

Paper for Consideration by ENCWG**Report on the Auto-generation of HDENC Depth Contours**

Submitted by:	HDENC depth contours sub-group
Executive summary:	A small group led by China MSA and participated by UKHO, CHS, NOAA, I4insight, SevenCs and Caris, carried out an auto-generation test of HDENC depth contours by different softwares. This report will introduce the test results.
Related documents:	S-65 Annex A , High Density (HD) ENC Production and Maintenance

Background

1. In January 2020, IHO released S-65 Annex A, High Density (HD) ENC Production and Maintenance Guidance (Edition 1.0.0). At the ENCWG-6 held in June 2021, China MSA submitted the document ENCWG6-11.1d, which introduced the manual cartographic intervention experience about the auto-generation of HDENC depth contours and suggested that other HDENC producing authorities share their experiences as reference information for potential HDENC producing authorities.

2. According to the minute of ENCWG-6[Action6/17] “*ENCWG members interested in providing information on their process for generating contours for HDENCs and/or participating in a small group to compile this information into a single document for reference to notify the Chair at their earliest convenience.*” China MSA took the lead in setting up a small group on the HDENC depth contours auto-generation, with the participation of UKHO, CHS, NOAA, I4insight, SevenCs and Caris.

3. The main purpose of this work is to analyze whether the auto-generated depth contours accurately and reasonably depict the sounding data, and whether the cases need manual cartographic intervention are included in the S-65 Annex A. There is no algorithm research in this test , because different softwares have different algorithms, the research and improvement of the algorithm should be carried out by the software manufacturers seperately.

Introduction

4. At the end of October 2021, China MSA provided a testdata file named "HDENC-TESTDATA-NEW.000". The test data is composed of multi beam scanning soundings. In order to show the test result more comprehensive, some Soundings were manually modified.

5. All participants fed back their test results by the end of November 2021. The depth contours in these test results were auto-generated by the HDENC production softwares without manual cartographic intervention.

● Overview of test data

File name	HDENC-TESTDATA-NEW.000
Number of soundings	582,541
Average sounding density	1 meter
File size	93.869 MB
Coordinate reference system	WGS-84
Longitude and latitude resolution	0.00000001
Depth resolution	0.1

● Test requirements

Contours interval	0~30m: 1m; Above30m:5m.
Other requirements	Depth contours are auto-generated by software without cartographic intervention.
	Provide the software and its version.
	Provide appropriate introduction documents.
	cartographic intervention experience are welcomed to provide.

● List of test results

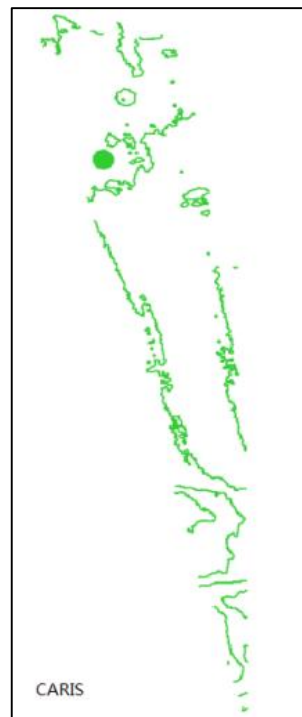
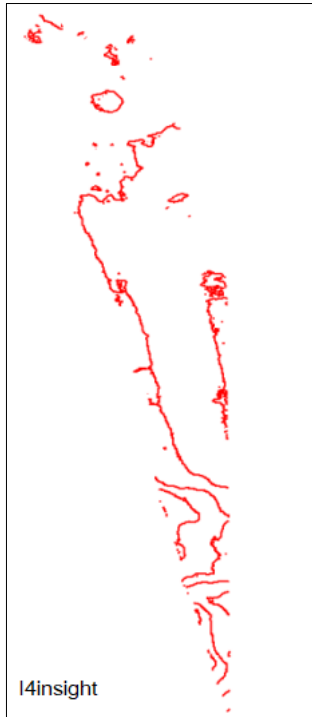
I4insight	CN5DEPCN.000
SevenCs	7C6MSA12.000
Caris	MSA_Compilation_Dec152021
UKHO	GB5CH001_000

CHS	CHS_HDENC_contours.000
CHINA MSA	TEST-DEP.000

● **List of test softwares**

I4insight	Dkart Bathy System 1.16.7 Dkart Editor 3.4.2
SevenCs	ENC Designer 4.7.0 FME 2021 ENC Bathymetry Plotter 2.0.0 7Cs Analyzer 5.0.1
Caris	Caris Base Editor(5.5.19)
UKHO	Caris Base Editor v5.4.5 Caris HPD Product Editor v3.2.13
CHS	Caris Base Editor v5.5.19
CHINA MSA	Caris Base Editor v5.4.5

