

Paper for Consideration by S-100WG/S-101PT/S-102PT

Data Quality Working Group Report

Submitted by:	DQWG (Chair)
Executive Summary:	Report of the outcome of the 15 th meeting of the HSSC-Data Quality Working Group, 4-7 February 2020
Related Documents:	S-100 Ed.4.0.0, S-101, S-102, S-111, S-121, S-122, S-123, S-127 Product Specifications and Feature Catalogues
Related Projects:	S-101PT; S-102PT; S-129PT, CSBWG

Introduction / Background

This paper provides the outcome of the DQWG-15 meeting and the relevant items for the S-100WG/S-101PT/S-102PT. The main objective for the DQWG is to ensure that the data quality aspects are addressed in an appropriate and harmonized way for all S-100 based product specifications. The DQWG should:

1. Periodically review S-100 based product specifications to ensure the data quality aspects have been taken into consideration and provide input papers for WGs and PTs consideration if deemed necessary;
2. Provide data quality educational material for the use of mariners;
3. Review appropriate methodology for the display of quality information to product specification developers.

Analysis/Discussion

Item 1:

S-100WG reported to DQWG showing the proposed review cycle for WG/PT development phase between version 1.0.0 and 1.9.n. DQWG was requested to perform a review upon request of a WG/PT within 30 working days when an updated Edition is made publicly available. All members agreed to this proposal.

Proposed Review Cycle for WG/PT Development Phase



At the start of the meeting, the follow S-1xx Product Specifications, Feature Catalogues and Validation Schema's were available:

Index	Product Specification	Feature Catalogue	Portrayal Catalogue	Validation Schema
S-101	S-101 Ed 1.0.0	S-101FC_1.0.0_20190409	S-101_PC_0.9.3	Not available
S-102	S-102 Ed 2.0.0	S-102FC_2.0.0	Not available	Not available
S-111	S-111 Ed 1.0.0	feature_catalogue	Not available	Not available
S-121	S-121 Ed 1.0.0	S-121_FC_1.0.0	There is no portrayal	Not available
S-122	S-122 Ed 1.0.0	S-122_FC_1.0.0	S-122_PC_Ed1.0.0	S-122.xsd
S-123	S-123 Ed 1.0.0	S-123_FC_1.0.0	Not available	S-123.xsd
S-127	S-127 Ed 1.0.0	S-127_FC_1.0.0	Not available	S-127.xsd
S-129	S-129 Ed 1.0.0	S-129_FC_1.0.0	S-129_PC_Ed1.0.0	Not available

NLHO has developed software to cross-check automatically the feature catalogues of different product specifications. The DQWG Chair performed a live demonstration of this software on his laptop, showing how to validate a feature catalogue against its associated XML Definition Schema (.xsd), for S-122, S-123 and S-127. Next, the XML Definition Schema's of S-122, S-123 and S-127 were tested against each other (validating the validators). This independent (from IHO Geospatial Information Registry) analysis tool looks very promising for data quality checks, datasets validation and product interoperability. The results of these checks have been included as Annex – A.

DQWG has developed an overview of the different Feature Catalogues in an excel sheet format. The content of each separate Feature Catalogue has been translated into a readable format in excel allowing to cross-check the various published Feature Catalogues against each other. See [DQWG15\(2020\)](#) -> 04.1B Rev2.

DQWG has developed guidelines on various Data Quality and Validation principles:

DQWG15-04.1C – Explaining Feature Catalogues;

DQWG15-04.3A – Data Validation ISO principles;

DQWG15-04.4A – How to Evaluate an S-1xx Exchange Set.

These guidelines and software tools will be made easy available through a Data Quality collaborative wiki access, hosted by NOAA.

Paper DQWG15-04.4B submitted by the S-100WG, Reporting Data Quality for S-100 Datasets, was discussed. The outcome was that DQWG agreed to the recommendation to update S-1xx part 4C with ISO-19157. No further action was considered to be done at this time.

The S-101 Feature Catalogue and the associated Decision Tree for allocating the appropriate CATZOC value were discussed. UK indicated feeling uncomfortable with the newly introduced element of Category of Temporal Variation. If a survey is carried out in a remote area where there has never been a full sea bottom coverage before, it is very difficult to establish if the seabed is changeable or not. The default option would then be to downgrade to a low CATZOC value but this does not justify the cost and accuracy of the initial survey. In addition, it was noted that there are several different approaches between Member States to translate the quality of a survey to a CATZOC value. Some use the object Survey Reliability (M_SREL, optional), some do not and downgrade the CATZOC value over time. After some discussion, it was agreed to remove the attribute Category of Temporal Variation from S-101 (advice to the S-101PT).

