Paper for Consideration by TSMAD/DCEG

Changes to S-101 Data Quality attributes and encoding guidance in the DCEG

Submitted by:	DQWG
Executive Summary:	Proposed changes to the S-101 and S-101 DCEG for Data Quality
Related Documents:	S-101, DCEG
Related Projects:	S-100

Introduction / Background

The Data Quality Working Group has updated the data quality model for S-101 and has fully developed the encoding rules for the use of the updated data model. A review of the DCEG sections that are relevant was completed and the following changes are proposed.

Analysis/Discussion

Summary of changes:

Proposal for Changes to relevant section of the DCEG (Appendix A):

General changes

- **Positional uncertainty** should be changed to **Horizontal Positional uncertainty**
  - From ISO 19157. This change may also have to be changed in many places in the DCEG
- **Quality of position** should be changed to **Quality of Horizontal Measurement**
  - This change may also have to be changed in many places in the DCEG
- **Survey date range** sub attribute data types should be truncated date, and sub attribute survey start is mandatory.
  - Added the abbreviation for Truncated Data = DT. Data Type needs to be added the section 2.4.2 Simple Attribute types from S-100 2.0. This change may also have to be changed in many places in the DCEG.

Quality of Non-Bathymetric data section

- The definition of **Quality of non-bathymetric data** should be reverted to the definition given in paper to TSMAD23-4.5.13B.
- Add **Category of temporal variation** but discuss if it needs to be mandatory.
- **Quality of Bathymetric Data** and **Quality of non-bathymetric** data may overlap.

Quality of Bathymetric data section

- **Quality of bathymetric data** should have **technique of vertical measurement** removed.
  - **Technique of vertical measurement** for **Quality of Survey**.
- **Survey date range** is retained for backwards compatibility to survey dates, and it must be clear that its use is only for expressing the range of dates of surveys that are used to generate the overall expression of data quality.
- Guidance for **Quality of bathymetric data** in an **Unsurveyed areas**
- **Unsurveyed areas** must be placed under **Swept areas** if no survey data exists below the swept depth.
  - o This means that you must have a **Swept area**, a **Depth area**, and a **Quality of bathymetric data** in the same area all with **depth range maximum value** set to the same value.
  - o Also this means that below that set of objects you will have another **Quality of bathymetric data** and an **Unsurveyed Area**.
  - o What this really means is that an **Unsurveyed Area** and a **Depth area** can overlap.
    - ▪ This is the only way we see right now to encode an area that is just swept and still follows the rules that would drive the display for data Quality.
- **Quality of Bathymetric Data** and **Quality of non-bathymetric data** may overlap.

Quality of survey

- Add **depth range maximum value** and **depth range minimum value**
  - o **Quality of Survey** objects must be stackable in the water column if **Quality of bathymetric data** objects ares stackable.

- Add **Technique of vertical measurement**
- **Quality of Survey** objects may overlap vertically

Swept areas, Unsurveyed areas and Dredged areas
- Swept area should be permitted over unsurveyed areas.
- Statements that say no depth or accuracy information under swept areas must be removed.
- Dredged area must have an added comment to say that the whole water column must be covered by bathymetric data quality.

Recommendations
DQWG recommends that DCEG and TSMAD agree to the changes in appendix A

Action Required of DCEG/TSMAD
The DCEG/TSMAD:

    a.   Discuss the change proposal

    b.   Agree to the changes to the DCEG or require DQWG to work on and alterative recommendation for the use of objects.

Appendix A

Changes to DCEG are in red.

Quality of non-bathymetric data

IHO Definition: **QUALITY OF NON-BATHYMETRIC DATA**. An area within which a uniform assessment of the quality of the nonbathymetric data exists. (Adapted from S-57 Edition 3.1, Appendix A – Chapter 1, Page 1.208, November 2000).	

S-101 Metadata Feature: Quality of non-bathymetric data (M_ACCY)

Primitives: Surface

Real World	*Paper Chart Symbol*	*ECDIS Symbol*

S-101 Attribute	S-57 Acronym	Allowable Encoding Value	Type	Multiplicity
Category of temporal variation		1 : unassessed 2 : event 3 : likely to change 5: unlikely to change	EN	1,1
Horizontal distance uncertainty	(HORACC)		RE	0,1
Orientation uncertainty			RE	0,1
Horizontal Positional uncertainty	(POSACC)		RE	1,1
Survey date range			C	0,1
Date end	*(SUREND)*	ISO 8601:2004	(S) DT	1,1
Date start	*(SURSTA)*	ISO 8601:2004	(S) DT	0,1
Vertical uncertainty	(VERACC)		RE	0,1

3.3.1   Quality of positions

The meta feature **Quality of Non-bathymetric Data** may be used to provide an indication of the overall uncertainty of position for all non-bathymetric features. It must not be used to provide the uncertainty of bathymetric information.

