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**Maritime Information Systems**

**Electronic Chart Display and Information System ECDIS**

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*Abstract*

The Electronic Chart Display and Information System (ECDIS) is a development in the navigational chart system used in naval vessels and ships. With the use of the electronic chart system, it has become easier for a ship’s navigating crew to pinpoint locations and attain directions.

Electronic Chart Display and Information System (ECDIS) means a navigation information system which, with adequate back up arrangements, can be accepted as complying with the up-to-date chart required by regulation V/19 & V/27 of the 1974 SOLAS Convention, by displaying selected information from navigation sensors to assist the mariner in route planning and route monitoring, and by displaying additional navigation-related information if required.

The present work is part of the course "Maritime Information Systems" of the Postgraduate Program of the University of Thessaly. It will be done a Summary report on ECDIS, how it works, how to use ENC electronic maps, design and execution of ship route and a reference will also be made to the WECDIS system that is used in military shipping companies.

After the introduction, follows a brief historical review of ECDIS. Chapter 3 includes the basic features and the technical specifications of the ECDIS. The Chapter 4 explains the System Electronic Navigational Charts also SENC. Subsequently the next chapter explain us how to design and execution a ship route. Finally the Chapter 6 presents the Warship Electronic Chart Display and Information System also WECDIS and their operational opportunities.

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# 1. Introduction

The present work is part of the course "Maritime Informatics" of the Postgraduate Program of the University of Thessaly. It will be done a Summary report on ECDIS, how it works, how to use ENC electronic maps, design and execution of ship route and a reference will also be made to the WECDIS system that is used in military shipping companies.



An Electronic Chart Display and Information System (ECDIS) is a computer-based navigation system that complies with IMO regulations and can be used as an alternative to paper navigation charts. Integrating a variety of real-time information, it is an automated decision aid capable of continuously determining a vessel’s position in relation to land, charted objects, navigation aids and unseen hazards.

Electronic Chart Display and Information System (ECDIS) means a navigation information system which, with adequate back up arrangements, can be accepted as complying with the up-to-date chart required by regulation V/19 & V/27 of the 1974 SOLAS Convention, by displaying selected information from navigation sensors to assist the mariner in route planning and route monitoring, and by displaying additional navigation-related information if required.

An ECDIS system displays the information from Electronic Navigational Charts (ENC) or Digital Nautical Charts (DNC) and integrates position information from position, heading and speed through water reference systems and optionally other navigational sensors. Other sensors which could interface with an ECDIS are radar, Navtex, Automatic Identification Systems (AIS), and depth sounders.

# 2. Chronology

The first Information systems appeared in the Second World War, while information systems applications in business began in the early 1950s. Since the early 1980s, the first Electronic Chart System (ECS) has been launched. These systems were able to simultaneously the map of the ship's area and the geographical coordinates of the ship's position on a computer screen.

In 1986 the International Maritime Organization (IMO) and IHO (International Hydrographic Organization) agreed to set up a working group to develop an electronic chart system containing cartographic and geographic data and other information. This system was called ECDIS (Electronic Chart Display Information System). In 1989 the Canadian hydrographic service presented the first electronic map on a Norwegian ship, who had a test trip, and in 1992 the ECDIS navigation information library was presented at the Hamburg Naval Academy.

In 1995, IMO and IHO at the 19th Assembly adopted Decision A.817 to amend Chapter 5 of SOLAS Regulation 20 of 1974. This Decision lists the standards with which an ECDIS electronic chart system should agree in order to be recognized as an official maritime aid and an equivalent of nautical maps.

In September 1997, the International Electro technical Committee (IEC) completed the final wording of international standards, which is the basis for the method of approval or certification of an IMO-compliant ECDIS valid from 30 March 1998 (Draft IEC 61174).

Later, in December 1998, the Maritime Safety Committee Committee-MSC adopted amendments to the implementation of the ECDIS standards to include the RCDS (i.e. allowed ECDIS to use electronic mosaic maps from hydrological offices where no vector mapping is available).

Mandatory installation of ECDIS in specific types and sizes ships start in July 2012 and are expected to be completed in all existing new ships by 2018 according to the following figure.



# 3. Characteristics of electronic chart systems

# 3.1 Basic ECDIS technical and functional specifications

According to the IMO's decisions, the ECDIS system, in order to be legally and functionally equivalent, must meet the following stringent technical and operational specifications of various international organizations and committees, such as:

1. The Electronic Navigation Charts (ENC) must have been constructed in accordance with S-57 specifications of the International Hydrographic Organization (IHO) and have been certified by an official Hydrographic Service.
2. The graphical display on the ECDIS screen is in accordance with the specifications (S-52 standard) of the International Hydrographic Organization (IHO).
3. To meet the minimum requirements of the ECDIS functional specifications in accordance with the relevant IMO decisions.
4. Certification of suitability for shipboard installation according to control procedures (IEC 61174) of the International Electro-technical Commission (IEC).

# 3.2 System and screen technical features

The basic ECDIS system consists of:

• Marinized PC.

• Display.

• Floppy Drive.

• CD-ROM drives (chart readers & corrections).

• Operating system.

• Serial and digital interface (Ethernet) for optional station Nav Planning Station.

According to International Maritime Organization (IOH) and International standards Hydrographic Organization (IMO), the ECDIS system screen must have the following techniques features and capabilities:

-Display shipping information for route planning and tracking of the journey.

-The ability to cover power interruptions of 45 minutes.

-The system screen must be color-coded at least 64 characters colors.

-The size of the map displayed on the screen should not be less than 270 mm x 270 mm.

-The design of a map on the screen should be within 5 seconds.

-Adjust the color and illumination of the screen with its help software rather than using switches or keypads on the device.

