

Paper for Consideration by NCWG

Depth Resolution on Charts

Submitted by:	IHO Secretariat (TSSO); Danish Geodata Agency.
Executive Summary:	This paper reports on the current allowed resolution for depths included in the S-101 ENC Product Specification and resultant conflict with S-4 clauses B-130 and B-412; and proposes a way forward.
Related Documents:	S-4; S-101.
Related Projects:	S-101 development.

Introduction / Background

1. For S-101 Edition 1.0.0 (December 2018) the coordinate multiplication factor for depths [CMFZ] has been set to 100, allowing soundings to be encoded to centimetre resolution. Additionally, the resolution for the S-101 simple attribute valueOfSounding has correspondingly been set to 0.01 metres.
2. IHO Publication S-4 – *Regulations of the IHO for International (INT) Charts and Chart Specifications of the IHO* provides the specifications for the structure and content of nautical charts, including both paper charts and ENCs. The specification included in S-4 for the resolution of depths on charts currently states that the standard units for depths and heights must be metres and decimetres (clause B-130); and additional guidance including proposed rounding of depths at greater than decimetre resolution is included at clause B-412.
3. The inclusion of centimetre resolution for encoded depths in S-101 ENCs introduces an inconsistency with the fundamental specifications included in S-4. This paper is intended to contribute to the facilitation of the resolution of this inconsistency.

Discussion

4. The fundamental IHO specification for the units of measure, position and bearings on charts is included at S-4 clause B-130. The units of measure for depths on charts is quoted as follows:

B-130 UNITS

The standard units for **depths** and **heights** must be metres (m) and decimetres (dm).

.....

5. In addition to the fundamental specification at B-130, S-4 clause B-412 includes the following guidance related to soundings and recommended rounding rules:

B-412 SOUNDINGS

Charted soundings must represent the depth measured from Chart Datum to the sea floor placed in such a way that the centre of gravity (geometric centre) of the set of numerals coincides with the position referred to.

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:

For depths

- to the nearest decimetre between 0,1 and 21:
0,001 to 0,099 rounds **down** to the nearest decimetre for example: a recorded depth of 4,38m rounds down to 4,3m
- to the nearest half metre from 21 to 31m:
0,001 to 0,499 rounds **down** to 0,0 for example: a recorded depth of 23,49m rounds down to 23m;
0,500 to 0,999 rounds **down** to 0,5 for example: a recorded depth of 23,51m rounds down to 23,5m;
- thereafter, to the nearest metre:
0,001 to 0,999 rounds **down** to 0,0 for example: a recorded depth of 31,85m rounds down to 31m

For drying heights

- to the nearest decimetre:
0,001 to 0,099 rounds **up** to the nearest decimetre for example: a recorded drying height of -2,32m rounds up to -2,4m

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.

6. The current S-101 specification regarding the encoding of depths, as stated in clause 10.1.2 of the S-101 Edition 1.0.0 Main document, is as follows:

10.1.2 Encoding of Depths

Depths are converted from decimal metres to integers by means of the [CMFZ] (see Annex B – clause B5.1.2). This Product Specification limits the resolution to two decimal places and therefore the [CMFZ] must be set to {100}.¹

EXAMPLE: A depth = 4.2 is converted in $Z = \text{depth} * \text{CMFZ} = 4.2 * 100 = 420$

The resolution above as stated for soundings allows soundings to be captured to centimetre resolution; and has also been applied to the S-101 attribute **value of sounding**, which has its resolution quoted in S-101 Edition 1.0.0 (current Data Classification and Encoding Guide Edition 1.0.1) as 0.01 metres.

7. The inconsistency that exists between the specification defined in S-4 and the S-101 ENC Product Specification is that the units of measurement for depths on charts as defined in S-4 is constrained to metres and decimetres; while the soundings and the depths of underwater hazards stored in an ENC dataset may be encoded to centimetre resolution, which may be intended to better facilitate interoperability with other S-100 based products such as S-102 and S-104.

