
ELECTRONIC CHARTS – THE USE OF RISK ASSESSMENT METHODOLOGY WHEN OPERATING ECDIS IN THE RASTER CHART DISPLAY SYSTEM (RCDS) MODE

Notice to all Masters and Deck Officers of Merchant Vessels, Owners, Skippers and Watchkeepers of Fishing Vessels, Maritime Education and Training Establishments and Chart Agents.

This Marine Guidance Note replaces MGN 194 (M+F) which was originally published in October 2001. It should also be read in conjunction with Annex 14 of the MCA Safety of Navigation, Implementing SOLAS Chapter V, 2002 - special publication. An electronic version of this publication can be found on the MCA website at:

<https://mcanet.mcga.gov.uk/public/c4/regulations/safetyofnavigation/index.htm>

Summary

The purpose of this Marine Guidance Note is primarily to provide an adaptable step-by-step outline of how to conduct an effective risk assessment into the use of raster navigational charts. As well as identifying a number of hazards that are inherent in electronic chart navigation, it should also assist in the selection of the optimum level of paper charts needed to compliment the electronic chart system, for operation in the RDCS mode, and the development of appropriate operational procedures.

Key Points

- The MCA require a risk assessment to be undertaken prior to authorising the use of ECDIS in the RCDS mode for primary navigation.
- The risk assessment will depend upon a vessel's physical dimensions, hydrostatic characteristics and area of operation and must address risks to own ship, other ships and environment resulting from ECDIS-related navigation hazards.
- The assessment should ensure all hazards have been identified and a system to manage the risks associated with those hazards has been successfully established onboard.

INTRODUCTION

1. Electronic charting systems are being increasingly installed in commercial merchant ships. The current trend for new ship builds is to install an integrated bridge system that includes an Electronic Chart Display & Information System (ECDIS).

2. ECDIS is capable of operating with both Raster Navigational Charts (RNC) and Electronic Navigational Charts (ENC). However, when used in the Raster Chart Display System mode (RCDS), the International Maritime Organisation (IMO) performance standards for ECDIS stipulate that the system has to be used “in conjunction with an appropriate portfolio of up-to-date paper charts”. The performance standards give no guidance on what constitutes an “appropriate” portfolio of paper charts.
3. Current UK policy is for a shipping company seeking MCA approval for operating ECDIS in the RCDS mode to undertake a risk assessment of the use of electronic charts.
4. Feedback from the industry indicates that this approach is acceptable but it would be beneficial if the MCA published guidance on how to carry out such a risk assessment.

OBJECTIVES

5. The primary objective of this Guidance Note, therefore, is to give advice on a suitable risk assessment methodology that shipping companies, shipboard personnel, shore-based charting agents and training establishments could use when operating ECDIS in the RCDS mode.
6. Having undertaken a risk assessment, it should be much easier to determine the optimum level of paper charts to compliment the electronic chart system, given a vessel’s physical dimensions, hydrostatic characteristics and area of operation. In addition, the risk assessment should significantly assist a ship’s operator to develop instructions and procedures for shipboard personnel on the safe and efficient operational use of electronic charts.
7. Attached are guidance notes on a risk assessment methodology that can be used to achieve the above aims. Part 1 of the notes outlines the assumptions used and general principles whilst Part 2 provides guidance on how the principles can be applied in practice.

Further Information

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Risk Assessment – Guidance Notes on Step-by-Step Approach
Part 1 – Assumptions Used and General Principles

ASSUMPTIONS

Throughout the assessment any assumptions made should be clearly stated. The main assumption is that ECDIS operators are properly trained and competent in the operation of ECDIS in the RCDS mode. This assumption is based on the obligation under the International Safety Management (ISM) code for competence and familiarisation with navigation equipment.

1. Key terms

1.1 Key terms used frequently in this MGN are defined below-

1.2 In the context of electronic charts, a *hazard* is a navigational error or operational failure that has the potential to cause harm.

1.3 *Risk* is a combination of two elements:

- The severity of the hazardous event.
- The likelihood that the hazard will occur.

