

Paper for Consideration by CHRIS 19

Enhancing the Presentation of Survey Quality in ENC

Submitted by:	UK
Executive Summary:	<p>To consider a recommendation of the UK's Marine Accident Investigation Branch (MAIB) arising from its investigation into the grounding of the jack-up barge <i>Octopus</i> (see Related Doc).</p> <p>Specifically, to investigate ways of ensuring that ECDIS displays provide a clear warning or indication to the mariner whenever the survey data used to produce the electronic chart in use is of poor quality.</p> <p>To determine appropriate IHO/CHRIS actions, which may include the tasking of WG(s).</p>
Related Documents:	<p>UK MAIB Report No 18/2007, published 9 August 2007: <i>"Report of the investigation of the grounding of the jack-up barge Octopus towed by the tug Harald, Stronsay Firth, Orkney Islands, 8 September 2006"</i>. (subject report is available in full at www.maib.gov.uk)</p>
Related Projects:	Development of S-101 – requirement for user input

Introduction / Background

1. Whilst under tow, the jack-up barge *Octopus* grounded on an uncharted shoal resulting in substantial costs, due to damage (approximate value UK£1M) and project delays.

- The location of the grounding is an area in the north of the British Isles that had not been subject to modern hydrographic survey.
- The shoal that caused the grounding (subsequently surveyed with a depth of 7.1m) was not previously known to the hydrographic community; the chart indicated depths >20m.
- The primary navigational tool in use was the largest scale paper chart; this clearly indicated the age and provenance of the source data (leadline survey of the 1840s) in a Source Diagram, along with additional cautionary notes.
- In planning and conducting navigation, the paper chart was used in conjunction with a monochrome electronic chart plotter (Seatrack).

2. For such incidents, the UK's Marine Accident Investigation Branch (MAIB) investigate and report on the circumstances, making recommendations as appropriate. The UK's Merchant Shipping Accident Reporting and Investigation Regulations 2005 state that:

the sole objective of the investigation of an accident ...shall be the prevention of future accidents through the ascertainment of its causes and circumstances.

3. The MAIB investigation noted that the old survey was accurately reflected in the paper chart and that additional cautions (both on the chart and in associated publications – Sailing Directions, Mariners Handbook) were provided and concluded that the UKHO's products were not at fault.

4. However, although not directly related to this particular incident, MAIB raised the question of how an ECDIS might have displayed the poor quality source information and whether adequate warnings would have been given to the user. In an ENC this can currently be done through use of the quality of data object – M_QUAL and the Category of Zone of Confidence attribute – CATZOC.

Specifically, the MAIB report notes:

- *While CATZOC data is available to ECDIS users, the industry's understanding of the system appears limited.*
- *Of ... concern is that many electronic navigation and charting systems using vector chart presentations, either do not display source data at all, or contain the information in sub-menus.*
- *MAIB's experience from previous accidents is that the training of watchkeepers in the use of ECDIS and ECS systems is, at best, patchy and that many are able to use only the systems' most basic functions. Specific concerns include:*
 - *CATZOCs do not provide the navigator with the detail currently shown in the source data diagrams on paper chart.*
 - *On ECDIS displays, CATZOC data is available, but has to be operator selected. Depending on the make/model of the ECDIS, this selection could be in any of the sub-menus.*
 - *ECS displays that use official electronic charts, are not always able to display CATZOC information, even when it is available, and basic ECS systems that use unapproved charts may not display CATZOC at all. Numerous vessels now carry ECS as a supplementary aid to their approved paper charts, but by default it has become the primary method of navigation for some navigators.*

5. In summary, the report highlights the following in respect of electronic charts:

- *The significance of CATZOC is not fully understood by many operators.*
- *The use of CATZOC is an ECDIS menu option and is therefore not immediately available to the navigator.*
- *CATZOC is unavailable on many unapproved ECS and chart plotters.*

6. **One of MAIB's recommendations is that UKHO and UK MCA (Maritime and Coastguard Agency):**

“Agree wording and put forward to the IHO/IMO a proposal that the relevant working groups investigate ways of ensuring that ECDIS displays provide a clear warning or indication to the mariner whenever the survey data used to produce the electronic chart in use is of poor quality.”