-The display of map data on the system screen during the day and the night must be in accordance with the specifications of the International Hydrographic Organization colors to ensure the best possible case performance and clarity and be clear and visible to more than one observer day and night.



# 3.3 System Electronic Navigation Charts Database (SENC)

In order for the ECDIS system to work and provide the foreseen capabilities, it should have map and shipping data for the sailing area. The above data are contained in the System Electronic Navigational Chart (SENC) and other ancillary data collected by different systems such as electronic positioning systems, sonar, etc. The SENC is a navigational information display system, derived from an appropriate transformation and integration of electronic shipping maps into ECDIS. In the system the bridge officer may, if necessary, add manually and more data.

The SENC Electronic Charts Database includes:

-Electronic Shipping Maps

-Electronic Shipping Maps Updates.

-Ancillary information that the operator can record both in its phase preparation and design, and during the trip.

The input of the information can be:

a) Automatically, registering corrections coming through Inmarsat satellites to the system via NAVTEX or EGC for announcements, or CDs or mail.

b) By hand, by the officers of the bridge.

Cartographic and shipping information of the ECDIS database must cover the design and execution needs of the seafarer. According to the specifications of the International Hydrographic Organization this information is:

- Elements of nautical charts: coastline, lights, shipwrecks.

- Prohibited areas for navigation, shooting areas, submarine drilling areas, etc.

- Supplementary information for pilots, pilots and other maritime publications.

- Notes entered by the seafarer

- Planned route / voyage.

- Relative and true sightings, distance circles, paths and velocities ship.

- Position and accuracy of the ship using a backup system positioning.

- Information from the radar image.

- Control elements of the ship (propellers, etc.).

- Reminders, e.g. the time of the pilot's request to enter the port,

- Complementary to maritime traffic.

- Indications of various ship systems and devices (sonar, engine room, etc.)

# 3.4 ECDIS interface with other navigation systems

ECDIS can be linked to other systems such as: compass, autopilot, roller, sounder, INMARSAT terminal, automatic system location / identity indication, LORAN-C positioning system, GPS, DGPS, GNSS, GLONASS, RADAR, ARPA, wind vane, water surface, current information, ice information, NAVTEX, EGC, etc.

According to IMO standards, an ECDIS system must be connected to the positioning system of a ship, a cycle-compass and a speed and distance measuring device. For ships that do not have a cycle-compass, the ECDIS must be connected to a marine signal transmitter.

ECDIS can be either stand-alone or embedded in a console.



*Picture: Stand-Alone ECDIS*

Additional navigation systems built into ECDIS are also the following without but only mandatory:

• AIS (automatic identification system)

• RADAR (Radar image overlay RIO)

• VDR (voyage data recorder)

• Echo sounder

• NAVTEX

• Meteorological instruments such as anemometers (measuring wind speed)

# 3.5 Display cartographic and shipping data on ECDIS

Most ECDIS packages offer the same functions and options. After activating the ECDIS system and displaying the status display "Normal imaging" the user has the ability to add or remove information from the screen.

A large part of the ECDIS screen is covered with the map image, while the minimum information from other sources should always appear as text, usually in one special window and "real time" graphically on the map itself. The sides around it screens are usually used to show or hide their bars tools and the menu. An alert indicator should be given by the system in case risk during navigation, which must be audiovisual. Although it is not mandatory, many ECDIS programs are capable of displaying information from the radar, ARPA and AIS.

According to the IMO specifications in ECDIS systems the user must have the ability to depict the elements of electronic nautical charts in the following ways:

Basic Display

The basic display includes the following information:

- Coastline.

- Isolated security (selected by the user among the isobases contained on the ECDIS electronic nautical maps).

- Indications of individual underwater hazards with depths less than isobaths security levels within the safety margin.

- Indications of individual superficial risks and other information to be provided to be taken into account when designing and monitoring the trip and are within safety barriers such as: bridges, overhead cables, light bulbs, etc.

- Maritime traffic systems.

- Scale and distance displays, such as a linear range of distances.

Standard display / default display.

The standard/default display includes all the status information from "basic display“ and in addition the following markings and indications:

- Maritime markings of lamps, wrecks, indicator lights alignment points, etc.

- Channel boundaries, floating diodes,

- Ferry routes.

- Clear areas and radar coverage areas.

- Prohibited areas and areas subject to restrictions (firing fields, submarine training areas, etc.).

- Map scale change limits.

- Indicators of measuring units of depths and altitudes.

Other information.

The information in this category must include at least the following:

- Individual depths.

- Description of individual risks.

- Description of shipping markings.

- Warning notes recorded by the user.

- Date of electronic nautical map.

- Geodetic reference system.

- Magnetic divergence.

The cartographic symbols displayed on the ECDIS screen are not contained in the digital files of ENCs. These are display in screen by selecting from a set of standard cartographic symbols (Presentation Library) of the ECDIS shipping software.

The graphical representation of the objects that make up the ENC (lights, shipwrecks, underwater cables, ducts, boundaries of restricted areas, etc.) is done with the help of application software with which:

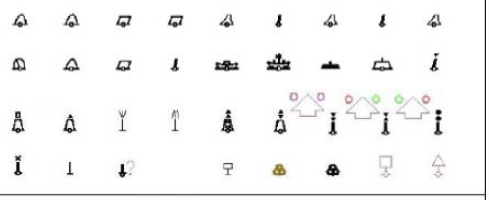
- Select the data (ENCs) to be displayed on the screen.

- The spatial and descriptive objects are analyzed and combined.

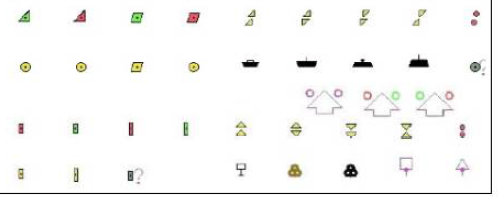
According to the values ​​of their descriptive attributes, their objects ENC are represented with the corresponding symbol library cartographic symbols.

