# Discussion on Water Level Adjustment and attribute substitution

## Introduction

This document discusses the portrayal and other functionalities of S-101 (ENCs) in conjunction with S-102 (Gridded bathymetry) and/or S-104 (Water level adjustment for surface navigation).

The functionality is described in S-98 Annex C *Harmonised User Experience for ECDIS and INS* – Appendix C-*4 User Selected Safety Contour and Water Level Adjustment.*

During the revision of the document a few problems have been detected which will be discussed in this document. If necessary, recommendations are made to amend the corresponding standards.

## Part 1 – Issues arising due to missing specifications in the existing standards

### Portrayal model

The portrayal model in S-100 (Part 9) describes how a portrayal can be generated for a given data set. Both the model and the scripting interface did not support the access to other datasets from the portrayal rules. Interoperability can only be achieved by restructuring the output of the portrayal process, the so-called display instructions. Functionality as required by S-98 for attribute substation and water level adjustment cannot be implemented with the currently existing mechanisms in S-100. E.g. the substitution and adjustment of depth values must be made prior to the creation of the display instructions. Technically it is possible to do this in the system, but the entire process is no longer fully machine readable.

A solution could be that the implementation of the script interface that returns an attribute value calls internally the substitution and adjustment functions depending on settings made by the end user. That means that we must add functionality into the generic host function in order to achieve the required behaviour. This kind of hard coding does not follow the model of having the portrayal defined in a machine-readable manner.

With this approach it seems to be possible to meet the targets within the expected time.

The alternative would be to amend S-100 first to introduce the functionality in either the portrayal or interoperability model first. This would delay the entire process by years considering that a first version usually has issues that coming up during the implementation. We are talking not about S-100 6.0 then but rather about 6.1 or 6.2 before it is in a shape to be used for ECDIS.

### Interoperability model

Analyses the required functionality with respect to the interoperability model of S-100 (Part 16) turns out that we need to implement **feature hybridization** and may be **spatial operation** as well.

The latter if the splitting of features as described above is implemented. These functionalities are bound to the operability levels 3 and 4 and no details are given in Edition 5 of S-100. (See S-100 16-9)

That means that implementation needs to be made at the OEMs convenience. It is not possible to use an interoperability catalogue for this purpose since the details of the model are not specified yet.

That means again, that the combination of S-101, S-102, and S-104 needs to be implemented in an OEM specific way. Otherwise, the planned time target cannot not be met.

## Part2 – Issues arising from existing standard elements

### Vertical datum

The standard (S-98) requires that only features that are bound to the same sounding or vertical datum as the S-102 or S-104 data are subject of attribute substitution and/or water level adjustment.

S-101 allows several sounding and vertical datum within one dataset. The binding can be done by meta objects (only implicit) or attributes. The mechanism of binding is currently under discussion but it not the binding mechanism but the fact that each feature can be bound to a different sounding or vertical datum. This is an inheritance from S-57 and finally from paper charts.

This means that some for some features the attribute substitution and water level adjustment can be performed and for others not. This will lead to a portrayal of e.g. depth values that are corrected and/or adjusted and those that are from the original S-101 data next to each other. Both values may inside the S-102/S-104 coverage that are marked in the portrayal but not distinguishable by the end user. Only in the pick report the differences can be detected.

Another similar problem is due the fact that water level adjustment should be made to both depth and height values in S-101. In the common case that the vertical datum and the sounding datum are not identical WLA can only be made to either depth or height but not to both. This is also completely untransparent to the user by the portrayal.

Recommendation:

**Use only one datum within an S-101 dataset for both vertical and sounding datum. Remove the corresponding meta features and the mechanism to bind individual features to different datums.**

### Curves and areas not completely within the S-102/S-104 coverage

In S-98 the case that a feature with line or area geometry is not completely covered by the S-102 or S-104 coverage is described as:

* First get the substitution value or adjustment value from the grid the overlap
* Second chose the shoaliest value from this and from the original attribute.

Especially for WLA this means that the none adjusted value is used for areas that are only partly covered by the S-104 coverage whereas adjacent areas that are completely covered are adjusted.

This is another untransparent behaviour since the end user can only see the difference in a pick report.

There are two solutions to improve the situation:

1. Only allow WLA (and attribute substitution) when the entire S-101 dataset is covered by S-102 or S-104 data
2. Split features at runtime and apply substation and WLA to the part the is covered (expensive calculations)

The first option will not work since S-101 datasets will often extend the S-102/S-104 because the cover land areas too. That mean that option 2 should be used which might have a risk of significant performance decrease.

### Sparsely filled grids

If a grid (especially S-102) may not be completely filled. This may have the reason that the coverage area for the data is not rectangular. That use case is ok since the coverage polygon is known and can be used for the portrayal and calculations.

Another case is that inside the coverage area some grid points do not have a known value. This has been observed in several data and will be called here as a sparsely filled grid.

To make the algorithm described in S-98 work this ‘no value’ grid cells must be excluded from the coverage area which leads to many holes within the coverage. Then the marking of the area where the substitution and/or adjustment is used would create a tremendous clutter on the screen which not acceptable.

In addition, many area features or line features will not be completely within the coverage (see the section above which leads to even more problems).

Recommendation:

**The coverage of S-102 and S-104 should not contain sparsely filled areas. (Real holes as for islands are allowed but should be part of the coverage polygon as holes).**

### S-104 data coding format

The S-104 product specification allows several different coding formats, as there are:

* Fixed Stations
* Regular Grid
* Ungeorectified Grid
* TINs
* Stationwise Fixed Stations

S-98 requires that for the Water Level Adjustment the data must be organized as Regular Grids. Since WLA is the primary reason for having that data the question is: Why the other formats are permitted? Data producers can freely choose one from the list above, but the main functionality cannot be achieved with such data that are not regular grids.

Recommendation:

**Remove the other coding formats from the S-104 product specification.**

**13.07.2023**

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