STANDARD FOR CERTIFICATION

No. 3.327

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

APRIL 2013

DET NORSKE VERITAS AS

FOREWORD

DNV is a global provider of knowledge for managing risk. Today, safe and responsible business conduct is both a license to operate and a competitive advantage. Our core competence is to identify, assess, and advise on risk management. From our leading position in certification, classification, verification, and training, we develop and apply standards and best practices. This helps our customers safely and responsibly improve their business performance. DNV is an independent organisation with dedicated risk professionals in more than 100 countries, with the purpose of safeguarding life, property and the environment.

Standards for Certification

Standards for Certification (previously Certification Notes) are publications that contain principles, acceptance criteria and practical information related to the Society's consideration of objects, personnel, organisations, services and operations. Standards for Certification also apply as the basis for the issue of certificates and/or declarations that may not necessarily be related to classification.

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.

CONTENTS

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

A	B	C
1.0	**General**	
1.1	**Earth Observation**	
1.1.1	Define 'Earth Observation'	K
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

Table 4-1 Table of Competencies (Continued)

Column A shows the ID for the competence Column B is the competence to be demonstrated Column C defines the cognitive level

A	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 aggregated interpreted 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	**Availability of data and services**	
3.2.1	Find the relevant providers of earth observation data and products for a particular area of operation	K
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)	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 ocean 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 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**	
4.1	**Resolution**	
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 temporal 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	U
4.2	**Interpolation and extrapolation of data**	
4.2.1	Explain the need for interpolation and extrapolation of data to create earth observation products, covering uncovered areas or lapses of time	U
4.2.2	Compare the reliability of data obtained through interpolation or extrapolation to information obtained through real-time measurement	I
4.2.3	Estimate how much of the earth observation product consists of inter- or extrapolated data and how much of it is based on actual measurement (near-real-time)	A
4.3	**Quality Indicators**	
4.3.1	Determine how a specific earth observation product was created and what this tells about the quality of the product	A
4.3.2	Monitor the quality of received earth observation data or products	A
4.3.3	Determine if an earth observation product is experimental or established	A
4.3.4	Interpret quality parameters of data or information on error margins	I
4.4	**Reliability of earth observation data**	
4.4.1	Explain why satellite-observations are not necessarily real-time observations	U
4.4.2	Recognise that data received from earth observation sources is not necessarily accurate	K
4.4.3	State factors which influence the reliability of earth observation data	K
4.4.4	Explain the relationship between frequency updates and the reliability of earth observation data	U
4.5	**Validation of received information**	
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**	
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

Table 4-1 Table of Competencies (Continued)

Column A shows the ID for the competence Column B is the competence to be demonstrated Column C defines the cognitive level

A	B	C
5.1.2	Define the level of detail required in images for a specific voyage	K
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 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**	
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
5.2.3	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 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 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 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**	
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	**In transit**	
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 data or products can be used to reduce sailing time, fuel-consumption, emissions, hull stress and discomfort	U
5.5.5	Explain how earth observation can contribute in an emergency situation	U
5.5	**Other uses**	
5.5.1	Describe environmental monitoring possibilities earth observation provides	U
5.5.2	Explain how earth observation data can be used in a legal context (litigation, insurance, claims, regulations, risk analyses and investigations)	U
5.5.3	Explain how earth observation can be used in case of contingencies (diversions, secondary ports, recalculating arrival times)	U
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
5.5.5	Explain the value of observing water temperatures through earth observation for the fishing industry	U
5.6	**Decision-making**	
5.6.1	Use earth observation data and products to make decisions	A
5.6.2	Combine the use of an earth observation product with other available sources in decision-making	A

Table 4-1 Table of Competencies (Continued)

Column A shows the ID for the competence Column B is the competence to be demonstrated Column C defines the cognitive level

A	B	C
5.6.3	Demonstrate maritime situational awareness when using earth observation data/products in decision-making	A
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	K
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