● **Overview of test results**



Analysis and discussion

6. In S-65 Annex A, the guidance about the auto-generated depth contours shows as below:

- Clause 6, paragraph 3: *For reasons of economy, it is considered that the cartographic quality of contours auto-generated and smoothed by modern production software tools is sufficient for use of HD bathymetry in ECDIS. Cartographic intervention should only be applied when matching the “standard” depth contours to adjoining data and in the depiction of isolated shoals and deeps(see clause 8).*
- Clause 8: *The automated contouring process may generate contours that are too small to easily be displayed at HDENC compilation scale. It is recommended that no isolated shoal or deep area should be smaller than 2.75mm across any dimension at the compilation scale of the HD ENC. Appropriate automated contour generation algorithms so as to avoid the creation of small shoals should be investigated.*

7. According to ENCWG6-11.1d, the cases that need manual cartographic intervention in the generation of HDENC depth contours are as follows (Note: the production software of HDENC used by China MSA when submitting ENCWG6-11.1d is Caris Base Editor 4.1, which has been updated to Caris Base Editor 5.4.5 now):

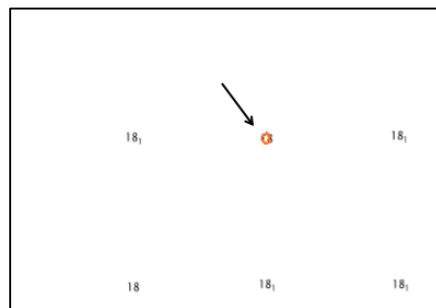
- Soundings are on depth contours;
- The shoals’ contours are too small;
- Intersection of depth contours.

8. In the test results submitted, the above problems have been solved to a certain extent. The details are as follows:

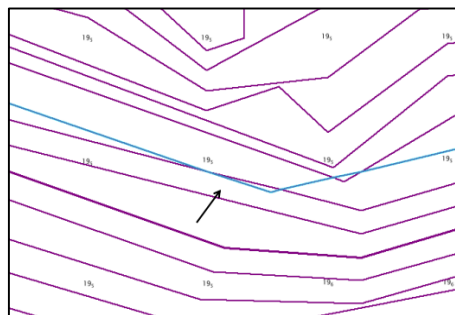
	Soundings are on depth contours (resolved)	The shoals’ contours are too small (resolved)	Intersection of depth contours (resolved)
I4insight	√	X	√
SevenCs	√	√	√
CARIS	√	√	√
UKHO	√	X	√
China MSA	√	X	√
CHS	√	√	X

9. As shown in the table above, some problems remain unsolved in some test results, eg.

- The depth contour of shoal is too small.



- Intersection of depth contours.

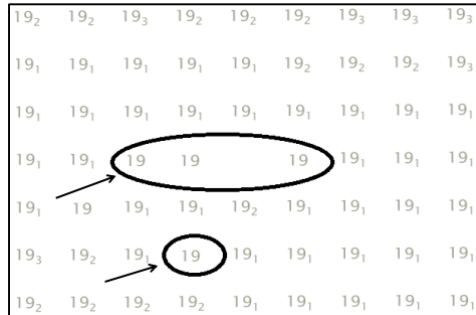


10. In addition to the above cases, we found the following cases may need manual cartographic intervention:

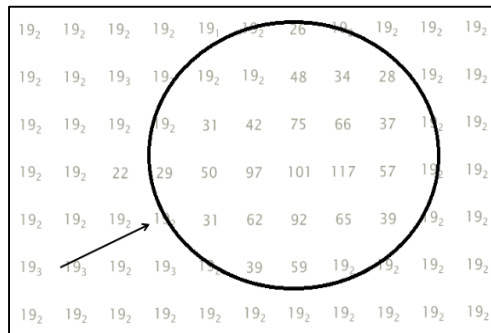
- The depth contours of shoals and deeps are not generated ;
- The depth contour does not match the sounding data;
- Depth contour is not smooth.

11. The depth contours of shoals and deeps are not generated(as shown in below figures).

- Shoals without corresponding depth contours.