Item 2:

The DQWG Chair introduced the draft S-67 Mariner's Guide to the Accuracy of Depth Information in ENC's. This document was initially drafted by Australia (Mike Prince) in 2017 Ed 0.4. At HSSC-9, DQWG proposed to publish this document as a standard (S-67) such that it closely relates to the existing publication S-66 "Facts about Electronic Charts and Carriage requirements." At HSSC-9 France requested the HSSC to ask the NCWG and the ENCWG to review this document prior to submission by DQWG. At HSSC-11 INTERTANKO commented on the development of S-67 and ask the IHO for a pragmatic and workable approach when developing this standard, stating that clear guidance for the Mariners and unambiguous use of ZOC is much appreciated by the industry.

DQWG has worked during 2019 by correspondence on this document. A Letter was sent out on 17th July 2019 to all DQWG members and the Chair of NCWG and ENCWG to actively participate in the review of Ed 0.9. The deadline for review was set to 15th December 2019. In total 323 comments were submitted by 17 different organizations, creating a review document of 47 pages.

Representatives of CSMART and INTERTANKO both responded very positive to this development and encouraged the DQWG to maintain the momentum. Mr. Jeff Wootton led and ad hoc sub-group to address the remaining issues, with the aim that the DQWG should be able to submit the final proposed Edition 1.0.0 for the endorsement of HSSC at their next meeting.

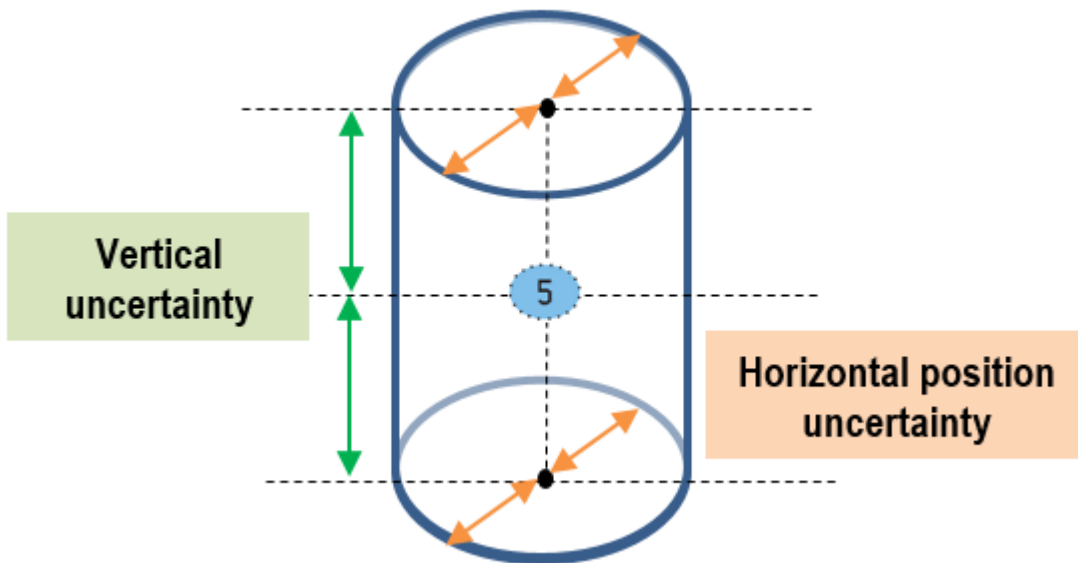
Due to the fact that S-67 describes the Accuracy of Depth Information in ENC's (in S-57), the question was raised why in S-57 we use the concept Zone of Confidence and in S-101 we call it Quality of Bathymetric Data. For the end user, the words Zone of Confidence are more familiar after being used for more than 20 years. If there is no good reason to change the name, the DQWG agreed that in S-101 the name Zone of Confidence should be used rather than Quality of Bathymetric Data.

Item 3:

One of the top priorities of the DQWG is to provide recommendations for modelling the quality of bathymetric data in S-101 ENC. Some use cases highlighted the critical role of these components for route planning and route monitoring for mariners. Questions were raised on the applicability of data quality indicators (horizontal and vertical accuracy) not only to wrecks, soundings, underwater rocks, ... but also to depth contours in future S-101 ECDIS. Principles for using data quality indicators were tested in some scenarios and reported by Italy, Finland and Norway. These examples demonstrated the potential of data quality indicators for improving safe navigation but also highlighted the complex situations in some coastal areas. It is considered that Hydrographic Offices will have to face new challenges when encoding some data, in particular when they are provided by different sources.

