S-68

GUIDELINES AND RECOMMENDATIONS FOR HYDROGRAPHIC OFFICES FOR THE ALLOCATION OF CATZOC/QOBD VALUES FROM SURVEY DATA

Edition 1.1.0 – March 2025

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CONTENTS

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1.1.0	March 2025	DQWG CATZOC subWG	Apply changes decided at DQWG20 and after.HSSC Final Draft.

1 Preface

The Data Quality Working Group (DQWG) provides guidance on data quality aspects to Hydrographic Offices, in particular to ensure harmonized implementation (Terms of Reference art.3.b.iv). At DQWG16 (February 2021, VTC) a dedicated sub-Working Group was created with the task of drafting guidelines and recommendations for Hydrographic Offices (HOs) based on best practice to help inform the allocation of S-57 Category Zone of Confidence (CATZOC) / S-101 Quality of Bathymetric Data (QoBD) values from survey data.

It is important to note that CATZOC/QoDB should depict the overall quality assessment for the data in the cartographic product. In this version of the Guidelines, only recommendations about minimum required survey order needed to assess the respective CATZOC/QoDB category are included. The HO needs to assess how their processing of the data affects the data quality and assess a relevant CATZOC/QoDB accordingly.

2 Introduction

The development of various S-1xx products and the possibilities to combine these datasets increases the need for clear dissemination of appropriate data quality elements and appropriate meta-quality information (CATZOC/QoBD) to the Mariner in order to facilitate safe route planning and voyage execution.

Developing standardized practice for the allocation of data quality elements will benefit both Hydrographic Offices (HOs) and the End User. Datasets provided by adjacent HOs may provide different depictions of the shape of the seabed and associated quality indicators. This work aims to provide tools to assess the self-consistency of datasets produced by one HO and may explain the differences to datasets produced by the adjacent HO.

Additionally, it is hoped that this work may have wider reaching benefits and contribute to additional guidance to help HOs to have more confidence in including other sources of depth data – for example CrowdSourced Bathymetry (CSB) data and Satellite Derived Bathymetry (SDB) – into their nautical charts where it is considered appropriate to do so.

3 Terms, Definitions and Abbreviations

3.1 Terms and definitions

3.1.1 Accuracy

The extent to which a measured or enumerated value agrees with the assumed or accepted value. (IHO S-44 Ed 5.0.0)

3.1.2 Bathymetric coverage

Extent to which an area has been surveyed using a systematic method of measuring the depth and is based on the combination of the survey pattern and the theoretical area of detection of the survey instrumentation. (IHO S-44 Ed 6.2.0)

3.1.3 Full bathymetric coverage

A 100% bathymetric coverage should be interpreted as "full" bathymetric coverage.

3.1.4 CATZOC capability

The preliminary value of Category Zone of Confidence to be allocated to survey data. It describes that due to the S-44 Survey Order, a survey has the potential to have a specific CATZOC. However, the CATZOC is not determined until all of the processing is complete where gridding and cartographic generalization have also been taken into consideration.

3.1.5 CATZOC value

Classification of the zone of confidence in data within an area based on the positional accuracy, survey equipment and coverage.

3.1.6   Feature detection

Ability of a system to detect features of a defined size. (IHO S-44 Ed 6.2.0)

3.1.7   Seafloor search

A systematic method of exploring the sea floor in order to detect features such as wrecks, rocks and other obstructions on the sea floor. (IHO S-44 Ed 5.0.0)

3.1.8   Significant feature

Feature that poses a potential danger to navigation or object one would expect to see depicted on a nautical chart or product. (IHO S-44 Ed 6.2.0)

3.1.9   Uncertainty

Estimate characterizing the range of values within which the true value of a measurement is expected to lie as defined within a particular confidence level. It is expressed as a positive value. (IHO S-44 Ed 6.2.0)

3.2   Abbreviations

This guidance document adopts the following convention for symbols and abbreviated terms:

CATZOC   Category of Zone of Confidence in Data
CSB   Crowd Sourced Bathymetry
DQWG   Data Quality Working Group
ENC   Electronic Navigational Chart
HO   Hydrographic Office
IHO   International Hydrographic Organization
ISO   International Organization for Standardization
QoBD   Quality of Bathymetric Data
SDB   Satellite Derived Bathymetry
ZOC   Zone of Confidence

3.3   Use of language

Within this document, including appendices and annexes:

- •   "Must" indicates a mandatory requirement.
- •   "Should" indicates an optional requirement, that is the recommended process to be followed, but is not mandatory.
- •   "May" means "allowed to" or "could possibly", and is not mandatory.

4   Data Capture

Hydrographic surveys capture bathymetric data about the depths and shapes of the seabed and underwater terrain primarily using a combination of sounders (multibeam and single beam echo sounders), lidar or satellites (Satellite Derived Bathymetry, SDB). IHO Publication S-44 defines the standards applicable to hydrographic surveys and sets minimum standards to be achieved. S-44 describes the orders of safety of navigation surveys, which are considered acceptable for the production of navigational products and services to enable surface vessels to navigate safely. As requirements may vary, five different orders of surveys are defined to cater for a different range of needs, i.e., Exclusive, Special, 1a, 1b, and 2 (for more information refers to IHO publication S-44).

It is acknowledged that some bathymetric data may be gathered that doesn't conform to IHO survey orders but could still be considered suitable for updating navigational charts (for example CSB).

5   Data Quality in ENCs

IHO Publication S-57 provides the existing guidance of how HOs should populate information about quality of bathymetric data.

The quality of the bathymetric data charted on the ENC is assessed according to six categories: five CATZOC for assessed data (A1, A2, B, C and D) and a sixth category (U) for data which has not been assessed (see Table 5-1 below). The attribute CATZOC is a mandatory attribute in the S-57 Meta Object class M_QUAL (Quality of Data). The Meta Object M_QUAL is mandatory for areas containing depth data; that is, CATZOC indication covers all areas of the ENC that contain bathymetry. CATZOC sectors may never overlap and/or have gaps between them. The assessment of bathymetric data quality and classification into one of the CATZOCs is based on a combination of:

- Position accuracy;
- Depth accuracy; and
- Seafloor coverage[1].

Table 5-1 – ZOC Categories

ZOC[2]	QoBD[3]	Position Accuracy[2]	Depth Accuracy[2]	Seafloor Coverage[2]
A1	1	5m + 1% depth	0.50m + 1% depth	Full area search undertaken, significant seafloor features detected and depths measured
A2	2	20 m	1.00 m + 2% depth	Full area search undertaken. Significant seafloor features detected and depths measured
B	3	50 m	1.00 m + 2 % depth	Full area search not achieved; uncharted features hazardous to surface navigation are not expected but may exist.
C	4	500 m	2.00 m + 5% depth	Full area search not achieved; depth anomalies may be expected.
D	5	Worse than ZOC C	Worse than ZOC C	Full area search not achieved, large depth anomalies may be expected.
U	6	Unassessed	Quality of data has yet to be assessed	
	O	Oceanic	Oceanic areas with water depth greater than 200m	

A full version of this table can be found in Annex A.

More detailed information about CATZOC can be found in IHO Publication S-67.

In S-101 QoBD, the CATZOC alphanumeric codes (A1, A2, B, C, D and U) are supplemented by a numerical scheme (1 for best quality data and 5 for worst, as well as 6 for unassessed areas). In addition to one attribute (CATZOC) defining all aspects of data quality, each data quality component (for example. position, depth, and coverage) are independently evaluated. Also, the attribute *Category of Temporal Variation* has been included and data assessment can be assigned a value of assessed (Oceanic) for areas of depths greater than 200m that do not pose a threat to surface navigation.

S-44 hydrographic survey order is only one input parameter (the main one) in determining the CATZOC/QoDB. However, each HO needs to take into consideration all processing parameters (e.g. gridding, cartographic generalization) when determining CATZOC/QoDB.

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[1] Includes both the extent to which an area has been surveyed, "seafloor coverage", and detection capability of significant features, "feature detection".

[2] Adapted from IHO S-57 Edition 3.1, Supplement 3 (June 2014), pp 13-14.

[3] Adapted from IHO S-101 Annex A Edition 2.0.0, (December 2024), pp51.

6   HO Best Practice Examples/National Methodologies

Information regarding the national methodologies employed for the allocation of CATZOC values from survey data was collected from 12 Hydrographic Offices (Australia, Brazil, Denmark, Finland, France, India, Italy, Japan, Netherlands, Norway, United Kingdom, and United States of America). A summary of responses is provided in Annex B.

