S-164/98SG11-2

Paper for Consideration by S164SG11

Proposal for a Representation and Realization Method for Safety Contour in S-98 Interoperability Scenarios

Submitted by:	China MSA
Executive Summary:	When selecting S-102 as the source of depth information and suppressing the S-101 depth features, or during the water level adjustment (WLA) processing, the ECDIS system can create or display accurate and safe contours from bathymetric grid data based on a user-set value. Three implementation options were designed and tested by the China MSA. After rigorous testing, it was observed that without creating any new line features, the system could clearly distinguish between safe and unsafe water areas through the line-like coloring method, thereby accurately presenting the safety contours. This approach not only simplifies data management but also significantly enhances system performance while achieving satisfactory visual presentation results. This proposal recommends modifying the definition of Own Ship's Safety Contour and making a decision based on the analytical test results presented: to clarify whether manufacturers need to extract and create new datasets for safety contours in interoperable scenarios, or whether they can effectively display safety contours through visual representation without generating any new line features.
Related Documents:	S-52(4.0.3);S-102 (2.1.0)； S-98(1.0.0)draft
Related Projects:	S-102PT; S-164/S-98 Sub-Group

Background

In the IHO Hydrographic Dictionary, Own Ship's Safety Contour is defined as: In ECDIS, the contour related to the own ship selected by the mariner from the contours provided for in the SENC, to be used by ECDIS to distinguish on the display between the safe and the unsafe water, and for generating anti-grounding alarms.

In S-52 (6.1.1) "Specifications for Chart Content and Display Aspects of ECDIS ", the safety contour is identified by a 0.6mm thick grey line. In the S-101 Portrayal Catalogue (1.2.0), the visualization of the safety contour is double coded by a thick grey line and a prominent change in depth shade. Whether in S-57 or S-101 ENCs, the safety contour is selected from the existing contours and expressed with a conspicuous grey line, without extract new line features.

S-98 Annex C "Harmonized User Experience for ECDIS and INS" defines the detailed mechanism of creation of user-selected safety contours and water level adjustments. When prioritizing the display of S-102 data while suppressing S-101 features, or enabling water level adjustment functionality, the current specifications do not provide clear guidance on whether customized safety contours require the extraction of new line features, and how to extract the safety contour in interoperability scenarios.

Given this, this proposal aims to conduct an in-depth analysis from multiple perspectives, to explore the specific approaches of displaying the safety contour using S-102 data or S-102 data after water level adjustment in interoperable scenarios.

Analysis

In the interoperability test recently conducted by the China Maritime Safety Administration, three S-100 based data products were used: S-101 ENC, S-102 Bathymetric Surface, and S-104 Water Level Information for Surface Navigation.

When using S-101 data, users set a value for the safety contour, but if the exact fit is not found from the available depth information in the ENC then the safety contour defaults to the next deepest which can be substantially deeper than the value requested by the user.

When prioritizing the display of S-102 data while suppressing S-101 features, or enabling water level adjustment functionality, the extraction or displaying of the accurate safety contour from bathymetric grid data can be performed based on a user-defined value. There are two ways to accomplish this.

The first approach focuses on displaying safety contours by distinguishing safe and unsafe water areas through linear coloring method without generating new line features. The current version 2.1.0 of S-102 Bathymetric Surface Product Specification does not explicitly specify how safety contour should be represented. Hence this method requires a clear representation of safety contour in the S-102 product specification and Portrayal catalogue.

The second approach leans towards creating new safety contours by extracting line features. The modeling and cartographic representation of the line feature need to be clearly defined (potentially referencing S-52 directly). Additionally, a thorough assessment is required to evaluate the feasibility of incorporating it into the S-102 or the S-98 interoperability catalogue to ensure that the newly extracted safety contour lines can be appropriately managed and utilized.

Based on these two approaches, the China MSA has designed three specific implementation methods and conducted testing. The following is a detailed discussion of the advantages and disadvantages of each method, aimed at providing a basis for subsequent decision-making processes.

Option 1: Use S-102 grid data or Water Level Adjustment (WLA) grid data, adopt a coloring method, and display the safety contour through algorithms

The coloring method does not require additional storage processing, as it is handled in real-time during the raster rendering stage, mainly based on the relationship between the current grid point and the neighboring grid points to determine the coloring method. As shown in Figure 1, this method can maintain good visual effects even at larger display scales. In addition to the safety contour, other contours in S-102 can also be rendered using this coloring method. When implementing S-98 interoperability, the system does not need to generate two separate data sets (safety contours and contours), and can also support and display the rapid dynamic changes of the safety contours and contours within an animation, tailored specifically for the user, from the start datetime to the end datetime selected by the user. After performance verification, this method ensures efficient data processing and good presentation.