The attributes **quality horizontal measurement, category of temporal variation** and **horizontal positional uncertainty** may be applied to any spatial type, in order to qualify the location of a feature.

Horizontal distance uncertainty, quality horizontal measurement and **horizontal positional uncertainty** must not be applied to the spatial type of any geo feature if they are identical to the **horizontal distance uncertainty, quality horizontal measurement** and **horizontal positional uncertainty** values of the underlying meta feature.

Quality horizontal measurement gives qualitative information, whereas **horizontal positional uncertainty** gives quantitative information.

Horizontal positional uncertainty on the **Quality of Non-bathymetric Data** applies to non-bathymetric data situated within the area, while **quality horizontal measurement** or **horizontal positional uncertainty** on the associated spatial types qualifies the location of the **Quality of Non-bathymetric Data** feature itself.

Meta features **Quality of Non-bathymetric Data** and **Quality of Bathymetric Data** may overlap.

Remarks:
- No remarks.

Distinction: Quality of bathymetric data; quality of survey.

Quality of bathymetric data

<table>
<tr><td colspan="6">IHO Definition: QUALITY OF BATHYMETRIC DATA. An area within which a uniform assessment of the quality of the bathymetric data exists. (S-57 Edition 3.1, Appendix A – Chapter 1, Page 1.216, November 2000).</td></tr>
<tr><td colspan="6"><u>S-101 Metadata Feature:</u> Quality of Bathymetric Data (M_QUAL)</td></tr>
<tr><td colspan="6"><u>Primitives:</u> Surface</td></tr>
<tr><td colspan="2">Real World</td><td colspan="2">Paper Chart Symbol</td><td colspan="2">ECDIS Symbol</td></tr>
<tr><td colspan="2">S-101 Attribute</td><td>S-57 Acronym</td><td>Allowable Encoding Value</td><td>Type</td><td>Multiplicity</td></tr>
<tr><td colspan="2">Category of temporal variation</td><td></td><td>1. : unassessed
2. : event
3. : likely to change
4. : likely to change but significant shoaling unlikely
5. : unlikely to change</td><td>EN</td><td>1,1</td></tr>
<tr><td colspan="2">Depth range maximum value</td><td>(DRVAL2)</td><td></td><td>RE</td><td>0,1</td></tr>
<tr><td colspan="2">Depth range minimum value</td><td>(DRVAL1)</td><td></td><td>RE</td><td>0,1</td></tr>
<tr><td colspan="2">Features detected</td><td></td><td></td><td>C</td><td>1,1</td></tr>
<tr><td></td><td>Least depth of detected features measured</td><td></td><td></td><td>(S) RE</td><td>1,1</td></tr>
<tr><td></td><td>Significant features detected</td><td></td><td></td><td>(S) BO</td><td>1,1</td></tr>
<tr><td></td><td>Size of features detected</td><td></td><td></td><td>(S) RE</td><td>0,1</td></tr>
<tr><td colspan="2">Horizontal Positional uncertainty</td><td>(POSACC)</td><td></td><td>RE</td><td>0,1</td></tr>
<tr><td colspan="2">Full seafloor coverage</td><td></td><td></td><td>BO</td><td>1,1</td></tr>
<tr><td colspan="2">Survey date range</td><td></td><td></td><td>C</td><td>1,1</td></tr>
<tr><td></td><td>Date end</td><td>(SUREND)</td><td>ISO 8601:2004</td><td>(S) DT</td><td>1,1</td></tr>
<tr><td></td><td>Date start</td><td>(SURSTA)</td><td>ISO 8601:2004</td><td>(S) DT</td><td>0,1</td></tr>
<tr><td colspan="2"><s>Technique of vertical measurement</s></td><td><s>(TECSOU)</s></td><td><s>1 : found by echo-sounder
2 : found by side scan sonar
3 : found by multi-beam
4 : found by diver
5 : found be lead-line
6 : swept by wire-drag
8 : swept by vertical acoustic system
9 : found by electromagnetic sensor
10 : photogrammetry
11 : satellite imagery
12 : found by levelling
13 : swept by side-scan sonar
15 : found by LIDAR</s></td><td><s>EN</s></td><td><s>0,*</s></td></tr>
<tr><td colspan="2">Vertical uncertainty</td><td>(SOUACC)</td><td></td><td>RE</td><td>0,1</td></tr>
<tr><td colspan="6"><u>INT 1 Reference:</u></td></tr>
</table>

