



8th Meeting of the ENC Standards Maintenance Working Group

Report on the Guidelines and recommendations for Hydrographic Offices for the allocation of CATZOC

ENCWG-8, Lombok- Indonesia, 25-29 September February 2023



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1. INTRODUCTION

International Hydrographic Organization

Minimum Bathymetry Standards for Safety of Navigation Hydrographic Surveys defined by S-44

Criteria	Order 2	Order 1b	Order 1a	Special Order	Exclusive Order
Area description (Generally)	Areas where a general description of the sea floor is considered adequate.	Areas where underkeel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas where underkeel clearance is considered not to be critical but features of concern to surface shipping may exist.	Areas where underkeel clearance is critical	Areas where there is strict minimum underkeel clearance and manoeuvrability criteria
Depth <u>THU</u> [m]+ [% of Depth]	20 m +10% of depth *Ba5, Bb2	5 m+5% of depth *Ba8, Bb3	5 m+5% of depth *Ba8, Bb3	2 m *Ba9	1 m *Ba10
Depth <u>TVU</u> (a) [m] and (b)	a = 1.0 m b = 0.023 *Bc7, Bd4	a = 0.5 m b = 0.013 *Bc8, Bd6	a = 0.5 m b = 0.013 *Bc8, Bd6	a = 0.25 m b = 0.0075 *Bc10, Bd8	a = 0.15 m b = 0.0075 *Bc12, Bd8
<u>Feature Detection</u> [m] or [% of Depth]	Not Specified	Not Specified	Cubic features > 2 m, in depths down to 40 m; 10% of depth beyond 40 m *Be5, Bf3 beyond 40m	Cubic features > 1 m *Be6	Cubic features > 0.5 m *Be9
<u>Feature Search</u> [%]	Recommended but Not Required	Recommended but Not Required	100% *Bg9	100% *Bg9	200% *Bg12
<u>Bathymetric Coverage</u> [%]	5% *Bh3	5% *Bh3	≤ 100% *≤ Bh9	100% *Bh9	200% *Bh12



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1. INTRODUCTION

ZOC Categories

ZOC	QoBD	Position Accuracy	Depth Accuracy	Seafloor Coverage
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	
	0	Oceanic	Oceanic areas with water depth greater than 200m	

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



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1. INTRODUCTION

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).
- 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, e.g., in the case where CATZOC A1 and A2 are combined (e.g., 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 assignments, some HOs may **downgrade** the CATZOC/QoBD values due to the passage of time, generalization, natural disasters, and the instability of bathymetry and so on, in order to ensure safety of navigation.



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

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

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

Seafloor 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%

Vertical Accuracy			
S-57/S-101 (ZOC)		S-44 (Survey)	
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	$\sqrt{((1.0^2 + (0.023*d)^2)}$

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	2	Not Specified



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3. CONVERSION MATRICES

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

- Data assessment
- Significant features detected
- Least depth of significant features known
- Full seafloor coverage achieved
- Depth accuracy
- Positional accuracy
- Category of temporal variation (S-101 only)



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The following Tables illustrate the valid CATZOCs for the Survey Orders. It is noted that the assigned CATZOC is the result of combining the allowable CATZOC of these 7 stages/criteria. In the following matrices:

- **green color is used to indicate that survey order meets the requirements of the respective CATZOC, e.g., the vertical uncertainty of Special Order meets the vertical accuracy criteria of all CATZOC (i.e., A1, A2, B, C, 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 (i.e., 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.**
- **Orange color is 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 accuracy 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 (i.e., there are no explicitly defined requirements for CATZOCs U and O).



