

S-101PT6 Remote Meeting

23-24 February 2021

Alternatives for Modelling of Quality of Bathymetric Data



IHO S-101 DCEG EDITION 1.0.0 QUALITY OF BATHYMETRIC DATA MODELLING

International Hydrographic Organization DQWG conclusions:

- Uncertainty about the ability of automated S-57 to S-101 conversion to adequately provide consistent S-101 portrayal of QoBD, particularly in a dual-fuel ECDIS environment. Recommendation: Add S-57 attribute CATZOC to S-101.
- Concerns over the implementation of the attribute category of temporal variation, from both an assessment perspective (new surveys in remote areas) and dataset updating processes to cater for degradation of QoBD over time. Recommendation: Remove category of temporal variation from S-101.
- A consistent method of encoding degrading QoBD over time in changeable areas is required. Recommendation: Add new attributes temporal validity and lowest QoBD category to Quality of Bathymetric Data (S-101PT5-16).
- A mechanism is required to portray horizontal and vertical accuracies for individual features. Recommendation: Mandate horizontal position uncertainty and vertical uncertainty for underwater hazard features.



IHO PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC DATA – ADDITION OF CATZOC

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- Will ensure consistency of portrayal of QoBD information where both S-57 and S-101 ENCs are being portrayed "side by side".
- Data Producers will be able to review the values populated for the "deconstructed" CATZOC component attributes in Quality of Bathymetric Data features during the S-57 to S-101 conversion process in slower time.
- Recommend that this attribute is only implemented for the S-57 to S-101 transition period.

HO Definition: QUALITY OF BAT of the bathymetric data exists. (S-	HYMETRIC DATA. A 57 Edition 3.1, Appen	An area within dix A – Chapt	which a uniform er 1, Page 1.216	assessme , Novembr	nt of the quality er 2000).	
S-101 Metadata Feature: Qualit	y of Bathymetric Dat	ta (M_QUAL)				
Primitives: Surface						
Real World	Paper Chart Symbol	per Chart Symbol ECDIS Symbol				
S-101 Attribute	S-67 Acronym	Allowable	Encoding	Туре	Multiplicity	
ategory of temporal variation		1 : extreme event 2 : likely to change and significant shoaling expected 3 : likely to change but significant shoaling not expected 5 : unlikely to change 6 : unassessed		EN	¢,1	
lata assessment		1 : assessed 2 : assessed (oceanic) 3 : unassessed		EN	1,1	
lepth range maximum value	(DRVAL2)			RE	0,1	
lepth range minimum value	(DRVAL1)				0,1	
eatures detected				с	1.1	
least depth of detected features measured				(S) BO	1.1	
significant features detected				(S) BO	1.1	
size of features detected				(S) RE	0,1	
ull seafloor coverage achieved				BO	1,1	
orizontal position uncertainty				e	4,4	
-uncertainty-fixed	(POSACC)			(S) RE	4,4	
uncertainty variable factor				(8) RE	0,4	
patial accuracy				C	1.7	
category of zone of confidence in c	data CATZOC	1 : zone o 2 : zone o 3 : zone o 4 : zone o 5 : zone o 6 : zone o (data r	f confidence A1 f confidence A2 f confidence B f confidence C f confidence D f confidence U not assessed)	EN	1,1	
fixed date range				(S) C	0,1	
date end	(DATEND)	ISO 8601: 2004		(S) TD	0,1	
date start	(DATSTA)	ISO 8601:	2004	(S) TD	0,1	
horizontal position uncertainty				(S) C	1,1	
uncertainty fixed	(POSACC)			(S) RE	1,1	
uncertainty variable factor				(S) RE	0,1	
vertical uncertainty				C	1,1	
uncertainty fixed	(SOUACC)			(S) RE	1,1	
unnerteinty verieble fentor				(S) RE	0,1	