The symbol library contains two different symbol categories, which are as follows:

- Traditionally symbols which are similar to the symbols of printed seafarers Maps. (picture a)



- Simplified symbols with simple geometric shapes (picture b)



The ECDIS operator has a wide choice of settings, so that he essentially creates himself the form of the electronic map depicted on the screen. The main options are:

■ Illustration of traditional or simplified symbols.

■ Illustration or hide of lamp features and sectors.

■ Adjust the color of the screen to the ambient lighting conditions (day with intense lighting, night, twilight).

■ Representation of cartographic information in three levels of detail (basic information, routine information, other information).

■ Illustration of dangerous shallow areas between coastline and isobaths safety selected by the user according to the ship's draft.

# 3.6 Backup ECDIS security system

In addition to the technical and functional specifications of the ECDIS system, the specifications of the IMO provide for backup security procedures to ensure safe navigation in the event of failure or malfunction of the basic system. A complete system ECDIS includes, in addition to the main ECDIS, a backup system to which it must preventive transfer of the components of the normal ECDIS system to the backup security system.

The backup ECDIS security system according to the IMO specifications is not necessary to cover all IMO requirements for ECDIS and hence the stand-by system can be installed on a shared PC. However, the ECDIS backup system must provides some basic features, such as:

1. Use of the latest version of electronic maps issued by Hydrographic Services and the specifications of the IHO.

2. Upgrade the above electronic maps with the available fixes for the whole of it area of ​​voyage.

3. Illustration and modification, if necessary, of the planned route being carried from the regular ECDIS system.

4. Automatic or manual positioning.

5. Shows the actual voyage of the ship with time indications for different positions (spots).

6. Measuring paths, distances and sightings on the electronic map.

7. Enter a significant number of points, lines and surfaces.

8. Provide indication when the electronic map is displayed on a larger scale than the scale of construction.

9. Provide an indication when an electronic chart of scale greater than that is available shown on the screen.

10. Recording the actual route of the positions (ship's points and capability appearance of these elements.

Because these capabilities of ECDIS backup systems are very general, various interpretations, according to which the backup security system ECDIS can take the following forms:

1. A second autonomous complete ECDIS system interconnected with the electronic system positioning (GPS, DGPS, etc.).

2. Another ECS electronic map system interconnected with the electronic positioning system (GPS, DGPS etc).

3. Nautical Radar with the ability to attach the image of the electronic map.

4. Positioning satellite receiver (GPS, GNSS, DGPS etc) with capability Electronic map display.

5. A complete portfolio of nautical maps, in which design is carried out, and Sailing in accordance with traditional methods.

# 4. Electronic Navigational Charts - ENC

# 4.1 Basic ENC technical and functional specifications

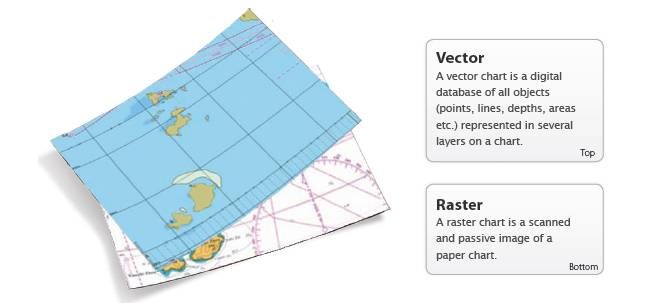
In accordance with the operational requirements of the IMO ECDIS systems must use special online maps vector, who called Electronic Navigational's Charts - ENC. The detailed definition of electronic Maritime Map given to functional specifications of the ECDIS systems of the International Maritime Organization (*IMO. 2006. "Acc.* Performance Standards for Electronic Chart Display and Information Systems (ECDIS"). *IMO Resolution MSC.232 (82) adopted on 5 Dec 2006)* and is as follows:

*"The Electronic Navigational Charts (ENC), is* standardized *as to the content, structure and the type of content, structure, format database made by the state hydrographic services, to be used with the ECDIS system. The ENC contains all the necessary for safe navigation cartographic information and may contain additional to the paper map information (e.g. Shipping Instructions - pilots), which can be considered necessary for the safety of shipping".*

The ENCs are a sophisticated database of geographical, shipping and other information, which consists of several individual elements, called objects (objects) and used to describe the position of the geometry and the properties of various natural entities represented on the maps, such as lighthouses, underwater pipelines, etc.

The items constituting a ENC does not contain graphics Maps and hydrographic symbols (e.g. symbol shipwreck, buoy marking etc.), but consist of tabulated information on:

* The position (coordinates (F, L) in geodetic reference system WGS-84) and the geometry (points, lines etc.) The various objects. Articles which contain tabulated information in this category are called "territorial objects" ("spatial objects").
* The description of the characteristics of objects with some descriptive characteristics or parameters (attributes), to determine the nature of any object and properties of such as a spot object is described as a sinking or lamp with specific characteristics (color, period, range etc.). Articles which contain tabulated information in this category are called "Descriptive objects" ("feature objects").

The Maps and hydrographic data of electronic navigational charts are divided into two main structures: Raster format and vector-based structure (vector format):

In the Raster format the electronic map as a whole, which is divided into smaller elementary parts, called mosaic tiles or (pixels). Each pixel is determined by the coordinates and the color. The performance of the map is achieved with the appropriate combinations of pixels.

The vector structure (vector), however, the Charter is broken down into individual areas and elements, which are small or large line segments, which can be stored or lend themselves to different levels of information. Each line is defined by successive line segments (vectors - Vectors), identified both with the coordinates of the points at the beginning and end, and with their color, type of service etc. The presentation of the charter achieved by the combination of the individual lines. The individual points in a map as beacons, wrecks, etc., are defined as lines of zero length, and the surfaces are defined as a whole closed line. The creation of a map with data vector structure is time-consuming, expensive and requires huge infrastructure and qualified staff. For this reason, does not currently such map for all sea areas.