2. Principles of risk assessment

2.1 A “risk assessment” is a careful examination of what could cause harm, so that decisions can be made as to whether adequate precautions to ‘control’ risk are in place. When using ECDIS in the RCDS mode, the harm could, for example, arise through grounding of the vessel or a collision due to navigational failure or misinterpretation of information. This risk of harm is mitigated by following identified onboard procedures and having an ECDIS system with suitable back-up facilities. The aim is to minimise navigational or marine accidents.

2.2 Any risk assessment must address potential harm to own ship, other ships and environment due to ECDIS related failures or navigational errors.

2.3 The assessment should:

- Identify the hazards that are present in operating ECDIS in the RCDS mode.
- Establish whether the severity of a hazard is significant and whether it is already covered by satisfactory precautions to ‘control’ the risk.

2.4 The likelihood of the failure of those precautions should be considered and appropriate emergency procedures developed.

3. Risk assessment in practice – Are there any rules to be followed?

3.1 There are no fixed rules about how a risk assessment should be undertaken. The intention is that the process should be simple, practical and meaningful. Guidance on the main elements of risk assessment for ECDIS, operating in the RCDS mode, are contained within Part 2. The assessment will depend on the type of ship, its hydrostatic characteristics, area of operation and the specifications of the ECDIS system fitted. The findings of the risk assessment should be recorded.

3.2 What should be assessed?

3.2.1 The assessment should cover all navigational risks arising from the operation and use of ECDIS in the RCDS mode. The assessment would not be expected to cover risks that are not reasonably foreseeable.

3.3 Who should conduct the assessment?

3.3.1 Suitably experienced personnel in the field of risk assessment, using additional specialist advice if appropriate, should carry out the assessment. Whilst ECDIS operators should have been trained

and be competent in the operation of ECDIS in the RCDS mode, as a result of companies' obligations under the International Safety Management (ISM) and the Standards of Training, Certification and Watchkeeping (STCW) Codes, it is not intended that the entire task of undertaking the risk assessment should lie exclusively with shipboard personnel. Overall responsibility for the risk assessment remains with the shipping company managers, who need to ensure that adequate resources have been allocated for the task.

3.4 How thorough should the assessment be?

3.4.1 The assessment of risks must be suitable and sufficient but the process need not be over-complicated. The amount of effort put into an assessment should depend on the degree of harm that may occur. Consideration should also be given to whether risks are already controlled by satisfactory precautions or procedures to ensure that they are as low as is reasonably practicable.

3.5 How should the risk assessment be documented?

3.5.1 Shipping companies should document the findings of the risk assessment using a simple proforma as, for example, the one contained in Annex III.

3.5.2 The following elements should be included:

- Identification of hazards.
- Current control measures in place.
- Severity of hazard.
- Likelihood of hazard.
- Action plan to reduce the level of risk.
- Emergency procedures.
- Administrative details, e.g. name of assessor and date.

3.6 What are the stages of risk assessment?

1. DEFINE THE HAZARD
2. CALCULATE THE RISK
3. DECIDE IF RISK IS TOLERABLE
4. CONTROL THE RISK AND RECORD PROCEDURES
5. REVIEW THE RISK & DEVELOP EMERGENCY PROCEDURES

3.6.1 **Further advice on how each stage may be accomplished is contained in Part 2 of the Guidance Note.**

Risk Assessment – Guidance Notes on Step-by-Step Approach

Part 2

GUIDANCE ON MAIN ELEMENTS OF RISK ASSESSMENT FOR ELECTRONIC CHART DISPLAY & INFORMATION SYSTEM (ECDIS) OPERATING IN THE RCDS MODE

STAGE 1 – DEFINE THE HAZARD

1.1 ECDIS has two official modes of operation: ECDIS mode when Electronic Navigational Chart (ENC) data is available and Raster Chart Display System (RCDS) mode when ENC data is unavailable. Hazards associated with the operation and use of ECDIS can be conveniently categorised under these two modes.

1.2 Defining the hazard when operating in ECDIS mode and ENC data is available.

1.2.1 In this mode, hazards could be failure of all or part of the system; the most obvious would be loss of electrical power. However, other hazards (e.g. virus infection of software) need to be considered.

