

## **ECDIS Limitations, Data Reliability, Alarm Management and Safety Settings Recommended for Passage Planning and Route Monitoring on VLCC Tankers**

G. Rutkowski

*Teekay Learning and Development Center, Manila, Philippines*  
*Teekay Shipping, Norway*

**ABSTRACT:** The purpose and scope of this paper is to describe the factors to consider when determining Electronic Chart Display and Information System (ECDIS) limitation, data reliability, alarm management and ship's safety parameter settings. For the optimum situational awareness, navigators must always recognize the level of display for objects presented when using ECDIS. The values for the safety depth and safety contour must be understood and entered to achieve a sensible and considered meaning and alarm settings. The navigators must remember that the display of underwater obstructions or isolated danger symbols can change according to the settings of this safety contour which also marks the division between navigable (safe) and non-navigable (unsafe) water. Improper management of the system may result in the anti-grounding alarms and other indications failing to activate as required for the safe conduct of the navigation. Consequently, it could give a false impression of safe waters around the vessel where some dangers may not be shown due to the limitations imposed by original chart scale. This paper recognizes the limitations of ECDIS display, the significance of appropriate safety settings as well as the alarm management recommended for passage planning & route monitoring on VLCC tankers.

### 1 INTRODUCTION

ECDIS is a complex, safety-relevant, software-based system with multiple options for display and integration. The primary function of the ECDIS is to contribute to safe navigation.

ECDIS should always have at least the same reliability and availability of presentation as the paper chart published by government authorized hydrographic offices. In such case ECDIS units on board are required to comply with one of two performance standards (either IMO resolution A.817(19), as amended or resolution MSC.232(82)), depending on the date of their installation.

Essentially, where an ECDIS is being used to meet the chart carriage requirements of SOLAS (regulation

V/18, V/19, V/27) it must be also type-approved, use up-to-date electronic nautical charts (ENC), be maintained so as to be compatible with the latest applicable IHO standards and have adequate, independent back-up arrangements in place to ensure safe navigation in case of ECDIS failure.

In addition, all ENCs and RNCs must be of the latest available edition and be kept up to date using both the electronic chart updates (ENC) and the latest available notices to mariners. The ECDIS, either with an ENC on display or operating in RCDS mode, should be capable of displaying all chart information necessary for safe and efficient navigation originated by, and distributed on the authority of government authorized hydrographic offices.

ECDIS software should be kept up to date such that it is capable of displaying up-to-date electronic charts correctly according to the latest version of IHO's chart content and display standards in accordance with IMO Safety of Navigation SN.1/Circ.266.

ECDIS system, until used accurately and properly, always can be recognized as a valuable tool in assisting navigators and allowing them more time to maintain a proper lookout and more detailed situational awareness. Unfortunately, it has been also noted (e.g. Weintrit (2009, 2018), IMO Resolution MSC. Circ.1391 (2010)), that many navigators have a tendency to put too much reliance on ECDIS with a potential to threaten the safety of navigation, which may contribute to accidents rather than preventing them.

Improper management of the system may also result in the anti-grounding alarms and other indications failing to activate as required for the safe conduct of the navigation.

provided, Electronic Navigation Charts (ENC) do not provide this information. Instead they provide the navigator with a facility to examine reliability and quality of source data presented on charts by means of Category Zone of Confidence (CATZOC).

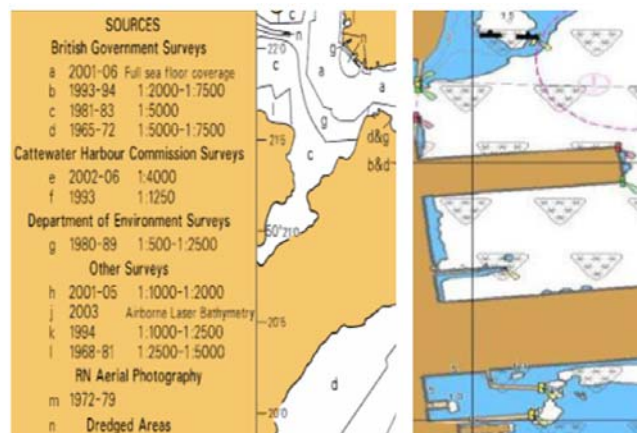


Figure 1. Example of Source Data Diagram from BA1697 (on the left) and example of CATZOC displayed on an ENC (on the right).