3.7.1 Quality, reliability and accuracy of bathymetric data (see S-4 – B-297)

Information about quality, reliability and uncertainty of bathymetric data is given using:
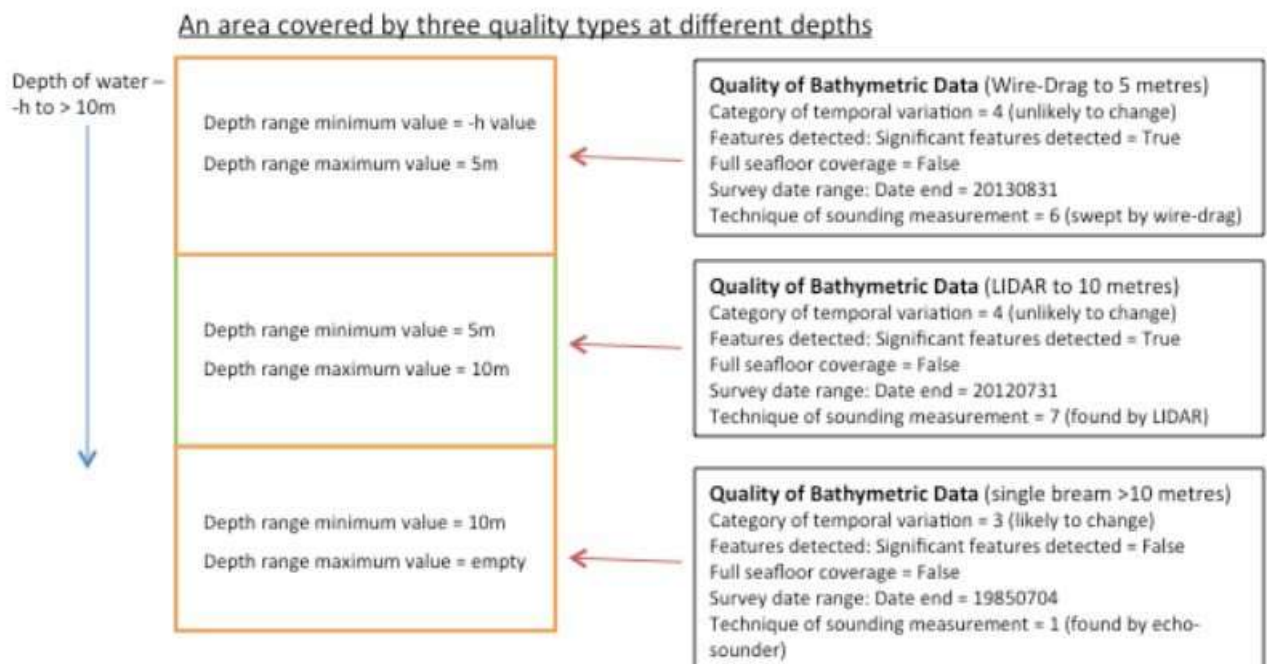- the meta feature **Quality of Bathymetric Data** for an assessment of the quality of bathymetric data;
- the meta feature **Quality of Survey** for additional information about individual surveys (see clause X.X);
- the attributes **quality of sounding measurement**, **technique of vertical measurement** and **vertical uncertainty** on groups of soundings or individual features;
- The attributes **horizontal positional uncertainty, category of temporal variation** and **quality horizontal measurement** on the spatial types (see clause X.X).

For the mariner, **Quality of Bathymetric Data** provides the most useful information. Therefore, the use of **Quality of Bathymetric Data** is mandatory for areas containing depth data, **Unsruveyed Areas** with overlaying **Swept Area**s or bathymetry on ENC datasets at maximum display scale 1:700000 and larger.

