this standard would remain applicable.

#### **1.3 Professional profile**

The master and bridge watchkeeping officer shall be able to define information needs for a specific voyage or operation and interpret and use earth observation data or products as a basis for their decisions during their operations.

#### **1.4 Required performance standard**

The officer shall be able to request, interpret and use earth observation data and products in the decisionmaking process without jeopardizing life, environment, ship or property.

#### **1.5** Possible uses of the standard

The Standard was developed to establish a foundation and common ground for both the development of competence of individuals as well as for training programs related to the use of earth observation data and products.

The standard can be used

- 1) by organisations to define their expectations towards training providers (e.g. ESA, IMO, branch organisations and companies);
- 2) by training developers and providers as the backbone of a learning programme;
- 3) by companies to verify the competence (or need for competence development) of their people and define their training needs;
- 4) by verifiers as a reference document for independent evaluation of training programs.

#### **2** Defining Competence

#### 2.1 General

Taxonomy of the required professional behaviour specifies the level on which the person should be able to operate. It is a hierarchical arrangement in four (4) levels of what a person has to master from simple to complex requirements, based on instructional design principles.

For every next level, it is a prerequisite that the preceding level is mastered. The required professional behaviour is expressed by means of a verb.

#### 2.2 Levels of cognition

Each competence requirement can be classed by the level of cognition required to meet the competence requirement.

| Level 1: Knowledge (K)     | To remember or to reproduce on basis of appropriate, previously learned information.  |
|----------------------------|---|
| Level 2: Understanding (U) | To give meaning to new situations and or new material by recollection and using necessary present information. To give evidence of insight in certain activities.   |
| Level 3: Application (A)   | To use previously acquired information in new and concrete situations to solve problems that have single or best answers.   |
| Level 4: Integration (I)   | To separate information into their component parts, to examine such information to develop divergent conclusions by identifying motives or causes, making inferences, and or finding evidence to support generalizations. To creatively apply prior knowledge and skills to produce a new or original whole. To judge the value of material based on personal values or opinions, resulting in an end product, with a given purpose, without real right or wrong answers. |

#### 2.3 Professional behaviour verbs

The lists of verbs in the table below are not exhaustive and should be used as guidance only.

| Level of cognition | Relevant action verbs   |  |
|--------------------|---|--|
| Knowledge (K)      | Choose, Cite, Describe, Distinguish, Find, Give example, Group, Identify, Indicate,<br>Know, Label, List, Listen, Locate, Match, Memorise, Name, Outline, Quote, Read, Recall,<br>Recognise, Record, Recite, Relate, Repeat, Reproduce, Retrieve, Review, Select, Show,<br>Sort, State, Underline, Write  |  |
| Understanding (U)  | Account for, Annotate, Associate, Classify, Compare, Define, Describe,<br>Discuss, Estimate, Exemplify, Explain, Give examples of, Give main idea, Identify, Infer,<br>Interpret, Observe, Outline, Paraphrase, Recognise, Reorganise, Report, Restate, Retell,<br>Research, Review, Summarise, Translate   |  |
| Application (A)    | Adapt, Apply, Arrange, Calculate, Carry out, Change, Collect, Compute,<br>Conclude, Construct, Demonstrate, Dramatise, Draw, Exhibit, Execute, Extract, Illustrate<br>Implement, Include, Instruct, Interpret, Interview, Make, Manipulate, Obtain, Operate,<br>Paint, Practice, Prepare, Sequence, Show, Sketch, Solve, Translate, Use   |  |
| Integration (I)    | Analyse, Appraise, Argue, Arrange, Assess, Attribute, Calculate, Categorise, Check,<br>Choose, Combine, Compare, Contrast, Criticise, Critique, Debate, Decide, Deconstruct,<br>Deduce, Defend, Design, Detect, Determine, Develop, Diagram,<br>Differentiate, Discriminate, Dissect, Distinguish, Evaluate, Examine, Experiment, Find,<br>Formulate, Group, Hypothesise, Infer, Investigate, Integrate, Interpret, Inspect, Inquire,<br>Judge, Justify, Measure, Monitor, Order, Organise, Outline, Plan, Predict, Prioritise,<br>Probe, Question, Rank, Rate, Recommend, Reject, Relate, Research, Revise,<br>Score, Separate, Select, Sequence, Sift, Structure, Survey, Tell why, Test, Validate, Value |  |

### **3** Competence Requirements

Each competence requirement is derived from a task that needs to be performed. The competence requirement is stated in objective format to clearly define what has to be done to satisfy the requirements of the competence. Each competence requirement starts with a verb and can be preceded by the sentence: "The Officer must be able to..."

At the same time it facilitates the derivation of assessment criteria and the assessments to measure individual competencies.

The 105 competence requirements are grouped into 5 distinct functional domains that are further sub-divided into 19 topics.

Each competence requirement is allocated a level of cognition that can be used to determine the type of assessment required to measure competence. Knowledge (K) and Understanding (U) can in most cases be measured through questioning. Asking for explanations or relevant facts provides insight in a person's elementary knowledge and understanding.

Application (A) and Integration (I) are the levels where a person has to demonstrate that he or she is able to use the knowledge and understanding in practical circumstances. These are normally measured by practical assignments. Practical assignments may also be of a "theoretical nature", depending on the competencies to be measured (e.g. the ability to make calculations, planning, reporting, etc.).

The table indicates the various levels of competence. It is the responsibility of both the training providers and the companies to ensure that people are competent before either issuing a certificate of competence or before giving people a certain responsibility.