Analysis of the results demonstrated that HOs allocate CATZOC values principally based on the parameters described in the ZOC table included in S-57 Supplement No. 3, June 2014. Some HOs do not use all the ZOC categories and some employ a slightly modified version, for example in the case where CATZOC A1 and A2 are combined (for example in Finland). However fundamentally all HOs that responded demonstrated a policy of allocating CATZOC values to indicate that particular data meets minimum criteria for position and depth accuracy and seafloor coverage in accordance with the ZOC table.

To allocate CATZOC, HOs commonly use two methods:

- Older survey: The lack of metadata requires HOs to allocate CATZOC with rules based on the age or 'currentness' of the data in conjunction with technical details of the methods used to conduct the survey.
- Recent survey: The decision of CATZOC value allocation is based on the parameters described in the ZOC table and more recently with the parameters associated with the various survey orders set out in S-44.

After assignment, some HOs s may downgrade the CATZOC/QoBD values due to the passage of time, generalization, natural disasters, the instability of bathymetry etc., in order to ensure safety of navigation. Details are provided in Table B-2 of the Annex B.

7   Survey Order – CATZOC Comparison

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 defines areas within which a uniform assessment exists for the quality of bathymetric data.

S-44 and S-57/S-101 share the following concepts:

1. Horizontal uncertainty [4](position);
2. Vertical uncertainty (depth); and
3. Completeness (bathymetric coverage[5] and feature detection).

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 an adjoining set of surveys into a single value of CATZOC. In addition, a single survey can be separated into more than one CATZOC values (one-to-many relation). Tables 7-1 – 7-4 present the relation of the S-44 and S-57/S-101 sharing concepts, where d is the depth at the location. NOTE: The vertical and horizontal uncertainties in the Tables represent the interval of ± the stated value.

Table 7-1 – Horizontal Uncertainty

Horizontal Uncertainty			
S-57/S-101 (ZOC)		S-44 (Survey)	
ZOC Category	ZOC Tolerance	Survey Order	Survey Tolerance
A1	5m + 0.05*d	Exclusive	1m
A2	20m	Special	2m

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[4] Since "accuracy" has been completely replaced by "uncertainty" in S-44 Edition 6.2.0, uncertainty will be used in the following sections to replace accuracy.

[5] Since the term "seafloor coverage" has been replaced by the term "bathymetric coverage" in S-44 Edition 6.2.0, bathymetric coverage will be used in the following sections to replace seafloor coverage.

B	50m	1a	5m + 0.05*d
C	500m	1b	5m + 0.05*d
D	>500m	2	20m + 0.1*d

Table 7-2 – Vertical Uncertainty

Vertical Uncertainty			
S-57/S-101 (ZOC) $a + (b \times d)$		S-44 (Survey) $\sqrt{a^2 + (b \times d)^2}$	
ZOC Category	ZOC Tolerance	Survey Order	Survey tolerance
A1	0.5m + 0.01*d	Exclusive	$\sqrt{(0.15^2 + (0.0075*d)^2)}$
A2	1.0m + 0.02*d	Special	$\sqrt{(0.25^2 + (0.0075*d)^2)}$
B	1.0m + 0.02* d	1a	$\sqrt{(0.5^2 + (0.013*d)^2)}$
C	2.0m + 0.05*d	1b	$\sqrt{(0.5^2 + (0.013*d)^2)}$
D	> 2.0m + 0.05* d	2	$\sqrt{(1.0^2 + (0.023*d)^2)}$

Table 7-3 – Completeness (Bathymetric Coverage)

Bathymetric Coverage			
S-57/S-101 (ZOC)		S-44 (Survey)	
ZOC Category	ZOC Requirement	Survey Order	Survey Requirement
A1	Full	Exclusive	200%
A2	Full	Special	100%
B	Not required	1a	≤100%
C	Not required	1b	5%
D	Not required	2	5%

Table 7-4 – Isolated Dangers (Feature Detection)

Feature Detection			
S-57/S-101 (ZOC)		S-44 (Survey)	
ZOC Category	ZOC Requirement	Survey Order	Survey Requirement
A1	Detected (2m, or 0.1*d if d>40m)	Exclusive	cubic features >0.5 meter
A2	Detected (2m, or 0.1*d if d>40m)	Special	cubic features > 1 meter
B	Features not expected but may exist	1a	cubic features > 2m, or 0.1*d if d>40m
C	Depth anomalies may be expected	1b	Not Specified
D	Large depth anomalies may be expected	Survey Order	Survey Requirement

8   Conversion Matrices

When assigning a CATZOC value, HOs are recommended to follow the guideline herein. This consists of stages in the following order:

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

The following Tables illustrate the valid CATZOC capability for the Survey Orders. It is noted that the assigned CATZOC is the result of combining the allowable CATZOC of these 7 stages/criteria and any other processing such as gridding or cartographic generalization. In the following matrices, green color is used to indicate that Survey Order meets the requirements of the respective CATZOC; for example, the vertical uncertainty of Special Order meets the vertical uncertainty criteria of all CATZOC (that is, A1, A2, B, C, and D). However, this "valid" relation does not mean appropriate. For example, the appropriate CATZOC for a Special Order survey is A1; CATZOC values of A2, B, C, and D are valid (that is, can be assigned) but do not justify the high data quality of the original survey. Red color is used to indicate that the Survey Order requirements do not meet those of the respective CATZOC, thus assigning this ZOC category is not recommended. Split cells are used to indicate relations that are valid up to a specific water depth, while for depths greater than the cell value the Survey Order criteria do not meet that of CATZOC. For instance, the vertical uncertainty of Survey Order 1a generally meets the CATZOC A1 but not for water depth greater than 145m. Lastly, grey color is used to indicate that Survey Order and CATZOC are not comparable (that is, there are no explicitly defined requirements for CATZOCs U and O).It is pointed out that the presented matrices represent valid CATZOC/QoBD capabilities based on S-44 Survey Orders minimum standards, however, hydrographic offices may follow different practices in particular cases. In the following sections, "d" is for water depth.

8.1   Check 1: Data assessment

Table 8-1 – Valid CATZOCs Capabilities for the Survey Orders based on data assessment

Data Assessment	Survey Order Requirement	Assessed	Assessed	Assessed	Assessed	Assessed	Assessed
ZOC Requirement	Survey Zoc/QoBD	Exclusive	Special	1a	1b	2	Unknown
Assessed	A1/1	🟩	🟩	🟩	🟩	🟩	🟥
Assessed	A2/2	🟩	🟩	🟩	🟩	🟩	🟥
Assessed	B/3	🟩	🟩	🟩	🟩	🟩	🟥
Assessed	C/4	🟩	🟩	🟩	🟩	🟩	🟥
Assessed	D/5	🟩	🟩	🟩	🟩	🟩	🟥
Unassessed	U/6	🟥	🟥	🟥	🟥	🟥	🟩
Assessed	-/Oceanic	🟩	🟩	🟩	🟩	🟩	🟩

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

8.2 Check 2: Significant features detected

Table 8-2 – Valid CATZOCs Capabilities for the Survey Orders based on significant features detected

Feature Detection	Survey Order Requirement	Cubic features >0.5 meter	Cubic features >1 meter	>2m, or 0.1*d if d >40m	Not Specified	Not Specified
ZOC tolerance	Survey Zoc/QoBD	Exclusive	Special	1a	1b	2
2m, or 0.01*d if d >40m	A1/1	green	green	green	red	red
2m, or 0.01*d if d >40m	A2/2	green	green	green	red	red
Not expected but may exist	B/3	green	green	green	green	green
Anomalies may be expected	C/4	green	green	green	green	green
Large anomalies may be expected	D/5	green	green	green	green	green
N/A	U/6	grey	grey	grey	grey	grey
N/A	-/Oceanic	grey	grey	grey	grey	grey

8.3 Check 3: Least depth of significant features known

Table 8-3 – Valid CATZOC Capabilities for the Survey Orders based on least depth of significant features known

Least Depth Measured	Survey Order Requirement	Cubic features >0.5 meter	Cubic features >1 meter	>2m, or 0.1*d if d >40m	Not Specified	Not Specified
ZOC tolerance	Survey Zoc/QoBD	Exclusive	Special	1a	1b	2
Measured	A1/1	green	green	green	red	red
Measured	A2/2	green	green	green	red	red
Not required	B/3	green	green	green	green	green
Not required	C/4	green	green	green	green	green
Not required	D/5	green	green	green	green	green
N/A	U/6	grey	grey	grey	grey	grey
N/A	-/Oceanic	grey	grey	grey	grey	grey

8.4 Check 4: Full bathymetric coverage achieved

Table 8-4 – Valid CATZOC Capabilities for the Survey Orders based on full bathymetric coverage achieved