Figure 1. Safety contours shown by coloring method

Advantages:

- High display speed
- Generating a seamless, linear effect that is visually pleasing
- No need to generate additional datasets or perform data management, greatly simplifying the complexity of the interoperation process.
- It facilitates the release and application of dynamic data services, Theoretically, the web end requires little data processing, making the data services relatively simple to use.

Disadvantages:

- Does not support data queries: Since the safety contour generated by the coloring method is not an actual spatial object, it cannot be accurately queried.
- Jagged display: When browsing at a relatively large scale, the inherent limitation of raster coloring may result in a jagged line display, which is not smooth enough.

Option 2: Using the S-102 grid values or the grid values after water level adjustment, extract the safety contours through spatial analysis and generate the safety contour data that exist in substance.

This option requires the generation of a temporary dataset of safety contours. When used as the source of the depth information in performing Level 1 interoperability, it is necessary to generate outside areas of S-102 coverage, contour datasets, etc., in addition to safety contour dataset.

Advantages:

- The safety contour extracted by spatial analysis is more visually pleasing.
- Supporting data interaction: Since the generated data are actual line features, it supports attribute information queries through mouse clicks, enhancing data interactivity.

Disadvantages.

- Dependence on Spatial Analysis Extraction Algorithms: The process of extracting safety contours involves determining how line objects traverse the S102 grids. Careful selection and adjustment of smoothing algorithms and coefficients are required, as shown in Figure 2.
- When dealing with large number of datasets, the generation of safety contours can be relatively slow. However, once generated, the efficiency of using these datasets is comparable to that of ordinary datasets.
- Data Management Challenges in Interoperability: Efficient management of temporary datasets (such as safety contours, contours, and S-102 coverage areas) is required when switching between Level 0 and Level 1 interoperability. There is also a need to consider whether these temporary datasets should be regenerated each time a switch is made.
- Increased management complexity on the Web side: When published as a data service, the Web side may require the development of more complex code to manage the temporarily generated datasets, thereby escalating the challenges associated with development and maintenance.

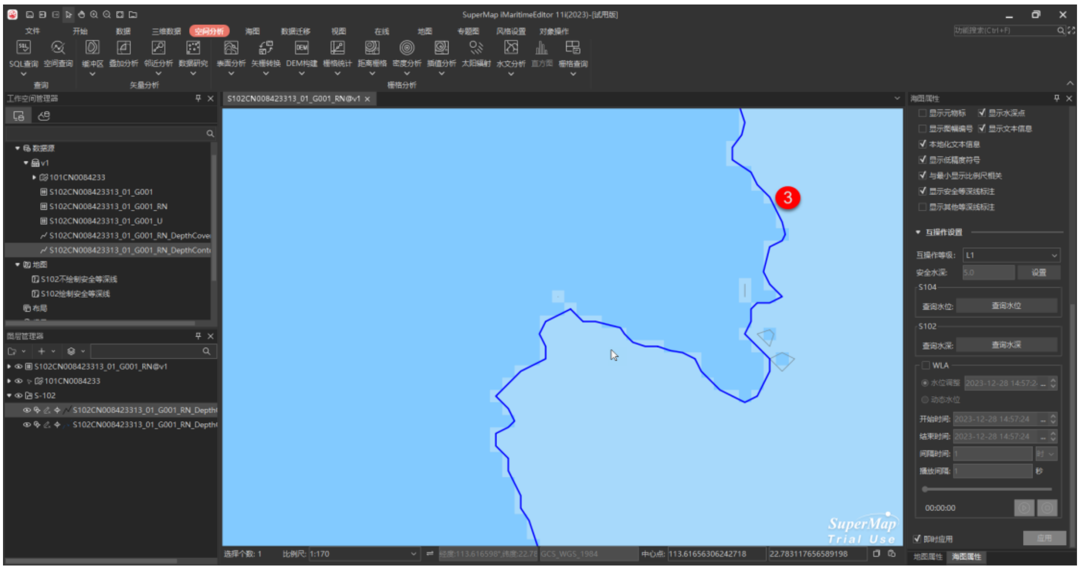

Figure 2. The extracted safety contour

Option 3. Extract safety contours and store the objects in memory solely for display purpose.

Advantages:

- The safety contour extracted by spatial analysis is more visually pleasing.

- Compared to Option 2, which generates temporary datasets, this scheme is simpler and theoretically easier to implement on the web side, requiring less processing on the web end.

Disadvantages:

- Similar to Option 2, this method also relies on spatial analysis algorithms to extract safety Contours.
- Memory and performance requirements: for large number of datasets, the generation process may be relatively slow, and the generation results are stored in memory, which requires a certain amount of memory configuration on the machine.
- The geometric shapes stored in memory are merely overlaid on the S-102 panel for display purpose and do not represent actual spatial objects. Therefore, they do not support querying.
- Performance Challenges: Compared to Option 1, this method may require redrawing when the map view changes or the map is moved. This involves re-extraction by using the spatial analysis algorithms and reordering and displaying objects according to S-101 drawing instructions, which can have a certain impact on performance.