## 2 ECDIS DATA RELIABILITY

Navigating a ship with ECDIS is fundamentally different from navigating with paper charts. Unlike paper charts where source data diagrams are mostly

ZOC	Position Accuracy	Depth Accuracy		Seafloor Coverage	Typical Survey Characteristics	Symbol
A1	± 5m	=0.50 + 1% <i>d</i>		Full area search undertaken. Significant seafloor features detected and depths measured.	Controlled, systematic survey high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system.	
		Depth [m]	Accuracy [m]			
		10	± 0.6			
		30	± 0.8			
A2	± 20m	=1.0 + 2% <i>d</i>		Full area search undertaken. Significant seafloor features detected and depths measured.	Controlled, systematic survey achieving position and depth accuracy less than ZOC A1 and using a modern survey Echosounder and a sonar or mechanical sweep system.	
		Depth [m]	Accuracy [m]			
		10	± 1.2			
		30	± 1.6			
B	± 50m	=1.0 + 2% <i>d</i>		Full area search not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.	Controlled, systematic survey achieving similar depth but lesser position accuracy less than ZOC A2 and using a modern survey echosounder, but no sonar or mechanical sweep system.	
		Depth [m]	Accuracy [m]			
		10	± 1.2			
		30	± 1.6			
C	± 500m	=2.0 + 5% <i>d</i>		Full area search not achieved, depth anomalies may be expected.	Low accuracy survey or data collected on an opportunity basis such as soundings on passage.	
		Depth [m]	Accuracy [m]			
		10	± 2.5			
		30	± 3.5			
D	Worse than ZOC 'C'	Worse Than ZOC 'C'		Full area search not achieved, large depth anomalies may be expected.	Poor quality data or data that cannot be quality assessed due to lack of information.	
U	Unassessed - The quality of the bathymetric data has yet to be assessed.					

\*In practice, it is usually assumed that the reliability error of bathymetric data measurements estimated for ZOC (D) and ZOC (U) zones assumes values at least 10% higher than the values estimated for the ZOC zone (C), which can also be recorded as: (2.0m ± 5% · *d*) · 1.1.

Figure 2. Categorization of CATZOC's. Source: Regulation of the IHO for International charts and charts specification of the IHO's white paper., Available at: <https://www.admiralty.co.uk>

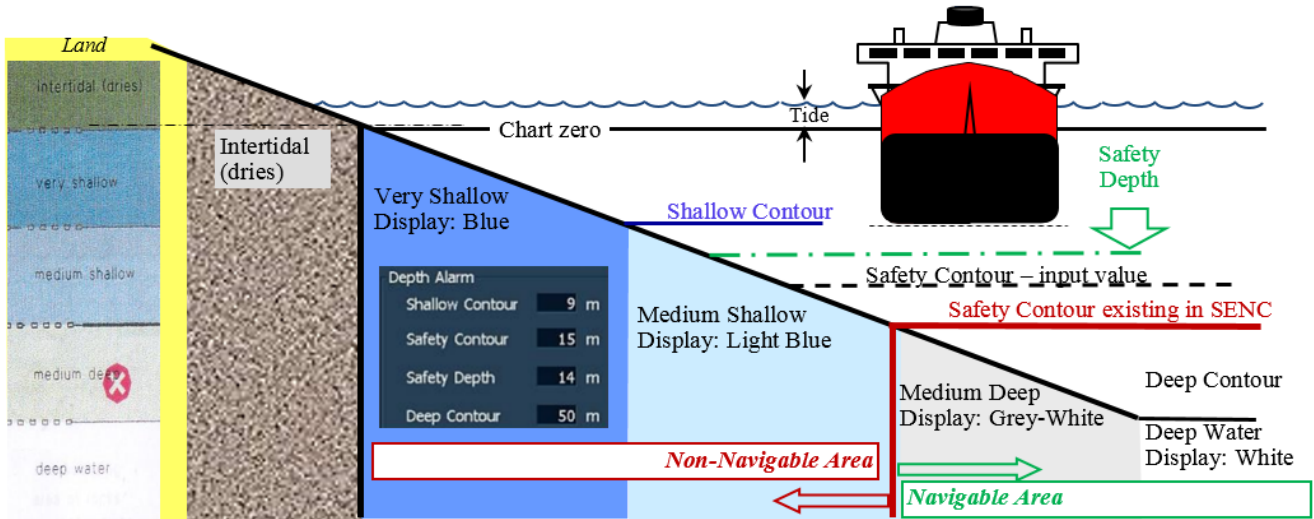


Figure 3. Mutual relationship between Safety Depth, Safety Contour, Shallow Contour and Deep Contour.