## 4 Table of competencies

| Table 4   | -1 Table of Competencies  |   |  |
|---|---|---|--|
| Column A shows the ID for the competence Column B is the competence to be demonstrated Column C defines the cognitive level |   |   |  |
| Α   | В   | С |  |
| 1.0   | General   |   |  |
| 1.1   | Earth Observation   |   |  |
| 1.1.1   | Define 'Earth Observation'  | Κ |  |
| 1.1.2   | Describe the various observation platforms (e.g. satellites, sensors) used for earth observation and data collecting  | U |  |
| 1.1.3   | Describe which information can be obtained through earth observation for the shipping industry  | U |  |
| 1.1.4   | Describe what information geo-physical measurements can provide   | U |  |
| 1.1.5   | Explain the difference between historic data and (near) real-time data and the value of both  | U |  |
| 2.0   | Sensors   |   |  |
| 2.1   | Optical sensors   |   |  |
| 2.1.1   | Describe the advantages and limitations of optical sensors used for earth observation in relation to extracting wave and current data, sea ice, icebergs and surface objects                                    | U |  |
| 2.1.2   | Describe the advantages and limitations of visual / thermal infrared sensors used for earth observation, including specific difficulties of using these sensors at high latitudes                               | U |  |
| 2.1.3   | Describe the advantages and limitations of spectrometers used for earth observation   | U |  |
| 2.2   | Active microwave  |   |  |
| 2.2.1   | Describe the general advantages and limitations of active microwave sensors used for earth observation  | U |  |
| 2.2.2   | Describe the advantages and limitations of Synthetic Aperture Radar (SAR) images used for earth observation   | U |  |
| 2.2.3   | Describe the ability and limitations of the Synthetic Aperture Radar to extract wind, wave and current data, sea ice concentration, sea ice drift, sea ice edge, sea ice type, icebergs and surface objects     | U |  |
| 2.2.4   | Describe the limitation of a Synthetic Aperture Radar (SAR) to measure wind, wave, current, ice and surface objects   | U |  |
| 2.2.5   | Recognise the need for ancillary information (incl. weather updates, local ice climatology and geography) in order to be able to interpret ice conditions from SAR imagery                                      | K |  |
| 2.2.6   | Describe the effects of incidence angle, polarisation and radar frequency bands on SAR imagery  | U |  |
| 2.2.7   | Describe the advantages and limitations of a Scatterometer used for earth observation   | U |  |
| 2.2.8   | Describe the ability and limitations of the Scatterometer to extract wind, wave and current data, sea ice concentration, sea ice drift, sea ice edge, sea ice type, icebergs and surface objects                | U |  |
| 2.2.9   | Describe the advantages and limitations of an Altimeter used for earth observation  | U |  |
| 2.2.10  | Describe the ability and limitations of the Altimeter to extract wind, wave and current data, sea ice concentration, sea ice drift, sea ice edge, sea ice type, sea ice freeboard, icebergs and surface objects | U |  |
| 2.3   | Passive microwave   |   |  |
| 2.3.1   | Describe the general advantages and disadvantages / limitations of passive microwave sensors used for earth observation   | U |  |
| 2.3.2   | Describe the ability and limitations of a passive microwave sensor to extract wind, wave and current data, sea ice concentration, sea ice drift, sea ice type, sea ice edge, icebergs and surface objects       | U |  |
| 2.3.3   | Explain the limitation of the passive microwave sensor to capture summer conditions for sea-ice as well as wind, wave current and surface objects   | U |  |
| 2.4   | Other sensors   |   |  |
| 2.4.1   | Describe the various surface-based sensors installed on board ships, offshore installations and coastal stations used to collect earth observation data, including their advantages and limitations             | U |  |
| 2.4.2   | Describe the weather and oceanographic instrumentation used to collect earth observation data as found in/on specific buoys and drifters  | U |  |
| 2.4.3   | Describe the Automatic Identification System (AIS) and what kind of information it can provide  | U |  |
| 2.4.4   | Explain how the combination of AIS data and visual / radar images can be used to enhance safety and security  | U |  |
| 3.0   | Data and Products   |   |  |
| 3.1   | Data processing   |   |  |
| 3.1.1   | Describe the difference between raw data and processed data   | U |  |
| 3.1.2   | Give an example of aggregated and processed earth observation data used in shipping   | U |  |