Issues of each option in different scenarios

Listed below are four distinct application scenarios, along with the potential shortcomings of the above options for each scenario.

Scenario 1: Independent Browsing of S-102 product

- Issue with Option 2: Introducing new feature types necessitates a careful consideration of whether the existing feature catalogue requires redefinition. When browsing S-102 data, it is necessary to attach safety contours.

Scenario 2: S102+S101 predefined combination with Level 1 interoperability set

- Issue with Option 2: While in S-98 specification new features can be introduced, the management of temporary datasets may pose a challenge.

Scenario 3: S102+S104 predefined combination, processing Water Level Adjustment (WLA)

- Issues with Option 2 and 3: Adopting either Option 2 or Option 3 would result in a new set of depth values after each water level adjustment, necessitating re-extraction, display, and plotting at every moment. Theoretically, performance would degrade significantly during playing dynamic water level animation. Additionally, Option 3 faces performance issues when dealing with large data volumes, and no effective solution has been found to address these issues.

Scenario 4: predefined combination of S-102, S-104, and S-101 with Level 1 interoperability set and Water Level Adjustment

- Issues: As a combination of the functionalities of Scenario 2 and Scenario 3, the considerations multiply accordingly. For instance, if Option 2 and 3 are adopted, is it necessary to re-generate the two dataset, safety contours and general contours, based on new depth value at every moment during playing dynamic water level animation.

In summary, when considering the display and interoperability of S-102 safety contours, Option 1 shows strong adaptability and performance advantages across various functional operations and scenarios (Figure 3), thus deserving priority consideration.

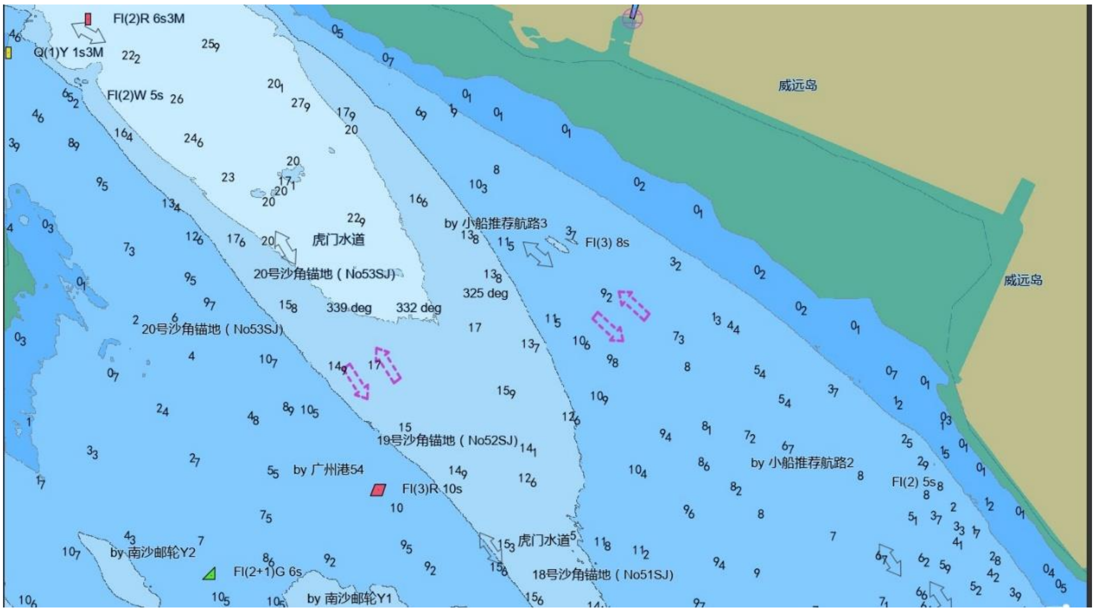

Figure 3. S102+S101 predefined combination with Level 1 interoperability set

Recommendations

1. Based on the description provided in Annex C of S-98, the safety contours can be generated from S-102 data or the depth information after WLA processing, and the concept of SENC should be extended to cover all S-100 products. Thus, it is recommended to update the definition of Own Ship's Safety Contour in IHO Hydrographic Dictionary. For instance, the definition could be: the contour related to the own ship selected by the mariner from the contours provided for in the SENC or generated from depth information in the SENC, to be used by ECDIS to distinguish on the display between the safe and the unsafe water, and for generating anti-grounding alarms.
2. Discuss the approaches and options analyzed above for generating safety contour and clarify whether manufacturers need to extract and create new datasets for safety contours in interoperable scenarios, or whether they can effectively display safety contours through visual representation without generating any new line features.

Action Required of S-164/S-98SG

The S-164/S-98SG is invited to:

1. Note the paper.
2. Discuss the Recommendation 1 and update the definition of Own Ship's Safety Contour.
3. Discussion on the Recommendation 2 and make explicit decisions.