More detailed information about a survey may be given using **Quality of Survey** (see clause X.X). For example, in incompletely surveyed areas, lines of passage soundings may be indicated as such using a curve **Quality of Survey** feature. This information is more difficult for the mariner to interpret. Therefore, the use of **Quality of Survey** is optional.

For individual features (wrecks, obstructions etc), or small groups of soundings, **quality of sounding measurement**, **technique of vertical measurement** and **vertical uncertainty** may be used to provide additional information about quality and uncertainty.

The meta feature **Quality of Bathymetric Data** 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 dataset containing depth data or bathymetry must be covered by one or more **Quality of Bathymetric Data**, which may overlap vertically in order to define the quality of bathymetric data at varying depths in the water column.

An area covered by three quality types at different depths

Depth of water – -h to > 10m

Depth range minimum value = -h value
Depth range maximum value = 5m

Quality of Bathymetric Data (Wire-Drag to 5 metres)
Category of temporal variation = 4 (unlikely to change)
Features detected: Significant features detected = True
Full seafloor coverage = False
Survey date range: Date end = 20130831
Technique of sounding measurement = 6 (swept by wire-drag)

Depth range minimum value = 5m
Depth range maximum value = 10m

Quality of Bathymetric Data (LIDAR to 10 metres)
Category of temporal variation = 4 (unlikely to change)
Features detected: Significant features detected = True
Full seafloor coverage = False
Survey date range: Date end = 20120731
Technique of sounding measurement = 7 (found by LIDAR)

Depth range minimum value = 10m
Depth range maximum value = empty

Quality of Bathymetric Data (single bream >10 metres)
Category of temporal variation = 3 (likely to change)
Features detected: Significant features detected = False
Full seafloor coverage = False
Survey date range: Date end = 19850704
Technique of sounding measurement = 1 (found by echo-sounder)

Remarks:
- To express completeness of bathymetric data, the complex attribute **features detected** must be encoded. **Features detected** indicates that a systematic method of exploring the sea floor, or the water column to the depth indicated by population of the attribute **depth range maximum value**, was undertaken to detect significant features. The sub-attributes **size of features detected** and **least depth of detected features measured** must not be encoded unless the sub-attribute **significant features detected** is set to *True*.
- Wherever possible, meaningful and useful values for the attributes **category of temporal variation**, **full seafloor coverage**, and the complex attribute **features detected** must be used for areas of bathymetry. For areas of unstable seafloors, the complex attribute **survey date range** (**date end**) must be used to indicate the date of the survey of the underlying bathymetric data.