The electronic shipping maps, using the above systems, often differ, due to the different structure and construction, in relation to the standard ΙΗΟ S-57. Currently used, because there are no electronic shipping maps vector structure standard S-57 for all sea areas. Such maps are e.g. electronic shipping maps of the graphic the US office. Used as a substitute for the electronic maps ECS, while recorded to CDs available for use and on the market

# 4.2 Structure and content of ENC

As mentioned Electronic Shipping Maps (ENCs) constitute a database which consists of several individual elements, called objects (objects). These objects that compose a ENC are divided into:

* Territorial objects (spatial objects) which are used for the determination of various physical and cartographic objects on the earth's surface, such as lights, wrecks, ducts, restricted areas, etc.
* Descriptive objects (feature objects) which are mainly used to describe various physical entities (e.g. wrecks, resin torches, submarine cables, prohibited areas, etc.) And classified in about 200 headings descriptive items, "object feature classes", or "feature objects". Examples of categories of classes objects are as follows: WRECKS (shipwrecks), LIGHTS (strobes). The descriptive objects always contain certain characteristics or parameters (attributes), which causes a full description, for example a descriptive object that belongs to the category of beacon lights is described with different characteristics (attributes), such as color, period etc.

The technical specifications S-57 of the International hydrographic surveying Organization provide for the use of some 200 characteristics (attributes) for the various classes of objects. In each class design objects for the use of specific characteristics (attributes). For some of the characteristics of each - as it is mandatory to record their prices (mandatory attributes), while the rest is optional (optional attributes).

The value given for each attribute (attribute) usually is selected from the list of authorized values depending on the nature of the described object. For example it is stated that for the attribute "CATWRK" (Category of wreck) used to describe the class of a shipwreck (category objects WRECKS), to have one of the following 5 values:

1. non-dangerous wreck

2. dangerous wreck

3. distributed remains of wreck

4. wreck showing mast/masts

5. wreck showing any portion of hull or superstructure

The descriptive items do not contain geometric information (shape and location of natural entities on the earth's surface). However, when required, the geometric information of a descriptive object (shape and position on the earth's surface) determined in accordance with the correlation with one or more territorial objects, or with another descriptive subject, which refers to a spatial

# 4.3 Categories of use

In accordance with the technical specifications of the standard S-57 of the IMO, depending on the shipping for its intended use, electronic shipping maps ENCs are classified under the following 6 categories of use:

Category 1 Overview

Category 2 General

Category 3 Coastal

Category 4 Approach

Category 5 Harbor

Category 6 Berthing

The ENCs each category have different density maps and other information depending on the maritime use. For example, A ENC CATEGORY 6 (berthing), contained objects reflecting all the buoys in the area covered by the Charter, while a category 3 ENC (coastal), contained objects that depict only the most important markers.

The following table shows the main categories of use ENCs per use and volume information feature:

|  |  |  |
| --- | --- | --- |
| **Category** | **Shipping use** | **The volume of data** |
| 1 Overview | Design voyage | Similar to the one which corresponds in printed maps scale less than: 1:2.25 m |
| 2 General | Shipping offshore | Similar to the one which corresponds in printed maps scale 1:2250.000-1:300.001 |
| 3 Coastal | Short sea shipping | Similar to the one which corresponds in printed maps scale 1:300.000-1:80.001 |
| 4 Approach | Approach coast | Similar to the one which corresponds in printed maps scale of 1:80,000; 1:40.001 |
| 5 Harbor | Coast approach | Similar to the one which corresponds in printed maps scale of 1:40000- 1:10.001 |
| 6 Berthing | Limitations | Similar to the one which corresponds in printed maps scale greater than 1:10,000 |

# 4.4 ENCs encryption

In 2003 the IHO accepted proposal of some operators (RENC) for the need to prevent unauthorized interception of electronic navigational charts (ENCs) and placing them in encrypted form instead of the form of the initial prototype (S-57). The process noted in the new standard to prevent unauthorized interception S-63 of the IHO which is the adoption of standards to prevent unauthorized interception used by some commercial distributors of electronic maps that cooperate with the IHO.

With this new encryption envisaging a more complex process of transferring and use keys for the disposal of the encrypted electronic maps in accordance with the standard S-63. In accordance with this procedure for the transfer of the authorization for use of the enc the user requires a combination of the key disposal of ENCs from the corresponding institution, with the key of the identity of the hardware and software manufacturing company of the ECDIS, which will be installed, and involvement of the International hydrographic surveying Office (International Hydrographic Bureau-IHB)

# Although the version of the standard S-63 from the IHO, the decisions of the IMO for the ECDIS systems (at least until 2015), mention is made of the standard S-57, providing the possibility to those Hydrographic Services wish to have the availability maps ENCs in accordance with the standard S-57 self without encryption

# 5. Design and execution of the voyage with ECDIS

# 5.1 Implention procedures classical shipping with the ECDIS

As already mentioned, the ECDIS fully covers the performance of all operations and procedures for preparing, enforcement and surveying voyage as they occur using the traditional methods to form a nautical chart and now offers several additional features. In accordance with the functional specifications of the ECDIS systems, the system provides the following possibilities for performing the basic operations and procedures of classical shipping:

1) Read the geographical coordinates of any point of electronic map (simply by positioning the cursor at that point).

2) Record the position of a point on the online map with the geographical position of the [by entering the corresponding values (F, L).

3) Measuring distance of a point from another

4) Position determination with design lines which correspond to optical bearing and measured with the radar distances.

5) Design bearings - safety distances.

6) Design polygon areas.