| Column A shows the ID for the competence     Column R is the competence to the demunstrated     Column C defines the cognitive level       A     B     C       31.3     Fxplain what is meant by aggregated interpreted products, such as oceanographic products.     U       31.4     Explain what is meant by aggregated interpreted products for a particular area of operation, corosidering anticipated challenges and failsen of data areface the reliability of earth observation products for a particular area of operation, corosidering anticipated challenges and needs (e.g. sec): e.c. iccbergs, ctc)     No       32.1     Find the relevant providers of earth observation data / products for a vorgae or area of operation, corosidering anticipated challenges and needs (e.g. sec): cic bergs, ctc)     No       32.3     Explain the importance of planning, sufficient lead time, adequate communication links and processing arrangements for the quality or near rel-time products     U       32.5     Describe the advantages of linking multi platform observations (data, products, images) for safety, security und navigational applications     K       4.0     Reliability and Accuracy of Earth Observation Data     U       4.1     Explain what is meant by LOW, MEDIUM and HIGH spatial resolution     U       4.1.3     Explain what is meant by LOW, MEDIUM and HIGH spatial resolution     U       4.1.4     Grevan indication of what is meant by LOW, MEDIUM and   | Table 4-1 Table of Competencies (Continued)   |   |    |  |
|---|---|---|----|--|
| B     C       3.1.3     Explain what is meant by automatically classified products, such as oceanographic products.     U       3.1.4     Explain what is meant by agregated interpreted products.     U       3.1.6     Explain how aggregation, merging and fusing of data affect the reliability of earth observation products.     U       3.1.6     Explain how aggregated interpreted products for a voyage or area of operation.     K       3.2.1     Find the relevant providers of earth observation data / products for a voyage or area of operation.     K       3.2.2     Determine how to obtain the correct earth observation data / products for a voyage or area of operation.     K       3.2.4     Describe meto ecean data which can be obtained through a Weather Routing Service     U       3.2.4     Describe meto ecean data which can be obtained through a Weather Routing Service     U       3.2.5     Describe meto ecean data which can be obtained through a Weather Routing Service     U       3.2.6     Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)     K       4.0     Reliability and Accuracy of Earth Observation Data     U       4.1.1     Explain what is meant by 'aptial resolution' and how this affects the reliability and accuracy of earth uobservation on what is meant by LOW, MEDI   | Column A shows the ID for the competence Column B is the competence to be demonstrated Column C defines the cognitive level |   |    |  |
| 31.3     Explain what is meant by aggregated interpreted products.     U       31.4     Explain how aggregation, merging and lising of data affect the reliability of earth observation products     U       31.5     Explain how aggregation, merging and lising of data affect the reliability of earth observation products     U       31.6     Explain the difference between a satellite image and an aggregated image     U       32.1     Find the relevant providers of earth observation data and products for a particular area of operation, considering anticipated challenges and needs (e.g. sea-ice, icebergs, etc)     X       32.3     Explain the importance of planning, sufficient lead time, adequate communication links and processing anticipated challenges and needs (e.g. sea-ice, icebergs, etc)     U       32.4     Describe the advantages of linking multipatform observations (data, products, linages) for safety, security U     U       32.5     Describe the advantages of linking multipatform observation (data, products, linages) for safety, security U     U       4.1.1     Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation     U       4.1.2     Coince an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution     U       4.1.3     Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation earth bise  | A   | В   | С  |  |
| 31.4   Explain what is meant by aggregated interpreted products   U     31.5   Explain how aggregation, merging and fusing of data affect the reliability of earth observation products   U     31.6   Explain the difference between a suellite image and an aggregated image   U     32.1   Find the relevant providers of earth observation data and products for a particular area of operation, considering anticipated challenges and needs (e.g. see-sic, icebergs, etc)   X     32.2.1   Find the relevant providers of earth observation data and products for a voyage or area of operation, considering anticipated challenges and needs (e.g. see-sic, icebergs, etc)   X     32.2.3   Explain the importance of planming, sufficient lead time, adequate communication links and processing urangeometed challenges and needs (e.g. see-sic, icebergs, etc)   X     32.4   Describe the advantages of linking multi platform observations (data, products, images) for safety, security in an any agregated which can be obtained through a Weather Routing Service   U     32.3   Find the invitations related to the availability of data (temporal, spatial and technical limitations)   K     4.0   Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)   K     4.1   Resolution   U   1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH sepolution   U     4.1.1 <t< td=""><td>3.1.3</td><td>Explain what is meant by automatically classified products, such as oceanographic products.</td><td>U</td></t<>  | 3.1.3   | Explain what is meant by automatically classified products, such as oceanographic products.   | U  |  |
| 3.1.5   Explain how aggregation, merging and fusing of data affect the reliability of earth observation products   U     3.1.6   Explain the difference between a satellite image and an aggregated image   U     3.2.1   Find the relevant providers of earth observation data and products for a varge or area of operation, a considering anticipated challenges and needs (e.g. sca-ice, icebergs, etc)   A     3.2.2   Determine how to obtain the correct earth observation data / products for a vorge or area of operation, a magements for the quality of near real-time products   A     3.2.4   Describe med cocean data which can be obtained through a Weather Routing Service   U     3.2.5   Describe the advantages of linking multi platform observations (data, products, images) for safety, security u and navigational applications   K     4.1   Resolution   U   U     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.3   Explain what is meant by LOW, MEDIUM and HIGH temporal resolution   U     4.1.4   Resolution   U     4.1.5   Explain the terms spectral and radiometric resolution of adha to information obtained through interpolation or extrapolation   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH temporal resolution   U  | 3.1.4   | Explain what is meant by aggregated interpreted products  | U  |  |
| 3.1.6   Explain the difference between a satellite image and an aggregated image   U     3.2.1   Find the relevant providers of earth observation data and products for a voyage or area of operation, considering anticipated challenges and needs (e.g. searce, icebergs, etc)   A     3.2.3   Find the relevant providers of earth observation data / products for a voyage or area of operation, acconsidering anticipated challenges and needs (e.g. searce, icebergs, etc)   A     3.2.3   Explain the importance of planning, sufficient lead time, adequate communication links and processing arrangements for the quality of near real-time products.   U     3.2.4   Describe med varianges of linking multi platform observations (data, products, images) for safety, security u   U     3.2.6   Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)   K     4.0   Recliability and Accuracy of Earth Observation Data   U     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth uo observation   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U  | 3.1.5   | Explain how aggregation, merging and fusing of data affect the reliability of earth observation products  | U  |  |
| 3.2   Availability of data and services   K     3.2.1   Find the relevant providers of earth observation data and products for a voyage or area of operation, considering anticpated challenges and needs (e.g. scat-ce, iccbergs, etc)   A     3.2.3   Explain the importance of planning, sufficient lead line, adequate communication links and processing urangements for the quality of near real-time products   U     3.2.4   Describe met ocean data which can be obtained through a Weather Routing Service   U     3.2.4   Describe met ocean data which can be obtained through a Weather Routing Service   U     3.2.5   Describe the davantages of linking multi platform observations (data, products, images) for safety, security unargational applications   K     4.0   Reliability and Accuracy of Earth Observation Data   Image and the importance of planning, and the splat intersolution   U     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.2   Explain the terems 'spectral and radiometric resolution or   | 3.1.6   | Explain the difference between a satellite image and an aggregated image  | U  |  |
| 3.2.1   Find the relevant providers of earth observation data and products for a particular area of operation, considering anticipated challenges and needs (e.g. sea-ice, icebergs, etc)   A     3.2.3   Explain the importance of planning, sufficient lead time, adequate communication links and processing arrangements for the quality of near real-time products   U     3.2.4   Describe met occan data which can be obtained through a Weather Routing Service   U     3.2.5   Describe met occan data which can be obtained through a Weather Routing Service   U     3.2.6   Recorbie the advantages of linking multi platform observations (data, products, images) for safety, security und navigational applications   K     4.0   Recliability and Accuracy of Earth Observation Data   U     4.1   Resolution   U     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.5   Explain the terms 'spectral and radiometric resolution and how these affect the reliability and accuracy of earth observation   U     4.1.6   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution  | 3.2   | Availability of data and services   |    |  |