Bathymetric coverage	Survey Order Requirement	200%	100%	≤100%		5%	5%
ZOC Requirement	Survey Zoc/QoBD	Exclusive	Special	1a		1b	2
Full	A1/1	green	green	=100%	<100%	red	red
Full	A2/2	green	green	=100%	<100%	red	red
Not required	B/3	green	green			green	green
Not required	C/4	green	green			green	green

Not required	D/5					
N/A	U/6					
N/A	-/Oceanic					

8.5   Check 5: Depth uncertainty

Table 8-5 – Valid CATZOC Capabilities for the Survey Orders based on depth uncertainty

Vertical Uncertainty	Survey Order tolerance	$\sqrt{(0.15^2 + (0.0075*d)^2)}$	$\sqrt{(0.25^2 + (0.0075*d)^2)}$	$\sqrt{(0.5^2 + (0.013*d)^2)}$	$\sqrt{(0.5^2 + (0.013*d)^2)}$	$\sqrt{(1.0^2 + (0.023*d)^2)}$
ZOC tolerance	Survey Zoc/QoBD	Exclusive	Special	1a	1b	2
0.5m+0.01*d	A1/1			d<145m / d≥145m (red)	d<145m / d≥145m (red)	(red)
1.0m+0.02*d	A2/2					
1.0m+0.02*d	B/3					
2.0m+0.05*d	C/4					
>2.0m+0.05*d	D/5					
N/A	U/6					
N/A	-/Oceanic					

8.6   Check 6: Positional uncertainty

Table 8-6 – Valid CATZOC Capabilities for the Survey Orders based on positional uncertainty

Horizontal Uncertainty	Survey Order tolerance	1m	2m	5m+0.05*d	5m+0.05*d	20m+0.1*d
ZOC tolerance	Survey Zoc/QoBD	Exclusive	Special	1a	1b	2
5m+0.05*d	A1/1					(red)
20m	A2/2			d≤300m / d>300m (red)	d≤300m / d>300m (red)	(red)
50m	B/3					d≤300m / d>300m (red)
500m	C/4					
>500m	D/5					
N/A	U/6					
N/A	-/Oceanic					

8.7   Check 7: Category of temporal variation

This is regardless of the S-44 classification of the survey. In S-57 and when upgrading to S-101, the default value of this attribute is "unlikely to change" and thus does not affect 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.

8.8   Summary

When the above steps are combined, we get the result of Table 8-7 that illustrates the minimum achieved Survey Order for each CATZOC.

Table 8-7 – Minimum achieved Survey Order for each CATZOC

Criterion Zoc/QoBD	Data Assessment	Features Detected	Least Depth	Bathymetric coverage	Depth Uncertainty	Position Uncertainty
A1/1	Assessed	1a	1a	1a （=100%）	1b(d<145m)	1b
A2/2	Assessed	1a	1a	1a （=100%）	2	1b(d<300m)
B/3	Assessed	2	2	2	2	2(d<300m)
C/4	Assessed	2	2	2	2	2
D/5	Assessed	2	2	2	2	2
U/6	Unassessed	-	-	-	-	-
-/Oceanic	Assessed	2	2	2	2	2

For example, according to the comparison tables of the previous Checks, a CATZOC A2 requires data to be assessed (Check 1); Feature Detection of, at least, Survey Order 1a (or Special or Exclusive) (Check 2); Least Depth Measured requirement of Survey Order 1a or higher (Check 3); Bathymetric coverage that satisfies Survey Order 1a or higher (Check 4), Depth uncertainty of Order 2 or higher (Check 5); and Position Uncertainty that satisfies Order 1b (depths below 300m) or higher (Check 6). The above detailed Table can be summarized with Table 8-8.

Table 8-8 – Summary of the valid CATZOC capabilities for the Survey Orders

Survey ZOC QoBD	Exclusive	Special	1a		1b	2		Unknown
A1/1			d<145m	d≥145m				
A2/2			d≤300m	d>300m				
B/3						d≤300m	d>300m	
C/4								
D/5								
U/6								
-/Oceanic								

9   Conversion of the Matrix for Hydrographic Surveys

The Matrix for Hydrographic Surveys, as presented in section 7.6 in S-44 edition 6.2.0, includes a range of selectable criteria for hydrographic survey parameters. It is possible to establish custom survey criteria by selecting appropriate parameters.

As a subset of The Matrix for Hydrographic Surveys, the following Table 9-1 includes a range of selectable parameters used for calculating the depth uncertainty.

Table 9-1 –Matrix for Hydrographic Surveys

Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14
"a" [m]	100	50	25	10	5	2	1	0.5	0.3	0.25	0.2	0.15	0.1	0.05
"b"	0.20	0.10	0.05	0.023	0.02	0.013	0.01	0.0075	0.004	0.002				

The method of assigning a CATZOC value described in chapter 8 is still applicable for the custom survey criteria established by Table 9-1. However, Table 8-5 will be converted into the following Table 9-2.

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Table 9-2 – Valid CATZOC Capabilities for Custom Survey Criteria based on depth uncertainty

b \ a	100	50	25	10	5	2	1	0.5	0.3	0.25	0.2	0.15	0.1	0.05
0.2	D	D	D	D	D	C (d>5.33)	A2 (d≤1.01)	A1 (d≤0.25)	A1 (d≤2.13)	A1 (d≤2.30)	A1 (d≤2.42)	A1 (d≤2.52)	A1 (d≤2.58)	A1 (d≤2.62)
								A2 (0.25<d≤4.89)	A2 (2.13<d≤5.33)	A2 (2.30<d≤5.40)	A2 (2.42<d≤5.45)	A2 (2.52<d≤5.50)	A2 (2.58<d≤5.53)	A2 (2.62<d≤5.55)
						D (d≤5.33)	C (1.01<d≤12)	C (4.89<d≤13.02)	C (5.33<d≤13.22)	C (2.30<d≤13.25)	C (5.45<d≤13.28)	C (5.50<d≤13.31)	C (5.53<d≤13.32)	C (5.55<d≤13.33)
							D (d>12)	D (d>13.02)	D (d>13.22)	D (d>13.25)	D (d>13.28)	D (d>13.31)	D (d>13.32)	D (d>13.33)
0.1	D	D	D	D	D	C (d>26.67)	A2 (d≤4.17)	A1 (d≤1.01)	A1 (d≤4.56)	A1 (d≤4.89)	A1 (d≤5.14)	A1 (d≤5.33)	A1 (d≤5.45)	A1 (d≤5.53)
								A2 (1.01<d≤11.16)	A2 (4.56<d≤12.04)	A2 (4.89<d≤12.18)	A2 (5.14<d≤12.30)	A2 (5.33<d≤12.39)	A2 (5.45<d≤12.45)	A2 (5.53<d≤12.49)
						D (d≤26.67)	C (4.17<d≤37.37)	C (11.16<d≤39.37)	C (12.04<d≤39.77)	C (12.18<d≤39.84)	C (12.30<d≤39.90)	C (12.39<d≤39.94)	C (12.45<d≤39.97)	C (12.49<d≤39.99)
							D (d>37.37)	D (d>39.37)	D (d>39.77)	D (d>39.84)	D (d>39.90)	D (d>39.94)	D (d>39.97)	D (d>39.99)
0.05	D	D	D	D	D	C	A2 (d≤19.05)	A1 (d≤4.17)	A1 (d≤10.51)	A1 (d≤11.16)	A1 (d≤11.67)	A1 (d≤12.04)	A1 (d≤12.30)	A1 (d≤12.45)
								A2 (4.17<d≤30.69)	A2 (10.51<d≤32.42)	A2 (11.16<d≤32.70)	A2 (11.67<d≤32.93)	A2 (12.04<d≤33.11)	A2 (12.30<d≤33.23)	A2 (12.45<d≤33.31)
							C (d>19.05)	C (d>30.69)	C (d>32.42)	C (d>32.70)	C (d>32.93)	C (d>33.11)	C (d>33.23)	C (d>33.31)
0.023	C (d>2201.84)	C (d>1075.74)	C (d>512.86)	C (d>175.72)	C (d>64.28)	A2 (127.09<d≤182.99)	A2 (d≤310.08)	A1 (d≤23.31)	A1 (d≤34.21)	A1 (d≤35.59)	·A1 (d≤36.66)	A1 (d≤37.46)	A1 (d≤38.02)	A1 (d≤38.35)
								A2 (23.31<d≤327.81)	A2 (34.21<d≤331.37)	A2 (35.59<d≤331.97)	A2 (36.66<d≤332.46)	A2 (37.46<d≤332.84)	A2 (38.02<d≤333.12)	A2 (38.35<d≤333.28)
	D (d≤2201.84)	D (d≤1075.74)	D (d≤512.86)	D (d≤175.72)	D (d≤64.28)	C (d≤127.09, and d>182.99)	C (d>310.08)	C (d>327.81)	C (d>331.37)	C (d>331.97)	C (d>332.46)	C (d>332.84)	C (d>333.12)	C (d>333.28)
0.02	C (d>2134.64)	C (d>1043.64)	C (d>498.26)	C (d>171.43)	C (d>63.14)	A2 (d>75)	A2	A1 (d≤33.33)	A1 (d≤45.15)	A1 (d≤46.71)	A1 (d≤47.94)	A1 (d≤48.86)	A1 (d≤49.50)	A1 (d≤49.87)
	D (d≤2134.64)	D (d≤1043.64)	D (d≤498.26)	D (d≤171.43)	D (d≤63.14)	C (d≤75)		A2 (d>33.33)	A2 (d>45.15)	A2 (d>46.71)	A2 (d>47.94)	A2 (d>48.86)	A2 (d>49.50)	A2 (d>49.87)
0.013	A2 (d>6493.18)	A2 (d>3203.66)	A2 (d>1559.26)	A2 (d>573.77)	A2 (d>247.17)	A2 (d>56.54)	A2	A1 (d≤144.93)	A1 (d≤159.47)	A1 (d≤161.73)	A1 (d≤163.54)	A1 (d≤164.92)	A1 (d≤165.89)	A1 (d≤166.47)
	C (2028.36<d≤6493.18)	C (992.78<d≤3203.66)	C (475.03<d≤1559.26)	C (164.52<d≤573.77)	C (61.26<d≤247.17)	C (d≤56.54)		A2 (d>144.93)	A2 (d>159.47)	A2 (d>161.73)	A2 (d>163.54)	A2 (d>164.92)	A2 (d>165.89)	A2 (d>166.47)
	D (d≤2028.36)	D (d≤992.78)	D (d≤475.03)	D (d≤164.52)	D (d≤61.26)									
A2 (d>5706.93)	A2 (d>2820.28)	A2 (d>1377.09)	A2 (d>511.65)	A2 (d>223.93)	A2 (d>5706.93)	A2 (d>53.52)	A2	A1	A1	A1	A1	A1	A1	A1
C	C	C	C	C	C	C								