8. Given that the S-4 specification as defined at B-130 is grounded on a fundamental cartographic principle as stated in the last paragraph of clause B-412 – “... *that the precision to which soundings are recorded on charts can never be misleading as to the accuracy of such soundings*” – this Paper is not intended to recommend that the units for depths on charts as defined in S-4 is amended. Indeed, the recommendations included in this Paper are based on the assumption that **there is no requirement to change this specification**. However, given the improvements in the technology for the measurement of depths (positioning and value) and similar improvements related to other factors contributing to the value and interpretation of charted depths such as tidal measurements and adjustments; tidal predictions; method of storage and capture on chart (digital) repomat and chart databases; and capabilities of end-user systems (ECDIS v “traditional” paper chart), this may be a timely opportunity to reconfirm the specification for the units of measure for depths on charts even taking into account such technological advances.

9. It must be noted that the specification for the encoding of depths as included in S-101 clause 10.1.2 is related to the capture and storage of depths in the ENC dataset and not necessarily the portrayal of these captured depths. It is considered that there is a gap in the S-101 ENC Product Specification in that there are currently no portrayal rules within the Product Specification describing how such captured depths are to be portrayed, including the resolution of the displayed depth, beyond utilising the portrayal specification for depths defined in the S-52 Specification that is based on the capture of depths in metres and decimetres. A paper has been developed for the S-101 Project Team designed to address this gap; this Paper has been included at Annex A. The endorsement of the Paper by the NCWG is considered important in regard to the recommendation in the Paper that the portrayal of depth information in S-101 ENCs must conform to the specifications as described in S-4.

10. In order to better relate the relationship between the values for depths that may be encoded for ENCs and the relevant charting specification in S-4, it is proposed that the rules for the rounding of depths include at S-4 – B-412 are revised so as to better reflect this relationship. Suggested redline amendments to clause B-412 have been included at Annex B for consideration of the NCWG. These redlines take into consideration:

- Reinforcing the B-130 convention that depths on charts must be portrayed in metres and decimetres;
- Soundings derived from a source database that have been reduced to a common datum (for the sake of specification in S-4 this common datum is assumed to be Chart Datum);
- Acknowledgement that depths between 21m and 31m that have been derived from higher accuracy modern surveys may be rounded to the nearest decimetre (as included in the current S-52 Standard);

¹ NOTE: The equivalent resolution for depths in the S-57 ENC Product Specification [SOMF] is set to {10}, specifying depths stored to decimeter resolution.

- Inclusion of guidance specific to the rounding of depths encoded to centimetre accuracy in S-101 ENCs so as to be portrayed in metres and decimetres in S-100 ECDIS. [NOTE: The paper to be submitted to the S-101 Project Team provides the option to amend the [CMFZ] in S-101 to {10}. If this is the preferred option of the S-101PT the guidance in B-412 will need to be amended accordingly.]; and
- General syntax standardisation throughout.

11. In addition to the redlines for clause B-412, further suggested redline changes to selected S-4 clauses have been included in Annex B for consideration, taking into account the considerations in the above paragraph. NOTE: While researching in S-4 for this Paper, several apparent cross-referencing errors were identified as follows:

- B-422: Cross reference is supposed to reference foul ground which is at clause B-422.9, however references clause B-422.8 (changing criteria for wrecks);
- B-444.8, B-422.9, B-445.1 (x2) and B-445.10: Cross references are supposed to reference submerged obstructions which is at clause B-422.10, however references clause B-422.9 (foul ground); and
- B-445.10: Cross reference is supposed to reference depths that are wire swept, found by sounding only or are estimated safe clearance which are at clauses B-422.3-5, however references only clause B-422.5.

Proposed redline amendments to these clauses is also included in Annex B, for consideration of the NCWG. It is recommended that a more thorough investigation should be conducted to ensure that all cross-references within S-4 to other clauses in S-4 are correct.

