



## ECDIS Type Approval According to International Standards

Dr Mathias Jonas

Type approval of ECDIS systems is one of the important prerequisites for introduction of real ECDIS navigation into practice. The approval process is performed according to different international standards. Most areas of functionality are well covered by appropriate tests and procedures. Beside that, some deficiencies of standardisation are leading to the need of flexible interpretation of the requirements. The added 'meta' chart data and data encryption are some of these open questions. In addition, legal matters like mutual recognition of approval certification and the further carriage of paper charts backing ECDIS are still not commonly agreed between national administrations.

### Fundamentals of Type Approval

Functional tests leading to an official approval of a new type of navigational equipment is a traditional mechanism of contribution to ships safety and protection of environment for many nations. International standards as the base of these tests are the fundamental prerequisite of global acceptance of this certification process in one of the most globalised industries - shipbuilding and ships operation.

The Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency) has, among other tasks, a long history as a type-approval organisation. The BSH is the so called 'Notified Body' of the Federal Republic of Germany for navigation and radio-communication equipment according to the Council Directive 96/98/EC of European Commission on Marine Equipment (MED). The MED covers the harmonised regulations of European Union for Navigation Equipment, Radio communication Equipment, Life-saving appliances and others. At the same time BSH serves as a accredited test laboratory according to DIN 45001 for type approval according to IEC, ISO, ETSI and other international test standards for the whole range of navigation equipment running a certified ISO 9001 quality assurance system. For ECDIS tests, BSH has another special condition: it also comprises the Hydrographic Office of Germany - one of the producers of official ECDIS chart data.

The applicable international standards for ECDIS there formed during the 1990's - initiated by IHO (International Hydrographers Organisation) and IMO (International Maritime Organisation). The basic idea of ECDIS - the use of vectorised chart data information was standardised by IHO in their Special Publications S-57 for the data distribution format and S-52 for Data presentation. The IMO has defined functional requirements based on vector data in its ECDIS Performance Standard (Resolution A.817(19)). The operational and performance requirements for an

ECDIS which are included in the named IHO and IMO publications are both dealt within one international agreed test standard: IEC 61174 of International Electrotechnical Commission. Because of its nature as a test standard, IEC 61174 describes test procedures for each of the requirements included. Currently the standard is added by a new chapter dealing with requirements and tests of raster charts which may optionally be incorporated into the ECDIS - the so called 'dual fuel' machines. Other parts of the test standard like backup requirements are currently under revision.

The BSH type approval process for ECDIS is strictly based on the IEC 61174 standard. The standard references normatively to two additional IEC test standards:

- IEC 61162 - Digital Interface for navigational data
- IEC 60945 - Environmental Conditions

Both standards are also a matter of the certification process conducted at BSH.

How is the test process performed in detail? Any person resident within European Union is allowed to submit an application for type approval to a Notified Body, e.g. to BSH. The applicant does not have to be a manufacturer; it is sufficient if he acts in the name of one. The applicant has to confirm by a recognisable certificate that he operates an approved quality assurance system for production process, final product inspection and testing of its devices. The submission of application is usually accompanied by preceding meetings between the applicant and BSH. After delivery and installation of the 'Equipment under Test' in the simulation environment of BSH laboratories, the test suite can start.

Some principles have to be considered as the base for all tests in order to grant type approval:

- **One-system approach**

No separation between software and hardware - a system, to be tested, comprises both and is tested in common.