7) Limit areas.

8) Indication of hand-written notes on the map.

# 5.1.1 Design lines position and manual plot positioning in the ECDIS

 In accordance with the IMO standards, the ECDIS has the possibility of manual surveying the position of the vessel on the screen of the system design on the screen lines position and positioning the intersection, just as in the traditional form a nautical chart. This function is very useful, because, even in the event of electronic identification system (GPS, DGPS Position, GNSS, etc.) the ECDIS continues to provide the possibility surveying voyage on screen without necessarily require the use of forms marine maps.

# 5.1.2 Design ability security and hazardous areas in the ECDIS

As has been mentioned, a standard of the ECDIS is the completion of the database of the SENC plus cartographical and shipping information from the user. This function is used principally for the delimitation of areas with polygonal lines. In the implementation of the voyage the ECDIS has the ability to recognize these areas depending on the category, so when you need to adopt hazard signs. For this purpose the user when entering the limits of these areas, must be described the planned areas as dangerous. The possibility of demarcation

Hazardous areas in the ECDIS is particularly useful when used RNC, because in this way it is possible to alert limits for shallow areas for the danger signals [as is well known, such native possibility does not exist in the rncs because these maps do not contain spatial and descriptive items, such as ENC, but only cubes].

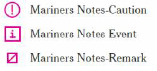
# 5.1.3 Indication of hand-written noted on the online map of the ENCIS

This function provides the sailor the possibility of manual introduction of symbols, graphics and text on the online map in correspondence with the notes/reminders are registered with a pencil in a standard form marine map.

These elements are assigned to the database SENC and then can be displayed on any map of the area used by the ECDIS. This area, after the entry in the database of the SENC ECDIS, shown in any online map on the screen of the ECDIS. The Demarcated in this way areas are identified by the user as dangerous or not. The ECDIS system has the ability to recognize these areas depending on the category, so that when it is necessary to adopt on danger signals. For this purpose the user on the ECDIS the areas must, if they are to be described as dangerous.

The ability of the system to reflect using the "Mariners Notes' handwritten notes as:

1) Points placed on the online map with explanatory text, which can be displayed with the following three symbols:



2) Lines and areas to be placed on the online map with explanatory text using the Mariners Notes-Drawing.

ECDIS systems from other construction companies carrying out the registration of hand-written notes with different tools.

# 5.2 Planning a ship route with ECDIS

The design route voyage with the ECDIS includes all the traditional work designing voyage in printed maps, but they are not carried out with a pencil, eraser, but implemented by the corresponding tools of the ECDIS.

In the ECDIS or design the route for the voyage from a point of departure (port of departure) until a final destination point (port of arrival) is carried out with the determination of successive points voyage, which correspond to the shift points for beam shaped ribs.

The voyage symbolized usually with the characters WP and a serial number e.g. WP1, WP2, WP3, etc.). With the use of voyage, the planned route consists of a succession of arms (legs), each of which is defined by two successive point’s voyage.



The determination of the voyage ECDIS systems is done in the following ways:

• By positioning the cursor at the desired point of electronic map and automatic registration of the coordinate system (F, L) to point to the database SENC.

• By entering the coordinates (F, L) each point.

During the design of a route in the ECDIS is created and recorded in the database SENC, a digital file with all the essential elements of the path for easy future use, such as for the design of new routes and for the safe operation of the voyage. The digital files with the elements of the proposed routes in the database SENC, with names specified by the user, e.g. Route1 etc.

The basic elements of a route of Database SENC, is:

1. The coordinates (f, (l) of the voyage. The voyage (WP) registered with the designer the voyage either by entering the geographical coordinates (F, L) each waypoint, either by selecting a point on the online map with the mouse or trackball).

2. Turn points tongue in each leg of the journey before the next change of course be determined by the designer of the voyage depending on the elements of the vessel for the speed to be observed during the voyage.

3. The safety limits route voyage CTD (Cross Track Distance), which shall be determined by the maximum allowable during the voyage deviation of the position of the ship from the planned route. This variation is determined by the designer the voyage depending on the specific shipping conditions of each region and on some systems it is possible to define:

(A) Different maximum allowable deviation for each leg of the journey.

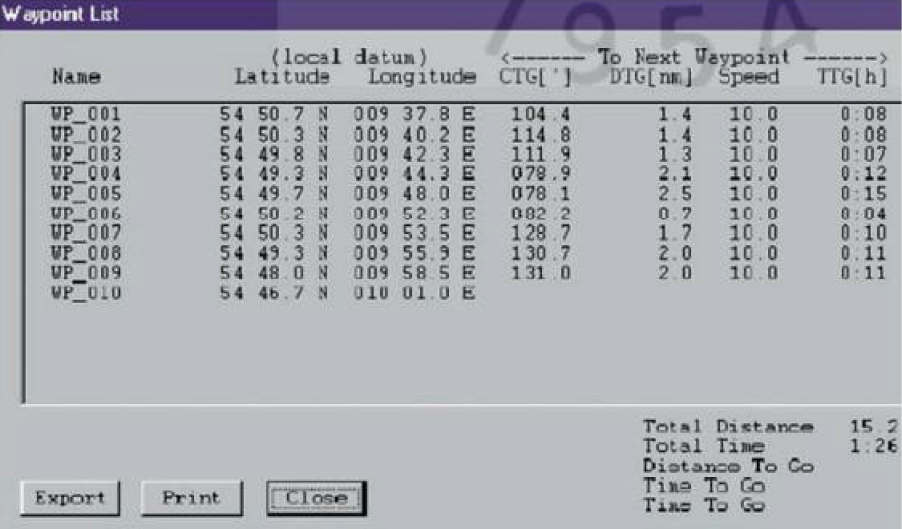
(B) Different maximum allowable deviation on both sides of each leg of the journey.