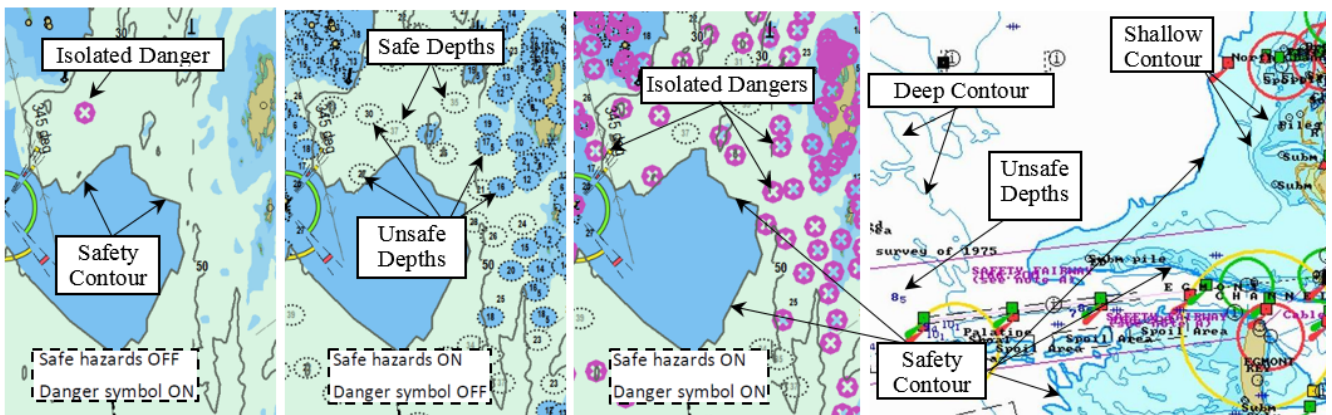


Figure 4. Display of Safety Depth, Safety Contour, Shallow Contour, Deep Contour, Safe Hazards and Isolated Danger presented on ENC maps in ECDIS systems.

This gives an estimate of the reliability of data related to five quality categories for assessed data (ZOC A1, A2, B, C and D) and a sixth category for data which has not yet been assessed. When displayed by the ECDIS, CATZOCs are distinguishable by the shape of the symbol and the number of asterisks contained within it.

The categorization of hydrographic data is based on three factors: position accuracy, depth accuracy and seafloor coverage for each ZOC to help manage the level of risk when navigating in a particular geographic area.

ZOC categories reflect a charting standard and not just a hydrographic survey standard. Depth and position accuracies specified for each ZOC category refer to the errors of the final depicted soundings and include not only survey errors but also other errors introduced in the chart production process.

Position accuracy of depicted soundings at 95% CI (2,45 sigma) with respect to the given datum.

Depth accuracy of depicted soundings at 95% CI (2,00 sigma) with respect to the given depth (d) in meters at the critical depth.

Position and depth accuracy need not be rigorously computed for ZOC's B, C and D but may be estimated based on type of equipment, calibrating regime, historical accuracy.

When using ENC's with low data accuracy navigator (OOW) has to be more vigilant, and carry out repeated cross checks with information available from other navigational aids.

Whenever possible the accuracy of the ENC's to be crossed checked with information available from local agents, Pilots or local authorities. CATZOC features must be considered while determining vessels safety contour settings. CATZOCs are only visible when the user has selected the appropriate ENC layer for display.

### 3 ECDIS SAFETY SETTINGS

Appropriate safety settings are of paramount importance for ECDIS display and safety of navigation. The OOW must understand the values for the safety depth, safety contour and set them properly to achieve a sensible and well thought-out implication.

In addition, the oncoming navigator during change of watch shall also verify the ECDIS display settings, alarms settings and safety parameters settings before taking over the watch.

Chart objects and information available in SENC for display are sub-divided into three categories: Base

Display, Standard Display and All Other Information (IMO Resolution A.817(19) and/or IMO Resolution MSC.232(82)).

The Base Display is the basic display provided by the SENC and is required for all charts. It is the basic data that cannot be altered by the operator.

The Display Base contains information on coastlines, safety contours, danger indications, traffic routing, scale, range, orientation and display mode, as well as units of depth and height. The Display Base is not intended to provide enough information for safe navigation just by itself.

The Standard Display, which is also a pre-arranged chart display, but which can be modified by the operator, and which is automatically shown when the ECDIS is first switched on. It contains the display base plus boundaries of channels etc., conspicuous features, restricted areas, chart scale boundaries and cautionary notes.