	(1999.59<d≤5706.93)	(978.99<d≤2820.28)	(468.71<d≤1377.09)	(162.63<d≤511.65)	(60.74<d≤223.93)	(1999.59<d≤5706.93)	(d≤53.52)							
	D (d≤1999.59)	D (d≤978.99)	D (d≤468.71)	D (d≤162.63)	D (d≤60.74)	D (d≤1999.59)								
0.0075	A1 (d>15004.54)	A1 (d>7445.49)	A1 (d>3666.33)	A1 (d>1400)	A1 (d>646.49)	A1 (d>200)	A1 (d>59.51)	A1	A1	A1	A1	A1	A1	A1
	A2 (5335.46<d≤15004.54)	A2 (2638.71<d≤7445.49)	A2 (1290.39<d≤3666.33)	A2 (481.62<d≤1400)	A2 (212.38<d≤646.49)	A2 (51.87<d≤200)								
	C (1981.98<d≤5335.46)	C (970.54<d≤2638.71)	C (464.84<d≤1290.39)	C (161.46<d≤481.62)	C (60.41<d≤212.38)	C (d≤51.87)	A2 (d≤59.51)							
	D (d≤1981.98)	D (d≤970.54)	D (d≤464.84)	D (d≤161.46)	D (d≤60.41)									
0.004	A1 (d>10851.40)	A1 (d>5395.98)	A1 (d>2668.30)	A1 (d>1031.83)	A1 (d>486.54)	A1 (d>159.99)	A1 (d>52.15)	A1	A1	A1	A1	A1	A1	A1
	A2 (5051.03<d≤10851.40)	A2 (2499.49<d≤5395.98)	A2 (1223.74<d≤2668.30)	A2 (458.33<d≤11031.83)	A2 (203.28<d≤486.54)	A2 (50.51<d≤159.99)								
	C (1966.18<d≤5051.03)	C (962.96<d≤2499.49)	C (461.36<d≤1223.74)	C (160.41<d≤458.33)	C (60.12<d≤203.28)	C (d≤50.51)	A2 (d≤52.15)							
	D (d≤1966.18)	D (d≤962.96)	D (d≤461.36)	D (d≤160.41)	D (d≤60.12)									
0.002	A1 (d>10154.13)	A1 (d>5051.03)	A1 (d>2499.49)	A1 (d>968.59)	A1 (d>458.33)	A1 (d>152.31)	A1 (d>50.51)	A1	A1	A1	A1	A1	A1	A1
	A2 (4974.69<d≤10154.13)	A2 (2462.09<d≤5051.03)	A2 (1205.80<d≤2499.49)	A2 (452.04<d≤968.59)	A2 (200.81<d≤458.33)	A2 (50.13<d≤152.31)								
	C (1961.54<d≤4974.69)	C (960.74<d≤2462.09)	C (460.34<d≤1205.80)	C (160.10<d≤452.04)	C (60.03<d≤200.81)	C (d≤50.13)	A2 (d≤50.51)							
	D (d≤1961.54)	D (d≤960.74)	D (d≤460.34)	D (d≤160.10)	D (d≤60.03)									

The impact of depth on the safety of surface navigation is negligible when the depth d>200m. Therefore, if we only consider the case where d ≤ 200m, Table 9-2 could be converted into Table 9-3.

Table 9-3 – Valid CATZOC Capabilities for Custom Survey Criteria based on depth uncertainty (d ≤ 200m)

a / b	100	50	25	10	5	2	1	0.5	0.3	0.25	0.2	0.15	0.1	0.05
0.2	D	D	D	D	D	C (5.33<d≤200) D (d≤5.33)	A2 (d≤1.01) C (1.01<d≤12) D (12<d≤200)	A1 (d≤0.25) A2 (0.25<d≤4.89) C (4.89<d≤13.02) D (13.02<d≤200)	A1 (d≤2.13) A2 (2.13<d≤5.33) C (5.33<d≤13.22) D (13.22<d≤200)	A1 (d≤2.30) A2 (2.30<d≤5.40) C (2.30<d≤13.25) D (13.25<d≤200)	A1 (d≤2.42) A2 (2.42<d≤5.45) C (5.45<d≤13.28) D (13.28<d≤200)	A1 (d≤2.52) A2 (2.52<d≤5.50) C (5.50<d≤13.31) D (13.31<d≤200)	A1 (d≤2.58) A2 (2.58<d≤5.53) C (5.53<d≤13.32) D (13.32<d≤200)	A1 (d≤2.62) A2 (2.62<d≤5.55) C (5.55<d≤13.33) D (13.33<d≤200)
0.1	D	D	D	D	D	C (26.67<d≤200) D (d≤26.67)	A2 (d≤4.17) C (4.17<d≤37.37) D (37.37<d≤200)	A1 (d≤1.01) A2 (1.01<d≤11.16) C (11.16<d≤39.37) D (39.37<d≤200)	A1 (d≤4.56) A2 (4.56<d≤12.04) C (12.04<d≤39.77) D (39.77<d≤200)	A1 (d≤4.89) A2 (4.89<d≤12.18) C (12.18<d≤39.84) D (39.84<d≤200)	A1 (d≤5.14) A2 (5.14<d≤12.30) C (12.30<d≤39.90) D (39.90<d≤200)	A1 (d≤5.33) A2 (5.33<d≤12.39) C (12.39<d≤39.94) D (39.94<d≤200)	A1 (d≤5.45) A2 (5.45<d≤12.45) C (12.45<d≤39.97) D (39.97<d≤200)	A1 (d≤5.53) A2 (5.53<d≤12.49) C (12.49<d≤39.99) D (39.99<d≤200)
0.05	D	D	D	D	D	C	A2 (d≤19.05) C (19.05<d≤200)	A1 (d≤4.17) A2 (4.17<d≤30.69) C (30.69<d≤200)	A1 (d≤10.51) A2 (10.51<d≤32.42) C (32.42<d≤200)	A1 (d≤11.16) A2 (11.16<d≤32.70) C (32.70<d≤200)	A1 (d≤11.67) A2 (11.67<d≤32.93) C (32.93<d≤200)	A1 (d≤12.04) A2 (12.04<d≤33.11) C (33.11<d≤200)	A1 (d≤12.30) A2 (12.30<d≤33.23) C (33.23<d≤200)	A1 (d≤12.45) A2 (12.45<d≤33.31) C (33.31<d≤200)
0.023	D (d≤200)	D (d≤200)	D (d≤200)	C (175.72<d≤200) D (d≤175.72)	C (64.28<d≤200) D (d≤64.28)	A2 (127.09<d≤182.99) C (d≤127.09, and 182.99<d≤200)	A2 (d≤200)	A1 (d≤23.31) A2 (23.31<d≤200)	A1 (d≤34.21) A2 (34.21<d≤200)	A1 (d≤35.59) A2 (35.59<d≤200)	A1 (d≤36.66) A2 (36.66<d≤200)	A1 (d≤37.46) A2 (37.46<d≤200)	A1 (d≤38.02) A2 (38.02<d≤200)	A1 (d≤38.35) A2 (38.35<d≤200)
0.02	D (d≤200)	D (d≤200)	D (d≤200)	C (171.43<d≤200) D (d≤171.43)	C (63.14<d≤200) D (d≤63.14)	A2 (75<d≤200) C (d≤75)	A2	A1 (d≤33.33) A2 (33.33<d≤200)	A1 (d≤45.15) A2 (45.15<d≤200)	A1 (d≤46.71) A2 (46.71<d≤200)	A1 (d≤47.94) A2 (47.94<d≤200)	A1 (d≤48.86) A2 (48.86<d≤200)	A1 (d≤49.50) A2 (49.50<d≤200)	A1 (d≤49.87) A2 (49.87<d≤200)
0.013	D (d≤200)	D (d≤200)	D (d≤200)	C (164.52<d≤200) D (d≤164.52)	C (61.26<d≤200) D (d≤61.26)	A2 (56.54<d≤200) C (d≤56.54)	A2	A1 (d≤144.93) A2 (144.93<d≤200)	A1 (d≤159.47) A2 (159.47<d≤200)	A1 (d≤161.73) A2 (161.73<d≤200)	A1 (d≤163.54) A2 (163.54<d≤200)	A1 (d≤164.92) A2 (164.92<d≤200)	A1 (d≤165.89) A2 (165.89<d≤200)	A1 (d≤166.47) A2 (166.47<d≤200)
0.01	D (d≤200)	D (d≤200)	D (d≤200)	C (162.63<d≤200)	C (60.74<d≤200)	A2 (53.52<d≤200)	A2	A1	A1	A1	A1	A1	A1	A1