- **Depth range minimum value** must only be used on a **Quality of Bathymetric Data** feature where a swept area occupies the entire **Quality of Bathymetric Data** surface, or **Quality of Bathymetric Data** features overlap. Where these features overlap such that varying bathymetric data qualities exist at different depths in the water column, the **depth range minimum value** for a **Quality of Bathymetric Data** must be equal to the **depth range maximum value** for the **Quality of Bathymetric Data** feature defining the quality for the level above (see diagram above).
- **Depth range maximum value** must only be used on a **Quality of Bathymetric Data** feature to specify the maximum depth to which all other attributes for the **Quality of Bathymetric Data** feature applies. When **depth range maximum value** is specified, values populated for all other attributes apply only to depths equal to or shoaler than **depth range maximum value**. No quality information is provided for depths deeper than **depth range maximum value**. Where **Quality of Bathymetric Data** features overlap such that varying bathymetric data qualities exist at different depths in the water column, the **depth range maximum value** for a **Quality of Bathymetric Data** must be equal to the **depth range minimum value** for the **Quality of Bathymetric Data** feature defining the quality for the level below (see diagram above).
- **Quality of Bathymetric Data** must be used over **Unsurvered areas with category of temporal variation = 1** (unassessed), **features detected: significant features detected** = *False* and **full seafloor coverage** = *False*.
- For **Swept areas** that have no survey data below the swept depth an **Unsurveyed area** must be used under both a **Depth area** the **Swept area**. This would be the only case that an **Unsurveyed area** and a **Depth area** can overlap.
- **Horizontal positional uncertainty** is used on a **Quality of Bathymetric Data** feature to specify the positional uncertainty of the depths covered by the surface.
- **Vertical uncertainty** is used on a **Quality of Bathymetric Data** feature to specify the vertical uncertainty of the depths covered by the surface. When **depth range minimum value** is specified, **vertical uncertainty** refers only to the uncertainty of the swept depth defined by **depth range minimum value**.
- **Technique of vertical measurement** must not be used on a **Quality of Bathymetric Data** feature to specify a lower quality than the values populated for the mandatory attributes for the feature instance indicate.
- When the **Quality of Bathymetric Data** area contains soundings from multiple surveys of different techniques, the attribute **technique of vertical measurement** must not be used. **Technique of vertical measurement** may be populated with multiple values only where the **Quality of Bathymetric Data** area is covered by a survey or surveys that have used multiple common techniques, e.g. an area covered by multiple surveys all using a modern echosounder combined with a sonar or mechanical sweep system.
- When the **Quality of Bathymetric Data** surface contains data from only one survey, the date of survey, if required, must be specified using the complex attribute **survey date range**, sub-attribute **date end**. When the **Quality of Bathymetric Data** surface contains data from two or more surveys, the date of the most recent and the oldest survey, if required, must be specified using the complex attribute **survey date range**.
- Additional quality information may be given using the meta feature **Quality of Survey**.
- **Quality of Bathymetric Data** areas must not be encoded over land.
- When **Quality of Bathymetric Data** and the meta feature **Quality of Non-bathymetric Data** are encoded in a dataset, they may overlap.
- **Horizontal positional uncertainty** on the **Quality of Bathymetric Data** applies to bathymetric data situated within the surface, while **quality horizontal measurement** or **horizontal positional uncertainty** on the associated spatial types qualifies the location of the **Quality of Bathymetric Data** feature itself.
- As a result of some disasters, e.g. 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 attribute **category of temporal variation** should be reclassified to value *2* (event), the Boolean attribute **full seafloor coverage** set to *False*, and complex attribute **features detected**, Boolean sub-attributes **least depth of detected features measured** and **significant features detected** set to *False* in the affected areas outside the area covered by emergency surveys.

3.7.1.1　Feature detection

In the context of bathymetry, a feature is any object, whether manmade or not, projecting above the sea floor, which may be considered to be a danger to surface navigation. Refer to S-44.

The ability to detect bathymetric features must be encoded using the complex attribute **features detected**. The sub-attribute **significant features detected** indicates whether the survey was capable of detecting features of a size indicated by the sub-attribute **size of features detected**. The sub-attribute **least depth of detected features measured** indicates whether the least depth of detected features was found. For instance, if a wreck was found, but it is not certain that the least depth of that wreck was measured, **least depth of detected features measured** must be set to *False*.

3.7.1.2　Temporal variation

The changeability of the bathymetry must be encoded using **category of temporal variation**. In order for a time reference to be given for the expression of temporal variation, the relevant dates of the bathymetric data must be encoded using the complex attribute **survey date range** if **category of temporal variation** is set to *2* (event) or *3* (likely to change).

3.7.1.3　Sounding uncertainty

Sounding uncertainty is encoded using the attribute **vertical uncertainty** on **Quality of Bathymetric Data**. If it is required to encode additional sounding uncertainty information, it must be done using the attribute **vertical uncertainty** on individual geo features (e.g. **Sounding**).

The uncertainty of sounding must not be encoded using **sounding uncertainty** on the depth geo feature, unless it is different to the value of **vertical uncertainty** encoded on **Quality of Bathymetric Data**.

~~3.7.1.4　Technique of vertical measurement~~

~~If it is required to encode the technique of sounding measurement, it must be done using the attribute **technique of vertical measurement** on either **Quality of Bathymetric Data** or on individual geo features (e.g. **Sounding**).~~

~~The technique of sounding measurement must not be encoded using **technique of vertical measurement** on the depth geo feature, unless it is different to the value of **technique of vertical measurement** encoded on **Quality of Bathymetric Data**.~~

Distinction: Quality of non-bathymetric data; quality of survey.