The operator can modify the amount of information displayed for the purposes of route planning and navigational monitoring. The operator decides what level of information is displayed during any particular situation or task. However, when working with these other levels of information display, an operator must immediately be able to return to the standard display with just one single key stroke or action of the controls.

The standard display, as defined in the ECDIS Performance Standards (IMO Resolution A.817(19) and/or IMO Resolution MSC.232(82)), does not necessarily display all the chart objects necessary for safe navigation under all circumstances, e.g. spot soundings or underwater obstructions.

These and other objects are all listed or classified as 'All Other Information' display. Different manufacturers provide different facilities for managing the display of chart objects and chart information. Control of individual groups of objects, e.g. spot soundings, tidal diamonds, place names, may vary according to each ECDIS manufacturer. Selection of certain layers of information or objects for display becomes more obvious with experience but until then navigators will need to understand the layer selection requirements for an efficient navigational display. Mariners need also to remember that displaying everything, without seamanlike consideration, should not be an option.

With some systems, it is possible to run a complete safety check for any hazards along the planned route at any time during the route planning process and on completion of planning. However, this functionality varies among the different makes. Some ECDIS appear only to undertake route check functions on larger scale ENC's and therefore alarms might not activate. This may not be also clearly indicated on the ECDIS display screen.

Mariners should always undertake careful visual inspection of the entire planned route using the 'All Other' display mode to confirm that it, and any deviations from it, is clear of dangers. Watch keeping Officers should verify that all compulsory information (base & standard) are selected. Masters are required to prescribe minimum display category

requirements on the ECDIS for each stage of the voyage. Usually there is also recommendation (e.g. based on Teekay Navigational Handbook (2017)) that the following information are included in user charts during passage planning stage: watch condition, position fix interval, primary and secondary position fix methods, parallel indexing, maximum speed based on minimum required UKC, echo sounder/printer activation, abort line/point of no-return, No Go Areas (anti grounding alarm enable), contingency/emergency anchorages, VTS reporting points, special zones (MARPOL, ECA, etc.), any master's remarks (any orders, comments, etc.), all important notices/remarks (1 hour notice to ER, ER to be manned, etc.). In addition, 'chart auto load' and 'chart auto scale' are to be on at all the times when in navigation. If two ECDIS are installed, one ECDIS should always be set to the best scale (1:1).

SCAMIN is an optional attribute by the chart producer (defined by IHO S57) that can be used to label ENC chart features to be suppressed above a certain display scale. The main function of SCAMIN is to de-clutter the chart display, enabling the user to focus on the most useful navigational information for the display scale in use. SCAMIN may affect the display as it removes certain information from the display if best scale chart is not being used i.e. safety critical information may be removed from the display. A buoy that has the IENC Encoding Guide's recommended SCAMIN setting of 10000 will only be shown on the display if the selected display scale is greater than 1: 10000 (Larger scale).

The system auto-filter means that unless navigating on the best scale chart, OOW will not see all the information available for display. Therefore, when zooming out the system will automatically deselect certain features from display such as soundings, lights and topographical detail. The only way to ensure that the display is not affected by SCAMIN is to always ensure that the chart is being used on the best scale. Navigators should always check the passage plans at 'compilation scale' before use and during route monitoring.

Compilation scale is the scale of the ENC at which the chart data was compiled based on the nature of the source data. It's the scale at which the chart information meets the IHO requirements for chart accuracy.

Navigators must exercise extreme caution when using the scale or zoom facility of the electronic charts. It is possible to zoom-in to a scale larger than that used in the compilation of the data which could create a false impression about the reliability of the charted information. Consequently, it could give a false impression of safe waters around the vessel.

Also, some features may be not displayed because of the SCAMIN (Scale Minimum) attribute of ENC objects. Zoom in/out function should only be used for short periods of time. If possible SCAMIN settings to be kept 'off' during the passage planning stage.

Safety depth (SD) is a value that serves to detect depths that are a danger to navigation. A depth equal to or less than the safety depth is highlighted on the chart in bold type when the display of the spot sounding is turned on. This alerts the user to know

the depths that are insufficient for the vessel to safely pass over. Additionally, if any extra allowance of depth is required due to local port or berth requirements, same should be included in the calculation of the safety depth. Safety Depth is not required to trigger any alarm or indication as per ECDIS performance standards.

Safety contour (SC) value is calculated considering Safety Depth and allowing for CATZOC; (Safety Contour = Safety Depth + CATZOC). In ocean waters if the calculated safety contour value is greater than 50m, then the value can be set at 50m.