				D (d≤162.63)	D (d≤60.74)	C (d≤53.52)								
0.0075	D (d≤200)	D (d≤200)	D (d≤200)	C (161.46<d≤200)	C (60.41<d≤200)	A2 (51.87<d≤200)	A1 (59.51<d≤200)	A1	A1	A1	A1	A1	A1	A1
				D (d≤161.46)	D (d≤60.41)	C (d≤51.87)	A2 (d≤59.51)							
0.004	D (d≤200)	D (d≤200)	D (d≤200)	C (160.41<d≤200)	C (60.12<d≤200)	A1 (159.99<d≤200) / A2 (50.51<d≤159.99)	A1 (52.15<d≤200)	A1	A1	A1	A1	A1	A1	A1
				D (d≤160.41)	D (d≤60.12)	C (d≤50.51)	A2 (d≤52.15)							
0.002	D (d≤200)	D (d≤200)	D (d≤200)	C (160.10<d≤200)	C (60.03<d≤200)	A1 (152.31<d≤200) / A2 (50.13<d≤152.31)	A1 (50.51<d≤200)	A1	A1	A1	A1	A1	A1	A1
				D (d≤160.10)	D (d≤60.03)	C (d≤50.13)	A2 (d≤50.51)							

10   The Implementation of the Allocation of CATZOC/QoBD Value from Survey Data

The implementation of the allocation of CATZOC/QoBD Value from survey data comprises of four phases as follows:

-    Phase 1: Hydrographic Input

-    Phase 2: Cartographic Input

-    Phase 3: Assignment of CATZOC/QoBD value

-    Phase 4: Review of CATZOC/QoBD value

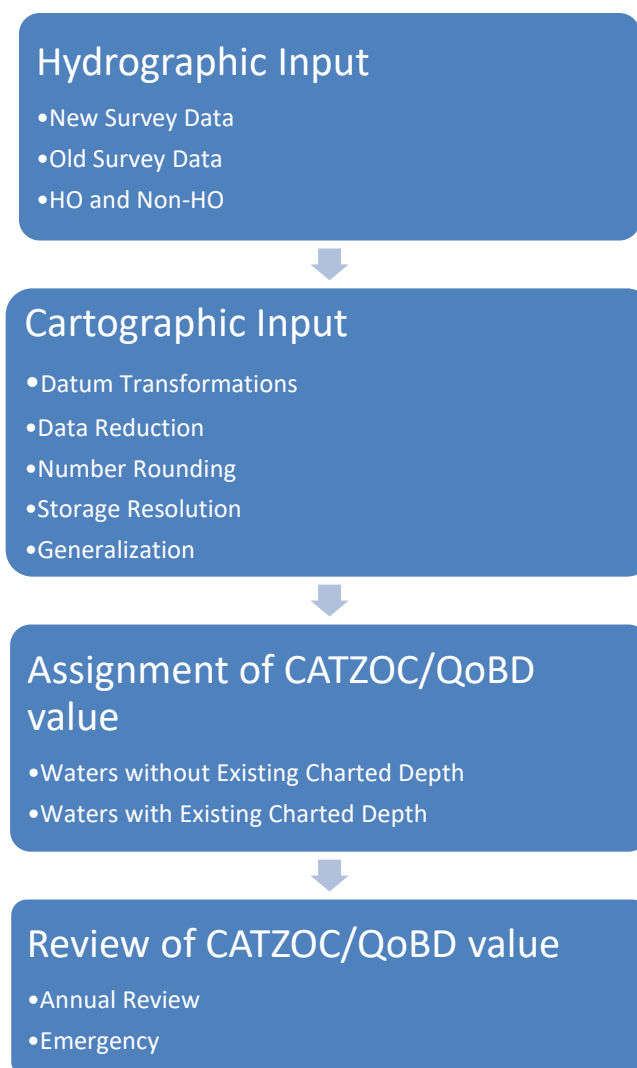The workflow of CATZOC/QoBD Assignment is shown in Figure 10-1.

Hydrographic Input

- New Survey Data
- Old Survey Data
- HO and Non-HO

Cartographic Input

- Datum Transformations
- Data Reduction
- Number Rounding
- Storage Resolution
- Generalization

Assignment of CATZOC/QoBD value

- Waters without Existing Charted Depth
- Waters with Existing Charted Depth

Review of CATZOC/QoBD value

- Annual Review
- Emergency

Figure 10-1 – CATZOC/QoBD workflow

10.1   Phase 1: Hydrographic input

10.1.1   Evaluation of CATZOC/QoBD capability for new survey data

New systematic survey data

The evaluation of CATZOC/QoBD capability for new systematic survey data must follow the guidelines set out in Chapters 8 and 9, and then be downgraded in accordance with 10.1.3.

If new systematic survey data is collected based on S-44, then Tables 8-7 and 8-8 could be directly used to evaluate of CATZOC/QoBD capability.

If new systematic survey data is collected based on a Member State's national standards which are not completely equal to S-44, then the relation between these national standards and S-44 must be established and tables similar to Table 8-7 and Table 8-8 could be made to be used in the evaluation of CATZOC/QoBD capability.

10.1.2   Evaluation of CATZOC/QoBD capability for old survey data

The CATZOC/QoBD capability for old survey data should be preliminary evaluated in accordance with guidelines set out in the following paragraphs of the section and then be downgraded in accordance with 10.1.3, 10.4.

Metadata of old survey data may be sufficient for data quality evaluation, provided it meets the criteria set out in the guidelines set out in Chapters 8 and 9. However, sometimes, it is very difficult to search sources of old survey data, which means that metadata of old survey data will be insufficient for data quality evaluation according to the guidelines described in Chapters 8 and 9. It is recommended to differ these two scenarios in the evaluation of CATZOC/QoBD capability for old survey data.

Old survey data with sufficient metadata

The CATZOC/QoBD capability for old survey data with sufficient metadata should be preliminary allocated in accordance with the guidelines described in Chapters 8 and 9.

Old survey data with insufficient metadata

Old survey data with insufficient metadata included in ENCs of Usage band 1 and 2 is recommended to be allocated a CATZOC/QoBD capability "D/5".