“

The new functionality proposed by the AHO aims to use measurements' uncertainties to inform mariners, at their request, about any positional and dimensional offsets charted objects may have. This information could be used to reduce risk by increasing safety margins when possible.



ECDIS expected performance:

- 1) At the mariners' request, ECDIS should display 'positional uncertainty circles' around safety critical hydrographic features. As a minimum: SOUNDG, WRECKS, OBSTRN and UWTRC. This information should be managed in its own layer (overlay) and should be switched ON/OFF with the touch of a button. While displayed, an indication on the ECDIS screen must alert the user that this optional layer is active.
- 2) At the mariners' request, ECDIS route checking safety functions should generate Warnings when a ship's safety framework is to cross:
 - a. the 'positional uncertainty circle' of a dangerous feature or
 - b. an otherwise non-dangerous feature whose vertical uncertainty makes it breach the safety margins established (e.g. safety contour is set to 7m and the ship is to cross an UWTRC with a charted least depth of 7.5m and a vertical uncertainty of $\pm 0.8\text{m}$).

These warnings must be easily differentiated from the ones generated without considering any uncertainty values. This includes portrayal and reporting.

- 3) Both functionalities listed above should be available during route planning and route monitoring.

Additionally, the AHO proposes the new S-100 ECDIS performance standard should also require the in-built safety functions to use a ship's width and height when calculating safe passages under bridges,

overhead cables, etc. Once again, the dimensions of a ship could be directly compared against charted clearances or use the extra safety buffer provided by the attributes 'horizontal distance uncertainty' and 'vertical uncertainty'.

“

The DQWG spend almost 1.5 days discussing the suggestions from AHO as above. In the end a most elegant and simple solution was found and approved by all members. This is presented in S-100WG5-07.6 – Conversion of M_QUAL/CATZOC to S-101.

During the conversion process from S-57 to S-101, the original CATZOC value is untouched and copied into the new Complex Feature (now Quality of Bathymetric Data). If no POSACC/SOUACC attribute values are populated, they should be computed and populated. But in order to avoid screen clutter, a Boolean parameter (default = OFF) should be introduced. This way it will avoid screen clutter but HO's have to ability to modify the Vertical Uncertainty and Horizontal Position Uncertainty and then activate the ability to portray the associated uncertainty of hazardous features dangerous to navigation, as they seem appropriate to alert the Mariner. A query by PRIMAR proved that less than 1% of all hazardous features dangerous to navigation currently have POSACC/SOUACC attributes populated.

Technical impact:

The current S-57 Appendix B-1 Annex A UOC Edition 4.1.0_Jan18_EN states:

The meta object M_QUAL defines areas within which uniform assessment exists for the quality of bathymetric data, and must be used to provide an assessment of the overall quality of bathymetric data to the mariner. Areas of a cell containing depth data or bathymetry must be covered by one or more M_QUAL, which must not overlap.

Meta object: Quality of data (M_QUAL)

Attribute	Meaning	Multiplicity
CATZOC	Category of Zone of Confidence in Data	1..1
DRVAL1	The minimum (shoalest) value of a depth range	0..1
DRVAL2	The maximum (deepest) value of a depth range	0..1
POSACC	The best estimate of the accuracy of a position	0..1
SOUACC	The best estimate of the accuracy of the sounding data	0..1
SUREND	The end date of the survey	0..1
SURSTA	The start date of the survey	0..1
TECSOU	Technique of sounding measurement	0..1
INFORM	Textual information about the object	0..1
NINFOM	Text (c...): Textual information in national language characters	0..1
NTXTDS	the string encodes the file name of an external text file that contains the text in a national language	0..1
TXTDSC	the string encodes the file name of an external text file that contains the text in English	0..1
SORDAT	The production date of the source, e.g. the date of measurement	0..1
SORIND	Information about the source of the object	0..1

Remarks:

- Wherever possible, meaningful and useful values of CATZOC should be used (that is, values other than CATZOC = 6 (data not assessed)) for areas of bathymetry. For areas of unstable seafloors, the attribute SUREND may be used to indicate the date of the survey of the underlying bathymetric data.
- A CATZOC category indicates that the depths encoded within a **M_QUAL** area meet the minimum criteria described in the CATZOC definition table. A CATZOC category may be further sub-divided by specifying depth and positional accuracy, and sounding technique, using the attributes POSACC, SOUACC and TECSOU, within separate **M_QUAL** areas.