ECDIS selects and highlights default safety contour, which is equal to or deeper than the safety contour value selected by the user. Safety Contour on ENC display will default to the next deeper contour if the depth contour of the set value is not available in the displayed ENC source data, e.g. if Safety Contour setting = minimum depth required = 9.0 m, the safety contour selected on most ENCs, where the original data is metric will be 10m (and not 9.0 m) or if 10 m contour is not available in SENC, then 15 m or 20 m whichever higher is the next available in SENC base. It shall be also noted that on ENCs where the original source data was imperial units (feet/ fathom) the depth contours on ENC may be in figures such as 9.1m, 18.2 m.

The safety contour marks the division between navigable (safe) and non-navigable (unsafe) water. If the navigator does not specify a safety contour, this will default to 30m or 50m value depending on type and/or model of ECDIS. The contours may also differ between electronic charts produced by different hydrographic offices. During route planning, an indication will be made if the route is planned to cross the ship's safety contour.

At the time of route monitoring, ECDIS should give an alarm if, within a specified time set by the navigator, own ship is likely to cross the safety contour.

The division between 'safe' navigable and 'unsafe' non-navigable water is highlighted by chart coloring, with blue color used to indicate unsafe area and white or grey for safe area. The unsafe area may be further defined with the selection of a shallow contour, showing dark blue in the shallow water and light blue between the shallow water and the safety contour. The shallow contour should be used to highlight the gradient of the seabed adjacent to the safety contour and the deep contour to highlight the depth of water in which own ship may experience squat.

Using ECDIS the navigator must also remember that displayed underwater obstruction or isolated danger symbols can change according to the settings of the safety contour. Furthermore, the safe water may also be sub-divided with the selection of a deep contour, in which case the area between the safe contour and the deep contour will be colored grey.

However, it has been also acknowledged that not all ECDIS manufacturers provide separate controls for safety contour and safety depth value, some have a common or a linked control. Some flexibility of the system is lost when there is only one common control for 'safety depth' for both the 'safety depth' and the 'safety contour'. In such cases, author recommends

that the safety contour value should be used for the safety depth on ECDIS with such feature.

Where the manufacturer provides for separate controls for safety depth and safety contour, the user can substantially increase their situational awareness by choosing the values as indicated in the following formulas:

$$SD = T_{max} + R_{UKC} + R_{squat} + R_d - H_{tide} \quad (1)$$

$$SC = SD + CATZOC \quad (2)$$

where:  $SD$ = safety depth [m];  $SC$ = safety contour [m];  $T_{max}$ = ship's draught [m];  $R_{squat}$ = estimated squat [m];  $R_{UKC}$ = required Under Keel Clearance [m];  $R_d$ = dynamic reserve caused by ship's oscillation on wave + rolling and pitching [m];  $H_{tide}$ = tide height above chart datum [m];  $CATZOC$ = Category of Zone of Confidence [m].

Example 1. Calculations for CATZOC(A1): Ship's draft  $T_{max}$ = 10 m, required Under Keel Clearance  $R_{UKC}$ = 2.0 m (UKC Policy for open costal water's =20% static draft  $T_{max}$ ), estimated maximum squat  $R_{squat}$ = 0.8m, depth of water ( $d$ )= 30 m, depth accuracy in CATZOC Area A1= 0.5 m + 1% depth = 0.8m. Tide height above chart datum  $H_{tide}$ =0.8m, dynamic reserve caused by ship's oscillation on wave  $R_d$ = 1.0m (in practice, it is usually taken as 2/3 of the wave height). Then using formula (1) and (2) we will have:

$$\text{Safety Depth (SD)} = 10.0 + 2.0 + 0.8 + 1.0 - 0.8 = 13.0 \text{m,}$$

$$\text{Safety Contour (SC)} = 13.0 + (0.5 + 0.01 \cdot 30.0) = 13.8 \text{m.}$$

However, Safety Contour on ENC display ( $SC_{SENC}$ ) will default to the next deeper contour if the depth contour of the input value (13.8 m) is not available in the displayed ENC source data (SENC).

In our example where ( $SC = 13.8$  m) the safety contour selected on most ENCs where the original data is metric will be ( $SC_{SENC}$ )=15 m (and not 13.8 m) or if 15 m contour is not available in SENC, then 20 m or 25 m whichever higher is the next available.

It shall be noted that on ENCs where the original source data was imperial units (feet/fathom) the depth contours on ENC may be also selected as e.g. 18.2m.