Old survey data with insufficient metadata sourced from the digitization of paper nautical charts is recommended to be allocated a CATZOC/QoBD capability equal to or worse than "B/3".

Old survey data with insufficient metadata before the application of single beam echo sounders in a Member State is recommended to be allocated a CATZOC/QoBD capability equal to or worse than "D/5".

Old survey data with insufficient metadata collected by single beam echo sounders is recommended to be allocated a CATZOC/QoBD capability equal to or worse than "C/4".

For old survey data with insufficient metadata collected by multibeam echo sounders, the CATZOC/QoBD capability for that in waters shallower than 40m is recommended to be equal to or worse than "B/3", while the CATZOC/QoBD capability for that in waters deeper than 40m are recommended to be equal to or worse than "A2/2".

Old survey data with insufficient metadata collected by hydrographic airborne laser sounder is recommended to be allocated a CATZOC/QoBD capability equal to or worse than "C/4".

Old survey data with insufficient metadata collected by non-systematic survey, such as scientific research and environmental survey, is recommended to be allocated a CATZOC/QoBD capability equal to or worse than "C/4".

Old survey data with insufficient metadata collected by Satellite-Derived Bathymetry is recommended to be allocated a CATZOC/QoBD capability equal to or worse than "D/5".

10.2   Phase 2: Cartographic input

When a cartographic process has been made to survey data during the product of nautical charts, the impact on the quality of the data must be evaluated. If it has a negative impact, the CATZOC/QoBD capability of survey data should be downgraded. The following kinds of cartographic processes need to be taken into consideration:

-    Datum Transformations.

-    Data Reduction

-   Number Rounding

-   Storage Resolution

-   Generalization

10.3   Phase 3: Assignment of the CATZOC/QoBD value

When new survey data is included in the nautical chart, the following two scenarios will occur:

-   Waters without existing charted depth. It means that there is no depth in the area covered by new survey data in a nautical chart.

-   Waters with existing charted depth. It means that there is depth in the area covered by new survey data in a nautical chart.

10.3.1   Waters without existing charted depth

In this scenario, the CATZOC/QoBD values of charted depth will be the CATZOC/QoBD capability of new survey data allocated in phase1 and 2.

10.3.2   Waters with existing charted depth

In this scenario, a comparison of data quality should be made between new survey data and existing charted depth. If the coverage of new survey data is inconsistent with that of the existing charted depth, the bigger coverage must be cut into one sub-coverage which is consistent with the smaller coverage before comparison and another rest sub-coverage. In the case of consistent coverage or sub-coverage, the following process will be implemented.

-   If the quality of new survey data is better than or equal to that of existing charted depth, replace the existing charted depth with the new survey data and allocate the CATZOC/QoBD values of the new survey data to the waters. A flowchart example is shown in Figure 10-2.
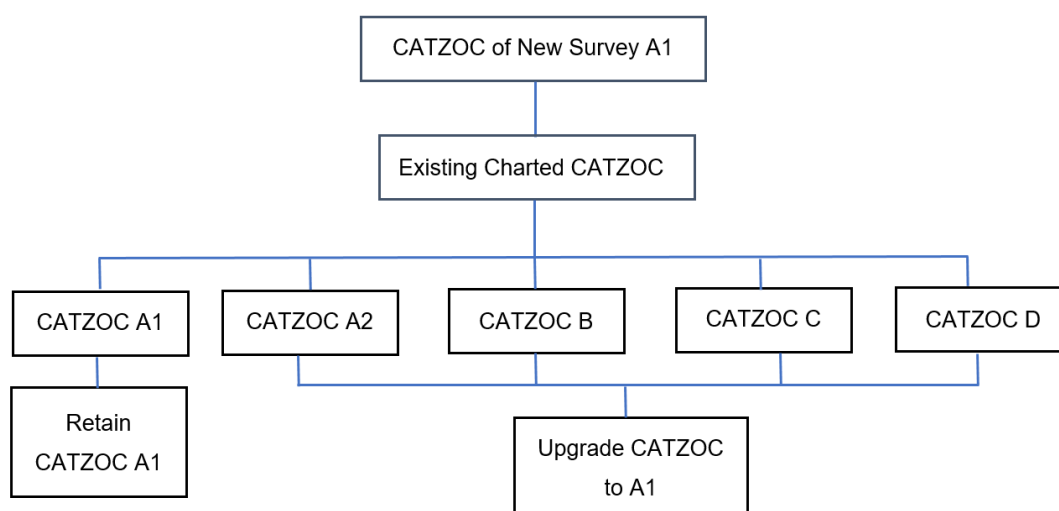

Figure 10-2 – CATZOC/QoBD flowchart when new survey data has a quality better than or equal to the existing charted depth

-   If the quality of new survey data is worse than that of the existing charted depth, for example, the new survey data is collected by single-beam echo sounding system while the existing charted depth is collected by multibeam echo sounding system, or the new data is collected by data collectors other than HOs while the existing charted depth is collected by HOs, it should be evaluated whether new survey data will replace the existing charted depth. If the answer is no, the CATZOC/QoBD values of the existing charted depth will be retained. If the answer is yes, replace the existing charted depth with new survey data. In addition, whether to keep the CATZOC/QoBD

values of existing charted depth retained should be further evaluated. A flowchart example is shown in Figure 10-3.
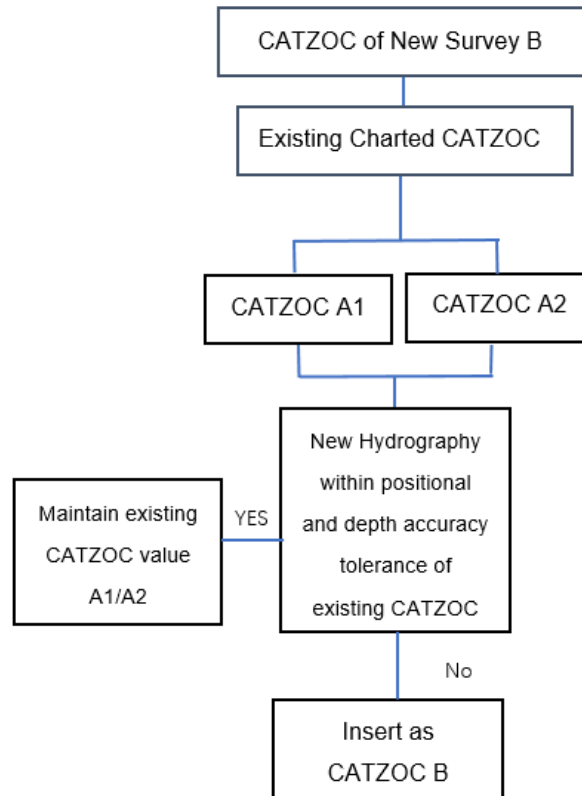

Figure 10-3 – CATZOC/QoBD flowchart when new survey data is worse

With regard to the remaining sub-coverage, if it is cut from new survey data, please refer to 10.3. Otherwise, no action is required.

10.4   Phase 4: Review of the CATZOC/QoBD value

10.4.1   Annual review

One significant limitation of the ZOC system is that it provides little information about when a survey was conducted, or whether the seabed is stable. While the date can be provided in another data field within an ENC, this is rarely done. In areas where the seabed is subject to change, HOs should downgrade the assigned ZOC category, and reevaluate it once a replacement survey is incorporated into a chart. Therefore, the CATZOC/QoBD value of charted depth should be maintained every year in order to make sure that the values are still valid and reliable.

The annual maintenance of CATZOC/QoBD values are recommended to follow the guidelines below.

10.4.2   Temporal degradation

For the vast majority of waters, the stability of the seabed and sediment deposition have been fully considered when the survey cycle of relevant nautical charts is determined by HOs. Therefore, the CATZOC/QoBD values of charted depth covering these waters will not be degraded year by year. However, considering that untimely updating of charted depth will have a significant negative impact on the validation and reliability of CATZOC/QoBD values, for areas that have not been resurveyed according to the regulated cycle, their CATZOC/QoBD values should be downgraded. The downgrade rule is to downgrade by 1 level for every regulated cycle exceeded. For example, if the regulated cycle is 4 years, the CATZOC/QoBD value will be downgraded by 1 level at the beginning of the fifth year, and by another level in the beginning of the ninth year, and so on.

10.4.3   Bathymetry Instability

For a very small number of waters with severe sediment deposition, values of the category of temporal variation should be allocated to charted depth covering these waters based on actual conditions in relevant S-101 ENCs. CATZOC/QoBD values of charted depth covering these waters in S-57 and S-101 ENCs should be downgraded according to the dredging cycle of these waters. For example, if the dredging cycle is 2 months, the CATZOC/QoBD value should be downgraded by 1 level for every 2 months when the charted depth is not updated with new survey data.