- DRVAL1 must not be used on a **M_QUAL** object, unless a swept area occupies the entire **M_QUAL** area (see clause 5.6).
- DRVAL2 must not be used on a **M_QUAL** object, except to specify the maximum depth to which the CATZOC category applies. When DRVAL2 is specified, the CATZOC category applies only to depths equal to or shallower than DRVAL2. No quality information is provided for depths deeper than DRVAL2.
- POSACC must not be used on a **M_QUAL** object, except to specify a higher positional accuracy of the depths than the CATZOC category indicates. When DRVAL1 is specified, POSACC must not be used - there is no positional accuracy information provided for any underlying depths in this circumstance.
- SOUACC must not be used on a **M_QUAL** object, except to specify a higher accuracy of the depths than the CATZOC category indicates. When DRVAL1 is specified, SOUACC refers only to the accuracy of the swept depth defined by DRVAL1 - there is no depth accuracy information provided for any underlying depths in this circumstance.
- TECSOU must not be used on a **M_QUAL** object to specify a lower quality than the CATZOC category indicates.
- When the **M_QUAL** area contains soundings from multiple surveys of different techniques, the attribute TECSOU must not be used. TECSOU may be populated with multiple values only where the **M_QUAL** area is covered by a survey or surveys that have used multiple common techniques, for example an area covered by multiple surveys all using a modern echosounder combined with a sonar or mechanical sweep system.
- When the **M_QUAL** area contains data from only one survey, the date of survey, if required, must be specified using the attribute SUREND. When the **M_QUAL** area contains data from two or more surveys, the date of the oldest survey, if required, must be specified using the attribute SURSTA, and the date of the most recent survey, if required, must be specified using SUREND.
- Additional quality information may be given using the meta object **M_SREL**.
- Where **M_QUAL** areas are encoded over land, CATZOC should be set to 6 (unassessed).
- **M_QUAL** may either be encoded over wet areas only, or alternatively a single **M_QUAL** object may be created for the whole cell over wet and dry areas, but see 1st bullet point above.
- When **M_QUAL** and the meta object **M_ACCY** are encoded in a cell, they should not overlap.
- When both **M_QUAL** and **M_ACCY** objects are used in a cell, the area covered by these objects should equal the area of data coverage for the cell.
- POSACC on the **M_QUAL** applies to bathymetric data situated within the area, while QUAPOS or POSACC on the associated spatial objects qualifies the location of the **M_QUAL** object itself.
- As a result of some disasters, for example earthquakes, tsunamis, hurricanes, it is possible that large areas of seafloor have moved and/or become cluttered with dangerous obstructions. Emergency surveys may subsequently be conducted over essential shipping routes and inside harbours. Outside these surveys, all existing detail is now suspect, whatever the quality of the previous surveys. In such cases, the CATZOC value should be reclassified to value 5 (zone of confidence D) in the affected areas outside the area covered by emergency surveys.

ISO Standard 19157 – Geographic Information – Data Quality, page 31 states:

Data quality specified at upper level (e.g. series) is applicable at lower level (e.g. dataset), see Table B.1. If the data quality differs between upper and lower level, then supplemental information should be provided at lower level.

This means that if not further specified, the objects that are covered by a **M_QUAL** object have the Vertical Uncertainty (SOUACC) and Horizontal Position Uncertainty (POSACC) as inherited by the CATZOC value.

ZOC	Position Accuracy	Depth Accuracy
A1	5m + 5% of depth	0.5m + 1% of depth
A2	20m	1.0m + 2% of depth
B	50m	1.0m + 2% of depth
C	500m	2.0m + 5% of depth
D	worse than ZOC C	worse than ZOC C

The S-101 Feature Catalogue Ed.1.0.0 has the complex Feature type Quality of Bathymetric Data. It contains the following elements: - multiplicity in brackets)

name	Quality of Bathymetric Data
definition	An area within which a uniform assessment of the quality of the bathymetric data exists.
code	QualityOfBathymetricData
alias	M_QUAL
attribute ref	Category of Temporal Variation (1..1)
attribute ref	Data assessment (1..1)
attribute ref	depthRangeMaximumValue (0..1)
attribute ref	depthRangeMinimumValue (0..1)
attribute ref	featuresDetected (1..1)
attribute ref	fullSeafloorCoverageAchieved (1..1)
attribute ref	horizontalPositionUncertainty (1..1)
attribute ref	surveyDateRange (1..1)
attribute ref	verticalUncertainty (1..1)
feature use type	meta
permittedPrimitives	surface

The S-101 Feature Catalogue also has Complex attributes:

name	Horizontal Position Uncertainty
definition	The best estimate of the accuracy of a position
code	horizontalPositionUncertainty
remarks	The expected input is the maximum of the two-dimensional error. The error is assumed to be positive and negative
attribute ref	uncertaintyFixed
attribute ref	uncertaintyVariable

name	Vertical Uncertainty
definition	The best estimate of the vertical accuracy of depths, heights, vertical distances and vertical clearances
code	verticalUncertainty
remarks	The complex attribute encodes the vertical uncertainty associated with any vertical measurement
attribute ref	uncertaintyFixed
attribute ref	uncertaintyVariable

The complex attributes horizontal position uncertainty and vertical uncertainty should be applied to the Complex Feature Types: Obstruction, Sounding, Under water / awash rock and Wreck.