Conclusions

12. The specification included in S-101 to allow soundings to be encoded to centimetre resolution requires discussion within the NCWG to evaluate the appropriateness of the current S-4 specification for the units of measure for depths on charts. This evaluation should consider both the specification itself in regard to any possible adjustment to the specification taking into account advances in data collection, adjustment, management and end-user technology; and the suitability of the associated guidance for rounding of depths. The NCWG should take a leading role in ensuring that all IHO Standards and Specifications are consistent in regard to the adherence to the fundamental specifications and regulations for chart content – S-4.

Recommendations

13. It is recommended that the NCWG discuss and reconfirm that the units of measure for all depths on charts must be metres and decimetres as currently quoted in S-4 – B-130 (taking into account paragraphs 4,6,7,8 of this Paper).

14. Pending this confirmation, it is recommended that the NCWG endorse the draft S-101PT8 Paper included at Annex A (taking into account paragraphs 6-9 of this Paper).

15. It is recommended that the NCWG endorse the redline changes to S-4 as included in Annex B (taking into account paragraphs 8-11 of this Paper).

Action Requested of the NCWG

16. The NCWG is invited to:

- 1) **Confirm** that the current specification mandating that the units of measure for depths on charts must be metres and decimetres as included at S-4 – B-130.
- 2) **Endorse** the draft Paper for submission to the S-101 Project Team included at Annex A.
- 3) **Discuss** and **Approve** the redline amendments to the impacted S-4 clauses relating to the rounding and depiction of depths on charts as included at Annex B.
- 4) **Initiate** any further action as appropriate.

Annexes:

A: Draft Paper for S-101PT8 – *Depth Resolution in S-101 ENCs*.

B: Draft redline changes to S-4.

Paper for Consideration by S-101PT

Depth Resolution in S-101 ENCs

Submitted by:	IHO Secretariat (TSSO); Danish Geodata Agency.
Executive Summary:	This paper reports on the resolution for depths currently included in S-101 and resultant conflict with S-4 clauses B-130 and B-412; and proposes possible options for moving forward.
Related Documents:	S-4; S-101 Main document; S-101 Annex A.
Related Projects:	S-101 development.

Introduction / Background

1. For S-101 Edition 1.0.0 (December 2018) the coordinate multiplication factor for depths [CMFZ] has been set to 100, allowing soundings to be encoded to centimetre resolution. Additionally, the resolution for the S-101 simple attribute valueOfSounding has correspondingly been set to 0.01 metres.
2. IHO Publication S-4 – *Regulations of the IHO for International (INT) Charts and Chart Specifications of the IHO* provides the specifications for the structure and content of nautical charts, including both paper charts and ENCs. The specification included in S-4 for the resolution of depths on charts currently states that the standard units for depths and heights must be metres and decimetres (clause B-130).
3. The inclusion of centimetre resolution for encoded depths in S-101 ENCs introduces an inconsistency with the fundamental IHO specification for chart content (S-4). This paper is intended to facilitate the resolution of this inconsistency, taking into account additional factors that may influence any decision taken.

Discussion

4. The S-4 specification for the units of measure for depths on charts, as stated in clause B-130, is as follows:

B-130 UNITS

The standard units for **depths** and **heights** must be metres (m) and decimetres (dm).

.....

- S-4 clause B-412 also includes the following guidance related to soundings and recommended rounding rules²:

B-412 SOUNDINGS

Charted soundings must represent the depth measured from Chart Datum to the sea floor placed in such a way that the centre of gravity (geometric centre) of the set of numerals coincides with the position referred to.