The process is as shown in Table 10-1.

Table 10-1 – Degradation rules for charted depth covering channels with significant siltation

Category of channel	Dredging cycle	Degradation rules
First class channels with significant siltation	2 months	Downgradation by 1 level for every 2 months exceeded.
Second class channels with significant siltation	3 months	Downgradation by 1 level for every 3 months exceeded.

10.4.4   Emergency

Emergencies may have extremely significant negative impacts on CATZOC/QoBD values of existing charted depth within the emergency area. After maritime accidents or natural disasters such as typhoons, earthquakes, volcanic eruptions, tsunamis, etc., there may be significant changes or obstacles to navigation on the seabed, resulting in the existing charted depth no longer being reliable. Therefore, the CATZOC/QoBD value of the existing charted depth must be temporarily assigned a value of "U". After resurvey, the existing charted depth will be replaced by the new survey data, and the CATZOC/QoBD value will be replaced by that of the new survey data too.

11   Recommendations on How to Transfer to the CATZOC/QoBD Allocation Scheme Based on S-68

Member States are encouraged to transfer their traditional CATZOC/QoBD allocation scheme to the CATZOC/QoBD allocation scheme based on S-68 through the following three optional paths:

-   Update CATZOC/QoBD values of an ENC only when producing a new Edition of the ENC. This option is the simplest and does not impose additional workload on cartographers, but for Member States with a large number of ENC cells, it will take a long time for them to complete the transformation.

-   Start a new program to update CATZOC/QoBD values of all ENCs at once. For example, do it while transferring from S-57 to S-101. This is the fastest way to complete the transformation, but it also imposes an additional workload, even a heavy burden, on cartographers.

-   Start a new program to update CATZOC/QoBD values of important navigable waters in all ENCs. The option will complete the conversion within important navigable waters as quickly as possible, improving the quality of data and enhancing the safety of navigation in these waters, while only imposing a limited additional workload on cartographers.

Member States are recommended to make decisions based on their needs and available resources.

12   CSB Data

This chapter will be completed later.

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Annex A: Zones of Confidence Categories

Table A-1 – Zones of Confidence categories

ZOC Category (note 1)	Position Accuracy (note 2)	Depth Accuracy (note 3)		Seafloor Coverage	Typical Survey Characteristics (note 5)
A1	± 5 m + 5% depth	=0.50 + 1%d		Full area search undertaken. Significant seafloor features detected (note 4) and depths measured.	Controlled, systematic survey (note 6) high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10	± 0.6		
		30	± 0.8		
		100	± 1.5		
		1000	± 10.5		
A2	± 20 m	= 1.00 + 2%d		Full area search undertaken. Significant seafloor features detected (note 4) and depths measured.	Controlled, systematic survey (note 6) achieving position and depth accuracy less than ZOC A1 and using a modern survey echo-sounder (note 7) and a sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10	± 1.2		
		30	± 1.6		
		100	± 3.0		
		1000	± 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 (note 6) achieving similar depth but lesser position accuracies than ZOC A2, using a modern survey echo-sounder (note 7), but no sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10	± 1.2		
		30	± 1.6		
		100	± 3.0		
		1000	± 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)	Accuracy (m)		
		10	± 2.5		
		30	± 3.5		
		100	± 7.0		
		1000	± 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 Ed 3.1 Supp 3 (Jun 2014), pp 13-14

Remarks:

To decide on a ZOC Category, all conditions outlined in columns 2 to 4 of the table must be met. Explanatory notes quoted in the Table:

Note 1: The allocation of a ZOC indicates that particular data meets minimum criteria for position and depth accuracy and seafloor coverage defined in this Table. ZOC categories reflect a charting

standard and not just a hydrographic survey standard. Depth and position accuracies specified for each ZOC category refer to the errors of the final depicted soundings and include not only survey errors but also other errors introduced in the chart production process.

Note 2: Position accuracy of depicted soundings at 95% CI (2.45 sigma) with respect to the given datum. It is the cumulative error and includes survey, transformation and digitizing errors etc. Position accuracy need not be rigorously computed for ZOCs B, C and D but may be estimated based on type of equipment, calibration regime, historical accuracy etc.

Note 3: Depth accuracy of depicted soundings = a + (b*d)/100 at 95% CI (2.00 sigma), where d = depth in meters at the critical depth. Depth accuracy need not be rigorously computed for ZOCs B, C and D but may be estimated based on type of equipment, calibration regime, historical accuracy etc.

Note 4: Significant seafloor features are defined as those rising above depicted depths by more than:
    Depth Significant Feature
    a. <40m: 2 m
    b. >40m: 10% depth

A full seafloor search indicates that a systematic survey was conducted using detection systems, depth measurement systems, procedures, and trained personnel designed to detect and measure depths on significant seafloor features. Significant features are included on the chart as scale allows. It is impossible to guarantee that no significant feature could remain undetected, and significant features may have become present in the area since the time of the survey.

Note 5: Typical Survey Characteristics - These descriptions should be seen as indicative examples only.

Note 6: Controlled, systematic surveys (ZOC A1, A2 and B) - surveys comprising planned survey lines, on a geodetic datum that can be transformed to WGS 84.

Note 7: Modern survey echo-sounder - a high precision single beam depth measuring equipment, generally including all survey echo-sounders designed post 1970.

Annex B: Summary of CATZOC Allocation of 12 Member States

Table B-1 – CATZOC allocation practice examples[6]

CATZOC	Allocation Practice Examples.
A1	- Surveys conducted using MBES meeting required accuracies, full seafloor coverage and feature detection requirements. (Australia) - Restricted to hydrographic surveys conducted for safety of navigation; scientific research surveys or environmental surveys are not considered to meet the required methodology or feature detection requirements. (Australia) - MBES or echo sweeping surveys and category 1 fairways, which have been surveyed, complied with a specific procedure combining modern SBES surveys and bar sweeping to provide full seafloor coverage. (Finland) - For surveys conducted from 2014, CATZOC A1 can be assigned to surveys that achieve the minimum standards for Special Order surveys as set out in S-44. (France) - Full area search / S-44 Special or 1a Order. (Japan) - Survey from MBES – survey achieves minimum standards for Order 1a survey as set out in S-44. (Netherlands) - Survey from 2014 using MBES (dependent on the type of echo sounder used). (Norway) - Controlled systematic survey with full seafloor search using a MBES with high position and depth accuracy. IHO S-44 order 1a or better. (UK) - Any survey coverage that meets A1 feature detection and uncertainty requirements. Horizontal and vertical uncertainty estimates must be computed and meet A1 accuracy standards at 95% confidence interval. (USA) - IHO S-44 Order 1a or better. (Denmark) - Maintained Depth as set out in S-44 the minimum standards for IHO Exclusive S-44 Order as set out in S-44, or Digital Survey using a MBES by HO and achieving the minimum standards for Special Order as set out in S-44. (India)
A2	- Surveys conducted using either MBES or SBES achieving required accuracies, full seafloor coverage and feature detection. (Australia) - Must be evidence of feature detection and investigations to determine least depths. (Australia) - Normally restricted to hydrographic surveys for safety of navigation (scientific research or environmental surveys are unlikely to meet required methodology or feature detection requirements). (Australia) - For surveys conducted from 2014, CATZOC A2 assigned to surveys that achieve the minimum standards for Order 1a surveys as set out in S-44. (France) - Surveys conducted since 1992 using MBES including full sea floor search and SSS. (France) - Surveys conducted since 1980 where scale >1:20,000 and SSS is used. (France) - Survey from SBES with SSS. (Netherlands) - Survey from 2014 using MBES (dependent on the type of echo sounder used). (Norway) - Surveys from 2000-2013. (Norway) - Surveys from 1990-2000 in areas deeper than 30m. (Norway) - Controlled systematic survey with less position and depth accuracy than CATZOC A1, undertaking a full seafloor search using either: SBES with SSS; Open spaced MBES with SSS; or MBES, full bottom coverage but uncertainty or processing does not meet CATZOC A1. IHO S-44 order 1a (but with IHO S-44 Order 2 for the positional and depth uncertainty). (UK) - Any survey coverage that meets A2 feature detection and uncertainty requirements. Horizontal and vertical uncertainty estimates must be computed and meet A2 accuracy standards at 95% confidence interval. (USA) - IHO S-44 order 1a (but with greater positional and depth uncertainty). (Denmark). - Modern multibeam surveys. (Greenland). - Digital Survey using a MBES by HO and achieving the minimum standards for order 1a or Special Order (Survey Scale ≥ Product scale) as set out in S-44. (India)

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[6] The information was collected in 2021 and 2022.