7. Further points of interest to IHO contained in the report are:

- *A recommendation that...” industry bodies responsible for vessels that operate in remote waters, such as cruise vessels, offshore supply vessels and vessels engaged in renewable energy installation: promulgate to the ship owners through their membership the safety lessons identified in this report, to emphasize to shipmasters and navigating officers, the need to carefully consider chart source data and, in the case of Electronic Navigational Charts (ENC), “Category of Zone of Confidence” (CATZOC) when planning and executing navigational passages.”*

- The citing of S-55 Status of Hydrographic Surveying and Nautical Charting Worldwide, noting the increased usage and exploitation of the marine environment (e.g. operations of large passenger cruise vessels, deeper draught vessels, development areas for renewable energy resources) and related issues of funding for, and prioritisation of, surveys.

Analysis/Discussion

8. The issues documented above highlight possible limitations in the methodology currently used to encode and portray survey information in ENCs and the ability of the ECDIS to provide sufficient warning to the user. It appears that MAIB consider that CATZOC is insufficient on its own and wishes to see an automated warning system of some kind.

9. Whilst there are limitations as to what could be achieved to address these issues within the constraints of the current version of the S57 ENC product specification and the ECDIS Performance Standards, it is possible that some refinement of current practice could alleviate some of the problem. Certainly it would be appropriate to remind mariners to take account of survey quality when route planning and, where under-keel clearance is an issue, to create user warning zones that the ECDIS can act on

10. The introduction of S100 and the S101 ENC product specification allows a full reconsideration of the issue and it is important that both end users and equipment manufacturers provide input on the matter.

11. *Some issues for consideration::*

- What should be considered a survey of poor quality? CATZOC C and D would seem to fit this description; however other factors such as mobility of the seabed would need to be considered.
- Some producers consider existing criteria used to define the CATZOC categories are too objective and do not reflect the reality of hydrographic surveying.
- In reality a large percentage of the world's navigable waters could fall into the poor quality category; given this fact is an automated indication or alarm a good idea? Mariners already complain about the number of alarms that ECDIS generates.
- Whilst the user can, in most instances, interrogate the ENC (through the "pick report") to obtain further information on source data quality, this information is often presented in way that is meaningless to anyone who isn't completely familiar with S-57 and its supporting documentation.

Further details of the encoding and meaning of data quality objects and attributes can be found at Annex A.

Conclusions

12. The UK MAIB report recommends that the ECDIS provides an indication when the route checking routine shows that the planned route intersects an area of poor survey quality, a similar warning or indication being given during route monitoring if the vessel lookahead detects that the vessel will enter such an area. This issue should be considered by CHRIS and its Working Groups with a view to

determining whether follow up action is required, for example with IMO in regard to the ECDIS Performance Standards.

Recommendations

13. In the short term CHRIS should task the TSMAD and CSMWG to investigate possible solutions which can be implemented in a timely and cost effective manner to address MAIB concerns as far as practical and within the existing standards framework. As part of these deliberations consideration could be given to IHO submitting a paper to NAV54 suggesting an addition, on the use of CATZOC on ENC's, to existing guidance on passage planning.

14. In the longer term IHO should take the opportunity to review these issues fully during the development of S101. User and equipment manufacturer input on this topic could be gained through an S101 workshop that looks at a range of S101 / ENC related issues. There will be a need to review the encoding and display of survey meta-data and its use in ECDIS. Attendees should include user groups and industry along with representatives from IHO Working Groups, including DQWG, TSMAD, CSMWG, S-44WG, and CSPCWG.