Check 1: Data assessment

Valid CATZOCs 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	↻	↻	↻	↻	↻	↻

d=depth

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



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Check 2: Significant features detected

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

d=depth



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Check 3: Least depth of significant features known

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

d=depth



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Check 4: Full seafloor coverage achieved

Valid CATZOCs for the Survey Orders based on Full seafloor coverage achieved

Seafloor Coverage	Survey Order Requirement	200%	100%	100%	Not required	Not required
ZOC Requirement	Survey Zoc/QoBD	Exclusive	Special	1a	1b	2
Full	A1/1	↻	↻	↻	↻	↻
Full	A2/2	↻	↻	↻	↻	↻
Not required	B/3	↻	↻	↻	↻	↻
Not required	C/4	↻	↻	↻	↻	↻
Not required	D/5	↻	↻	↻	↻	↻
N/A	U/6	↻	↻	↻	↻	↻
N/A	-/Oceanic	↻	↻	↻	↻	↻

d=depth



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Check 5: Depth accuracy

Valid CATZOCs for the Survey Orders based on Depth accuracy

Vertical Accuracy	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 <u>Zoc/QoBD</u>	Exclusive	Special	1a	1b	2
0.5m+0.01*d	A1/1	↻	↻	d ≥ 145m	d ≥ 145m	↻
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	↻	↻	↻	↻	↻

d=depth



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Check 6: Positional accuracy

Valid CATZOCs for the Survey Orders based on Positional accuracy

Horizontal Accuracy	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					
20m	A2/2			d>300m	d>300m	
50m	B/3					d>300m
500m	C/4					
>500m	D/5					
N/A	U/6					
N/A	-/Oceanic					

d=depth



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Check 7: Least depth of significant features known

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 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.



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3. CONVERSION MATRICES

When the above steps are combined we get the following table that illustrates the minimum achieved Survey Order for each CATZOC.

minimum achieved Survey Order for each CATZOC

Criterion <u>Zoc/QoBD</u>	Data Assessment	Features Detected	Least Depth	Seafloor Coverage	Depth Accuracy	Position Accuracy
A1/1	Assessed	1a	1a	1a	1b(d<145m)	1b
A2/2	Assessed	1a	1a	1a	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	<u>Unassessed</u>	-	-	-	-	-
-/Oceanic	Assessed	2	2	2	2	2

d=depth



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Summary of the valid CATZOCs for the Survey Orders

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

d=depth

Notes:

It is pointed out that the presented matrices represent a direct comparison between CATZOC/QoBD and S-44 Survey Orders minimum standards, however, hydrographic offices may follow different practices in particular cases.



- The Section 7.6 of S-44 Ed 6.1.0 introduced a new specification matrix that provides a range of selectable criteria for bathymetric parameters and other data types collected, reported, and delivered as part of a hydrographic survey.

Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
B	BATHYMETRY														
a	Depth THU [m]	500	200	100	50	20	15	10	5	2	1	0.5	0.35	0.1	0.05
b	Depth THU [% of depth]	20	10	5	2	1	0.5	0.25	0.1						
c	Depth TVU "a" [m]	100	50	25	10	5	2	1	0.5	0.3	0.25	0.2	0.15	0.1	0.05
d	Depth TVU "b" Note 1	0.20	0.10	0.05	0.023	0.02	0.013	0.01	0.0075	0.004	0.002				
e	Feature Detection [m]	50	20	10	5	2	1	0.75	0.7	0.5	0.3	0.25	0.2	0.1	0.05
f	Feature Detection [% of Depth]	25	20	10	5	3	2	1	0.5	0.25					
g	Feature Search [%]	1	3	5	10	20	30	50	75	100	120	150	200	300	
h	Bathymetric Coverage [%]	1	3	5	10	20	30	50	75	100	120	150	200	300	

- A spreadsheet that translates the new S-44 matrix parameters into CATZOC is in development. The scope of the spreadsheet is to help HOs in assigning CATZOC with producing an aggregated CATZOC value for the input survey parameters.



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ACTION REQUIRED OF DQWG

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The ENCWG is invited to:

Note the information provided.



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Thanks a lot for your attention!

**If you have any question or comment, please don't hesitate to
Email to :**

3511431@qq.com