Quality of survey

IHO Definition: **QUALITY OF SURVEY**. An area within which a uniform assessment of the reliability of source survey information exists. (S-57 Edition 3.1, Appendix A – Chapter 1, Page 1.218, November 2000).
S-101 Metadata Feature: **Quality of survey (M_SREL)**
Primitives: Curve, Surface

Real World	Paper Chart Symbol	ECDIS Symbol		

S-101 Attribute	S-57 Acronym	Allowable Encoding Value	Type	Multiplicity
Depth range maximum value	(DRVAL2)		RE	0,1
Depth range minimum value	(DRVAL1)		RE	0,1
Features detected			C	0,1
Least depth of detected features measured			(S) BO	0,1
Significant features detected			(S) BO	1,1
Size of features detected			(S) RE	0,1
Full seafloor coverage			BO	1,1
Line spacing maximum	(SDISMX)		IN	0,1
Line spacing minimum	(SDISMN)		IN	0,1
Technique of vertical measurement	(TECSOU)	3 : found by echo-sounder 4 : found by side scan sonar 3 : found by multi-beam 6 : found by diver 7 : found be lead-line 6 : swept by wire-drag	EN	0,*
Measurement distance maximum			RE	0,1
Measurement distance minimum			RE	0,1
Quality horizontal measurement	(QUAPOS)	1 : surveyed 2 : unsurveyed 3 : inadequately surveyed 4 : approximate 5 : position doubtful 6 : unreliable 7 : reported (not surveyed) 8 : reported (not confirmed) 9 : estimated 10 : precisely known 11 : calculated	EN	0,1

Quality of sounding measurement	(QUASOU)	1 : depth known 2 : depth or least depth unknown 3 : doubtful sounding 4 : unreliable sounding 6 : least depth known 7 : least depth unknown, safe clearance at value shown 8 : value reported (not surveyed) 9 : value reported (not confirmed) 10 : maintained depth 11 : not regularly maintained	EN	0,*
Scale value maximum	(SCVAL1)	scale value maximum < scale value minimum	IN	0,1
Scale value minimum	(SCVAL2)	scale value minimum > scale	IN	0,1

		value maximum		
Survey authority	(SURATH)		TE	1,1
Survey date range			C	0,1
Date end	*(SUREND)*	ISO 8601:2004	(S) DT	1,1
Date start	*(SURSTA)*	ISO 8601:2004	(S) DT	0,1
Survey type	(SURTYP)	1 : reconnaissance / sketch survey 2 : controlled survey 4 : examination survey 5 : passage survey 6 : remotely sensed 7 : full coverage 8 : systematic survey 9 : non-systematic survey 10 : inadequately surveyed 11 : spot-sounding survey 12 : acoustically swept survey 13 : mechanically swept survey	EN	1,*

INT 1 Reference:

3.10.1 Survey reliability and source of bathymetric data

The survey reliability and/or details of the source surveys used in compilation may be encoded using the meta feature **Quality of Survey**.

Remarks:
- To express completeness of bathymetric data, the complex attribute **features detected** should be encoded. **features detected** indicates that a systematic method of exploring the sea floor was undertaken to detect significant features. The sub-attributes **size of features detected** and **least depth of detected features measured** must not be encoded unless the sub-attribute **significant features detected** is set to *True*.
- If the attributes **technique of vertical measurement** and **vertical uncertainty** are required, they must be encoded on either the meta feature **Quality of Bathymetric Data** (see clause X.X) or on individual geo features (e.g. **Sounding**).
- If the attribute **measurement distance maximum** is set to *0* (zero) for the full area of the survey, the attribute **full seafloor coverage achieved** should be set to *yes*.
- Where populated, the value for the attribute **measurement distance minimum** must not be larger than the value populated for **measurement distance maximum**.
- **Quality horizontal measurement** on the **Quality of Survey** applies to bathymetric data situated within the area, while **Quality horizontal measurement** or **horizontal positional uncertainty** on the associated spatial types qualifies the location of the **Quality of Survey** feature itself.
- **Quality of Survey** objects may overlap vertically only if **Quality of bathymetric data** object in the same area overlap vertically
- **Quality of Survey** objects that overlap vertically must have **depth range minimum value** and **depth range maximum value** attributed so the full water column within that the **Quality of bathymetric data** has been accounted for.

3.10.2 Quality of sounding

If it is required to encode the quality of sounding, it must be done using the attribute **quality of sounding measurement** on either the **Quality of Survey** or on individual geo features (e.g. **Sounding**).

The quality of sounding must not be encoded using **quality of sounding measurement** on the depth geo feature, unless it is different to the value of **quality of sounding measurement** encoded on **Quality of Survey** (see tables at clauses X.X and X.X).

Remarks:
- No remarks.

Distinction: Accuracy of data; quality of bathymetric data