**DQWG14-04A**

## Paper for Consideration by Data Quality Working Group

## [National methodologies: from survey data to CATZOC values]

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| ***Submitted by:*** | DQWG Chair |
| ***Executive Summary:*** | Paper describing the relation between quality of survey and quality of bathymetric data in Electronic Navigational Charts. |
| ***Related Documents:*** | National methodologies provided by IHO Member States. |
| ***Related Projects:*** | S-44, S-101, Satellite Derived Bathymetry, C-55 |

## Introduction / Background

The IHO Standards for Hydrographic Surveys (S-44) and the IHO Transfer Standard for Digital Hydrographic Data (S-52) are not synchronized when it comes to Data Quality of individual surveys into an aggregated Meta Quality cartographic result. This misalignment results in different interpretations by various Hydrographic Offices producing Electronic Navigational Charts when making a uniform assessment of the quality of bathymetric data of a certain area. This paper will propose a best practise method collected from various Hydrographic Offices around the world, so it can be implemented in the S-101 IHO Electronic Navigational Chart product specification as recommendations.

## Analysis/Discussion

S-44 Table 1 lists the minimum standards for Hydrographic Surveys. It is a mixture of Bathymetric Data and non-Bathymetric Data in the water/at the surface and of non-Bathymetric Data connected to land (coastline/topography significant to navigation). S-57 and S-101 meta object M\_QUAL (meta\_quality) defines areas within which a uniform assessment exists for the quality of bathymetric data. The differences between S-57 and S-101 is that in S-101 the attribute *Category of temporal variation* has been included and that Data assessment can be assigned a value of assessed (Oceanic). This *Category of temporal variation* attribute will by default be set to value 5: *unlikely to change* and the Hydrographic Office is recommended to set this value for each area to the appropriate level when upgrading to S-101.

S-44 and S-57 share the following concepts:

1. Horizontal accuracy (position)
2. Vertical accuracy (depth)
3. Completeness (full seafloor coverage)
4. Isolated dangers (feature detection)

The S-57 M\_QUAL has a mandatory attribute CATZOC (=Category Zone of Confidence). There is a one-to-one or many-to-one relation between S-44 assigned values of surveys and S-57 assigned values of CATZOC. This means that a single survey can translate directly into a single value of CATZOC or that an adjacent set of surveys translate into a single value of CATZOC. In theory a single survey can be separated into more than one CATZOC value but this is very unlikely to happen.

To relate both concepts, a cross-table is presented for each of the four sharing concepts:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | ZOC value | Special Order | 1a | 1b | 2 |
| A1 | ± 5m + 0.05\* depth | 2 m | ± 5m + 0.05\* depth | ± 5m + 0.05\* depth | 20 m + 0.1\* depth |
| A2 | ± 20m | 2 m | ± 5m + 0.05\* depth | ± 5m + 0.05\* depth | 20 m + 0.1\* depth |
| B | ± 50m | 2 m | ± 5m + 0.05\* depth | ± 5m + 0.05\* depth | 20 m + 0.1\* depth |
| C | ± 500m | 2 m | ± 5m + 0.05\* depth | ± 5m + 0.05\* depth | 20 m + 0.1\* depth |
| D | > 500m | 2 m | ± 5m + 0.05\* depth | ± 5m + 0.05\* depth | 20 m + 0.1\* depth |

Table 1: cross reference on horizontal accuracy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | ZOC value | Special Order | 1a | 1b | 2 |
| A1 | ± 0.5m + 0.01\* depth | √((0.252 + (0.0075\*depth)2) | √((0.52 + (0.013\*depth)2) | √((0.52 + (0.013\*depth)2) | √((1.02 + (0.023\*depth)2) |
| A2 | ± 1.0m + 0.02\* depth | √((0.252 + (0.0075\*depth)2) | √((0.52 + (0.013\*depth)2) | √((0.52 + (0.013\*depth)2) | √((1.02 + (0.023\*depth)2) |
| B | ± 1.0m + 0.02\* depth | √((0.252 + (0.0075\*depth)2) | √((0.52 + (0.013\*depth)2) | √((0.52 + (0.013\*depth)2) | √((1.02 + (0.023\*depth)2) |
| C | ± 2.0m + 0.05\* depth | √((0.252 + (0.0075\*depth)2) | √((0.52 + (0.013\*depth)2) | √((0.52 + (0.013\*depth)2) | √((1.02 + (0.023\*depth)2) |
| D | > 2.0m + 0.05\* depth | √((0.252 + (0.0075\*depth)2) | √((0.52 + (0.013\*depth)2) | √((0.52 + (0.013\*depth)2) | √((1.02 + (0.023\*depth)2) |