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:

For depths

- to the nearest decimetre between 0,1 and 21:
0,001 to 0,099 rounds **down** to the nearest decimetre for example: a recorded depth of 4,38m rounds down to 4,3m
- to the nearest half metre from 21 to 31m:
0,001 to 0,499 rounds **down** to 0,0 for example: a recorded depth of 23,49m rounds down to 23m;
0,500 to 0,999 rounds **down** to 0,5 for example: a recorded depth of 23,51m rounds down to 23,5m;
- thereafter, to the nearest metre:

² A paper has been submitted to the NCWG7 meeting (November 2021) proposing amendments to S-4 clause B-412 to better take into account requirements for ENCs and derivation of charted depths from source databases.

0,001 to 0,999 rounds **down** to 0,0 for example: a recorded depth of 31,85m rounds down to 31m

For drying heights

- to the nearest decimetre:
0,001 to 0,099 rounds **up** to the nearest decimetre for example: a recorded drying height of -2,32m rounds up to -2,4m

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.

5. The current S-101 specification regarding the encoding of depths, as stated in clause 10.1.2 of the S-101 Edition 1.0.0 Main document, is as follows:

10.1.2 Encoding of Depths

Depths are converted from decimal metres to integers by means of the [CMFZ] (see Annex B – clause B5.1.2). This Product Specification limits the resolution to two decimal places and therefore the [CMFZ] must be set to {100}.³

EXAMPLE: A depth = 4.2 is converted in $Z = \text{depth} * \text{CMFZ} = 4.2 * 100 = 420$

6. The inconsistency that exists between the specification defined in S-4 and the S-101 ENC Product Specification is that the units of measurement for depths on charts as defined in S-4 is constrained to metres and decimetres; while the soundings stored in an ENC dataset may be encoded to centimetre resolution, which may be intended to better facilitate interoperability with other S-100 based products such as S-102 and S-104. The following paragraphs raise issues related to this inconsistency, taking into account some additional factors.

7. Encoding v display in S-101: While the S-101 ENC Product Specification specifies the resolution to which depths can be encoded (stored) in an ENC dataset, there is no specification at present that defines the resolution to which encoded depths are to be displayed in S-100 ECDIS. In S-57/S-52, depth information is encoded to decimetre resolution and displayed to decimetre resolution for depths up to 31 metres and metre resolution thereafter; and requires no specification in regard to any manipulation of encoded depths beyond truncating depths over 31 metres to metre resolution where they have been encoded to decimetre resolution (in accordance with S-4). Assuming the encoding of depths to centimetre resolution is retained, is the same principle as specified in S-4 and currently applied in S-57/S-52 going to be applied for the display of depths for S-101 ENCs? If so, can this be managed within the Portrayal Catalogue; and where is this going to be specified? Any discussion on this point will also need to take into account features containing the simple attribute valueOfSounding as an allowable attribute (in particular underwater hazards), for which the depth is displayed in some ECDIS settings. In this situation the issue is complicated by the fact that the depth value as encoded will be discoverable to the mariner in an ECDIS Pick Report, which may be different to the actual displayed value.

8. Uncertainty: For S-101 ENC, the parameters for the value of the vertical uncertainty of depths as a component of an overall indication of the quality of bathymetric data for an area is included in the S-101 meta feature QualityOfBathymetricData and retains the same values as defined for the S-57 attribute CATZOC. For the highest (A1) CATZOC value, the vertical uncertainty component is quoted as “0.50m + 1%d” (d = depth), therefore the best accuracy for a depth measurement that is at or close to the Chart datum is half a metre. This is a large disparity from the centimetre resolution to which depths can currently be encoded in S-101, taking into account the specification at B-412, last paragraph, (see paragraph 4 above) “... that the precision to which soundings are recorded on charts can never be misleading as to the accuracy of such soundings”. In addition, the vertical uncertainty of a measured depth may be encoded on individual feature instances (and is mandatory for underwater hazards and the meta feature QualityOfBathymetricData) using the complex attribute verticalUncertainty, for which the fixed component of the uncertainty (sub-attribute uncertaintyFixed; for example the 0.50m specified to satisfy CATZOC A1) can only be encoded to decimetre resolution. It seems illogical to allow depths to be encoded to centimetre accuracy but have the accuracy of such depths indicated only to decimetre accuracy.