Justification and Impacts

15. *Benefits of the proposed recommendations*

- Enhance the users' understanding and visibility of data quality issues within ENC's
- Provides a reasoned and active response to a M/S's maritime safety agency's recommendation

16. *Resource implications*

- If accommodated within WG work plans, progressing by existing meeting / workshop schedules or by correspondence (ie without the need to convene special forum), minimal funding impact.

17. It is proposed that the Working Groups named above take the first recommendation as a high priority. The second recommendation is seen as supportive to development of S101 and could be progressed as convenient by that WG.

Action Required of CHRIS



18. *The CHRIS is invited to:*

- a. Note MAIB concerns; discuss them, and if in agreement with the recommendations, forward them to TSMAD, CSWG for consideration.
- b. Consider the need for an S101 workshop to gain feedback on these and other ENC related issues to ensure full resolution in next generation ENC's/ECDIS systems. If CHRIS agrees this need then it should give TSMAD approval to set up such a workshop.

Annex A

Encoding of Survey Quality information in ENC

Two S-57 meta-objects, M_QUAL (quality of data) and M_SREL (survey reliability), are used to encode information relating to the quality, reliability and accuracy of bathymetric data. Annex A contains an extract from the S-57 Use of the Object Catalogue for ENC explaining in more detail the encoding of these meta-objects.

M_QUAL and its attribute CATZOC (Annex B) are mandatory and used to define the positional accuracy, depth accuracy and seafloor coverage of the source survey. M_QUAL is depicted using a star based pattern fill  for the 5 assessed CATZOC categories and  for unassessed. The symbology can be toggled on and off in ECDIS menu options and more detailed information about the survey found by pick report.

M_SREL has similar characteristics to the analogue source diagram, but is not symbolized and therefore it is potentially difficult to discover details by pick report.

Extract from S-57 - Use of the Object Catalogue for ENC

2.2.3 Quality, reliability and accuracy of bathymetric data

Information about quality, reliability and accuracy of bathymetric data is given using:

- the meta object **M_QUAL** for an assessment of the quality of bathymetric data,
- the meta object **M_SREL** for additional information about the survey,
- the attributes QUASOU, SOUACC and TECSOU on groups of soundings or individual objects,
- the attributes POSACC and QUAPOS on the spatial objects (see clause 2.2.4.1).

For the mariner, **M_QUAL** provides the most useful information. Therefore, the use of **M_QUAL** is mandatory for areas containing depth data or bathymetry.

More detailed information about a survey may be given using **M_SREL**. For example, in incompletely surveyed areas, lines of passage soundings may be indicated as such using a linear **M_SREL** object. This information is more difficult for the mariner to interpret. Therefore, the use of **M_SREL** is optional.

For individual objects (wrecks, obstructions etc), or small groups of soundings, QUASOU, SOUACC and TECSOU may be used to provide additional information about quality and accuracy.

2.2.3.1 Quality of bathymetric data

The meta object **M_QUAL** defines areas within which uniform assessment exists for the quality of bathymetric data, and must be used to provide an assessment of the overall quality of bathymetric data to the mariner. Areas of a cell containing depth data or bathymetry must be covered by one or more **M_QUAL**, which must not overlap.

Meta object: Quality of data (**M_QUAL**)

Attributes: CATZOC DRVAL1

 DRVAL2 - the maximum depth to which the quality information applies

 POSACC SOUACC SURSTA SUREND TECSOU
 INFORM NINFOM

Remarks:

