**DQWG14-06B**

**HOW TO PROVIDE MEANINGFUL QUALITY OF BATHYMETRIC DATA INFORMATION IN S-101 ENCs.**

References:

A. IHO CL 50/2017 - *August 2017*

B. S101 Data Classification and Encoding Guide 1.0.0 – *December 2018*

C. DQWG Terms of Reference, 9th HSSC Meeting – *November 2017*

D. DQWG meeting 11 – Decision Tree – *May 2016*

E. DQWG meeting 12 – *June 2017*

F. DQWG meeting 14 – *February 2019*

G. S-57 Edition 3.1, Appendix A – Chapter 1, Page 1.216, November 2000

Dear Hydrographer,

As reported in Reference A, vessels at sea must today be fitted with Electronic Chart Display and Information Systems (ECDIS). The Data Quality Working Group has made an inventory on National Methodologies from survey data to Quality of Bathymetric Data (QoBD) values.

Quality of Bathymetric Data is defined as an area within which a uniform assessment of the quality of the bathymetric data exists (reference G). Based on these National Methodologies, this document describes a best practice how to classify QoBD. This will ensure a smooth conversion of S-57 ENCs to S-101 ENCs in a consistent manner across all ENC Producers.

**Zones of Confidence Categories (S-57)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ZOC Category | Position  Accuracy  (note 2) | Depth Accuracy (note 3) | | Seafloor Coverage | Typical Survey Characteristics |
| A1 | ± 5 m + 5% depth | =0.50 + 1%d | | Full area search undertaken. Significant seafloor features detected and depths measured. | Controlled, systematic survey (note 6) high position and depth accuracy achieved using DGPS and a multi-beam, channel or mechanical sweep system. |
| Depth (m)  10  30  100  1000 | Accuracy (m) ± 0.6  ± 0.8  ± 1.5  ± 10.5 |
|  | | | | | |
| A2 | ± 20 m | = 1.00 + 2%d | | 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 echo-sounder and a sonar or mechanical sweep system. |
| Depth (m) 10  30  100  1000 | Accuracy (m) ± 1.2  ± 1.6  ± 3.0  ± 21.0 |
|  | | | | | |
| B | ± 50 m | = 1.00 + 2%d | | 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 accuracies than ZOCA2, using a modern survey echo-sounder, but no sonar or mechanical sweep system. |
| Depth (m) 10  30  100  1000 | Accuracy (m) ± 1.2  ± 1.6  ± 3.0  ± 21.0 |
|  | | | | | |
| C | ± 500 m | = 2.00 + 5%d | | 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) 10  30  100  1000 | Accuracy (m) ± 2.5  ± 3.5  ± 7.0  ± 52.0 |
|  | | | | | |
| 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 | | | | |
| Column: 1 | 2 | 3 | | 4 | 5 |
| Source: IHO S-57 Ed3.1 Supp 3 (Jun 2014), pp 13-14 | | | | | |

**Quality Levels (S-101)**

The table below describes the allowable values for each resulting QoBD value.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| QoBD value | data assessment | Category of temporal variation | full seafloor coverage,  features detected | least depth of detected features measured | size of features detected | vertical uncertainty | horizontal position uncertainty |
| 1 | 1: assessed | 5: unlikely to change | YES | YES | value (m) | 0.50 (fixed)  0.01 (variable) | 5.00 (fixed)  0.05 (variable) |
|  |  |  |  |  |  |  |
| 2 | 1: assessed | 3: likely to change but significant shoaling not expected.  5: unlikely to change | YES | YES | value (m) | 1.00 (fixed)  0.02 (variable) | 20.0 (fixed) |
|  |  |  |  |  |  |  |
| 3 | 1: assessed | 3: likely to change but significant shoaling not expected. | NO | NO | NULL | 1.00 (fixed)  0.02 (variable) | 50.0 (fixed) |
|  | 5: unlikely to change |  |  |  |  |  |
| 4 | 1: assessed | 3: likely to change but significant shoaling not expected. | NO | NO | NULL | 2.00 (fixed)  0.05 (variable) | 500.0 (fixed) |
|  | 5: unlikely to change |  |  |  |  |  |
| 5 | 1: assessed | 1: extreme event  2: likely to change and significant shoaling expected  3: likely to change but significant shoaling not expected.  5: unlikely to change | NO | NO | NULL | greater than  2.00 (fixed)  0.05 (variable) | greater than  500.0 (fixed) |
| O | 2: assessed (oceanic) | VOID | VOID | VOID | VOID | VOID | VOID |
| U | 3: unassessed | 6: unassessed | NO | NO | NULL | Not available | Not available |

The columns should be read from left to right and top to bottom.

Note 1. Oceanic should only be used to cover open ocean in waters deeper than 200 meters.

Note 2. After an extreme event (for example earthquakes, tsunamis, hurricanes) has taken place and the charted area has not yet been resurveyed, the Quality Level drops to 5.

Note 3. Whenever possible, meaningful and useful values for the attribute category of temporal variation must be used for areas of bathymetry. When making the transition from S-57 to S-101, the default value of this attribute = 5 (unlikely to change).

Note 4. For areas of unstable seafloors, the complex attribute survey data range (date end) must be used to indicate the date of the (collection of) survey(s) of the underlying bathymetric data. In case the seafloor is **likely to change and significant shoaling expected** before a re-survey is performed and published, the **category of temporal variation** value should be set to 2, resulting in QoBD value = 5.