4. Some safety parameters, which are recorded by the user, for the verification and validation of the service, as the depth of security for the voyage over shallow, the amount of the security for the voyage under a bridge and the safety distance from critical to safety of the voyage.

5. The distances between successive points voyage (these figures are calculated automatically by the system software).

6. The total distance of the planned route from the start point to the end point of the voyage, and the duration of the voyage depending on the speed to be complied with.

In the diagram below shows an example of the voyage of a route in the SENC.



We note that these figures contain many different useful information such as: The serial number (name) of voyage, the distances between successive points voyage and arms route, or planned for each leg speed voyage, the time voyage from one point to the next, the total distance voyage and the total time voyage (for the entire route).

The digital files of the SENC of the designed routes provide to the sailor great flexibility and comfort because it is possible:

• The appearance of the whole or part of the active route in any imaging system monitor online map

• The use of the route designed for a particular voyage, for the execution of the same voyage at a later time.

• The transfer of routes, which are entered in the database Email Map SENC in another spare ECDIS.

In the ECDIS the use of voyage and the legs of one or more routes to create a new route shall be:

• Move the different points on the voyage,

• The Delete existing points of the voyage,

• The addition of new voyage.

**Checking and validation planned route**

To complete the design a new route, Nautilus House must perform the control and validation of service designed with the use of the possibilities offered by the ECDIS, in order to identify potential human errors in the design, such as crossing from shallow etc.

The test and validation of new route in the ECDIS based on certain criteria laid down at the stage of design voyage as:

(A) Depth safe voyage over shallow.

(B) Safety height for the voyage under a bridge,

(C) Safety distance from critical to safety of the voyage.

On the basis of these criteria the ECDIS, during the planned route, identified the wrong design because the route passes in less than a fixed distance from a buoy marking.

The route will redraw and shown automatically, based on the new point location voyage WP002. Then repeat the procedure from the ECDIS until received by the system indicates that the path successfully parsed.

**Establishment of a turn tongue.**

Another important feature of ECDIS to secure design of the voyage is the determination of the Wheel Over Point. The tongue turn points are close at the end of each leg of a planned route at a certain distance from the location of the waypoint voyage, which, determines the end of a leg voyage and the beginning of the next.

During the design of a route voyage, turn points tongue must be fixed in such a way that during the voyage, the Bridge Officer can determine easily, such as: The measurement of distance or bearing from this point on the coast, the crossing by aligning two points etc..

**Enter vessel on the ECDIS.**

Because the ECDIS interfacing with other nautical electronic instruments and systems must ensure that this interface are not undermined the possibilities of interconnected systems, such as the satellite receiver for determining position GPS/GNSS. For this purpose, the ECDIS provides the possibility of registration in the database Email Map SENC various basic parameters of the vessel as:

1) The Vessel dimensions (length, width, and possibly other geometric data for the shape of the vessel).

2) The boat draft.

3) The exact positions aerials position fixing systems, radar, etc.

4) The exact location of turning point of the vessel.

5) The information board (turning circle, head reach etc.).

With the entry of the basic parameters of the vessel in the SENC means:

1) The use of high-accuracy of modern systems for determining position, such as the accuracy of entry 1 to 5 m of the DGPS system for navigation accuracy in restricted waters and entry-attaching to a port.

2) The exact correlation with the image of the Radar when it has interfaced with the ECDIS, the exact position (position) of the vessel.

3) The extrapolation of the measured with the depths device on the surface of the sea, depending on the depth of the transducer.

4) The reliable operation of the warning display panel (depth of safety, safety distances, etc.).

**Recording and retrieval of data recorders in the ECDIS.**

Another important function of the ECDIS is a recording of basic data of the voyage and the possibility of recovery for study and analysis of the circumstances of an accident.

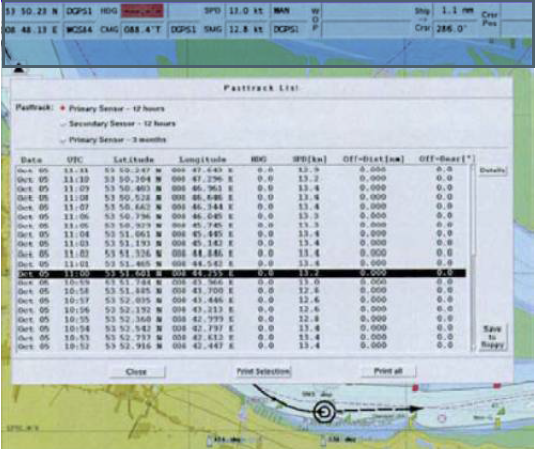
In accordance with the requirements of the functional specifications of the IMO, the ECDIS must record and recover some of the key elements of the voyage required to record the history of the piloting and used enc and other information for the last 12 hours of the voyage. For this purpose shall be continuous recording at intervals not greater than 1 min the following elements:

1) Position (position, course and speed of the vessel for redesign of the program itinerary and the recovery of the detailed historic piloting.

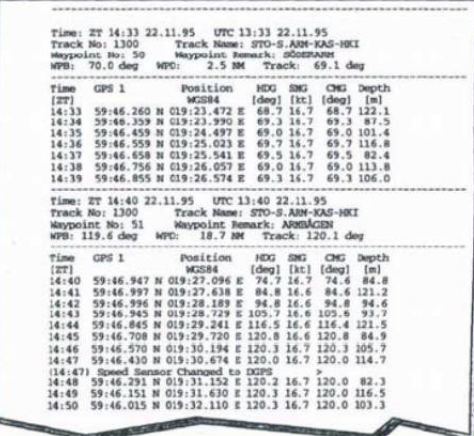
2) Detailed information used, as issuer ENC, number of bay, year of issue, official corrections.