an ar Attrib	rea basi bute Tvr	ed on the position of the posi	onal accuracy, survey equi n	pment and coverage.	
1) z	zone of	confidence A1			
, u h (I <u>HO Def</u> undertal high pos (LOP) ai A – Cha	inition: Position ken. Significant sition and depth nd a <u>multibeam</u> pter 2, Page 2.1	nal Accuracy +/- 5 metres; seafloor features detected accuracy achieved using , channel or mechanical so 107, November 2000).	Depth Accuracy 0.5 m d and depths measure DGPS or a minimum t weep system. (Adapter	etce +1% depth; Full area seard d; Controlled, systematic surve hree high quality lines of positio d from S-57 Edition 3.1, Append
2) z	zone of	confidence A2			
ll a s N	I <u>HO Def</u> undertal achievin sonar or Novemb	inition: Position ken. Significant g position and mechanical sw ler 2000).	al Accuracy +/- 20 metres seafloor features detecte depth accuracy less than a eep system. (Adapted from	Depth Accuracy 1.0 m d and depths measure ZOC A1 and using a m m S-57 Edition 3.1, App	etre + 2% depth; Full area seard ed; Controlled, systematic survi odern survey <u>echosounder</u> and endix A – Chapter 2, Page 2.10
3) z	zone of	confidence B			
ll n C n A	I <u>HO Def</u> not ach Controlle modern Appendi	inition: Position ieved, uncharte ed, systematic survey <u>echoso</u> x A – Chapter 2	al Accuracy +/- 50 metres, ed features hazardous to survey achieving similar de inder, but no sonar or med 2, Page 2.107, November 2	Depth Accuracy 1.0 m surface navigation a epth but lesser position chanical sweep system 2000).	etre + 2% depth; Full area seard re not expected but may exis accuracies than ZOCA2, using . (Adapted from S-57 Edition 3.
4) z	zone of	confidence C			
li D D	I <u>HO Def</u> not achie basis su Novemb	inition: Position eved, depth and ch as sounding: ier 2000).	al Accuracy +/- 500 metres omalies may be expected; s on passage. (Adapted fro	; Depth Accuracy 2.0 g Low accuracy survey o om S-57 Edition 3.1, Ap	netre + 5% depth; Full area seard r data collected on an opportuni bendix A – Chapter 2, Page 2.10
5) z	zone of	confidence D			
n a N	I <u>HO Defi</u> not achi assesse Novemb	inition: Position eved, large de d due to lack of ier 2000).	al Accuracy worse than ZO oth anomalies may be exp information. (Adapted from	C C; Depth Accuracy w bected; Poor quality da m S-57 Edition 3.1, App	orse than ZOC C; Full area sean ita or data that cannot be qual sendix A – Chapter 2, Page 2.10
6) z	zone of	confidence U	data not assessed		
ļ	I <u>HO Def</u> Appendi	inition: The qua ix A – Chapter 2	lity of the bathymetric data , Page 2.107, November 2	has yet to be assessed	I. (Adapted from S-57 Edition 3.
Rem. • Th	<u>iarks:</u> he full ca	ategorisation of	each category is as follow	s:	
	1	2	3	4	5
Z	zoc 1	Position Accuracy ²	Depth Accuracy ^a	Seafloor Coverage	Typical Survey Characteristics ⁶
			=0.50 + 1%d	Full area search	Controlled, systematic survey 6

Recommendation: Add the attribute categoryOfZoneOfConfidenceInData (as modelled in S-57 M_QUAL) to the QualityOfBathymetricData feature for the period of transition from S-57 to S-101. ECDIS portrayal to be associated with this attribute; and S-57 to S-101 conversion software to map to both this attribute and the S-101-specific quality related attributes.



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IHO PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC DATA – CATEGORY OF TEMPORAL VARIATION (1)

- The capability to provide an indication of the temporal nature of QoBD was considered to be a significant improvement to the data model during the development of S-101 Edition 1.0.0.
 - Removing this capability may be seen as a "backward step".
- The **category of temporal variation** attribute is the second attribute considered in the QoBD "Decision Tree":



Suggest that this attribute is removed from the decision tree, particularly given the additional revised modelling proposed for addressing temporal aspects of the display of bathymetric data quality.

* Note that category of temporal variation = 6 (Unassessed) is not included in the Decision Tree.



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IHO PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC DATA – CATEGORY OF TEMPORAL VARIATION (2)

- Given the recommendation of removing **category of temporal variation** from the DQWG Decision Tree and further proposals for revised modelling to improve portrayal of temporal degradation of QoBD in ECDIS, is there a requirement to retain this attribute given that its only functionality in ECDIS will be access via ECDIS Pick Report?
- Information may be displayed in ECDIS as a border legend.
- **Recommendation:** Attribute categoryOfTemporalVariation to be retained as a non-mandatory attribute for QualityOfBathymetricData for ongoing implementation and testing purposes. A new complex attribute spatialAccuracy to be introduced and modelled in accordance with one of the options included in the Annex to Paper S-101PT6-12.