The mechanism provides 7 different stages in the following priority:

1. Data assessment
2. Category of temporal variation
3. Full seafloor coverage achieved / significant features detected
4. Least depth of detected features measured
5. Size of features detected
6. Vertical uncertainty
7. Horizontal position uncertainty

The Meta feature Quality of Bathymetric Data defines areas within which uniform assessment exists for the quality of bathymetric data, and is used to provide an assessment of the overall quality of bathymetric data to the mariner. Areas of a dataset at maximum display scale 1:700000 and larger containing depth data or bathymetry must be covered by one or more Quality of Bathymetric Data features, which may overlap vertically. At maximum display scales smaller than 1:700000, Quality of Bathymetric Data features must be encoded where no larger maximum display scale ENC data is available.

**Relation between surveys, depth areas and Quality of Bathymetric Data**:

A single survey will measure the seafloor in a certain area relative to Chart Datum. Resulting from this single survey, one or more depth areas will be created. Depth areas have two attributes (depth range minimum value, depth range maximum value). A collection of surveys will measure a wider area of the seafloor, resulting in probably more depth areas, depending on the slope of the seabed. This is called an association (*semantic relationship between two or more classifiers that specifies connections among their instances*).

In practice many depth areas share the same Quality of Bathymetric Data value. In that case, we speak of an aggregation (*special form of association that specifies a whole-part relationship between the aggregate (whole) and a component part*). If a survey is carried out to a specific depth which is not bounded by a depth contour line, than the resulting Depth Area will have two separate Quality of Bathymetric Data values.

ENCs should form a seamless coverage in the navigable waters of the producer’s area of responsibility. However, it is often impractical to do so for all ECDIS display scales, and therefore S-101 ENCs declare a scale range, which dictate between what scales the data can be used.

When assigning meaningful Quality of Bathymetric Data information in an ENC, the Hydrographic Office should take into account the maximum display scale and minimum display scale. [[1]](#footnote-1)

|  |  |
| --- | --- |
| maximum display scale | minimum display scale |
| 700,000 | > 700,000 |
| 350,000 | 700,000 |
| 180,000 | 350,000 |
| 90,000 | 180,000 |
| 45,000 | 90,000 |
| 22,000 | 45,000 |
| 12,000 | 22,000 |
| 8,000 | 12,000 |
| 4,000 | 8,000 |
| 3,000 | 4,000 |
| 2,000 | 3,000 |
| 1,000 | 2,000 |

The largest chart scale available will have the maximum level of detail (LoD) and distinctiveness of areas of Quality of Bathymetric Data. The Hydrographic Office should assign values of Quality of Bathymetric Data at the highest level of detail possible. Then lower scale charts will inherit these values. Adjacent areas of Quality of Bathymetric Data will merge together (aggregation process) in smaller scale charts. The lowest value of two (or more) merging areas should be the aggregated value in the smaller scale chart.

Decision Tree:

|  |  |  |  |
| --- | --- | --- | --- |
| Step | Question / Result | Answer = YES | Answer = NO |
| 1 | Is data assessment = Unassessed? | Go to 2 | Go to 3 |
| 2 | **Quality Level = Unassessed** | | |
| 3 | Is data assessment = Oceanic? | Go to 4 | Go to 5 |
| 4 | **Quality Level = Oceanic** | | |
|  |  | | |
| 5 | Is category of temporal variation = unlikely to change? | Go to 6 | Go to 12 |
| 6 | Full seafloor coverage achieved and significant features detected? | Go to 7 | Go to 19 |
| 7 | Least depth of detected features measured? | Go to 8 | Go to 19 |
| 8 | Size of features detected available? | Go to 9 | Go to 19 |
| 9 | Is vertical uncertainty ≤ 0.5m + 1% depth? | Go to 10 | Go to 16 |
| 10 | Is horizontal position uncertainty ≤ 5m + 5% depth? | Go to 11 | Go to 17 |
| 11 | **Quality Level = 1** | | |
|  |  |  |  |
| 12 | Is category of temporal variation = likely to change but significant shoaling not expected? | Go to 13 | Go to 25 |
| 13 | full seafloor coverage achieved and significant features detected? | Go to 14 | Go to 19 |
| 14 | Least depth of detected features measured? | Go to 15 | Go to 19 |
| 15 | Size of features detected available? | Go to 16 | Go to 19 |
| 16 | Is vertical uncertainty ≤ 1.0m + 2% depth? | Go to 17 | Go to 22 |
| 17 | Is horizontal position uncertainty ≤ 20m? | Go to 18 | Go to 20 |
| 18 | **Quality Level = 2** | | |
|  |  |  |  |
| 19 | Is vertical uncertainty ≤ 1.0m + 2% depth? | Go to 20 | Go to 22 |
| 20 | Is horizontal position uncertainty ≤ 50m? | Go to 21 | Go to 23 |
| 21 | **Quality Level = 3** |  |  |
|  |  |  |  |
| 22 | Is vertical uncertainty ≤ 2.0m + 5% depth? | Go to 23 | Go to 27 |
| 23 | Is horizontal position uncertainty ≤ 500m? | Go to 24 | Go to 27 |
| 24 | **Quality Level = 4** |  |  |
|  |  |  |  |
| 25 | Is category of temporal variation = extreme event? | Go to 27 | Go to 26 |
| 26 | Is category of temporal variation = likely to change and significant shoaling expected? | Go to 27 | Go to 2 |
| 27 | **Quality Level = 5** |  |  |

1. S-101 DCEG par. 3.4 page 41 [↑](#footnote-ref-1)