1.2.2 In defining the hazards in this mode, the following should be among those considered:

1. Hardware failure.
2. Software failure.
3. Power failure.
4. Failure to update charts correctly.
5. Input failure.
6. Virus infection.
7. Operator error through lack of training and/or familiarisation.

1.3 Defining the hazards when operating in RCDS mode when ENC data is unavailable

1.3.1 When operating ECDIS in the RCDS mode, due to the unavailability of ENC data, the full functionality of ECDIS is unachievable when operating ECDIS in the RCDS mode and therefore it can only be used together with an appropriate portfolio of paper charts. Therefore, by analysing this reduced functionality – specifically, each of the practical navigational limitations of the mode as specified in paragraph 3 of SN/Circ.207 (See Annex 14 of the MCA Special Publication) associated hazards can be defined. For example, 3.1 of SN/Circ.207 states “...RCDS is a chart-based system similar to a portfolio of paper charts”. This limitation therefore generates a potential hazard that the next chart may be unavailable. All RCDS limitations can be analysed in a similar fashion to establish potential hazards. An example of such an analysis is contained in Annex I.

1.4 Failure Analysis

1.4.1 A useful tool in defining the hazards is a Failure Mode and Effects Analysis (FMEA) or similar failure analysis. An FMEA identifies the consequences if the primary element of ECDIS was to fail. This assists in defining the hazards associated with a particular ECDIS. System manufacturers will normally supply an FMEA on request.

STAGE 2 – DETERMINE RISK

2.1 The risk from the hazard may be determined by estimating:

- The potential severity of the hazard occurring
- The likelihood that the hazard will occur

2.2 These two components need to be established independently, then combined to establish the level of risk referred to as the risk factor.

Risk Factor = Severity of Hazard X Likelihood of Hazard Occurring

2.3 Severity of hazard

2.3.1 The severity of the hazard is the consequence of the hazard occurring. The consequence could result in damage to own or other vessel, damage to the environment, or to personnel. The extent or severity of a hazard occurring is dependent on the individual type of vessel, the area of operation and the competence of the operators.

2.3.2 For example, a deep laden tanker transiting the Dover Strait without an appropriate electronic chart would experience greater difficulties than a shallow draught high-speed ferry operating in the same area.

2.3.3 During the risk assessment it is important that the individual characteristics of the vessel and area of operation are considered.

2.3.4 The following list indicates issues among those that need to be considered:

1. Draught.
2. Dimensions of vessel.
3. Manoeuvring characteristics, including stopping distance.
4. Squat criteria.

5. Navigational constraints, ports, narrow channels, traffic separation schemes etc.
 6. Weather.
 7. Local assistance available.
 8. Competence of ECDIS operators.
 9. Reliance on ECDIS for navigation.
 10. Nature of cargo.
- 2.3.5 The consequence of each hazard occurring needs to be carefully considered in relation to specific aspects of the vessel and the area of operation. Those completing the risk assessment can estimate the level of severity of the consequence as MINOR, MAJOR or CRITICAL.
- 2.3.6 For each vessel it can then be established if the hazard would result in a minor, major or critical situation. In determining the severity of each identified hazard the following factors need to be among those considered.
- 2.3.7 **MINOR**
- Interruption of availability of navigation information.
 - Reduced functionality of ECDIS in the RCDS mode.
 - Increased workload of bridge team.
- 2.3.8 **MAJOR**
- Severe disruption to availability of navigation information.
 - Loss of alarm functions.
 - Unable to continuously monitor vessel's position.
 - Difficulty in maintaining planned track.
- 2.3.9 **CRITICAL**
- Loss of safety critical navigational information.
 - ECDIS, in the RCDS mode, is totally unreliable.
 - Unable to monitor vessel's track.
 - Unable to maintain planned track.
- 2.3.10 For example, a vessel finding that the "next RNC chart is unavailable" may be able to use a different scale chart of the area and maintain track with parallel indexing and clearing bearings techniques. In this case, the severity of the hazard "next RNC chart unavailable" could be deemed as "MAJOR". However, if the same vessel did not have any other chart of the area, either electronic or paper, and had not adopted parallel indexing or visual means of navigation then the severity could be deemed as "CRITICAL".
- 2.3.11 In the majority of cases the severity of the hazard varies according to the location of the vessel. The severity of "next RNC chart unavailable" would be less whilst a vessel was in open waters than if navigating in coastal or harbour approaches. For the risk assessment, the worst-case scenario should be used to assess the severity of the risk.
- 2.4 **Likelihood of hazard occurring**
- 2.4.1 In order to establish the likelihood of the hazard occurring, the adequacy of control measures already in place need to be considered. Such control measures include procedures or ECDIS specifications that reduce the likelihood of the risk occurring. These include the back-up arrangements in place and onboard operational procedures.
- 2.4.2 Each identified hazard needs to be separately considered.
- 2.4.3 Methods of controlling or reducing the particular hazard should then be considered to establish the probability or likelihood of the hazard occurring. Improving the procedures of ECDIS operation can often reduce the likelihood of the hazard occurring.