- A CATZOC category indicates that the depths encoded within a **M_QUAL** area meet the minimum criteria described in the CATZOC definition table. A CATZOC category may be further sub-divided by specifying depth and positional accuracy, and sounding technique, using the attributes POSACC, SOUACC and TECSOU, within separate **M_QUAL** areas.
- DRVAL1 must not be used on a **M_QUAL** object, unless a swept area occupies the entire **M_QUAL** area.
- DRVAL2 must not be used on a **M_QUAL** object, except to specify the maximum depth to which the CATZOC category applies. When DRVAL2 is specified, the CATZOC category applies only to depths equal to or shoaler than DRVAL2. No quality information is provided for depths deeper than DRVAL2.
- POSACC must not be used on a **M_QUAL** object, except to specify a higher positional accuracy of the depths than the CATZOC category indicates. When DRVAL1 is specified, POSACC must not be used - there is no positional accuracy information provided for any underlying depths in this circumstance.
- SOUACC must not be used on a **M_QUAL** object, except to specify a higher accuracy of the depths than the CATZOC category indicates. When DRVAL1 is specified, SOUACC refers only to the accuracy of the swept depth defined by DRVAL1 - there is no depth accuracy information provided for any underlying depths in this circumstance.
- When the **M_QUAL** area contains soundings of two or more different techniques, the attribute TECSOU must not be used.
- When the **M_QUAL** area contains data from only one survey, the date of survey, if required, must be specified using the attribute SUREND. When the **M_QUAL** area contains data from two or more surveys, the date of the oldest survey, if required, must be specified using the attribute SURSTA, and the date of the most recent survey, if required, must be specified using SUREND.
- Additional quality information may be given using the meta object **M_SREL**.
- Where **M_QUAL** areas are encoded over land, CATZOC should be set to 6 (unassessed).
- **M_QUAL** may either be encoded over wet areas only, or alternatively a single **M_QUAL** object may be created for the whole cell over wet and dry areas.
- When **M_QUAL** and the meta object **M_ACCY** are encoded in a cell, they should not overlap.
- When both **M_QUAL** and **M_ACCY** objects are used in a cell, the area covered by these objects should equal the area of data coverage for the cell.
- POSACC on the **M_QUAL** applies to bathymetric data situated within the area, while QUAPOS or POSACC on the associated spatial objects, qualifies the location of the **M_QUAL** object itself.

2.2.3.2 Survey reliability

The survey reliability may be encoded using the meta object **M_SREL**.

Meta object: Survey reliability (**M_SREL**)

Attributes: QUAPOS QUASOU SCVAL1 SCVAL2 SDISMN SDISMX

Remarks:

- If the attributes SOUACC and TECSOU are required, they must be encoded on either the meta object **M_QUAL** or on individual geo objects (e.g. **SOUNDG**).
- If it is required to encode information to indicate the source of a survey, it must be done using the attribute SURATH on **M_SREL** (see clause 2.2.5.1).
- QUAPOS on the **M_SREL** applies to bathymetric data situated within the area, while QUAPOS or POSACC on the associated spatial objects, qualifies the location of the **M_SREL** object itself.

Zone of Confidence Table

1	2	3		4	5
ZOC ¹	Position Accuracy ²	Depth Accuracy ³		Seafloor Coverage	Typical Survey Characteristics ⁵
A1	± 5 m	a = 0.5 b = 1		Full seafloor ensonification or sweep. All significant seafloor features detected ⁴ and depths measured.	Controlled, systematic high accuracy Survey on WGS 84 datum; using DGPS or a minimum three lines of position (LOP) with multibeam, channel or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 0.6 ± 0.8 ± 1.5 ± 10.5		
A2	± 20 m	a = 1.0 b = 2		Full seafloor ensonification or sweep. All significant seafloor features detected ⁴ and depths measured.	Controlled, systematic survey to standard accuracy; using modern survey echosounder with sonar or mechanical sweep.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
B	± 50 m	a = 1.0 b = 2		Full seafloor coverage not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.	Controlled, systematic survey to standard accuracy.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
C	± 500 m	a = 2.0 b = 5		Full seafloor coverage 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 30 100 1000	± 2.5 ± 3.5 ± 7.0 ± 52.0		
D	worse than ZOC C	worse than ZOC C		Full seafloor coverage not achieved, large depth anomalies may be expected.	Poor quality data or data that cannot be quality assessed due to lack of information.