B	- Controlled systematic surveys conducted using SBES meeting required accuracies, and meeting minimum RAN line spacing requirements for water depth. (Australia)
	- Scientific research or environmental surveys using MBES meeting required accuracies and coverage equivalent to RAN line spacing requirements for water depth. (Australia)
	- Surveys conducted using LIDAR where full seafloor coverage not achieved. (Australia)
	- Evidence of interlining and shoal investigations expected in shallow water. (Australia)
	- Full seafloor coverage not achieved; depth anomalies may exist.
	- Surveys using either MBES or SBES where shallows systematically surveyed. (Finland)
	- For surveys conducted from 2014, CATZOC B can be assigned to surveys that achieve the minimum standards for Order 1b or Order 2 (if p>310m) surveys as set out in S-44. (France)
	- Surveys conducted since 1992 using MBES including full sea floor search without sides scan sonar. (France)
	- Surveys conducted since 1970 where scale >1:5,000 (P<20m) or Scale >1:10, 0000 (P<100m). (France)
	- ENCs derived from digitalization of paper charts. (Italy)
	- Surveys conducted by SBES (dependent online spacing). (Japan)
	- Survey from SBES without SSS. (Netherlands)
	- Surveys from 1990-2000 in areas shallower than 30m. (Norway)
	- Surveys from 1950-1990. (Norway)
	- Controlled, systematic survey, which is not 100% seafloor coverage. LIDAR surveys will usually be CATZOC B. IHO S44 Order 2 (can in certain situations fail line spacing requirement of IHO order 2) or failing any other requirement for CATZOC A1 or A2. (UK)
	- 1) Any survey coverage that meets A1/A2 uncertainty requirements but fails to meet A1/A2 feature detection requirements, 2) Any survey coverage that meets B uncertainty requirements, 3) Examples may include set line spacing coverage, trackline coverage. (USA)
	- IHO S44 Order 2 or data failing any requirement for CATZOC A1 or A2. (Denmark)
	- Single beam and existing surveys including fair sheets (Internal reference Multiplex) since 1989. (Greenland).
	- Digital Survey (Survey Scale ≥ Product scale) using a SBES by HO and achieving the minimum standards for order 1a as set out in S-44, or Digital Survey using a MBES by HO and achieving the minimum standards for order 1b as set out in S-44. (India)
C	- Controlled systematic surveys not meeting accuracy or coverage requirements for CATZOC B. (Australia)
	- Opportunity soundings meeting required accuracy requirements for CATZOC C. (Australia)
	- Areas that surveyed by systematic SBES surveys or with comprehensive SBES surveys or where depths based on old graphical sounding charts, but shallows not systematically surveyed. (Finland)
	- For surveys conducted from 2014, CATZOC C can be assigned to surveys that achieve the minimum standards for Order 2 surveys as set out in S-44. (France)
	- Surveys conducted between 1935 and 1970. (France)
	- Coastal surveys conducted before 1935. (France)
	- Passage sounding obtained from MBES. (France)
	- Surveys conducted by SBES (dependent on line spacing). (Japan)
	- ENCs derived from digitalization of paper charts. (Italy)
	- Surveys pre-1950. (Norway)
	- Used for lead-line surveys and Satellite Derived Bathymetry. (UK)
	- Any survey coverage that meets C uncertainty requirements. (USA)
	- Older data falling below IHO S44 Order 2(Denmark). Surveys and fair sheets older than 1989. (Greenland).
	- Digital Survey (Survey Scale < Product scale) using a SBES by HO and achieving the minimum standards for order 1a as set out in S-44, or Digital Survey (Survey Scale ≥ Product scale) using a SBES by HO and achieving the minimum standards for order 1b as set out in S-44. (India)

D	- Soundings with little or no metadata and/or on unknown datum's. (Australia)
	- No coastal surveys conducted before 1935. (France)
	- Reconnaissance surveys. (France)
	- Passage soundings obtained from SBES. (France)
	- For surveys conducted from 2014, CATZOC D assigned to surveys that fail to achieve the minimum standards for any of the Orders of surveys as set out in S-44. (France)
	- Surveys conducted by SBES (dependent on line spacing). (Japan)
	- Surveys conducted before 1966. (Japan)
	- Used to define unsurveyed area or Aerial photography. (UK)
	- Any survey coverage that does not meet C uncertainty requirements. (USA)
	- Also used to define Unsurveyed areas with any bathymetric features in or older undetermined sources that cannot be qualified (Denmark). Reconnaissance lines / Tracks of Soundings or rocks in Unsurveyed areas and older undetermined sources that cannot be qualified. (Greenland)
	- Non-Digital Survey achieving the minimum standards for order 1a as set out in S-44, Digital Survey (Survey Scale < Product scale) using a SBES by HO and achieving the minimum standards for order 1b as set out in S-44, or Digital Survey (Survey Scale ≥ Product scale) implemented by other agency and achieving the minimum standards for order 2 as set out in S-44. (India)
U	- Quality of survey unassessed.
	- Non-Digital Survey implemented by other agency and achieving the minimum standards for order 2 as set out in S-44. (India)

Table B-2 Notes of CATZOC allocation practice

Member State	CATZOC Values Used	Usage band/ Scale dependent	Down-grading	Down-grading with time	Down-grading with generation	Comments
Australia	A1, A2, B, C, D	No info	No	No	No	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.
Brazil	A1, A2, B, C, D, U	No info	No	No	No	Approximately 80% of ENCs are derived from digitalization of paper charts. Since 2014 the categories are allocated in accordance with the criteria in ZOC table.
Denmark	A1, A2, B, C, D	No info	No	No	No	Replacing CATZOC = U (unassessed) in Unsurveyed areas with CATZOC D. Relation between the theoretical values in CATZOC and survey standards as given in S44 has been established.
Finland	A1, A2, B, C, U	No Info	No	No	No	A1 and A2 are combined as one category.
France	A1, A2, B, C, D	Yes	Yes	No	Yes	Matrix for ZOC /S-44. CATZOC could be downgraded due to generalization (safety purpose).
India	A1, A2, B, C, D, U	No Info	No	No	No	Relation between the theoretical values in CATZOC and survey standards as given in S44 has been established. Other factors include Maintained Depth (MD), Bathymetric Data based on Digital Surveys (DS), Bathymetric Data based on Non-Digital Surveys (NDS), relation between Survey Scale and Product scale, distinction between official (INHO Survey) and private surveys (Other Agency Survey), and so on.

Italy	A1, A2, B, C, D, U	Yes	Yes	No	No	In ENCs of usage band 1(Overview) and 2 (General) only CATZOC D is used.
						For ENCS in usage band 3 (coastal), 4 (approach), 5 (harbor) and 6 (berthing) CATZOC assigned in accordance with the ZOC table.
						ENCs derived by digitalization from paper charts – CATZOC B and C are used in accordance with survey date and technology - downgraded to include errors introduced in the ENC production process (change of datum and digitalization process).
						CATZOC values are sometimes downgraded due to the instability of bathymetry.
Japan	A1, B, C, D, U	No Info	No	No	No	CATOC are not downgraded due to the passage of time, however CATZOC D was temporarily allocated to areas affected by the Tsunami of 2011 prior to the completion of new surveys.
Netherlands	A1, A2, B, D	No Info	Yes	Yes	No	If areas are not surveyed in accordance with established resurvey frequency downgrade of CATZOC is considered. Downgrades of CATZOC are also considered in less frequently surveyed areas known to be changeable and following extreme events.
Norway	A1, A2, B, C, D	No Info	No	No	No	In general, CATZOC allocation is based on consideration of the survey date/type of technology used in line with the ZOC table.
						Surveys are in some areas of Svalbard incomplete. Large areas have not been surveyed using modern technology. In the ENCs these areas have mostly been given CATZOC D
UK	A1, A2, B, C, D,	No Info	No	No	No	CATZOC is not downgraded due to the passage of time however following natural disasters, existing hydrographic detail may become suspect and may be reclassified to CATZOC D; outside any areas covered by emergency surveys.
USA	A1, A2, B, C, D	No Info	No	No	No	For Survey conducted by NOAA CATZOC is allocated in line with the ZOC table. (See notes above in the "Table B-1 CATZOC Allocation Practice Examples".)

Annex C: Document Contributors

The Chair of the Data Quality Working Group, Lingzhi WU (China), supported by the Secretary Scott Youngblut (Canada) and the IHO Secretariat would like to thank the following participants (in alphabetic order) for their efforts and contributions:

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