| 3.2.2   Determine how to obtain the correct earth observation data / products for a voyage or area of operation, a considering anticipated challenges and needs (e.g. sea-ice, icebergs, etc)   N     3.2.3   Explain the importance of planning, sufficient lead time, adequate communication links and processing arrangements for the quality of near real-time products   U     3.2.4   Describe the advantages of linking multi platform observations (data, products, images) for safety, security u and navigational applications   U     3.2.6   Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)   K     4.0   Reliability and Accuracy of Earth Observation Data   U     4.1.1   Resolution   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.3   Explain what is meant by tow, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U   | 3.2.1   | Find the relevant providers of earth observation data and products for a particular area of operation   | Κ  |  |
| 3.2.3   Explain the importance of planning, sufficient lead time, adequate communication links and processing updates and the quality of near real-time products.   U     3.2.4   Describe the quality of near real-time products.   U     3.2.5   Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)   K     4.0   Reliability and Accuracy of Earth Observation Data   U     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.3   Explain what is meant by 'temporal resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.1.5   Explain the terms 'spectral and radiometric resolution' and how these affect the reliability and accuracy of earth observation   U     4.1.4   Give an indication of data   U   U     4.1.5   Explain the terms 'spectral and radiometric resolution' and how these affect the reliability and accuracy of earth observation and extrapolation of data   U <td>3.2.2</td> <td>Determine how to obtain the correct earth observation data / products for a voyage or area of operation, considering anticipated challenges and needs (e.g. sea-ice, icebergs, etc)</td> <td>Α</td>  | 3.2.2   | Determine how to obtain the correct earth observation data / products for a voyage or area of operation, considering anticipated challenges and needs (e.g. sea-ice, icebergs, etc) | Α  |  |
| 3.2.4   Describe met ocean data which can be obtained through a Weather Routing Service   U     3.2.5   Describe the davantages of linking multi platform observations (data, products, images) for safety, security u     3.2.6   Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)   K     4.0   Reliability and Accuracy of Earth Observation Data   V     4.1   Resolution   U     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.1.6   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.2.1   Explain the cert for interpolation of data   terepolation of acta   U     4.2.1   Interpolation and extrapolation of data   terepolation to information obtained   1     4.2.2   Resign the need for interpolation product consists of inter- or extrapolated data and how much of the arth observation product was created and what this tells about the quality of the product   A     4.3.1   Determine if an earth observation produ   | 3.2.3   | Explain the importance of planning, sufficient lead time, adequate communication links and processing arrangements for the quality of near real-time products                       | U  |  |
| 3.2.5   Describe the advantages of linking multi platform observations (data, products, images) for safety, security used an avigational applications   U     3.2.6   Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)   K     4.0   Reliability and Accuracy of Earth Observation Data   K     4.1   Resolution   U     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.3   Explain what is meant by themporal resolution' and how this affects the reliability and accuracy of earth observation   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH paptial resolution   U     4.1.5   Fxplain the terms 'spectral and radiometric resolution' and how these affect the reliability and accuracy of earth observation   U     4.1.5   Fxplain the terms 'spectral and radiometric resolution of data   U     4.2.1   Explain the need for interpolation of data   U     4.2.2   Compare the reliability of data obtained through interpolation or extrapolated data and how much of it is based on actual measurement (near-real-time)   A     4.3.1   Determine how a specific earth observation product consists of inter- or extrapolated data and how much of it is based on actual measurement (near-real-time)   A <t< td=""><td>3.2.4</td><td>Describe met ocean data which can be obtained through a Weather Routing Service</td><td>U</td></t<>   | 3.2.4   | Describe met ocean data which can be obtained through a Weather Routing Service   | U  |  |
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| 4.0   Reliability and Accuracy of Earth Observation Data     4.1   Resolution     4.1.1   Explain what is meant by 'spatial resolution' and how this affects the reliability and accuracy of earth<br>observation   U     4.1.2   Give an indication of what is meant by LOW, MEDIUM and HIGH spatial resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH temporal resolution   U     4.1.4   Give an indication of what is meant by LOW, MEDIUM and HIGH temporal resolution   U     4.1.6   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.1.6   Give an indication of what is meant by LOW, MEDIUM and HIGH spectral and radiometric resolution   U     4.2.1   Explain the need for interpolation and extrapolation of data to create earth observation products, covering<br>uncovered areas or lapses of time   U     4.2.1   Explain the need for interpolation and extrapolation or extrapolation to information obtained<br>through real-time measurement   1     4.2.2   Compare the reliability of data obtained through interpolation or extrapolated data and how much<br>of it is based on actual measurement (near-real-time)   A     4.3.3   Determine how a specific earth observation product was created and what this tells about the quality of freeived earth observation data or products   A     4.3.3  | 3.2.6   | Recognise the limitations related to the availability of data (temporal, spatial and technical limitations)   | Κ  |  |
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| 4.4.4   Explain the relationship between frequency updates and the reliability of earth observation data   0     4.5   Validation of received information   4.5.1     4.5.1   Assess the validity of earth observation data or products for a particular point in time   A     4.5.2   Determine if the obtained earth observation data or product is appropriate for the task to be carried out   A     4.5.3   Check the accuracy of an earth observation data-sample/product   I     4.5.4   Investigate unusual readings in the earth observation products   I     4.5.5   Communicate unusual information with data provider   A     4.5.6   Compare received earth observation data with actual verifiable conditions   I     5.0   Using Earth Observation Data   I     5.1.1   Defining needs   I   | 4.4.3   | State factors which influence the reliability of earth observation data   | K  |  |
| 4.5Valuation of received information4.5.1Assess the validity of earth observation data or products for a particular point in timeA4.5.2Determine if the obtained earth observation data or product is appropriate for the task to be carried outA4.5.3Check the accuracy of an earth observation data-sample/productI4.5.4Investigate unusual readings in the earth observation productsI4.5.5Communicate unusual information with data providerA4.5.6Compare received earth observation data with actual verifiable conditionsI5.0Using Earth Observation DataI5.1.1Defining needsI5.1.1Define own needs in relation to earth observation data or products for a specific voyage or situationK   | 4.4.4   | Explain the relationship between nequency updates and the reliability of earth observation data   | U  |  |
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| 4.5.2Determine if the obtained early observation data of product is appropriate for the task to be carried outIV4.5.3Check the accuracy of an earth observation data-sample/productI4.5.4Investigate unusual readings in the earth observation productsI4.5.5Communicate unusual information with data providerA4.5.6Compare received earth observation data with actual verifiable conditionsI5.0Using Earth Observation DataI5.1Defining needsI5.1.1Define own needs in relation to earth observation data or products for a specific voyage or situationK  | 452   | Determine if the obtained earth observation data or products for a particular point in time   | Δ  |  |
| 4.5.4   Investigate unusual readings in the earth observation products   I     4.5.5   Communicate unusual information with data provider   A     4.5.6   Compare received earth observation data with actual verifiable conditions   I     5.0   Using Earth Observation Data   I     5.1   Defining needs   I     5.1.1   Define own needs in relation to earth observation data or products for a specific voyage or situation   K   | 453   | Check the accuracy of an earth observation data-sample/product  | I  |  |
| 4.5.5   Communicate unusual information with data provider   A     4.5.6   Compare received earth observation data with actual verifiable conditions   I     5.0   Using Earth Observation Data   I     5.1   Defining needs   I     5.1.1   Define own needs in relation to earth observation data or products for a specific voyage or situation   K  | 4.5.4   | Investigate unusual readings in the earth observation products  | I  |  |
| 4.5.6   Compare received earth observation data with actual verifiable conditions   I     5.0   Using Earth Observation Data   I     5.1   Defining needs   I     5.1.1   Define own needs in relation to earth observation data or products for a specific voyage or situation   K   | 4.5.5   | Communicate unusual information with data provider  | A  |  |
| 5.0   Using Earth Observation Data     5.1   Defining needs     5.1.1   Define own needs in relation to earth observation data or products for a specific voyage or situation   | 4.5.6   | Compare received earth observation data with actual verifiable conditions   | Ι  |  |
| 5.1     Defining needs       5.1.1     Define own needs in relation to earth observation data or products for a specific voyage or situation     K  | 5.0   | Using Earth Observation Data  | _  |  |
| 5.1.1 Define own needs in relation to earth observation data or products for a specific voyage or situation K   | 5.1   | Defining needs  |    |  |
|   | 5.1.1   | Define own needs in relation to earth observation data or products for a specific voyage or situation   | Κ  |  |