Example 2: Calculations for CATZOC(D/U): Ship's draft  $T_{max}$ =10 m, required Under Keel Clearance  $R_{UKC}$ = 2.0 m, estimated maximum squat  $R_{squat}$ = 0.8 m, depth of water ( $d$ )= 30 m, depth accuracy in CATZOC (D)= ( $2.0 \text{m} \pm 5\% \text{ depth}$ )  $\cdot 1.1 = 3.85$  m, tide height above chart datum  $H_{tide}$ = 0.8 m, dynamic reserve caused by ship's oscillation on wave  $R_d$ = 1.0 m. In such case using formula (1) and (2) we will have:

$$\text{Safety Depth (SD)} = 10.0 + 2.0 + 0.8 + 1.0 - 0.8 = 13.0 \text{ m,}$$

$$\text{Safety Contour (SC)} = 13 + (2 + 0.05 \cdot 30) \cdot 1.1 = 16.85 \text{m.}$$

Safety Contour on ENC display ( $SC_{SENC}$ ) will default to the next deeper contour if the input value ( $SC = 16.85$  m) is not available in the displayed ENC source data.

In our example the safety contour selected on most ENCs where the original data is metric will be ( $SC_{SENC} = 20$  m (and not 16.85 m) or if 20 m contour is not available in SENC, then 25 m or 30 m whichever higher is the next available).

Since allowance for CATZOC is considered in Safety Contour, there may be situations where vessel have to cross and navigate within safety contour area. This will enable the audio & visual alarm. When navigating within the safety contour limits, vessel must mark all 'No-Go' areas and navigate with particular caution. This is the only safe water setting that gives alarm/advance warning to the user as per ECDIS performance standards (IMO Resolution A.817(19) and/or IMO Resolution MSC.232(82)).

It is important to note that Safety Depth and Safety Contour settings are dynamic and not fixed for the entire planned route. It will have to be monitored and changed by the user as required for each leg/section of the voyage depending on factors like UKC requirements, speed and available depth and width of water.

Shallow contour setting is generally selected equal to the maximum dynamic draft of the vessel, (*Shallow Contour*  $\approx T_{max}$ ). These indicates the depth below which vessel will run aground. In certain ports with high tidal ranges, the vessels are likely to encounter a scenario wherein the Shallow Contour values will be greater than Safety Contour and/or Safety Depth values. For safety reasons, this setting (Shallow Contour greater than Safety Contour) are not accepted by ECDIS'. In such scenarios, the Shallow contour value should be set equal to Safety Depth values.

Deep contour should be set at twice the draft of the vessel, (*Deep Contour*  $\geq 2 \cdot T_{max}$ ). This is meant to make the user aware that below this value shallow water effects shall get pronounced. The area between the deep contour and safety contour is generally shaded in light grey color and deep waters are marked in white color. However, it must be also noted that alarms and/or indication are not associated with shallow and deep contours.

Isolated Dangers there are underwater abstractions (shallows, rocks, wrecks, reef, offshore loading installation etc.) with a depth above them smaller or equal values of the declared safety contour.

In ECDIS, isolated hazards can be presented on the screen in the form of a red border with a transparent X in the center, but only if the user activates the appropriate layer of additional information about the navigational threats (Safe Hazards ON, Danger symbol ON) – see figure 4.

#### 4 ECDIS ALARM MANAGEMENT

ECDIS provides a large number alarms and indications. An alarm in this context means an alarm or alarm system which announces by audible means,

or audible and visual means, a condition requiring attention. An indicator is a visual indication giving information about the condition of a system or equipment. From navigators 'perspective, ECDIS alarm management is very critical as it could vary from manufacturer to manufacturer. Some manufacturers allow the mandatory alarms to be disabled and some even allow choice of chart scale for alarm checking.

In addition, the level of control over alarms may vary from being very detailed control to minimal control. The vessel's voyage specific parameters including alarms shall be programmed during the appraisal stage of passage planning and must be approved by the Master.

When ECDIS is in use for navigation, the navigating officer OOW must ensure that appropriate alarms and/or indications (as mentioned) below are available and active on ECDIS. Failure to do so may lead to missing out significant navigational information and may lead to rendering the type approval certificate of the system invalid.

All alarms on navigational hazards, information input malfunction, information conflict by way of visual and audible alarms requires an immediate response from operator. All ECDIS alarms and indications shall be acknowledged and investigated. The OOW shall not rely solely on automated monitoring alarms generated by the ECDIS. Reconciliation between the view from the bridge and the vessel position with respect to charted features shall be maintained including a check that the sensors are providing an accurate fix of the vessel position.