- 2.4.4 For example the likelihood of the hazard “next RNC chart unavailable” is reduced if the charts are loaded onto the ECDIS hard drive and charts are reviewed at the passage planning stage. A review of the onboard operating procedures may, therefore, be all that is required. Similarly, when considering the purchase of an ECDIS system, the built-in control features need to be considered.
- 2.4.5 The hazards identified in Table I and those in Annex II are intended to provide guidance in assessing the likelihood of a hazard occurring. The personnel completing the risk assessment should consider which section best describes their ECDIS specification and control procedures. The adjacent section identifies the likelihood of the hazard occurring. This identified likelihood is then used in the risk assessment process. It can be seen from this process that the greater the specification of the ECDIS and the better the onboard control procedures, then the likelihood of the hazard occurring is, as a consequence, reduced.

Table I
Establishing the likelihood of the hazard occurring

HAZARD (example)	“Next RNC chart is unavailable”
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD OF HAZARD OCCURRING
RNC charts are accessed directly from CD.	LIKELY
RNC charts are loaded onto the ECDIS hard drive. ECDIS opens next available RNC chart automatically. ECDIS allows for viewing and examination of next RNC chart. ECDIS provides chart catalogue facility.	UNLIKELY
Required RNC charts can be selected and reviewed during passage planing. Required RNC charts can be saved to separate file or workspace. Appropriate paper charts prepared during passage planning and available.	HIGHLY UNLIKELY

2.5 Risk factor

- 2.5.1 The risk factor is determined by combining the *SEVERITY* of the hazard by the *LIKELIHOOD* of the hazard occurring.

Risk = Severity x Likelihood

Table II

Establishing the risk factor, risk control and action plan.

		SEVERITY OF HAZARD		
		MINOR	MAJOR	CRITICAL
LIKELIHOOD OF HAZARD OCCURRING	HIGHLY UNLIKELY	TRIVIAL RISK	TOLERABLE RISK	MODERATE RISK
	UNLIKELY	TOLERABLE RISK	MODERATE RISK	SUBSTANTIAL RISK
	LIKELY	MODERATE RISK	SUBSTANTIAL RISK	INTOLERABLE RISK

2.6 Risk Severity

2.6.1 The level of risk forms the basis of deciding whether additional or improved controls are required and the timescale for action.

2.6.2 **TRIVIAL** No action required.

2.6.3 **TOLERABLE** No additional controls required. Monitoring required.

2.6.4 **MODERATE** Efforts made to reduce the risk within a defined period.

2.6.5 **SUBSTANTIAL** Urgent action to be taken, ECDIS can not to be relied upon.

2.6.6 **INTOLERABLE** ECDIS not to be used for navigation until risk has been reduced. Immediate action required for reducing risk.

STAGE 3 – DECIDE IF RISK IS TOLERABLE

3.1 Having established the severity of a hazard and the likelihood of that hazard occurring, the risk assessment then requires the risk factor to be established. The risk factor establishes the level of risk and whether that risk is tolerable. For example a vessel may have established a hazard with a “MAJOR” severity yet, due to control procedures, the likelihood is “HIGHLY UNLIKELY”. As can be seen from Table II the risk, in this case, would be tolerable. However, if for the same hazard the likelihood was “LIKELY” then the risk would no longer be tolerable.