| Column A shows the ID for the competence     Column B is the competence to be demonstrated     Channe C defines the level of detail required in images for a specific voyage     C       1.12     Define the level of detail required in images for a specific voyage     C     C       1.14     Determine an acceptable age of data or products in relation to a specific activity / area of operation     A       1.15     Define input parameters for a swather fax or other metocean observation/forecasting system     A       1.26     Interpretation of carrent observation data / products     A       2.1.1     Recognise that no standard generally exists for carth observation images and products (e.g. use of colours, system)     I       2.2.2     Interpret data / products produced by an active microwave sensor     I     I       2.2.3     Interpret data / products produced by an active microwave sensor     I     I       2.2.4     Identify various types of arath observation images     U     I       2.2.5     Compare and interpret data / product is primarily based on statistics or actual measurement     A       2.2.1     Identify various types of carth observation images     A       2.1.0     Determine the relevant resolutions of an image     A       2.1.1     Determine the  | Table 4-  | Table 4-1 Table of Competencies (Continued)   |   |  |  |
|--|---|---|---|--|--|
| B     C       5.12     Define the level of detail required in ages for a specific voyage     K       5.13     Explain which types of data/products (e.g. images) to use in which situation and from which provider     K       5.14     Determine an acceptable age of data or products in relation to a specific activity / area of operation     A       5.15     Define input parameters for a suil plan model     A       5.21     Interpretation of earth observation data / products     A       5.21     Interpretation of earth observation data / products     K       5.2.1     Interpret data / products produced by an active microware sensor     I       5.2.4     Interpret data / products produced by an active microware sensor     I       5.2.5     Compare and interpret data / products of an area of operation created at different moments in time     I       5.2.6     Compare and interpret data / products of an image     U     U       5.2.8     Describe the limitations of a arious types of images     U     U       5.2.9     Determine if a product is primarily based on statistics or actual measurement     A       5.2.10     Determine if approduct data/ product correctly     A       5.2.11     Determine map deta  | Column A shows the ID for the competence Column B is the competence to be demonstrated Column C defines the cognitive level |   |   |  |  |
| 512   Define the level of datal products (e.g. images) to use in which situation and from which provider   K     51.4   Determine an acceptable age of data or products in relation to a specific activity / area of operation   A     51.6   Define input parameters for a awather fax or other metocean observation/forecasting system   A     51.6   Define input parameters for a awather fax or other metocean observation/forecasting system   A     52.1   Interpretation of earth observation data / products   A     52.1   Recognise that no standard generally exists for carth observation images and products (e.g. use of colours, symbols, projectino, scale, etc.)   K     52.2   Interpret data / products produced by an active microwave sensor   I     52.4   Interpret data / products produced by a pasive microwave sensor   I     52.6   Find the specifications of an earth observation images   U     52.8   Describe the limitations of various types of mages   U     52.9   Determine if a product is primarily based on statistics or actual measurement   A     52.10   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     52.11   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operati   | Α   | В   | С |  |  |
| 5.1.3   Explain which types of data/products (e.g. images) to use in which situation and from which provider   U     5.1.4   Determine an acceptable age of data or products in relation to a specific activity / area of operation   A     5.1.5   Define input parameters for a seal plan model   A     5.1.6   Define input parameters for a seal plan model   A     5.1.1   Recognise that no standard generally exists for carth observation images and products (e.g. use of colours, seale, etc.)   K     5.2.1   Interpret data / products produced by an active microwave sensor   I     5.2.4   Interpret data / products produced by a passive microwave sensor   I     5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   I     5.2.6   Identify various types of earth observation product   A     5.2.7   Identify various types of an arch observation of an entop operation of the asset of the a   | 5.1.2   | Define the level of detail required in images for a specific voyage   | Κ |  |  |
| 5.1.4   Determine an acceptable age of data or products in relation to a specific activity / area of operation   A     5.1.6   Define input parameters for a weather fax or other metocan observation/forecasting system   A     5.1.6   Define input parameters for a sul plan model   A     5.2   Interpretation of earth observation data / products   K     5.2.1   Recognise that no standard generally exists for arth observation images and products (e.g. use of colours, symbols, projection, scale, etc.)   K     5.2.1   Interpret data / products produced by an active microwave sensor   I     5.2.4   Interpret data / products produced by a passive microwave sensor   I     5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   I     5.2.6   Find the specifications of an earth observation images   U     5.2.8   Describe the limitations of various types of images   U     5.2.10   Determine the relevant resolutions of an image   A     5.2.112   Determine train devant resolutions of an image   A     5.2.12   Determine train an image and what they inficate   U     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of co   | 5.1.3   | Explain which types of data/products (e.g. images) to use in which situation and from which provider  | U |  |  |
| 5.1.5   Define input parameters for a weather fax or other metocean observation/forecasting system   A     5.1.6   Define input parameters for a sail plan model   A     5.2   Interpretation of earth observation data / products   K     5.2.1   Recognise that no standard generally exists for earth observation images and products (e.g. use of colours, symbols, projection, scale, etc.)   K     5.2.2   Interpret data / products produced by an optical sensor   I     5.2.4   Interpret data / products produced by an asive microwave sensor   I     5.2.4   Interpret data / products produced by an asive microwave sensor   I     5.2.6   Find the specificacions of an earth observation product   A     5.2.7   Identify various types of earth observation images   U     5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine if a product is primarily based on statistics or actual measurement   A     5.2.11   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain vectors in an image and what they indicate   U  | 5.1.4   | Determine an acceptable age of data or products in relation to a specific activity / area of operation  | А |  |  |
| 5.1.6   Define input parameters for a sail plan model   A     5.2   Interpretation of earth observation data / products   K     5.2.1   Recognise that no standard generally exists for earth observation images and products (e.g. use of colours, symbols, projection, scale, etc.)   K     5.2.1   Interpret data / products produced by an active microwave sensor   I     5.2.4   Interpret data / products produced by an active microwave sensor   I     5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   A     5.2.8   Describe the limitations of various types of images   U     5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.15   Explain the added value of (neart) real-time data in addition to historic data in using voyage planning   U     5.2.16   Recognise that an earth observation data in voyage planning   U     5.2.16   Recognise that an earth  | 5.1.5   | Define input parameters for a weather fax or other metocean observation/forecasting system  | Α |  |  |