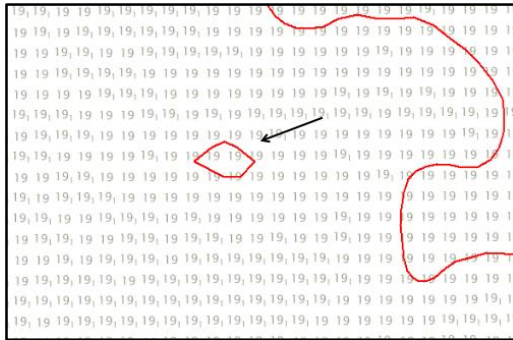
- Deepes without corresponding depth contours.



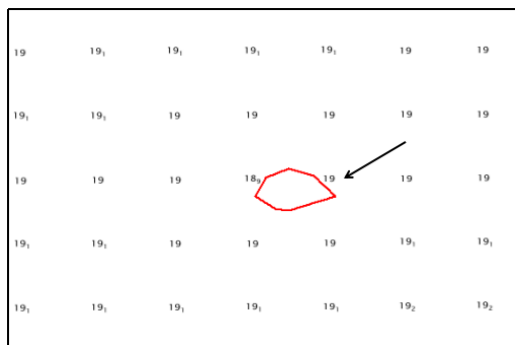
As it is recommended in clause 8 of S-65 Annex A, shoals and deeps smaller than 2.75mm may be omitted. But the Shoals and deeps bigger than 2.75mm should not be omitted. In the Auto-generation of HDENC depth contour, it is suggested to pay more attention to the isolated shoals or deeps, especially the shoals. After all, the lack of shoals information may easily lead to serious consequences.

12. The depth contour does not match the soundings (as shown in below figures).

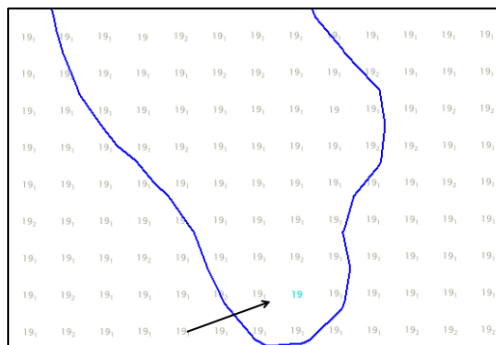
- The depth area defined for the shoal is too small, all 19m soundings are not included in the depth area.



- There is no soundings in below depth area, and the soundings are outside the corresponding depth area.

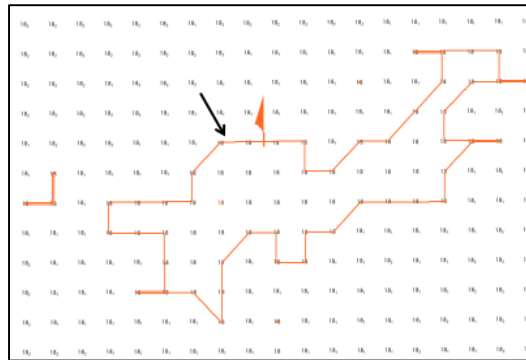


- The below depth contour can not depict the soundings suitably.



This kind of problem is not mentioned in S-65 Annex A , but we believe manual cartographic intervention should be processed.

13. Some depth contours are not smooth.



This kind of problem is mentioned as “it is considered that the cartographic quality of contours auto-generated and smoothed by modern production software tools is sufficient for use of HD bathymetry in ECDIS” in clause 6 of S-65 Annex A. However, we recommend manual cartographic intervention for the depth contours in the figure above, some parameters may need to be setted manually during this process.

Conclusion

14. The test result shows that the existing softwares can meet the requirements of HDENC production. At the same time, the depth contours auto-generated by different softwares are still different in some areas, and some of them need manual cartographic intervention. However, the number of depth contours that need to be processed manually is small, which has a limited impact on the production efficiency of HDENC.

Proposal

15. The following changes are recommended to the clause 6, paragraph 3 of S-65 Annex A :

For reasons of economy, it is considered that the cartographic quality of contours auto-generated by modern production software tools is sufficient for use of HD bathymetry in ECDIS. Cartographic intervention mainly be applied when matching the “standard” depth contours to adjoining data and in the depiction of isolated shoals and deeps(see clause 8). The following cases also should be noticed and optimized if exist:

- *When the depth contour does not match the soundings;*
- *When the depth contours have intersection;*
- *When the depth contour is not smooth.*

16. All software manufacturers continue to optimize the depth contour auto-generation algorithms of HDENC, and provide users with guidelines for manual cartographic intervention of HDENC depth contour if convenient.

Action requested by ENCWG

17. The ENCWG is requested to:

- a. Note the information provided;
- b. Consider the clarification of S-65 Annex A.