9. Physical factors: Such factors include tides (including the uncertainty of predicted tide values); weather factors such as atmospheric pressure and wind; and vessel related factors such as vessel squat. These factors all add to the uncertainty for the mariner of charted depths in regard to developing and executing a voyage plan, which have all been taken into account in the specification in S-4 for the units of measure for depths on charts.

³ NOTE: The equivalent resolution for depths in the S-57 ENC Product Specification [SOMF] is set to {10}, specifying depths stored to decimeter resolution.

10. Purpose of ENC's: The S-101 ENC Product Specification states that “*The purpose of an ENC dataset is to provide official navigational data for navigation systems for the safe passage and route planning of vessels between destinations.*” (S-101 Main document clause 1.4). It is important that the Product Specification is developed within this purpose, scope and in conformance with related IHO Specifications such as S-4; and as such avoid inclusion of data modelling that is not required to satisfy the purpose and scope. This will then provide information that is fit for purpose for the intended use in regard to conformance to specifications/conventions for data content so as to best satisfy the requirements of the end-user. S-101 is not intended to be a generic data transfer standard or provide a definitive model for data producer's database structures and data resolutions. It is likely that within the S-100 environment S-101 will be just one output from such databases, with other outputs intended to satisfy the requirements for other S-100 based Product Specifications. Such Product Specifications may have different resolution for bathymetry implemented to satisfy the specific purpose and use of that particular product and it may be considered that differing set-for-purpose resolutions included in S-100 based Product Specifications should not be an issue with regard to interoperability in a S-100 ECDIS. An unfortunate side-effect of S-57 implementation is that many data producers have developed their source databases using the S-57 data model as reflected in the S-57 Object Catalogue, including the resolutions for units of measure such as depth and distance; and continue to look to resolutions quoted in IHO Product Specifications/Standards to inform such decision making.

11. An additional discrepancy in the allowable resolutions of encoded depth information in S-101 exists between the centimetre resolution for soundings and the attribute valueOfSounding; and the decimetre resolution allowable for the attributes depthRangeMaximumValue, depthRangeMinimumValue, maximumPermittedDraught and valueOfDepthContour. Note also that attributes related to heights (elevation, height, verticalClearanceValue and verticalLength) can only be encoded to decimetre resolution, however this should be considered acceptable given the use of such information by the mariner in the navigational ENC.

Conclusions

12. In order to comply with the specifications for nautical chart content as included in S-4, depths in ENC must be represented in metres and decimetres. Taking into account the centimetre resolution to which soundings can currently be encoded in an ENC dataset ([CMFZ] = {100}), this representation may be achieved in two ways:

- Amending [CMFZ] to {10} to reflect decimetre resolution of depths in ENC; and ensuring any S-101 attributes that quote depth information (for example valueOfSounding) also have decimetre resolution; or
- Retaining [CMFZ] = {100} and including S-101 portrayal rules such that all displayed depths, including depths that may be included in the ECDIS Pick Report, are displayed in metres and decimetres.

13. If the S-101PT considers that there is a requirement to depict any depth information (through representation of soundings or through the ECDIS Pick Report) to centimetre resolution in ECDIS, this should be brought to the attention of the NCWG for corresponding amendments to S-4 so as to ensure consistency within the IHO Publications.

14. There is a requirement that all resolutions of related measurements (depth, height, distance etc) in S-101 are consistent within the Product Specification. An activity should be initiated within the S-101 data model (DCEG and Feature Catalogue) to ensure that this consistency is realised, with the consistency for depths to be resolved in accordance with the decision made in relation to paragraph 12 above.

Recommendations

15. That the S-101PT determine the most appropriate method for ensuring conformance with the specifications for the depiction of depths on charts as mandated in S-4, as summarised in paragraph 12 above, and apply this methodology to S-101.