The Feature Type Obstruction contains:

name	Obstruction
definition	In marine navigation, anything that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel
code	Obstruction
remarks	The term is usually used to refer to an isolated danger to navigation
alias	OBSTRN
attribute ref	categoryOfObstruction (0..1)
attribute ref	condition (0..1)
attribute ref	expositionOfSounding (0..1)
attribute ref	featureName (0..*)
attribute ref	height (0..1)
attribute ref	maximumPermittedDraught (0..1)
attribute ref	natureOfSurface (0..*)
attribute ref	product (0..*)
attribute ref	qualityOfVerticalMeasurement (0..*)
attribute ref	reportedDate (0..1)
attribute ref	status (0..*)
attribute ref	techniqueOfVerticalMeasurement (0..*)
attribute ref	valueOfSounding (0..1)
attribute ref	verticalLength (0..1)
attribute ref	verticalUncertainty (0..1)
attribute ref	waterLevelEffect (1..1)
attribute ref	scaleMinimum (0..1)
attribute ref	defaultClearanceDepth (0..1)
attribute ref	surroundingDepth (0..1)
featureUseType	geographic
featureBinding role type	aggregation
association ref	MooringTrotAggregation
permittedPrimitives	point
permittedPrimitives	curve
permittedPrimitives	surface

The Obstruction Feature type is missing the attribute ref: horizontalPositionUncertainty, which is needed for the permittedPrimitive = point.

The Feature Type Sounding contains:

name	Sounding
definition	A measured water depth or spot which has been reduced to a vertical datum (may be a drying height).
code	Sounding
remarks	Drying heights (drying soundings) are indicated by a negative value
alias	SOUNDG
attribute ref	featureName (0..*)
attribute ref	qualityOfVerticalMeasurement (0..*)
attribute ref	reportedDate (0..1)
attribute ref	status (0..1)
attribute ref	techniqueOfVerticalMeasurement (0..*)
attribute ref	verticalUncertainty (0..1)
attribute ref	scaleMinimum (0..1)
featureUseType	geographic
permittedPrimitives	pointSet

The Sounding Feature type is missing the attribute ref: horizontalPositionUncertainty

The Feature Type Underwater/awash rock contains:

Name	Under water / awash rock
definition	A concreted mass of stony material or coral which dries, is awash or is below the water surface
code	UnderwaterAwashRock
alias	UWTROC
attribute ref	expositionOfSounding (0..1)
attribute ref	featureName (0..*)
attribute ref	natureOfSurface (0..1)
attribute ref	qualityOfVerticalMeasurement (0..*)
attribute ref	reportedDate (0..1)
attribute ref	status (0..1)
attribute ref	techniqueOfVerticalMeasurement (0..*)
attribute ref	valueOfSounding (1..1)
attribute ref	verticalUncertainty (0..1)
attribute ref	waterLevelEffect
attribute ref	scaleMinimum (0..1)
attribute ref	defaultClearanceDepth (0..1)
attribute ref	surroundingDepth (0..1)
featureUseType	geographic
permittedPrimitives	point

The Under water / awash rock Feature type is missing the attribute ref: horizontalPositionUncertainty.

The Feature Type Wreck contains:

Name	Wreck
definition	The ruined remains of a stranded or sunken vessel which has been rendered useless
code	Wreck
alias	WRECKS
attribute ref	categoryOfWreck (0..1)
attribute ref	expositionOfSounding (0..1)
attribute ref	featureName (0..*)
attribute ref	height (0..1)
attribute ref	qualityOfVerticalMeasurement (0..1)
attribute ref	radarConspicuous (0..1)
attribute ref	reportedDate (0..1)
attribute ref	status (0..*)
attribute ref	techniqueOfVerticalMeasurement (0..*)
attribute ref	valueOfSounding (0..1)
attribute ref	verticalUncertainty (0..1)
attribute ref	visuallyConspicuous (0..1)
attribute ref	waterLevelEffect (1..1)
attribute ref	scaleMinimum (0..1)
attribute ref	defaultClearanceDepth (0..1)
attribute ref	surroundingDepth (0..1)
featureUseType	geographic
permittedPrimitives	point
permittedPrimitives	surface

The Wreck Feature type is missing the attribute ref: horizontalPositionUncertainty.