IHO PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC DATA – DISPLAY OF TEMPORAL DEGRADATION (1)

- Australian proposal (refer Paper S-101PT5-16):
 - Introduction of new attributes temporal variation and lowest QoBD category.
- Requires new conditional portrayal routine in ECDIS. This may be problematic as the routine will require an interpretation of the QoBD category that is nominally achieved by the constituent QoBD attributes.



S-101PT6, Remote Meeting, 23-24 February 2021

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- Alternate proposal: Utilise the existing S-101 functionality of complex attributes and multiplicity (Option 1).
 - Contain horizontal position uncertainty and vertical uncertainty within a new complex spatial accuracy, which also contains the sub-complex fixed date range so as to provide an indication of the period for which these uncertainties are valid.
 - Also include attribute category of zone of confidence in data within the complex so as to provide capability to display degrading quality over time.
 - Assign multiplicity [1..*] so as to provide the capability to encode degrading horizontal and vertical uncertainty over time.
 - Resultant portrayal will indicate a degrading level of the QoBD over time in accordance with the DQWG Decision Tree. ECDIS Pick Report should also provide more quantitative, consistent information.

least depth of detected features measured			(S) BO	1,1
significant features detected			(S) BO	1,1
size of features detected			(S) RE	0,1
full seafloor coverage achieved			BO	1,1
horizontal position uncertainty			e	4,1
-uncertainty fixed	(POSACC)		(S) RE	4,1
-uncertainty variable factor			(S) RE	0,1
spatial accuracy			С	1,*
category of zone of confidence in data	CATZOC	1 : zone of confidence A1 2 : zone of confidence A2 3 : zone of confidence B 4 : zone of confidence C 5 : zone of confidence D 6 : zone of confidence U (data not assessed)	EN	1,1
fixed date range			(S) C	0,1
date end	(DATEND)	ISO 8601: 2004	(S) TD	0,1
date start	(DATSTA)	ISO 8601: 2004	(S) TD	0,1
horizontal position uncertainty			(S) C	1,1
uncertainty fixed	(POSACC)		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1
vertical uncertainty			С	1,1
uncertainty fixed	(SOUACC)		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1
survey date range			С	1,1
date end	(SUREND)	ISO 8601:2004	(S) TD	1,1
date start	(SURSTA)	ISO 8601:2004	(S) TD	0,1
vertical uncertainty			e	4,4
-uncertainty fixed	(SOUACC)		(S) RE	4,4
			(S) RE	0,1



IHO PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC DATA – DISPLAY OF "POSITIONAL UNCERTAINTY" CIRCLES ON INDIVIDUAL FEATURES (1)

- International Hydrographic Organization
- Requirement is to provide functionality to portray "uncertainty circles" as required on navigational hazards (Sounding, Obstruction, Underwater/Awash Rock and Wreck features). Additionally, allow "worst case" indication of depths for these features.
- Methodology:
 - Mandate the population of **horizontal position uncertainty** and **vertical uncertainty** for these features.
 - Provide cartographic capability to select the features within the dataset for which the horizontal "uncertainty circles" are to be displayed in certain ECDIS display settings.
- It has been noted that repetitive population of these attributes individually for each feature instance would be a burden for compilers.







IHO DATA – DISPLAY OF "POSITIONAL UNCERTAINTY" CIRCLES ON INDIVIDUAL FEATURES (2)

 Recommendation: Mandate the association of the information type Spatial Quality to all encoded Sounding, Obstruction, Underwater/Awash Rock and Wreck features of depth 30 metres or less.

Remarks:

- For rocks which do not cover (islets), see clause 5.4.2.
- All Underwater/Awash Rock features should be encoded using one of the above combinations of attributes.
- For guidance regarding the population of the complex attribute vertical uncertainty, all Underwater/Awash Rock features of depth 30 metres or less an instance of the information type Spatial Quality (see clause 25.4) must be associated to the associated point geometry, using the association Spatial Association. Where value of sounding is populated with an empty (null) value, the value for the attribute vertical uncertainty (uncertainty fixed) on the associated Spatial Quality feature must also be populated as empty (null). See also clause 3.7.1.3 (Quality of Bathymetric Data).
- Note that this proposal also requires the removal of the complex attribute vertical uncertainty as an allowable attribute for Sounding, Obstruction, Underwater/Awash Rock and Wreck features.