Table 2: cross reference on vertical accuracy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | ZOC value | Special Order | 1a | 1b | 2 |
| A1 | YES | YES | YES | NO | NO |
| A2 | YES | YES | YES | NO | NO |
| B | NO | YES | YES | NO | NO |
| C | NO | YES | YES | NO | NO |
| D | NO | YES | YES | NO | NO |

Table 3: cross reference on completeness

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | ZOC value | Special Order | 1a | 1b | 2 |
| A1 | detected (2 meter, 10% of depth (>40m)) | cubic features > 1 meter | cubic features > 2 meter, 10% of depth (>40m) | NA | NA |
| A2 | detected (2 meter, 10% of depth (>40m)) | cubic features > 1 meter | cubic features > 2 meter, 10% of depth (>40m) | NA | NA |
| B | not expected but may exist | cubic features > 1 meter | cubic features > 2 meter, 10% of depth (>40m) | NA | NA |
| C | unknown, depth anomalies may be expected | cubic features > 1 meter | cubic features > 2 meter, 10% of depth (>40m) | NA | NA |
| D | unknown, large depth anomalies may be expected | cubic features > 1 meter | cubic features > 2 meter, 10% of depth (>40m) | NA | NA |

Table 4: cross reference on isolated dangers

When assigning a CATZOC value, HO’s are recommended to follow the guideline (paper DQWG14-06B) developed by the DQWG. This consists of stages in the following order:

1. Data assessment
2. Category of temporal variation (S-101 only)
3. Significant features detected
4. Least depth of significant features known
5. Full seafloor coverage achieved
6. Depth accuracy
7. Positional accuracy

The result is then computed by going through these 7 stages and indicating a valid (green) or fault (red) outcome:

Check 1: Data assessment

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ZOC | Special Order | Order 1a | Order 1b | Order 2 | unknown | Assessed as Oceanic |
| A1 | valid | valid | valid | valid | fault | fault |
| A2 | valid | valid | valid | valid | fault | fault |
| B | valid | valid | valid | valid | fault | fault |
| C | valid | valid | valid | valid | fault | fault |
| D | valid | valid | valid | valid | fault | fault |
| U | fault | fault | fault | fault | valid | fault |
| Oceanic | fault | fault | fault | fault | fault | valid |

If a CATZOC value is given U=unassessed or Oceanic, then no further checks are required.

Check 2: Category of temporal variation

This is regardless of the S-44 classification of the survey and will be further explained in a different paper. In S-57 and when upgrading to S-101, the default value of this attribute is “unlikely to change” and thus not affecting the outcome of this checking process. HO’s are however requested to assign the correct value to this attribute when making the upgrade to S-101.

Check 3: Significant features detected

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ZOC | Special Order | Order 1a | Order 1b | Order 2 |
| A1 | valid | valid | fault | fault |
| A2 | valid | valid | fault | fault |
| B | valid | valid | valid | valid |
| C | valid | valid | valid | valid |
| D | valid | valid | valid | valid |

Check 4: Least depth of significant features known:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ZOC | Special Order | Order 1a | Order 1b | Order 2 |
| A1 | valid | valid | fault | fault |
| A2 | valid | valid | fault | fault |
| B | valid | valid | valid | valid |
| C | valid | valid | valid | valid |
| D | valid | valid | valid | valid |

Check 5: Full seafloor coverage achieved

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ZOC | Special Order | Order 1a | Order 1b | Order 2 |
| A1 | valid | valid | fault | fault |
| A2 | valid | valid | fault | fault |
| B | valid | valid | valid | valid |
| C | valid | valid | valid | valid |
| D | valid | valid | valid | valid |