Temporal validity:

As indicated the attribute Category of Temporal variation is suggested to be removed from the Complex Feature Type Quality of Bathymetric Data. However, the horizontal and/or vertical uncertainty of the assessment of an area may degrade over time. There will still be a mechanism needed to (automatically) increase the Horizontal Position Uncertainty and Vertical Uncertainty values as time goes by in areas of unstable seabed.

S-4 article B-416 Areas of continual change states:

Areas of continual and rapid change occur in many tidal rivers and estuaries, for example Hugli River (India) and Bahia Buenaventura (Colombia); over bars in the approaches to some ports, for example Esbjerg (Denmark) and Karachi (Pakistan); and over some off-lying banks, for example The Goodwin Sands (UK) and The Eastern Approaches to Nantucket Sound (USA).

So when a highly accurate survey has been done in these areas, the appropriate Quality of Bathymetric Data value should applied to the data at the time of the survey, and the attribute Survey Date Range should be populated. As time goes by, it is then up to the Hydrographic Office to adjust the values for horizontal and vertical uncertainty in order to inform the Mariner of the degradation of accuracy, unless a re-survey is carried out to compensate for the loss of accuracy.

Rounding of depths

In paper charts depths are rounded according to S-4 article B-412:

Rounding of depths, including drying heights, must always be on the safe (shoaler) side (that is: soundings must be rounded down and drying heights rounded up, if necessary). The rounding should be:

- to the nearest decimetre between 0,1 and 21m;
- to the nearest half metre from 21 to 31m;
- thereafter, to the nearest metre.

However, these soundings must be adjusted as a function of the degree of accuracy with which depths were actually measured, so that the precision with which soundings are recorded on charts can never be misleading as to the accuracy of such soundings.

In S-57 ENC's the valueOfSounding (real type) is maintained as it was acquired during the survey. The rounding of depth according to S-4 is done by the portrayal engine of S-52. However, some HOs change the valueOfSounding in the S-57 ENC to match the paper chart result. This should not be done as it will create a mismatch between the provided depths when the verticalUncertainty value is applied.

This is demonstrated in the figures below:

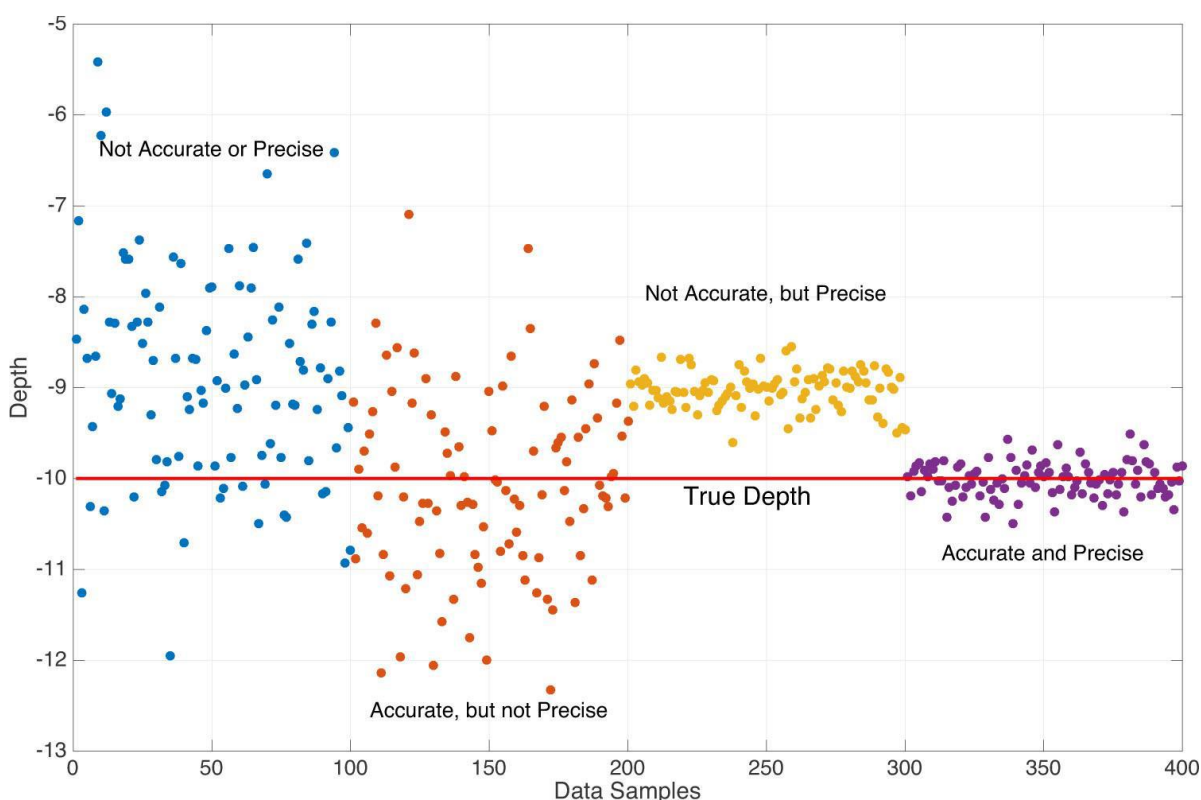


Image of the difference between accurate and precise (ref B_12_Ed2.0.0_2020, page 32)

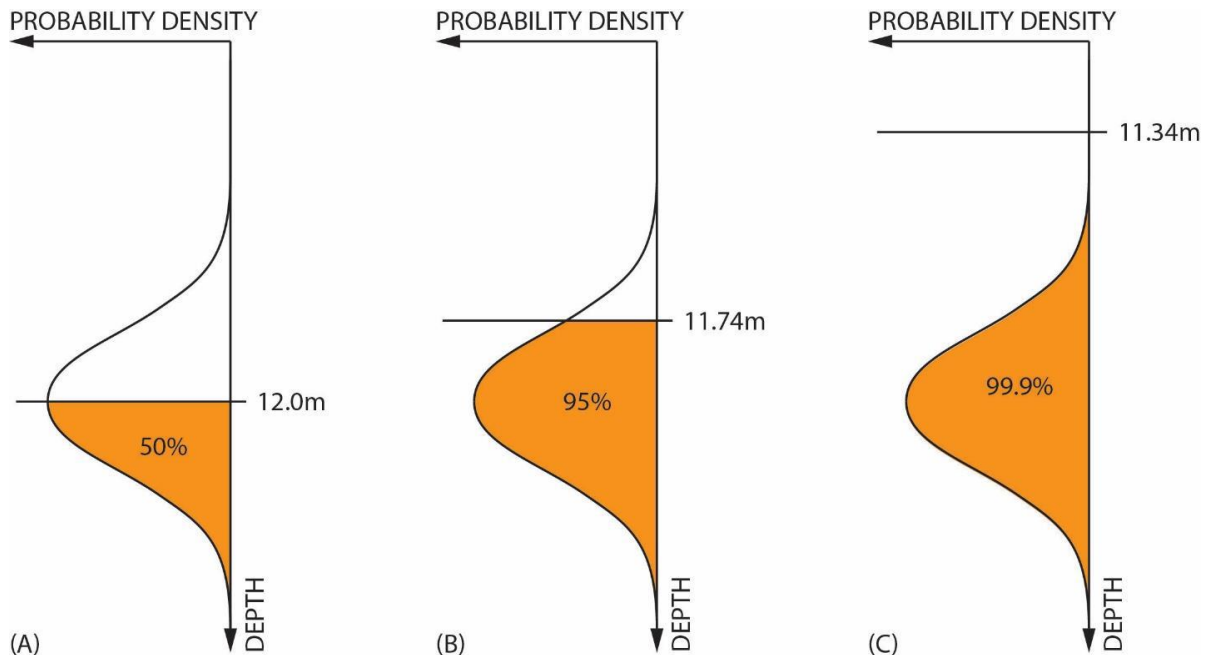


Image of the applied vertical Uncertainty, 95% and 99.9% (ref B_12_Ed2.0.0_2020, page 38)

In the example above the average shape of the seabed has a valueOfSounding = 12.0m
 When the 95% uncertainty margin is applied, the portrayed depth becomes 11.74m
 When the 99% uncertainty margin is applied, the portrayed depth becomes 11.34m

In this case the starting value is 12.0m therefor there is no mismatch.

Let's use an example at a depth of 33.8m and with a 95% confidence interval of 1.5m:
 In an ENC the calculated depth becomes $33.8 - 1.5 = 32.3\text{m}$, which can be used for decision making.
 In a paper chart, the provided depth becomes 33.0m.