3.2 Using the example hazard of “Next RNC chart is unavailable”, as can be seen in Table III:

The severity has been determined as.....**MAJOR**

The likelihood has been determined as.....**HIGHLY UNLIKELY**

Using the table above the risk is determined as.....**TOLERABLE RISK**

3.3 Risk factor related to paper chart reduction

- 3.3.1 The exact number, scale and type of paper charts required should be identified during the risk assessment process and will vary depending on type of vessel and area of operation. The severity or likelihood of some hazards can be reduced by use of appropriate up-to-date paper charts as a back-up system.
- 3.3.2 Individual vessels must give consideration to own ship dimensions and take into account navigationally critical areas such as:
1. Harbour approaches.
 2. Traffic separation schemes.
 3. Narrow channels.
 4. Anchorages.
 5. Areas to be avoided (ATBA).
 6. Areas of high traffic density.
- 3.3.3 The level of paper chart reduction relates to the established risk factor; the greater the risk factor, the less the paper chart reduction. A vessel with an intolerable risk factor will not achieve any reduction in paper charts, whilst a trivial risk factor could result in maximum paper chart reduction. When all the identified hazards have been assessed the greatest risk factor is taken as the level of overall risk.
- 3.3.4 The appropriate portfolio of up-to-date paper charts will reduce the risk factor of ECDIS operating in RCDS mode, by reducing the severity of the hazard or by reducing the likelihood of the hazard occurring and should therefore be established during the risk assessment process.
- 3.3.5 However, the justification for any reduction in paper charts has to be fully supported by the outcome and results of the risk assessment.

STAGE 4 – CONTROL PROCEDURES

4.1 Control Procedures

- 4.1.1 Control is the adoption of procedures or equipment that eliminates or reduces the established risk. In developing additional or improved control procedures the following points are among those that need to be considered:
1. Ensuring against over reliance of ECDIS by adopting traditional navigational methods such as parallel indexing and clearing bearings.
 2. Developing procedures to maximise the efficiency of the ECDIS system.
 3. Developing procedures to guard against human error whilst operating and supporting the ECDIS. This includes the correct procedure for chart corrections and data installation.
 4. Considering the levels of training and familiarisation of navigating officers.
 5. Ensuring adequate technical support is available.
 6. Number and scale of paper charts constituting the appropriate portfolio.

4.2 Emergency Procedures

- 4.2.1 In the event of an ECDIS failure, suitable and sufficient procedures are required to ensure that safe navigation is not compromised. The risk assessment will identify the principal hazards and control measures required. For each of these hazards, emergency procedures are required in the event of the hazard occurring. For example, if the ECDIS did not produce the next RNC chart, despite the control measures in place, then the navigating officer must initiate emergency procedures, such as switching to the approved back-up arrangements.
- 4.2.2 It is therefore important that each vessel considers the appropriate emergency procedures for its particular onboard system. In establishing these procedures the following should be taken into account:
1. Back up systems, including second ECDIS system or other method approved by the national maritime administration.

2. The provision of appropriate paper charts.
 3. Technical support available both onboard and ashore.
 4. Changing to other sensor inputs such as second gyro compass or GPS system.
- 4.2.3 The developed control procedures should be incorporated into the onboard Safety Management System. Existing procedures will need to be reviewed to ensure that no conflicting instructions or policies occur.

STAGE 5 – REVIEW THE RISK

- 5.1 A successful risk assessment will ensure hazards have been identified and a system to manage the risks associated with those hazards has been successfully established onboard.

5.2 Review adequacy of control plan

- 5.2.1 The adequacy and practicality of the established procedures should be verified by asking:

1. Will the revised controls lead to tolerable risk levels?
2. Are new hazards created?
3. Are the control methods practical?
4. Are the control methods possible within navigational time constraints?
5. What do the ship's officers think of the ECDIS control methods?

- 5.2.2 The value of the risk assessment depends on the appropriateness of the control and emergency measures developed. It is important to develop a policy of continual review to ensure the procedures remain meaningful and practical.