16. If the above is determined to be in line with paragraph 12.2 above, S-101PT to develop portrayal rules such that all depths are displayed to decimetre resolution; and ensure these rules are documented in the appropriate location.

17. That the S-101PT discuss any requirement that may be relevant to justify depiction of any depth information derived from ENC's in ECDIS to greater than decimetre resolution. It is suggested that any such discussion should also involve the NCWG and DQWG. If any such requirement is identified, this should be communicated to the NCWG so that appropriate action can be taken to update S-4.

18. That the S-101PT, through the DCEG Sub-Group, conduct a review of all attributes related to a unit of measure and ensure that there is consistency throughout S-101 in regard to the application of the unit of measure. For depths, this will need to take into account the decision made for the resolution of soundings in ENC data.

Action Requested of the S-101PT

19. The S-101PT is invited to:

- 1) **Agree** on a methodology to ensure that all depth depiction from ENC in ECDIS is in metres and decimetres in line with S-4 regulations for the depiction of depths on charts.
- 2) **Discuss** any possible requirement to display depths from ENC in ECDIS to greater resolution than metres and decimetres and initiate any appropriate action, including notification to the NCWG for possible amendments to S-4.
- 3) **Instruct** the DCEG Sub-Group to review the resolution of all attributes related to a unit of measure to ensure consistency within the S-101 ENC Product Specification.

Proposed Redline Changes to S-4

B-412 SOUNDINGS

Charted soundings must represent the depth measured from Chart Datum to the sea floor placed in such a way that the centre of gravity (geometric centre) of the set of numerals coincides with the position referred to.

The standard units of measure for the display of depths, including drying heights, on charts must be metres (m) and decimetres (dm) (see B-130).

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:

For depths

- to the nearest decimetre between 0,001 and 21m:
0,001 to 0,099 rounds **down** to the nearest decimetre. For example: a recorded depth, **adjusted to Chart Datum**, of 4,38m rounds down to 4,3m.
- to the nearest half metre **between 21.001 and 31m***:
0.001 to 0,499 rounds **down** to 0,0. For example: a recorded depth, **adjusted to Chart Datum**, of 23,49m rounds down to 23m;
0,501 to 0,999 rounds **down** to 0,5. For example: a recorded depth, **adjusted to Chart Datum**, of 23,81m rounds down to 23,5m.
- ~~thereafter~~, to the nearest metre **from 31,001m**:
0,001m to 0,999 rounds **down** to ~~0,0~~ **the nearest metre**. For example: a recorded depth, **adjusted to Chart Datum**, of 31,85m rounds down to 31m.

* Soundings sourced from high order surveys using modern survey techniques may be of a degree of accuracy such that the depths between 21.001 and 31m may be rounded down to the nearest decimetre as for depths up to 21m.

For depths stored in a source bathymetric database, the above rounding conventions equate to truncating the stored depth values to the required resolution. For ENC where depths may be stored in the dataset to the nearest centimetre, all numbers after the second decimal place of a metre should be truncated. For display of these depths in ECDIS, rounding to the nearest decimetre should be applied between 0.001 and 31m; and to the nearest metre from 31.001m, in accordance with the above rounding conventions.

For drying heights

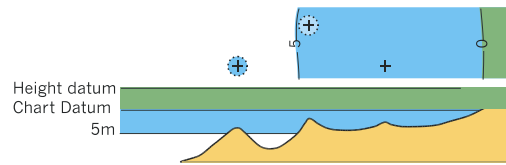
- to the nearest decimetre:
0,001 to 0,099 rounds **up** to the nearest decimetre. For example: a recorded depth, **adjusted to Chart Datum**, of -2,32m rounds up to -2.4m.