In addition to these components, which are in the last 12 hours of the voyage, the ECDIS must maintain the corresponding figures for the whole of the voyage with recordings at intervals of not more than four hours.

Another basic requirement of functional specifications of the IMO for the ECDIS is the system to provide the user with the possibility of occurrence of these elements in a special window or printing, but does not allow modification or erasure of the recorded data of the voyage. The voyage data log files are text files and can be printed. In this way the log files of the ECDIS can be used to analyze the circumstances of an accident by the competent investigative committees.



Retrieve recorded data voyage on the ECDIS



Print recorded data recorders in the ECDIS

# 6. WECDIS (Warship Electronic Chart Display and Information Systems)

# 6.1 Introduction

An advanced form of Electronic Chart Display and Information Systems are the Warship Electronic Chart Display and Information Systems (WECDIS) which combines a system of shipping functions ECDIS systems (Safety at Sea) and part of the Information Center a modern Battleship. The main functions of the WECDIS determined by each country according to its own national needs. However, in order to ensure interoperability between naval vessels of the member and systems of the NATO (North Atlantic Treaty Organization), has adopted the standardization agreements "STANAG 4564 - Standard for Warship Electronic Chart Display and Information System (WECDIS)" in which shall be as follows: (I) The Essential (mandatory) operational capabilities of a simple system WECDIS (ii) Additional (recommended) business potential of a system WECDIS.

A special feature of the WECDIS is their ability to process digital Geospatial data known as additional Military Geospatial Data (Additional Military Layers-AML). The Aml issued mainly from official state services such as Hydrographic Services of NATO member countries and their use of the systems WECDIS contributes significantly to the support of maritime companies, influencing the decision-making process in tactical and operational level.

The WECDIS systems combine a system of shipping functions of ECDIS and part of the functions of the Business Center a modern Battleship. Interconnected with the regular system of military vessel and the complete configuration include the main WECDIS system installed on the Bridge and the alternative operations center.

The automated collection, processing and display the shipping/regular information on the WECDIS system on the bridge of the Battleship assist in maritime safety and allows the Officer Navy Direction to perform its duties as an engineer officer in charge of the board are:

- Understand/assess directly the shipping and operational status (navigational - situation awareness).

- Upgrade quality the correctness of decisions to be taken.

- Accelerate the decision-making process.

- Support more effective management of weapons systems of the ship.

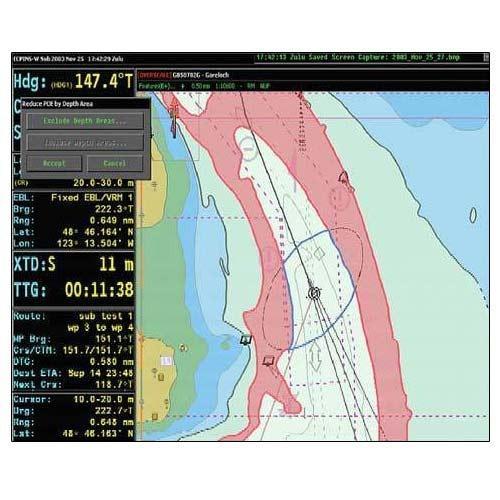
The interconnection and interaction of the WECDIS system with the regular system of military vessel may be necessary, making possible the following:

- Direct dispatch to the operations center all necessary for the support of maritime companies, data and information.

- The provision of integrated operational image to the captain of the Battleship (at the bridge) by combining the shipping information of the sub-frame with the business information center.

- Transmission of integrated operational image on the Operation Commander and the other warships and air via digital data exchange systems.

- Exchange directly to unusable regular data and information between nautical units (interoperability).

- More comprehensive operational support the corresponding army commander at sea.

The Standardization Agreement NATO STANAG 4564 Ed.2 specifies the types of digital data used in the WECDIS, known as the WECDIS Data Products (WDP), which are defined groups data containing all the related information to support the functions of the WECDIS. The categories of digital data WDP is the following:

A. Core Navigational Information - CNI: Include all necessary digital data in vector format (vector) required for safe navigation. Such information is essentially the Electronic Navigational’s (ENCs) and/or Digital Nautical Chart (DNCs).

B. Auxiliary Navigation Information-ANI: Include all necessary digital data needed to conduct safe navigation feature that can be used as reserve of the Cni Information or where it is not available CNI information. Essentially the ANI information other electronic charts vector such as Admiralty Raster Chart Service (ARCS)

C. In addition Military Data-AML: In the case of digital Geospatial files (Geospatial information manufactured specifically for the support of seafarers.

# 6.2 Operational Opportunities on WECDIS

In accordance with the standardization agreement NATO STANAG 4564 the operational capacity of the WECDIS systems shall be determined according to national needs of each country. These capabilities are classified in three categories:

A. Essential Business Features: Simply stand-alone systems WECDIS, covering all the main shipping requirements of the ECDIS and optional features such as interface with radar/ARPA (Automatic Radar Plotting Aid), Automatic identification systems-AIS & Navigational Telex (Navtex receivers), providing data weather and tide, plot hazardous areas for Navigation, interface with systems GMDSS & INMARSAT etc. Provide basic business functions such as the presentation of data Automatic recognition of warships (Warship Automatic Identification System-WAIS), the plot accurately areas exercises and business and the presentation of operational data combined with display of the ship in real time on an online map ENC.

B. Additional Operational Capacity: WECDIS systems to support specialized maritime companies. Supplied with a wide range of digital data, providing specialized features to support business needs, missions of each type of warships. Have the possibility to interconnect with regular management information systems-sensors-arms.

C. Advanced Business Features: WECDIS systems can supplying a wide range of digital data and holding products Geospatial information to support Interdisciplinary Enterprises. Used by technologically advanced Warships Nautical countries (USA and France) have viewing capabilities maritime power and using appropriate strategic long-range missile TOMAHAWK and SCALP NAVAL.