- **Vector chart functionality**

- Based on IEC 61174, documents with 210 sections, comprising each test of the test section, accompanied by additional information about the use and interpretation of test data set are used to perform the tests
- For data processing like data installation, update and display, the IHO test chart data set, and in parallel, actual BSH chart data are used
- In addition to that, the revision of each item of electronic chart 1 and comparison of the printed version of S-52 with the display and the use for the visualisation of the real data is done

- **Raster chart functionality**

- Test by adaptation of the ENC tests to RNC comprising another 73 sections in the similar shape as for ENCs (until September 2000)
- In future, the test sections drafted by the IEC TC80/MT1/ECDIS Maintenance Team will be used

- **Interface**

- The tests of system reaction for each interface telegram and each analogue input/output (if applicable) are dealing with the following matters:
  - correct syntax and correct processing
  - system behaviour in case of
    - no information at input
    - broken cable
  - Revision of alarm management based on these failures for its logic

- **Back up**

Back up requirements are described in a separate Annex G of IEC 61174 on a functional level. The practical approach to this is the test of the capability of a double installation to interchange and manage common route plans and the ability of the back up to survive with separate sensor input in case either one fails

- **Robustness of system**

- Test of conformance to the IEC 60945 requirements/test section comprises:
  - heat
  - cold
  - humidity

- vibration
- ergonomics
- electromagnetic influence to other devices and resistance against it
- BSH does not perform these tests itself. Instead, recognisable tests have to be done by an accredited test house that delivers appropriate test reports

- **Test results**

EACH of the items above will be noted in resulting test report. A system does not pass unless ALL items are stated as sufficiently operating.

- **ECDIS-compliant monitor**

- Separate tests of colour calibration abilities are performed for each monitor used with ECDIS. If passed, a separate test report is issued
- Today the main objection against flat panels is that they were found unable to dim the screen significantly for use at night. On the other hand the use of flat panels on board would have significant advantages, not only because of their bright clear picture but also because the weight of the units and the less space they need - an important factor for smaller vessels and high speed crafts. The noted IEC ECDIS Maintenance Team currently refines the test procedures according to changes of IHO C&MWG requirements for ECDIS colours and the process of the monitor calibration and verification. With this refinement, the dynamic range for the luminance might be in the luminance range offered by modern flat panel technology. *In order to cover the whole range of required ECDIS colours from bright day to night by a flat panel, a remote adaptation of brightness and contrast settings dependent from the selected colour scheme is needed. The industry currently investigates if there are solutions for all of the noted problems and the door to the use of flat panels for ECDIS can be opened in the next future*

- **Additional functionality's**

Only for the mandatory functions included in the ECDIS standard appropriate tests are defined. Only these functions can be required by the test house. But all systems already tested provide a number of additional features beyond this core functionality. This raises the question if and how these features should be tested. The above noted IEC 60945 does not only include requirements on physical properties, it also states the consideration of additional features beyond the core functionality required by the appropriate special standard (in this case IEC 61174 for ECDIS):

Paragraph 4.1 'General' of IEC 60945:

"Where an equipment provides a facility which is additional to the minimum requirements of both this standard and the relevant equipment standard, the operation and, as far as is reasonably practicable, the malfunction of such additional facility shall not degrade the performance of the requirement."

This 'rubber band paragraph' entitles the test house to investigate whether an additional function affects the core functionality and, in case, how the function can be tested. Keeping in mind that the composition of an ECDIS is a regular computer running special software, it would be hard to state that there are software modules which don't have any effects to other software modules. For the test of additional functions, BSH by agreement with the applicant therefore goes two ways:

- a) Brief test of proper function according to description in users handbook /technical documentation, observing if there are irregular interaction with core functions
- or
- b) Systematic tests described in a specific test scenario

The following examples may enlighten both ways:

### **Provision of Advanced S-57 Data Capabilities Like Pictures and Temporary Objects**

The S-57 product specification includes the possibility to attach picture files in tiff-format to chart objects and to create temporary existing objects carrying attributes about its start and expiry of their existence.