| 5.2   Interpretation of earth observation data / products   K     5.2.1   Recognise that no stindard generally exists for earth observation images and products (e.g. use of colours, key moles, projection, scale, etc.)   K     5.2.3   Interpret data / products produced by an optical sensor   I     5.2.4   Interpret data / products produced by an active microwave sensor   I     5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   A     5.2.6   Find the specifications of an earth observation product   A     5.2.7   Identify various types of earth observation images   U     5.2.8   Describe the limitations of various types of images   U     5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine if the specificant and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.11   Determine in the appetition year measurements in an active microwave sensor   M     5.2.12   Determine in the appetition year measurements in an active microwave image   U     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain tweatresin an image and what they indicate   U <td>5.1.6</td> <td>Define input parameters for a sail plan model</td> <td>А</td>  | 5.1.6   | Define input parameters for a sail plan model   | А |  |  |
| 5.2.1   Recognise that no standard generally exists for earth observation images and products (e.g. use of colours, sole, etc.)   K     5.2.2   Interpret data / products produced by an optical sensor   I     5.2.3   Interpret data / products produced by an astive microwave sensor   I     5.2.4   Interpret data / products produced by a passive microwave sensor   I     5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   I     5.2.6   Find the specifications of an earth observation product   A     5.2.10   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine if nelevant resolutions of an image   A     5.2.11   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.12   Determine map details in an image and what they indicate   U     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.1   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.10   Describe the possible uses of carth observation data an voyage planning or voyage simulation software   U     5.3.31 <t< td=""><td>5.2</td><td>Interpretation of earth observation data / products</td><td></td></t<>   | 5.2   | Interpretation of earth observation data / products   |   |  |  |
| 5.2.2   Interpret data / products produced by an optical sensor   I     5.2.3   Interpret data / products produced by an active microwave sensor   I     5.2.4   Interpret data / products produced by a passive microwave sensor   I     5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   I     5.2.6   Find the specifications of an carth observation images   U     5.2.7   Identify various types of earth observation images   U     5.2.8   Describe the limitations of various types of images   A     5.2.10   Determine if a product is primarily based on statistics or actual measurement   A     5.2.11   Determine in a product is primarily based on statistics or actual measurement   A     5.2.12   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.12   Determine and potential product correctly   SA     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.1   Describe the possible uses of earth observation data and potential delays   U     5.3.2   Explain how earth   | 5.2.1   | Recognise that no standard generally exists for earth observation images and products (e.g. use of colours, symbols, projection, scale, etc.)               | Κ |  |  |
| 5.2.3   Interpret data / products produced by a passive microwave sensor   I     5.2.4   Interpret data / products produced by a passive microwave sensor   I     5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   I     5.2.6   Find the specifications of a mearth observation product   A     5.2.7   Identify various types of earth observation images   U     5.2.8   Describe the limitations of various types of images   U     5.2.10   Determine if a product is primarily based on statistics or actual measurement   A     5.2.11   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.12   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.14   Explain vectors in an image and what they indicate   U     5.2.15   Explain in earth observation product may consist of various sources of information, with various levels of reliability in the same image   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.4 <b>Oyage planning</b> U     5.3.5   Lexplain how carth observation cata and recent earth observation data <td>5.2.2</td> <td>Interpret data / products produced by an optical sensor</td> <td>Ι</td>   | 5.2.2   | Interpret data / products produced by an optical sensor   | Ι |  |  |
| 5.2.4   Interpret data / produced by a passive microwave sensor   I     5.2.6   Find the specifications of an earth observation product   A     5.2.7   Identify various types of earth observation images   U     5.2.9   Describe the limitations of various types of images   U     5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine if a product is primarily based on statistics or actual measurement   A     5.2.11   Determine the relevant resolutions of an image   A     5.2.12   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.15   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.2   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage si   | 5.2.3   | Interpret data / products produced by an active microwave sensor  | Ι |  |  |
| 5.2.5   Compare and interpret data / products of an area of operation created at different moments in time   I     5.2.6   Find the specifications of an earth observation images   U     5.2.7   Identify various types of earth observation images   U     5.2.9   Describe the limitations of various types of images   U     5.2.10   Determine if a product is primarily based on statistics or actual measurement   A     5.2.11   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.12   Determine ing details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.15   Explain the advalue of (neary real-time data in voyage planning   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.1   Describe the possible uses of earth observation data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.1   Describe what important information earth observation data   A     5.3.4   Explain how carth obse   | 5.2.4   | Interpret data / products produced by a passive microwave sensor  | Ι |  |  |
| 5.2.6   Find the specifications of an earth observation product   A     5.2.7   Identify various types of earth observation images   U     5.2.8   Describe the limitations of various types of images   U     5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine the relevant resolutions of an image   A     5.2.11   Determine the relevant resolutions of an entroper resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.12   Determine map details in an image such as projection, scale, symbols, colours and their meaning   S.     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.15   Explain the ameth observation product may consist of various sources of information, with various levels of reliability in the same image   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.2   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data can provide in relation to considered routes, weather rout   | 5.2.5   | Compare and interpret data / products of an area of operation created at different moments in time  | Ι |  |  |
| 5.2.7   Identify various types of earth observation images   U     5.2.8   Describe the limitations of various types of images   U     5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.11   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.12   Determine map details in an image and what they indicate   U     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   V     5.3   Vogage planning   U     5.3.1   Describe the possible uses of earth observation data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe what important information earth observation data provide in relation to considered routes, weather r   | 5.2.6   | Find the specifications of an earth observation product   | Α |  |  |