For depths stored in a source bathymetric database, the above rounding conventions equate to truncating the stored depth values to the required resolution and adjusting the resolved value up by one where any removed integer is non-zero. For ENC where drying heights may be stored in the dataset to the nearest centimetre, the second decimal place of a metre should be rounded up if required (for example, -2.321m rounds up to -2.33m). For display of these drying heights in ECDIS, rounding up to the nearest decimetre should be applied in accordance with the above rounding convention.

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.

B-421.4 Rocks which are always underwater must be shown as follows, according to their depth:

- a. Where the depth is unknown but the rock is considered to be dangerous to some surface vessels capable of navigating in the vicinity, by the symbol + with danger line and blue tint.



K13

- b. Where the depth is known, by either:
- the symbol + with the depth, in metres and decimetres, alongside it in brackets, or
 - by a sounding with the abbreviation for a rocky seabed beneath it (see B-425).

35

R **K15** Underwater rock of known depth, not dangerous to surface navigation.

Numerals for the depth must be shown, **in metres and decimetres**, in the normal style for soundings (see B-412). Blue tint should be added as appropriate to the depth.

If the rock is considered to be dangerous to some surface vessels capable of navigating in the vicinity, because the rock is significantly shallower than the general depth in the vicinity, the symbol + or the sounding should be enclosed in a danger line.

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B-422 WRECKS, FOUL GROUND, OBSTRUCTIONS

- a. The **international abbreviation** 'wk' must be used wherever the symbol for a charted feature does not identify it as a wreck.
- b. To give the mariner the maximum useful information, the least depth over a wreck (or, if unknown, an estimated safe clearance), **in metres and decimetres**, must be charted in preference to symbols K28 and K29. **Numerals for the depth must be shown in the normal style for soundings (see B-412)**. An exception is the remains of a wreck which are charted as foul ground (see B-422.9). For wrecks visible or partly visible at chart datum, the height or drying height should be shown in brackets, if known. **Drying heights must be shown above Chart Datum in the standard way (see B-413.1)**. The symbol K29 should be used for all wrecks in waters over 200 metres deep.
- c.

B-444.8 Pipeline installations. Diffusers and cribs at the end of pipes, and templates, manifolds (see B-445.1) and other underwater installations associated with pipelines should be charted in the same way as other obstructions, either with the abbreviation 'obstn' or an appropriate legend, eg 'Diffuser', 'Manifold'. All specifications relating to obstructions apply; see B-411.6 and B-422.10.

B-422.9 A foul area is

The **foul ground** symbol should be used as a point symbol to indicate small areas of sea floor debris, for example: the distributed remains or a wreck; a dropped anchor; the site of cleared production platform (provided the platform has been removed to the sea floor):.

K31/L22

Note: Platforms which have been cut-off **above** the sea floor must be charted as obstructions, see B-422.10.

The depth over the area, if known and required, may be shown **in metres and decimetres**, adjacent to the symbol, for example:

(22)

Numerals for the depth must be shown in the normal style for soundings (see B-412).

Larger areas of foul ground should

B-445.1 Wells, Wellheads, Templates and Manifolds.

- a. **Abandoned wells.** In the course of developing an oil or gas field,
- b. **'Wellhead'** is a term used to describe a submarine structure projecting some distance above the sea floor

The symbol must be a danger circle with the legend 'Well'. Where the depth of water over the top of the wellhead is known, it may be inserted within the danger circle (as for any other obstruction, see B-422.10).

 **L21.1**
  **L21.2**

.....

- f. **Templates and Manifolds.**
- These installations must be charted, if required, as obstructions (see B-422.10) with the legends 'Template', 'Manifold', or equivalent, instead of 'Obstr'.

B-445.10 Underwater turbines, for generating electricity from tidal currents, must be represented:

 **L24**

Where the depth of water over the turbine is known, it may be inserted within the danger circle. The rules for blue tint, swept and safe clearance depths must be applied as for wrecks and other obstructions (see B-411.6, B-415, B-422.3-5 and B-422.10), for example:





.....