Unfortunately, their handling by user functions is not defined by the current ECDIS standardisation:

- Pictures

ECDIS has five colour schemes, which can be performed in minimum by an 8 bit graphics card providing 256 colours at least. These 256 colours are practically completely occupied by the ECDIS colour schemes. Tiff-files do not use the colours of the ECDIS colour schemes. Because ECDIS needs most of the colours of the 8-bit graphics card, tiff-files cannot be displayed with their right colours at the same time as the chart display is running (especially at night). The second problem is the version/issue control. The tiff-files do not carry any standardised time stamp needed to update them by replacement. It could be possibly handled alternatively via the object attribute but in this case, a name convention for the associated picture file is missing

- Temporary objects

Most systems are displaying temporary objects continuously and will be therefore alarm them permanently (also in case of invalidity). Only the pick report displays the start date and the end date of objects validity. The situation is not safe in any case and therefore unsatisfactory. The main problem here is the lack of requirements how to handle these objects on functional level. On the list of unsolved questions are among others:

- Route checking

Currently requirements for route checking is not based on a distinct date of departure nor arrival. In case of temporary objects, the checker might have to consider this during the planning phase or before starting a route. If the route checker finds a temporary object, should this explicitly noted in the check report? Planned speed for a route is a plan – what happens if the planned passage of an area with temporary restrictions is in timely vicinity of the start of this restriction but not within or just outside?

- Route monitoring

Being within a restricted area during its first appearance is the wrong moment of recognition – there has to be a new function, a timely look ahead somehow similar to the look ahead for antigrounding. Antigrounding is orientated on the actual course for 6 to 12 minutes ahead but what could be the orientation for temporary objects detection? May be the actual route for at least the next 24 hours?

- Visualisation

May be the above problems can be supported by an appropriate visualisation – like highlight the object transparently gaining attention before getting valid or other more appropriate solutions

Because of the deficiencies of current definition/standardisation of both features, the noted functionality cannot be tested systematically. Each manufacturer is free to implement the noted feature, as he likes. In case he does, BSH only tests if the features are working as envisioned by the manufacturer and whether we do not affect the standardised core functionality.

## **Processing of Encrypted Data**

Data encryption is a prominent example for crucial additional functionality beyond the minimum requirements. After a transition period, since July 1999 the European ENC Coordinating Centre of northern and western Europe in Stavanger, Norway distributes chart data of its ten data delivering Hydrographic Services under the brand 'PRIMAR' only as encrypted data. The reasons for encryption technology are for short:

- Authentication (data integrity, uniformity and quality)
- Selective access (commercial aspect)
- Protection against data piracy (unauthorised data modification)
- Data compression

The encryption method and, following to this, also the decryption method is not internationally standardised by the international bodies of IHO. On the other hand it is obvious that the implemented PRIMAR data decryption functions of an ECDIS affect the core data processing functionality and has to be tested in more detail. Therefore, BSH together with ASPO Systems (now NAVINTRA) and PRIMAR has developed a test suite for systematic tests of proper ECDIS decryption functionality of PRIMAR data. The chart data

used for are issued by the British Admiralty and encrypted by PRIMAR for test purposes. Identical cells and updates - encrypted and unencrypted, are used for tests mainly focused on:

- Type of CD (Base or update CD)
- Issue of CD
- Load CDs in acceptable sequence
- Coverage control
- Permit control
- Edition control
- Authentication control
- Public key control
- content control

Two of our applicants have already passed this test suite successfully. The PRIMAR data processing capability is noted in the certificates as additional feature; the test report contains the test results for this function in detail.

#### **- Adaptation of BSH certificates to software changes and hardware modifications**

The approved system configuration with main components and software version is detailed in certificate. Due to the Maritime Equipment Directive (MED), the manufacturer has the responsibility to inform the test house about any changes that could potentially affect the tested capabilities of the formerly approved system. In practice, there is a distinction between 'software-bug fixing' and reasonable functional upgrade. For 'bug fixing' and accompanying minor changes the last open digit of the noted software version can be counted higher by the manufacturer without detailed information forwarded to BSH. In case of more relevant changes, it is mandatory to inform BSH in detail. Both the BSH and the holder of certificate then investigate together which parts of core functionality are potentially affected by the intended modifications and which tests have to be possibly repeated.

Changes of major hardware components like central processing units or monitors today are mainly shipped with appropriate IEC 60945 certificates. After successful passing of brief overall function tests, BSH ECDIS-certificate will be adapted to the new components and then reissued.