5.3 Record Keeping

- 5.3.1 Having established the action plan and procedures the results should be recorded by a simple method, which allows for quick reference. Such an example is illustrated in Table III overleaf.

5.4 Regular Review

- 5.4.1 A further stage of the risk assessment is to adopt a procedure to ensure the risks are regularly reviewed and that the control procedures are practical.

- 5.4.2 As can be seen from the pro-forma Risk Assessment Record (at Annex III) it is recommended that a future review date is set. This date should be recorded elsewhere so that review takes place as planned. If it does not, this would constitute a breach of the ISM Code.

- 5.4.3 It should be noted that the pro-forma allows for the determination of the 'inherent risk' before any control procedures have been initiated, followed by the subsequent determination of the 'residual risk' after various mitigating options have been implemented.

**Table III
RCDS BACK-UP RISK ASSESSMENT PRO FORMA – EXAMPLE**

HAZARD	SEVERITY	LIKELIHOOD	RISK
Next RNC chart is unavailable	Major	Highly Unlikely	Tolerable Risk

ACTION PLAN

1. No additional controls required.
2. Continue to monitor effectiveness of current controls.

CONTROL PROCEDURES

1. Ensure all charts and licences are loaded onto the hard drive.
2. Review the chart catalogue prior to each voyage and after each chart update to ensure currency of chart licence.
3. Review all charts required during passage planning and prior to land fall.
4. Save required charts for intended voyages on separate file.
5. Plot position on paper chart at regular intervals.

EMERGENCY PROCEDURES

1. Manually open chart by using chart catalogue facility.
2. Change over to ECDIS back-up arrangements.
3. Call Master and reduce speed if required.
4. Contact shore side support.

Date		By	
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ANNEX I
Example Analysis of RCDS mode limitations and potential hazards

LIMITATION (See also Paragraph 3 of SN/Circ 207)	POTENTIAL HAZARD
1. Chart based system.	Next RNC chart unavailable. Lack of anticipation of approaching and developing navigational hazards.
2. Alarms not triggered by chart data.	Vessel may enter designated danger areas. Planned passage may cross danger areas.
3. Datum shifts.	Vessel's position on the chart may shift, especially between charts.
4. Display cluttered with radar and Automatic Radar Plotting Aid (ARPA) overlay.	Important navigational information is obscured / misinterpreted.
5. Look ahead capability reduced.	Lack of anticipation of approaching and developing navigational hazards.
6. Orientation of chart not practical.	Unable to utilise "course – up" or "ship's head up" orientations.
7. RNC cannot be interrogated.	Navigational information not readily available.
8. Not possible to select safety contours.	Vessel may enter designated danger areas. Planned passage may cross danger areas.
9. Different display features due to different source data.	Important navigational information is obscured / misinterpreted.
10. Excessive zooming degrades display.	Loss of navigational data. Vessel navigating on inappropriate chart scale.
11. No indication of the electronic position - fixing system and RNC compatibility.	Accuracy of chart less than position-fixing system in use.

ANNEX II
Establishing the likelihood of the hazard occurring

Table Hazard

- (i) Next RNC chart unavailable.
- (ii) Lack of anticipation of approaching and developing navigational hazards.
- (iii) Vessel may enter designated danger areas.
- (iv) Planned passage may cross danger area.
- (v) Vessel's position on chart may shift especially between charts.
- (vi) Important navigational information is obscured / misinterpreted.
- (vii) Loss of navigational data.
- (viii) Navigational information not readily available.
- (ix) Accuracy of chart less than the position fixing system in use.
- (x) Hardware failure.
- (xi) Software failure.
- (xii) Power failure.
- (xiii) Failure to up date charts correctly.
- (xiv) Input failure – Position.
- (xv) Input failure – Course and Speed.
- (xvi) Virus infection.

The above list is not intended to be exhaustive and ECDIS users must be prepared to include any additional hazards that have been identified for their particular circumstances.