The main basic operational capabilities of a WECDIS system are as follows:

- Design voyage and automatic calculation: The total distance voyage, the arrival time at a specific point voyage depending on the speed of the required speed for arrival at a specific point voyage at a fixed time, the required speed and time to curb specific target surface.

- Single and Continuous display on monitor various categories online maps regardless of the type and scale, such as vector maps ENCs, DNCs and maps ARCS.

- Display regular information as landmines, areas of exercises, airways civil aircraft areas Limited Diving Areas Y/B, etc. specific thematic levels (user defined layers-UDL) for future immediate recovery and utilization, such as e.g. bearing and safety distances from specific points, creating lines of entry (Limiting Danger Lines-LDL), turn points and results for specific information by AML data.

The additional operational capabilities of a WECDIS system are as follows:

- Selective search for information from AML data (e.g. normal routes submarines, mines, airspace for military aircraft, etc.).

- Imaging areas safe landing helicopter and sectors weapons naval vessels.

- Route design research in search rescue operations - Search and Rescue.

- Imaging seabed morphology and environment when conducting operations MCM

The main advanced operational capabilities of a WECDIS system are as follows:

- Presentation of data Guided Projectile (K/B) Surface (missile data) which includes the fields of security sprays K/B.

- Image Presentation TV CAMERA to identify objectives and correlation with image video RADAR.

# 6.3 Additional Military System Data on WECDIS

ECDIS and WECDIS labeled as "real time- GIS applications in the marine environment". A special feature of the WECDIS is the selective ability to assimilate, exploit and to present operational Geospatial data known as additional Military Geospatial Data (Additional Military Layers-AML). The term Geospatial Data, in accordance with the manual of the NATO AAP-6 (2010) the term Geospatial assigned as "Of or related to any entity whose position is referenced to the Earth."

The standardization of NATO STANAG 7170, adopted the concept and outlined the products AML Created in coordination with the Hydrographer of the British Admiralty Pier-United Kingdom Hydrographic Office (UKHO). The purpose of this directive, was to develop range of digital data to meet the requirements necessary to "non-shipping" Geospatial information, to support operational defense requirements of each country member of NATO.

Nato member states have adopted nine product specifications AML, while another product is under preparation.

The approved types of AML products are the following:

Products AML vector - Vector AML

- Contour Line Bathymetry (CLB)

- Environment, Seabed and Beach (ESB)

- Large Objects Nets - Large Bottom Objects (LBO)

- Parent Shipping Information and Services - Maritime Foundation and Facilities (MFF)

- Routes, areas and limits - Routes, Areas and Limits (RAL)

- Small Objects Depth, Small Bottom Objects (SBO) (UKHO currently produces the V1.0)

Products AML interlaced form - Gridded AML

- Integrated Water Column - Integrated Water Column (IWC)

- Sediments, the environment and the sea floor and coastlines Interlaced Form Gridded Sediment, Environment, Seabed and Beach (GS ESB).

Today, many Member States and non-NATO, apply the aml and are capable of producing similar products.

The products AML , used by different types of warships (frigates, submarines, transporters, etc.). In order to meet specific business requirements which are defined at national level. The main products AML used for the conduct of maritime companies are the following:

- Safe Navigation channels

- Plot territorial sea, continental shelf and Exclusive Economic Zone

- Airway political and military A/F

- Areas of drills, throwing Fields

- Data analysis of coastal areas and shoreline characteristics to conduct operations Navy Shelling

- Hazardous Areas .

- Compact bottom objects - Small Bottom Objects

- Oceanographic information (e.g. temperature variation, speed of sound with depth) of its usefulness in anti-submarine operations

- Regular information

- Regular information to support Amphibians)

# 7. Conclusion

Since ECDIS was developed, the overall safety of navigation has increased continuously.

It offers many benefits to the watch keeping officer: not only does it replace the paper chart but it increases situational awareness and works as an anti-grounding tool when set up correctly. It constitutes the main component of the vessel’s navigational system and the operator can participate in the navigational benefits through proper knowledge and handling of the ECDIS. The list of benefits associated with the proper use of ECDIS is given below (without claiming to be exhaustive):

**Benefits of ECDIS**

• Reduced workload for the navigator (charts and nautical publications updating, voyage planning, all information in “one hand”)

• Navigation in real time increasing situational awareness in combination with proper lookout

• Automatic route monitoring (warnings and indications of hazards to the operator, in time arrivals)

• Automatic track control (reduces bunker costs), if ECDIS is connected to the autopilot

• Prediction of special maneuvers (predicted path, trial maneuvers, docking mode)

• Availability of a chart during the night without night vision loss

• Access to additional information resources

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The technology that produces the benefits can, inevitably, also lead to risks. An ECDIS is only as good as the operator who handles it and does not replace the navigator: good navigational skills and seamanship are still essential for safe navigation. The most common potential risks are false operation, misinterpretation of the ECDIS data and over-reliance on it.

In replacing paper charts with ECDIS, mariners who are used to navigating on paper charts, will need to critically upgrade their competence in how to use the new technology and, most importantly, how to use it in the context of best practices for good Seamanship.

**Potential Disadvantages of ECDIS**

• Too much information on the screen may cause clutter and can be distracting

• Submenus can be very complex

• The size of chart displayed on the screen monitor is very much reduced compared with the paper chart

• Some symbols may be misinterpreted due to unfamiliarity

• Automatic plotting of position can lead to complacency concerning the vessel’s position and proximity to dangers.

• Confusion with ECS, unauthorized use for primary navigation

In order to minimize the risk of misinterpretation, to reduce potential ECDIS errors and to make the most efficient use of the ECDIS on board, a professional, coordinated generic and type specific ECDIS training delivered by a certified training institute is essential.

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