#### **- Legal status of ECDIS type approval certificates granted by BSH**

By adoption of MED, The Federal Republic of Germany has already adopted the ECDIS standard IEC 61174 under national law. However, ECDIS, together with its applicable international standards, is only noted in Annex A2 of MED, which is currently not mandatory for the member states of the European Union. Therefore, the BSH certificates currently only have national validity. Maritime administrations of other nations are today not obliged but free to recognise BSH ECDIS approval certificates. This will change after the next upgrade of the Annexes A1, the mandatory part of the Maritime Equipment directive where all of the so-called 'Wheelmark devices' are included. The upgrade will probably be before the end of this year. If the new Annex A1 is reissued, BSH will reissue all the ECDIS-certificates of national validity as 'Wheelmark certificates', valid for the whole European Union without any change of their content.

#### **- Carriage of approved ECDIS = abstention from paper chart?**

According to IMO Resolution A.817(19), a compliant ECDIS system with backup, used together with official S-57 ENC data is a legal substitution of paper charts. The ECDIS certificates granted by BSH are stating this compliance. However, other administrations like port state control of other countries are possibly not aware of the fact that an electronic device may fulfil carriage requirements for navigational charts. Therefore, the German maritime administration bodies are seriously engaged to gain international attention for BSH approval activities. The actual problem of substitution in practice is the lack of official S-57 ENC data. In order to get full coverage for the operational area; the portfolio is mainly filled up with raster charts. Very often, the benefits of this 'dual fuel'-operation are in question, because the status of raster charts as paper chart substitution is not clear. It is true, that today the legal status of raster charts with respect to the carriage requirements of paper charts is not fully agreed between the nations. The question affects duties of national administration as the flag state and as port state. Consequently, Germany

has made a proposal here containing recommendations for an adequate portfolio of paper charts to be carried on board in parallel to chart data of the same sea area:

"The master and the officers of the navigational watch should use appropriate paper charts if the system needs to be operated in the RCDS mode because of a lack of sufficient ENC-coverage. The paper charts selected for this purpose, should be at least sufficient to:

- 1 appraise the intended route or track of the voyage or passage in medium-scale charts 1:750,000 to 1: 1,500,000<sup>1</sup>
- 2 keep the execution of the voyage in accordance with the voyage plan or any changes made thereto at the open sea in medium-scale charts 1:150,000 to 1:500'000; and
- 3 monitor the track in the approaches to harbours or in congested narrow coastal waters in medium scale charts larger than 1:150,000.

It is up to the discretion of the master to carry additional paper charts in larger scales as the above noted if this is in his opinion necessary to ensure the safety and efficiency of navigation and the protection of the marine environment."

The carriage requirement of paper charts in RCDS covered areas only between small and medium scales from 1:750,000 to 1:150,000 will definitely save a considerable amount of large scale paper charts to be carried in parallel to the electronic raster charts. The German maritime administration is currently looking for international acceptance of this approach. Positive signals have been received from Scandinavia and Great Britain. A commonly agreed handling between all European flag states is envisioned in the first step.

## **References**

<sup>1</sup> Section 100 Part 1 IHO Chart Specifications of the IHO medium and large scale charts

This paper was presented at DGON – Symposium, ISIS 2000, at Wilhelmshaven, Germany 11 – 13 September.

## **Biography**

Dr Mathias Jonas, is presently responsible for the performance of legal type approval of Electronic Chart Systems, Integrated Navigation Systems, Voyage Data Recorder, Satellite Navigation receiver at Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographical Agency). After passing examination for nautical officers at the Maritime Academy of Rostock-Warnemünde in 1986. Employed as scientific assistant at the Maritime Academy from 1987 to 1991. Promoted about theoretical problems of manoeuvre prediction for ships at the University of Rostock in 1992. Involved in the SHOPSY project at ISSUS, Hamburg from 1991 to 1993. Since 1994 employed at BSH, Hamburg.