In normal circumstances ECDIS automatically provide warnings if it malfunctions or when developing a fault and/or if it has detected an approaching navigation problem.

There are also three categories of situations which can trigger warnings. Navigational hazards, alerting the operator to a potential navigational hazard during route planning or monitoring, such as the ship crossing a safety contour.

Information input malfunction, indicating the breakdown of a sensor, such as the failure of the GNSS or of the ECDIS itself and in addition 'information conflict', indicating a datum or chart miss-match, such as a changed horizontal geodetic datum or a wrong scale setting which could cause a miscalculation of distances.

The five mandatory alarms (as per IMO ECDIS Performance standards) are: crossing safety contour, deviation from route, positioning system failure, approach to critical point and different geodetic datum.

Alarm or Indication must be activated when malfunction of ECDIS and/or when vessel approaching to area with special conditions.

It must be also noted, that appropriate indication should be available on ECDIS screen in case of the following circumstances: default safety contour, information over scale, large scale ENC available, different reference system, no ENC available, customized display, route planning across safety contour, route planning across specified area, crossing

a danger in route monitoring mode and/or in case of system test failure.

When ECDIS is in use for navigation using raster charts (RCDS), to comply with the performance standards, the navigating officer should ensure that the following alarms are available and active: deviation from route, approach to mariner entered feature (e.g. area, line), positioning system failure, approach to critical point. Alarm and/or indication should be activated for different geodetic datum and malfunction of RCDS mode.

In addition, the following indication should be available on ECDIS screen: ECDIS operating in the raster mode, large scale information available or over-scale and large scale RNC available for the area of the vessel. Failure to do so may lead to missing out significant navigational information and may lead to rendering the type approval certificate of the system invalid.

ECDIS shall also detect and provide an alarm or indication when entering areas in which special condition exists, such as: traffic separation zone, inshore traffic zone, restricted area, caution area, offshore production area, areas to be avoided, user defined areas to be avoided, military practice area, seaplane landing area, submarine transit lane, anchorage area, marine farm, aquaculture, Particularly Sensitive Sea Area (PSSA) etc.

However, it must be also noted that too many alarms can lead to an 'Alarm Overload' situation.

On the other hand, too less can lead to false sense of security. Effectively stepping up and stepping down the number of alarms/indications at the various stages of the voyage is important for efficient ECDIS assisted navigation.

The ECDIS specific information regarding when the system detects and provide an alarm should be readily available near the ECDIS unit. Master shall adjust the alarm setting parameters throughout the voyage to ensure that they are optimized for the prevailing circumstances and conditions.

However, he shall also ensure that at any given time during the passage, the OOW are aware of the settings. The system may give alarms by way of visual, audible and visual/audible.

Other than the mandatory alarms, the ECDIS may have the following alarms:

- Anchor watch alarm/indication to indicate when the vessel drifts out from the set limits of swinging circle at anchorage.
- Wheel over positions alarm/indication to indicate when reaching those points.
- CPA/ TCPA alarm/indication for targets input provided by ARPA and AIS (e.g. suggested guidance for VLCC tankers includes combined CPA and TCPA of 1.0 NM and 12 mins and/or more than 4 opposing targets on either side within 3 NM radius).

The guard zone (also known as Safety Frame) provides the user with an advance warning of dangers/cautions. The user sets the dimensions of this guard zone which must be altered according to the prevailing circumstances to prevent unnecessary alarms or to give adequate warning. The navigators

need to remember that not all dangers are enclosed by a contour and guard zone remains active even if it is not selected to display on the screen.

In order for the alarm system to be properly effective (when the route is being monitored) the own ship's guard zone must be set in a seamanlike manner, i.e. with a sensible time or range warning depending on proximity to hazards and planned speed etc. It is also recommended to set the guard zone as large as possible as the circumstances allow.

Safety Frame / Watch Vector are also known as 'Anti Grounding Cone' or 'Look Ahead Setting'.

The setting is based on stopping distance and turning circle criteria of the vessel. Without proper setting of this feature, early warning of most of the navigational hazards in and around the vessel's route shall not be available. However, this feature does not provide alarms for ARPA and AIS targets. The safety frame/watch vector is to be set up depending on the Master's discretion and recommended values for Safety Frame/ Watch Vector/ Look Ahead Settings and for VLCC tankers are usually as follows:

- Open Sea: Ahead: 15 min, width: 1.0 NM on either side.
- Coastal Waters: Ahead: 10 min, width: at least equal to the tactical diameter of the vessel in NM on either side.
- Harbor/ Confined Water: 5 min, at least 0.25NM or as much as possible.