Table (i)

HAZARD Next RNC chart unavailable	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Charts are accessed direct from CD.	LIKELY
Charts are loaded onto ECDIS hard drive. ECDIS opens next available chart automatically. ECDIS allows for viewing and examination of next RNC chart. ECDIS provides chart catalogue facility.	UNLIKELY
Required charts can be selected and reviewed during passage planning. Required charts can be saved to separate file or workspace. Appropriate paper charts prepared and available.	HIGHLY UNLIKELY

Table (ii)

HAZARD Lack of anticipation of approaching and developing navigational hazards	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
ECDIS operates with a fixed chart scale limited look-ahead capability.	LIKELY
ECDIS allows for easy zooming of chart scales. Relative motion or fixed own ship operation selected. Approaching navigation hazards identified during passage planning and annotation made on chart.	UNLIKELY
Second independent ECDIS screen available to provide adequate look-ahead capability. Correct alarms set up during passage planning to indicate approaching navigation dangers and risk of collision. Paper chart of general area used in conjunction with ECDIS.	HIGHLY UNLIKELY

Table (iii)

HAZARD Vessel may enter designated danger areas	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Danger areas not identified or selected e.g. safety contour. Vessel's parameters not entered. ECDIS not fitted with adequate visual and audible alarm.	LIKELY
Danger areas and safety contour identified with allowance for predicted tidal height. Clear visual and audible alarms fitted and activated.	UNLIKELY
Alarmed margins of safety, allowing for the vessel's manoeuvring and turning capacity, have been established. Methods such as Clearing Bearings and Parallel Indexing ensure against over reliance and vessel remains in safe water.	HIGHLY UNLIKELY

Table (iv)

HAZARD Planned passage may cross danger areas	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Planned passage not checked visually by navigator. Route checking facility unavailable. Route checking facility incorrectly set up.	LIKELY
Planned passage visually checked by navigator and bridge team as appropriate. Route checking facility correctly set up with appropriate alarms activated. Adequate margins of safety allowed (channel borders), taking into account wind, tide and shallow water effects.	UNLIKELY
Simulated passage run on ECDIS prior to departure. Passage plan checked by second navigator prior to departure. Passage plan plotted on paper chart of general area.	HIGHLY UNLIKELY

Table (v)

HAZARD Vessel's position on chart may shift especially between charts	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Position inputs to ECDIS from navigation systems are NOT set to WGS 84 datum. ECDIS averages out the datum shifts for the area of operation.	LIKELY
All position inputs to ECDIS are set to WGS 84 datum. ECDIS applies datum shift provided by hydrographic office for chart in use. ECDIS provides alarms when using a chart with ill-defined datum.	UNLIKELY
Vessel's position is checked against visual navigation methods. Radar is used to check accuracy of charted position by comparing location of acquired fixed target and charted symbol. ECDIS allows the chart to be re-aligned in areas of ill-defined datum only.	HIGHLY UNLIKELY

Table (vi)

HAZARD Important navigational information is obscured/misinterpreted	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Layering operation not used by ECDIS operator. Radar overlay continually displayed. Electronic chart symbols unfamiliar to the ECDIS operator.	LIKELY
Additional layers, as required, are selected by the operators and a standard display has been established. Radar overlay and/or ARPA data selected as required. Chart symbols fully understood by operators.	UNLIKELY
Two independent ECDIS display screens are available showing different layers of information. Other electronic data such as tidal information can be accessed from a separate display. Paper charts for navigationally critical areas available.	HIGHLY UNLIKELY

Table (vii)

HAZARD Loss of navigational data	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
ECDIS system allows raster charts to be zoomed beyond the construction scale. ECDIS uses unofficial data charts in contradiction to SOLAS requirement.	LIKELY
ECDIS warns the operator if raster charts are over-scaled. Only official data RNC charts are installed.	UNLIKELY
Procedures ensure only up-to-date official data charts are used. Prior to sailing the charts are checked to ensure all required charts are loaded with proper usage and scales. Paper charts for navigationally critical areas available.	HIGHLY UNLIKELY

Table (viii)

HAZARD Navigational information not readily available	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Nautical publications not readily available.	LIKELY
Navigational information such as tides are shared in the same raster format. Hydrographic Office electronic nautical publications are installed. Notices to Mariners are automatically loaded during chart correction process.	UNLIKELY
Nautical information not available from the ECDIS can be manually annotated onto the electronic chart during passage planning.	HIGHLY UNLIKELY