Check 6: Depth accuracy

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ZOC | Special Order | Order 1a | | Order 1b | | Order 2 |
| A1 | valid | valid (0-146m) | fault (147-200m) | valid (0-146m) | fault (147-200m) | fault |
| A2 | valid | valid | | valid | | valid |
| B | valid | valid | | valid | | valid |
| C | valid | valid | | valid | | valid |
| D | valid | valid | | valid | | valid |

Check 7: Positional accuracy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ZOC | Special Order | Order 1a | Order 1b | Order 2 |
| A1 | valid | valid | valid | fault |
| A2 | valid | valid | valid | fault |
| B | valid | valid | valid | valid |
| C | valid | valid | valid | valid |
| D | valid | valid | valid | valid |

When combining these 7 steps we get the following result:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ZOC | Special Order | Order 1a | Order 1b | Order 2 | unknown | Assessed as Oceanic |
| A1 | valid | valid (d<147m) | fault | fault | fault | fault |
| A2 | valid | valid | fault | fault | fault | fault |
| B | valid | valid | valid | valid | fault | fault |
| C | valid | valid | valid | valid | fault | fault |
| D | valid | valid | valid | valid | fault | fault |
| U | fault | fault | fault | fault | valid | fault |
| Oceanic | fault | fault | fault | fault | fault | valid |

Please note that valid does not mean appropriate. For example a special order survey has the appropriate CATZOC level of A1. Values of A2, B, C and D are valid but does not justify the high quality of the original survey.

Please note that the values from table 1,2 and 4 are using depth to compute the aggregated CATZOC value. Implicitly this depth is used for the full water column from surface to seabed, regardless of the navigational depth. However, both in S-44 and S-57 and in C-55 certain depth limits are noted and sometimes used. We can distinguish three different depth bands in this perspective:

1. From sea surface to “safe navigation depths.”
2. From “safe navigation depths” to 200 m depth (edge of continental shelf)
3. Deeper than 200m depth.

Areas deeper than 200m can be classified as Assessed, Oceanic in S-101, meaning the quality of oceanic bathymetric data has been assessed, however details are not required.

S-44 Table 1 regards areas deeper than 100m not to be an issue for the type of surface shipping expected to transit the area. However for isolated dangers, the 40m depth value is used as value to assign a minimal size to detected features.

C-55 index provides information of each Member state of the following:

|  |  |  |
| --- | --- | --- |
|  | Depth < 200m | Depth > 200m |
| Adequately surveyed | % of national area | % of national area |
| Re-survey required | % of national area | % of national area |
| Never systematically surveyed | % of national area | % of national area |

Table 5: Criteria for C-55 values

The shipping industry has provided information by correspondence that they consider the depth range of 0 to 50 meters significant for surface navigation, which is twice the maximum draft of existing vessels. DQWG is requested to consider recommending three depth range bands: 0-50m, 50-200m and deeper than 200m.

Four HO’s have at this moment (November 2018) shared their national methodologies from survey to CATZOC. Without metadata CATZOC is allocated based on the source of the survey, the date (age), the scale, the technique of sounding and chart scale used. One HO comments that CATZOC C category is too wide. It covers old (but good for their day) hydrographic surveys which cannot be transformed accurately to modern datums, and also opportunity soundings such as passage sounding.

## Conclusions

The assignment of quality of individual surveys and its translation to a CATZOC value is not a straightforward process. A conversion table on four different elements can be used in combination with a 7 step process to assign meaningful CATZOC values.

## Recommendations

Propose the valid and appropriate relation between S-44 and CATZOC to be drafted as a guidance. (1 page document).

Setting three depth range bands: 0-50 meters, 50-200 meters and >200 meters when relating S-44 to S-101 to C-55.

## Justification and Impacts

If Oceanic from S-101 is going to be used, C-55 status for areas > 200m may by default have a 100% status of adequately surveyed with respect to surface navigation.

## Action Required of Data Quality Working Group

The DQWG is invited to:

a. discuss this paper;

b. draft a recommendation for HO’s;

c. provide input papers to other Working Groups as deemed necessary.