The cross-track limits (XTL) setting made for each leg during the planning stage shall be reviewed taking into account the available sea room and Master's discretion. Recommended settings for XTL values for VLCC tankers are as follows:

- Open Sea: Minimum XTL: 1.0 NM either side of the course.
- Coastal water: Minimum XTL: 0.5 NM either side of the course.
- Harbor/ Confined Waters: Minimum XTL: 0.25NM on either side or as much as possible.

## 5 CONCLUSION

Navigators should always cross check ECDIS information with the other sources and most importantly, a visual lookout, as 'human eyes are the most valuable tool at a mariner's disposal'.

When monitoring a route, the prudent navigator must always maintain a check on the integrity of the displayed position of own ship. When the source of the displayed position is the own ships GNSS, there is always a possibility that the position displayed may not coincide with the ship's actual position in relation to the chart or the charted hazards.

A check may be made quite simply by utilizing one or any of the following: manual position fixing (visual/Radar), look out of the window, comparison of ARPA overlay of a fixed mark with the charted position, comparison of a radar overlay with conspicuous land or fixed targets, observation of a parallel index on the radar display to monitor comparison with planned track, monitoring the depth

shown by echo sounder where appropriate, checking the track history etc.

Navigators must also take into consideration the ECDIS limitation when using the scale or zoom facility of the electronic charts. It is possible to zoom-in to a scale larger than that used in the compilation of the data which could create a false impression about the reliability of the charted information.

Consequently, it could give a false impression of safe waters around the vessel where some dangers may not be shown due to the limitations imposed by original chart scale.

It is essential that the Masters, navigating officers, and ship-owners are aware of the benefits of managing the chart display, safety settings, and alarm system of ECDIS.

Too many alarms can lead to an 'Alarm Overload' situation and on the other hand too less can lead to false sense of security.

Effectively stepping up and stepping down the number of alarms/indications at the various stages of the voyage is important for efficient ECDIS assisted navigation.

The values for the safety depth and safety contour must be understood and entered to achieve a sensible and considered meaning.

The navigators must remember that the display of underwater obstructions or isolated danger symbols can change according to the settings of this safety contour which also marks the division between navigable (safe) and non-navigable (unsafe) water.

Additionally, the shallow contour could be utilized to indicate the gradient of the seabed (adjacent to a channel) and the deep contour to indicate the depth of water in which own ship may experience squat and interaction. Consequently,

improper management of the system may result in the anti-grounding alarms and other indications failing to activate as required for safe conduct of the navigation.

## REFERENCES

- IHO's 'Regulation of the IHO for International charts and charts specification of the IHO's white paper.' Zones of Confidence taken from: <https://www.admiralty.co.uk>
- IMO Resolution A.817(19): Performance Standards for Electronic Chart Display and Information Systems (ECDIS). Available at: <http://www.ecdis-info.com>.
- IMO Resolution MSC.1/Circ.1503/Rev.1, ECDIS – New guidance for good practice (2017-06-16)
- IMO Resolution MSC.232(82) adopted on 5 December 2006: *Adoption of The Revised Performance Standards for Electronic Chart Display and Information Systems (ECDIS)*. Available at: <http://www.imo.org>.
- IMO Resolution MSC. Circ.1391, Operating Anomalies Identified within ECDIS (2010-12-07).
- IMO Safety of Navigation SN. Circ.266 Rev 1. Maintenance of ECDIS (22 Oct 2007).
- Teekay internal document No.: SP1915 v.2, Navigational Handbook, (2017-02-28).
- Teekay internal document No.: RF1112 v.3, ECDIS - Category Zone of Confidence (CATZOC).
- Teekay internal document No.: RF1113 v.5, ECDIS Navigation (General, Technical & Safety Information), March 2018.
- Weintrit, A. 2009, *The Electronic Chart Display and Information System (ECDIS). An Operational Handbook*. A Balkema Book. CRC Press, Taylor & Francis Group. ISBN: 9780415482462.
- Weintrit A.: Reliability of Navigational Charts and Confidence in the Bathymetric Data Presented. *Scientific Journals of the Maritime University of Szczecin*, No. 54 (126), pp. 84–92, 2018.
- Weintrit A.: Accuracy of Bathymetric Data in the Electronic Navigational Charts. *Scientific Journals of the Maritime University of Szczecin*, No. 55 (127), pp. 60-69, 2018