However, for HOs who change the valueOfSounding prior to applying the vertical Uncertainty:
 in such an ENC the calculated depth becomes $33.0 - 1.5 = 31.5\text{m}$

Looking at the Feature Types Obstruction, the attributes maximum permitted draught, default clearance depth, value of sounding are present. The simple features according to the S-101 Feature Catalogue are:

name	Maximum permitted draught
definition	The maximum draught of a vessel permitted along a route, in a channel or dock, at a berth, or over a submerged feature
code	maximumPermittedDraught
valueType	real

name	Default clearance depth
definition	The depth value determined for an underwater hazard of unknown depth, based on the depth of the surrounding area.
code	defaultClearanceDepth
valueType	real

name	Value of sounding
definition	The value of the measurement of a sounding relative to the chart datum.
code	valueOfSounding
remarks	A drying height is indicated by a negative value. The unit of measure is defined in the DUNI subfield of the DSPM record or in the DUNITS attribute of the M_UNIT meta object class, e.g., metre (m). The resolution is 0.1 m or 0.1 fm or 0.1 ft
valueType	real

Conclusions and recommendations

The following recommendations are made to the S-101PT for their next meeting:

- Remove the attribute Category of temporal variation from the Feature Type Quality of Bathymetric Data;
- To introduce an attribute ref Temporal validity for Quality of Bathymetric Data;
- Take note of the S-67 (draft) standard and avoid any discrepancies between this publication and the S-101 Data Classification Encoding Guide;
- Consider renaming the Feature Type Quality of Bathymetric Data into Zone of Confidence;
- Note the recommendations made by the DQWG regarding the conversion of M_QUAL/CATZOC to S-101 and automatically calculating (but not applying) the horizontal and vertical uncertainty values for the Feature Types: Obstruction, Sounding, Under water / awash rock and Wreck.
- Ensure that the S-101 Feature Catalogue has the appropriate attribute ref's of horizontalPositionUncertainty for (as a minimum) Obstruction, Sounding, Under water / awash rock and Wreck.
- Ensure that the SUREND attribute of M_QUAL (now optional) remains mandatory for Quality of Bathymetric Data (attribute ref = surveyDataRange);
- Note paper S-101PT4-5.4: Proposal for a global revision of S-101 attribute "Quality of horizontal measurement". The proposal by DQWG is that for isolated dangers hazardous to navigation, the quality of horizontal measurement should not be used, but the horizontalPositionUncertainty and verticalUncertainty of the permittedPrimitives=point features should be used to alert the mariner and facilitate autonomous shipping. The quality of horizontal/vertical measurement is a secondary option to inform the mariner and is only remaining in S-101 for legacy reasons.

The following recommendations are made for the S-101PT and S-102PT for their next meeting:

- Note the issues identified by the DQWG about rounding of depths;
- Discuss how to overcome any mismatch between an S-101 dataset and overlying S-102 datasets regarding valueOfSounding, maximumPermittedDraught and defaultClearanceDepth in relation to the recommendations made by the DQWG to HSSC regarding the visualization of Quality of Bathymetric Data, in detail on the automatic calculation of the vertical uncertainties related to Quality of Bathymetric Data;
- Discuss how to overcome any mismatch provided by S-102 data where the Uncertainty values of the S-102 data are applied or not and how to properly inform the mariner for decision making when combining S-101 and S-102 data.

Justification and Impacts

The transition from S-57 to S-101 is a very good opportunity for HO's to enrich their existing S-57 ENC's with uncertainty values to facilitate autonomous shipping. This can be done automatically during the conversion process but it will also require an assessment afterwards by the HO's, if the calculated values are valid or should be adjusted to reflect the uncertainty of the real world. A global revision on the concept of (rounding of) depths is required in order not to confuse the mariner. By default the "as-is" situation is portrayed but at the mariners' request, ECDIS route checking safety functions should generate Warnings when a ship's safety framework is in danger, based on the uncertainty values provided by the HO's and the mariner's setting of ECDIS.

Action Required of the S-100WG/S-101PT/S-102PT

The S-100WG, S-101PT and S-102PT are invited to:

- a. Note this report;
- b. Request a DQWG review of the Product Specification / Feature Catalogue for any update between Edition 1.0.0 and 1.9;
- c. Avoid discrepancies between S-67 and S-101 Data Classification Encoding Guide;
- d. Ensure that horizontalPositionUncertainty and verticalUncertainty attributes are available for Obstruction, Sounding, Under water / awash rock and Wreck Feature Types;
- e. Discuss the issue of (rounding of) depths and provide recommendations to avoid confusion when using S-101 and S-102 data simultaneously;
- f. Liaise with the DQWG as considered necessary.