Table (ix)

HAZARD Accuracy of chart less than position-fixing system in use	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
ECDIS using unofficial data in contradiction to SOLAS requirements. Charts are not updated correctly.	LIKELY
The ECDIS provides an indication of the electronic navigation system's compatibility with raster chart. Radar overlay available.	UNLIKELY
Visual means of checking position such as Parallel Indexing, Clearing Bearings and Transits are used to monitor the performance of ECDIS. ARPA targets of fixed objects are used to confirm position.	HIGHLY UNLIKELY

Table(x)

HAZARD Hardware failure	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
System based on domestic computers not designed to withstand marine environment, in contradiction to SOLAS requirement. System exposed to extreme conditions such as temperature, humidity and vibration.	LIKELY
ECDIS system uses type-approved hardware. ECDIS in protected position. Regular maintenance and servicing conducted by qualified person.	UNLIKELY
Second ECDIS system immediately available. Other type-approved electronic backup solution, loaded with identical ECDIS software, immediately available. Paper charts for navigational critical areas available.	HIGHLY UNLIKELY

Table (xi)

HAZARD Software failure	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
System uses software other than type-approved electronic chart software. Limited random access memory (RAM) and hard disc drive space.	LIKELY
Type approved ECDIS software used. No other software used on the system. Sufficient RAM and hard disc drive space available.	UNLIKELY
Software tested prior to departure. Diagnostic testing programme provided and used. Second ECDIS system immediately available.	HIGHLY UNLIKELY

Table (xii)

HAZARD Power failure	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Single power supply with no emergency back up available, in contradiction to SOLAS requirement. No alarm to indicate power failure.	LIKELY
Emergency power supply available automatically. Alarms indicate power disruption.	UNLIKELY
Second emergency power supply available. ECDIS software available on type-approved electronic backup solution, battery powered and always fully charged. Paper charts for navigationally critical areas available.	HIGHLY UNLIKELY

Table (xiii)

HAZARD Failure to update charts correctly	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Chart corrections NOT installed on a weekly basis. Chart corrections loaded onto hard drive but NOT checked until chart required. Notice to mariners NOT automatically loaded.	LIKELY
Chart corrections installed on a weekly basis. Check program run after charts corrected to ensure corrections compatible with chart edition. Notice to mariners automatically loaded and easy access available.	UNLIKELY
Actual chart corrections can be examined on the chart. Procedure in place to cross reference corrections with paper charts carried onboard.	HIGHLY UNLIKELY

Table (xiv)

HAZARD Input failure Position	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
ECDIS input from single GPS. GPS position on chart NOT monitored by visual navigation.	LIKELY
ECDIS input from two independent positioning systems. GPS position monitored by visual methods of navigation. Alarms activated when input failure occurs.	UNLIKELY
Quality of GPS fix monitored especially 'signal to noise ratio'. Ability to perform manual fix on the electronic chart for cross reference of GPS position.	HIGHLY UNLIKELY

Table (xv)

HAZARD Input failure Course and Speed	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
Log and gyro input unavailable.	LIKELY
Speed log and gyro compass input to ECDIS. DR mode indicated. Position monitored by visual means and radar.	UNLIKELY
Ability to manually plot DR and EP positions.	HIGHLY UNLIKELY

Table (xvi)

HAZARD Virus infection	
ECDIS SPECIFICATION & CONTROL PROCEDURES	LIKELIHOOD
System shared with other software.	LIKELY
All software anti-virus scanned before installation. No other software sharing the system.	UNLIKELY
Anti-virus software fitted to ECDIS automatically detects viruses. Alarms fitted.	HIGHLY UNLIKELY

ANNEX III – Risk Assessment Pro-Forma

SS/MV _____

Future Review Date _____

HAZARD	INHERENT RISK		
	SEVERITY	LIKELIHOOD	RISK
CONTROL PROCEDURES			
EMERGENCY PROCEDURES			
ACTION PLAN			
Hazard	RESIDUAL RISK		
	Severity	Likelihood	Risk
Date		By	