| 5.2.8   Describe the limitations of various types of images   U     5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine the relevant resolutions of an image   A     5.2.11   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.12   Determine may details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.13   Explain the arbiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   Vayage planning     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.2   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain the addes value of (near) real-time data and recent earth observation data / products   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe  | 5.2.7   | Identify various types of earth observation images  | U |  |  |
| 5.2.9   Determine if a product is primarily based on statistics or actual measurement   A     5.2.10   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.12   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.13   Geolocate the received dat/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.4   Explain how earth observation data during a voyage   K     5.4.1   Describe what important information earth observation data during a voyage   K     5.4.1   In transit   5   S  | 5.2.8   | Describe the limitations of various types of images   | U |  |  |
| 5.2.10   Determine the relevant resolutions of an image   A     5.2.11   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.12   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.1   Describe the possible uses of earth observation data in voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data in using voyage planning or voyage simulation software   U     5.3.5   Describe what important information earth observation data and protein in relation to considered routes, weather routing charts and seasonal ice outlook   A     5.3.4   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.3.4   Explain how earth observation can contribute to enhanced security at sea   U  | 5.2.9   | Determine if a product is primarily based on statistics or actual measurement   | Α |  |  |
| 5.2.11   Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed   A     5.2.12   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.15   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various kevels of reliability in the same image   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.1   Describe the possible uses of earth observation data in suing voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.4   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Descr   | 5.2.10  | Determine the relevant resolutions of an image  | Α |  |  |
| 5.2.12   Determine map details in an image such as projection, scale, symbols, colours and their meaning   A     5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.15   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   W     5.3   Voyage planning   U     5.3.1   Describe the possible uses of earth observation data in voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe what important information earth observation data can provide in relation to considered routes, weather routing charts and seasonal ice outlook   U     5.3.4   In transit   A     5.4.4   In transit   A     5.4.4   In transit   A     5.4.4   In transit   U     5.4.4   Explain how earth observation can contribute to safe navi   | 5.2.11  | Determine if the spatial, spectral and temporal resolution of a product are sufficient for the area of operation or the task to be performed                | А |  |  |
| 5.2.13   Geolocate the received data/product correctly   A     5.2.14   Explain vectors in an image and what they indicate   U     5.2.15   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   K     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.2   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Describe the possible uses of earth observation data during a voyage   K     5.4.2   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.4.3   Explain how earth observation can contribute to enhanced security at sea   U     5.4.1   Describe the possible uses of earth observation ane mergency situation   U   | 5.2.12  | Determine map details in an image such as projection, scale, symbols, colours and their meaning   | Α |  |  |
| 5.2.14   Explain vectors in an image and what they indicate   U     5.2.15   Explain the ambiguity of coastal zone measurements in an active microwave image   U     5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   K     5.3   Voyage planning   U     5.3.1   Describe the possible uses of earth observation data in voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.5   Describe what important information earth observation data can provide in relation to considered routes. weather routing charts and seasonal ice outlook   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Describe the possible uses of earth observation data during a voyage   U     5.4.3   Explain how earth observation can contribute to aften avigation (surface objects, shoals)   U     5.4.4   Explain how earth observation can contribute to  | 5.2.13  | Geolocate the received data/product correctly   | Α |  |  |
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| 5.2.16   Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image   K     5.3   Voyage planning   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.2   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe what important information earth observation data can provide in relation to considered routes, weather routing charts and seasonal ice outlook   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Describe the possible uses of earth observation data during a voyage   K     5.4.2   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.4.3   Explain how earth observation data or products can be used to reduce sailing time, fuel-consumption, emissions, hull stress and discomfort   U     5.4.4   Explain how earth observation can contribute in an emergency situation   U     5.5  | 5.2.15  | Explain the ambiguity of coastal zone measurements in an active microwave image   | U |  |  |
| 5.3   Voyage planning   U     5.3.1   Describe the possible uses of earth observation data in voyage planning   U     5.3.2   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe what important information earth observation data can provide in relation to considered routes, weather routing charts and seasonal ice outlook   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Describe the possible uses of earth observation data during a voyage   K     5.4.2   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.4.4   Explain how earth observation can contribute to enhanced security at sea   U     5.5.5   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.5.5   Explain how earth observation can contribute to enhanced security at sea   U     5.5.5   Explain how earth observation can contribute in an emergency situation   U <td>5.2.16</td> <td>Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image</td> <td>K</td>  | 5.2.16  | Recognise that an earth observation product may consist of various sources of information, with various levels of reliability in the same image             | K |  |  |