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IHO PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC DATA – DISPLAY OF "POSITIONAL UNCERTAINTY" CIRCLES ON INDIVIDUAL FEATURES (3)

- Recommendation: Introduce a new mandatory Boolean attribute display uncertainties for all encoded Sounding, Obstruction, Underwater/Awash Rock and Wreck features of depth 30 metres or less. This attribute is intended to be a cartographic attribute allowing selective display of horizontal uncertainty circles as required.
 - During the S-57 to S-101 conversion process, this attribute will be set to No.
 - The attribute display uncertainties is a cartographic attribute intended to reduce screen clutter in some ECDIS display settings by limiting the display of the horizontal position accuracies of a sounding to those considered by the encoder to be important to the mariner, and is mandatory for all Underwater/Awash Rock of depth 30 metres or less. Factors to be considered in populating this attribute include depth in relation to the general nature of the seabed, proximity to other dangers, intention of the ENC, proximity to routes taken by vessels, and the types of vessels intended to utilise the ENC.
 - A rock represented on paper charts by a spot sounding and an associated nature of seabed (underwater rock not dangerous to surface navigation) should be encoded using a single Underwater/Awash Rock feature, with the sounding value encoded using the attribute value of sounding. Where Underwater/Awash Rock is encoded, there must be no Sounding feature encoded coincident.
 - For area rock and coral reef features, see clause 12.1.1.
 - When a group of rocks is surrounded by a danger line, each rock should be encoded as a separate **Underwater/Awash Rock** feature covered by an obstruction area feature (**Obstruction** see clause 13.6).





IHO PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC DATA – A STEP FURTHER? (1)

- International Hydrographic Organization
- Feedback from the initial circulation of the draft S-101PT6 Paper suggests a need for a more direct association between the Quality of Bathymetric Data feature and the uncertainties associated to individual features.
- A possible extension to the proposed remodelling for **Quality of Bathymetric Data** as outlined as Option 1 in paper S-101PT6-12 is as follows (Option 2):
 - Apply the remodelling of horizontal and vertical uncertainties to the complex attribute spatial accuracy to the Information type Spatial Quality;
 - Remove the horizontal and vertical uncertainty attributes from **Quality of Bathymetric Data** altogether;
 - Mandate the association of an instance of Spatial Quality to each instance of Quality of Bathymetric Data. This could be done by using the association Spatial Association, or by introducing a new Composition association (named for example Bathymetric Data Quality Composition).
 - For this option, the **quality of zone of confidence in data** attribute could be modelled as a subattribute of a new complex (for example **zone of confidence**) to provide capability to encode degrading overall quality indication over time.
 - [If a new Composition association is implemented, additional consideration may be given to using this association for associating **Spatial Quality** to the individual feature instances.]



PROPOSED REMODELLING OF QUALITY OF BATHYMETRIC IHO **DATA – A STEP FURTHER? (2)**

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3.7 Quality of bathymetric data (Option 2)

IHO Definition: QUALITY OF BA	THYMETRIC DATA. A 57 Edition 3.1, Append	∖n area within dix A – Chapt	which a uniform er 1, Page 1.216	assessme , Novembe	nt of the quality er 2000).
S-101 Metadata Feature: Qual	ity of Bathymetric Dat	a (M_QUAL)			
Primitives: Surface					
Real World	Paper Chart Symbol	per Chart Symbol ECDIS Symbol			
S-101 Attribute	S-57 Acronym	Allowable Encoding Value		Туре	Multiplicity
category of temporal variation		1 : extreme event 1 : likely to change and significant shoaling expected 3 : likely to change but significant shoaling not expected 5 : unlikely to change 6 : unassessed		EN	0,1
data assessment		1 : sssessed EN 1,1 2 : sssessed (oceanic) 3 : unassessed		1.1	
depth range maximum value	(DRVAL2)			RE	0,1
depth range minimum value	ange minimum value (DRVAL1)			RE	0,1
features detected				С	1,1
least depth of detected features measured				(S) BO	1,1
significant features detected				(S) BO	1.1
size of features detected				(S) RE	0,1
full seafloor coverage achieved				BO	1,1
horizontal position uncertainty				e	4,4
	(POSACC)			(S) RE	4,4
				(S) RE	0,1
survey date range				С	1,1
date end	(SUREND)	ISO 8601:2004		(S) TD	1,1
date start	(SURSTA)	ISO 8601:2004		(S) TD	0,1
vertical uncertainty				e	4,4
-uncertainty fixed	(SOUACC)			(S) RE	4,4
				(S) RE	0,1
zone of confidence					0,*
category of zone of confidence in	data CATZOC	1 : zone of confidence A1 EN 1,1 2 : zone of confidence A2 3 : zone of confidence B 4 4 : zone of confidence C 5 : zone of confidence D 0 6 : zone of confidence U (data not assessed) 1		1,1	
fixed date range				(S) C	0,1
date end	(DATEND)	ISO 8601:	2004	(S) TD	0,1
date start	(DATSTA)	ISO 8601: 2004 (S) TD 0.1			0.1