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| 5.3.2   Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software   U     5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe what important information earth observation data can provide in relation to considered routes, weather routing charts and seasonal ice outlook   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Describe the possible uses of earth observation data during a voyage   K     5.4.2   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.4.3   Explain how earth observation can contribute to enhanced security at sea   U     5.4.4   Explain how earth observation can contribute in an emergency situation   U     5.5.4   Explain how earth observation can contribute in an emergency situation   U     5.5.1   Describe environmental monitoring possibilities earth observation provides   U     5.5.2   Explain how earth observation can be used in a legal context (litigation, insurance, claims, regulations, risk analyses and investigations)   U     5.5.3   | 5.3.1   | Describe the possible uses of earth observation data in voyage planning   | U |  |  |
| 5.3.3   Assess the suitability of an intended route using earth observation data   A     5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe what important information earth observation data can provide in relation to considered routes, weather routing charts and seasonal ice outlook   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Describe the possible uses of earth observation data during a voyage   K     5.4.2   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.4.3   Explain how earth observation data or products can be used to reduce sailing time, fuel-consumption, emissions, hull stress and discomfort   U     5.4.4   Explain how earth observation can contribute in an emergency situation   U     5.5.5   Explain how earth observation data con products can be used to reduce sailing time, fuel-consumption, emissions, hull stress and discomfort   U     5.5.1   Describe environmental monitoring possibilities earth observation provides   U     5.5.3   Explain how earth observation can be used in case of contingencies (diversions, secondary ports, regulations, risk analyses and investigations)   U     5.5.4   Explain how earth observation are used to monitor real-time   | 5.3.2   | Explain the added value of (near) real-time data in addition to historic data in using voyage planning or voyage simulation software                        | U |  |  |
| 5.3.4   Explain how earth observation can assist in assessing security threats and potential delays   U     5.3.5   Describe what important information earth observation data can provide in relation to considered routes, weather routing charts and seasonal ice outlook   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4.1   Describe the possible uses of earth observation data during a voyage   K     5.4.2   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.4.3   Explain how earth observation can contribute to enhanced security at sea   U     5.4.4   Explain how earth observation can contribute in an emergency situation   U     5.5.5   Explain how earth observation can contribute in an emergency situation   U     5.5.6   Other uses   U     5.5.7   Explain how earth observation data cur products can be used to reduce sailing time, fuel-consumption, emissions, hull stress and discomfort   U     5.5.5   Explain how earth observation and used in a legal context (litigation, insurance, claims, regulations, risk analyses and investigations)   U     5.5.1   Describe environmental monitoring possibilities earth observation for the fishing industry   U     5.5.3   Explain how earth observation can b   | 5.3.3   | Assess the suitability of an intended route using earth observation data  | А |  |  |
| 5.3.5   Describe what important information earth observation data can provide in relation to considered routes, weather routing charts and seasonal ice outlook   U     5.3.6   Conduct a risk assessment, using both historic data and recent earth observation data / products   A     5.4   In transit   5.4.1     5.4.1   Describe the possible uses of earth observation data during a voyage   K     5.4.2   Explain how earth observation can contribute to safe navigation (surface objects, shoals)   U     5.4.3   Explain how earth observation data or products can be used to reduce sailing time, fuel-consumption, emissions, hull stress and discomfort   U     5.5.4   Explain how earth observation data can be used to reduce sailing time, fuel-consumption, emissions, hull stress and discomfort   U     5.5.5   Explain how earth observation data can be used in a mergency situation   U     5.5.1   Describe environmental monitoring possibilities earth observation provides   U     5.5.2   Explain how earth observation can be used in a legal context (litigation, insurance, claims, regulations, risk analyses and investigations)   U     5.5.3   Explain how earth observation are used to monitor real-time tidal conditions and bathymetry to facilitate port entry of large vessels with critical draught   U     5.5.4   Explain how earth observing water temperatures through earth observation   | 5.3.4   | Explain how earth observation can assist in assessing security threats and potential delays   | U |  |  |
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| 5.5.3Explain how earth observation can be used in case of contingencies (diversions, secondary ports,<br>recalculating arrival times)U5.5.4Explain how earth observation are used to monitor real-time tidal conditions and bathymetry to facilitate<br>port entry of large vessels with critical draughtU5.5.5Explain the value of observing water temperatures through earth observation for the fishing industry<br>5.6.1U5.6.1Use earth observation data and products to make decisionsA5.6.2Combine the use of an earth observation product with other available sources in decision-makingA  | 5.5.2   | Explain how earth observation data can be used in a legal context (litigation, insurance, claims, regulations, risk analyses and investigations)            | U |  |  |
| 5.5.4Explain how earth observation are used to monitor real-time tidal conditions and bathymetry to facilitate<br>port entry of large vessels with critical draughtU5.5.5Explain the value of observing water temperatures through earth observation for the fishing industryU5.6Decision-making5.6.15.6.1Use earth observation data and products to make decisionsA5.6.2Combine the use of an earth observation product with other available sources in decision-makingA  | 5.5.3   | Explain how earth observation can be used in case of contingencies (diversions, secondary ports, recalculating arrival times)                               | U |  |  |
| 5.5.5Explain the value of observing water temperatures through earth observation for the fishing industryU5.6Decision-making5.6.1Use earth observation data and products to make decisionsA5.6.2Combine the use of an earth observation product with other available sources in decision-makingA   | 5.5.4   | Explain how earth observation are used to monitor real-time tidal conditions and bathymetry to facilitate port entry of large vessels with critical draught | U |  |  |
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| 5.6.2 Combine the use of an earth observation product with other available sources in decision-making A  | 5.6.1   | Use earth observation data and products to make decisions   | А |  |  |
|  | 5.6.2   | Combine the use of an earth observation product with other available sources in decision-making   | Α |  |  |

Sec.4 Table of competencies - Page 11

| Table 4  | Table 4-1 Table of Competencies (Continued)   |   |  |  |
|----------|---|---|--|--|
| Column A | Column A shows the ID for the competence Column B is the competence to be demonstrated Column C defines the cognitive |   |  |  |
| Α        | В   | С |  |  |
| 5.6.3    | Demonstrate maritime situational awareness when using earth observation data/products in decision-making              | Α |  |  |
| 5.7      | Communication   |   |  |  |
| 5.7.1    | Describe any links between obtained earth observation data and technical components on board                          | U |  |  |
| 5.7.2    | Recognise the dependency on having communication links in order to receive data/products                              | Κ |  |  |
| 5.7.3    | Recognise occurring problems related to dataflow and refreshing of data/products                                      | K |  |  |
| 5.7.4    | Explain the problem of maintaining communication links in polar regions   | U |  |  |