24.5 Spatial Quality (Option 2)

6 404 lafe musting True C						
S-101 Information Type: Spat	tial Quality					
Primitives: None						
Real World	Paper Chart Symbol	ər Chart Symbol		ECDIS Symbol		
S-101 Attribute	S-57 Acronym	Allowable Value	Encoding	Туре	Multiplicity	
horizontal position uncertainty				ç	0,1	
-uncertainty fixed	(POSACC)			(S) RE	4,4	
				(S) RE	0.1	
quality of horizontal measurement	(QUAPOS)	1: surveyed 2: <u>unsurveyed</u> 3: inadequately surveyed 4: approximate 5: position doubtful 6: unreliable 9: estimated 10: precisely known 11: calculated		EN	0,1	
spatial accuracy				С	1,*	
fixed date range				(S) C	0,1	
date end	(DATEND)	ISO 8601: 2004		(S) TD	0,1	
date start	(DATSTA)	ISO 8601:	2004	(S) TD	0,1	
horizontal position uncertainty				(S) C	0,1	
uncertainty fixed	(POSACC)			(S) RE	1,1	
uncertainty variable factor				(S) RE	0,1	
vertical uncertainty				С	0,1	
uncertainty fixed	(SOUACC)	,		(S) RE	1,1	
uncertainty variable factor				(S) RE	0,1	
vertical uncertainty				e	0,1	
upcortainty fixed	(VERACC)			(S) RE	11	

25.XX Quality of bathymetric data composition (Option 2 only)

Quality of Bath related characte	nymetric Data Comp eristics of bathymetric	osition: IHO Definition: The mandatory ass data and the horizontal position and vertical	sociation between the quality- uncertainties of the data.
Remarks: • No remarks.			
Role Type	Role	Associated With	Multiplicity
Association	Defined for	Quality of Bathymetric Data	1,1
	Defines	Spatial Quality	1,1



IHO VERTICAL UNCERTAINTY FOR VERTICAL CLEARANCES

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- Question: Is this information considered to be important enough (or relevant) for the navigational ENC?
- For consideration:
 - Information may be difficult to determine/obtain, or not available to the Producing Authority.
- The same consideration should be applied to horizontal clearances.
- **Recommendation**: Vertical and horizontal uncertainty to remain optional in relation to clearances in S-101, however additional guidance should be considered for inclusion if it is considered that this information is important in certain circumstances and if the information is available.



RENAMING QUALITY OF BATHYMETRIC DATA TO ZONE OF CONFIDENCE

- The suggestion for this recommendation from the DQWG is derived from ECDIS user feedback that the terms "ZOC", "CATZOC" and "Zone of Confidence" are more familiar to the end user that "Quality of Bathymetric Data". However, additional factors to consider include:
 - "Quality of Bathymetric Data" implicitly describes the purpose of the feature, while "Zone of Confidence" does not imply any relationship to quality of bathymetry except to those familiar with the term from S-57;
 - Other quality-related names used in S-101 are "Quality of Non-Bathymetric Data", Quality of Survey" and "Spatial Quality". Re-naming Quality of Bathymetric Data will introduce an inconsistency in naming, both in S-101 and in the IHO GI Registry.
- **Recommendation**: Meta feature name Quality of Bathymetric Data to be retained. However, "Zone of Confidence" and "ZOC" to be included as aliases.

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FURTHER INFORMATION OR DISCUSSION

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