Title: Part 10c – CRS Attributes
S-100 Maintenance - Change Proposal Form

Organisation	SevenCs (HB) Portolan Sciences LLC (RM)	**Date**	07-Feb-2020
Contact	Holger Bothien Raphael Malyankar	**Email**	Holger.Bothien@sevencs.com raphaelm@portolansciences.com

Change Proposal Type *(Select only one option)*

1.Clarification	2.Correction	3.Extension
		X

Location (*Identify all change proposal locations)*

No.	S-100 Version No.	Part No.	Section No.	Proposal Summary
1	4.0.0	10c	9.4 10	Replace metadata attributes 4 & 5 in Table 10c-6 (horizontalDatumReference, horizontalDatumValue) with the attributes in Table 1 in this change proposal. Add a new table (Table 2 in this proposal) listing allowed projection methods to clause 10c-10. Add enumerations for typeOfHorizontalCRS, verticalCoordinateBase, and verticalCoordinateReference to clause 10c-10. Revise the head of clause 10c-10 to “Common Enumerations and Dictionaries”
2		10c	9.4	Replace metadata attribute 10 in Table 10c-6 (verticalDatumReference) with the attributes in Table 3 in this proposal.
3		10c	9.4	Add a clarification to the remarks column in Table 10c-6 for attributes 7a-7d: “For Projected CRS latitude and longitude always refer to the underlying Geodetic CRS.”

Change Proposal

Details for items (1) and (2) are under provided under the respective sub-heads below.

Item (3) is intended to clarify the purpose of attributes7a-7d (westBoundLongitude, etc.), because formally “latitude” and “longitude” refer only to Geodetic CRS, but the ISO model uses the attribute names westBoundLongitude, etc., in EX_GeographicBoundingBox.

Text in italic font is explanatory and should not be added to S-100.

Item 1

The following attributes must be used to define the horizontal and vertical CRS in an S-100 HDF5 file. In most case a single code is enough to describe the CRS. User defined CRS are possible although the level of detail is limited to the general use cases.

Horizontal CRS are limited to Geodetic CRS 2D and Projected CRS.

If user defined there are only the following coordinate systems are supported:

- *Geodetic CS (Latitude, Longitude) – Degrees*
- *Cartesian CS (Northing, Easting or Easting, Northing) – Metres*

For the horizontal Datum all EPSG predefined Datum are allowed or any combination of predefined Prime Meridians or predefined Spheroids.

The projection methods are limited to the one given in the table below.

Note, that if the horizontal CRS is defined by the EPSG code, the defined CRS should not use any other elements than the one allowed for user defined CRSs. (e.g. no projection method that is not in the table).

The table below shows attributes that are intended to replace attributes 4 and 5 (Horizontal Datum, Horizontal Datum Number) in Table 10c-6. Table 10c-X refers to the "Projection methods" table (Table 2 in this proposal).

Table 1. Attributes for horizontal CRS

Name	CamelCase	Mult	DataType	Remarks
Horizontal CRS	horizontalCRS	1	Integer	EPSG code or -1 If user defined
Name of the Horizontal CRS	nameOfHorizontalCRS	0..1	String	Mandatory if *horizontalCRS* = -1
Type of the Horizontal CRS	typeOfHorizontalCRS	0..1	Enumeration	Mandatory if *horizontalCRS* = -1; *1: Geodetic CRS 2D* *2: Projected CRS* *(To be replaced with reference to new enumeration in 10c-10).*
Horizontal Coordinate System	horizontalCS	0..1	Integer	Mandatory if *horizontalCRS* = -1 Allowed Values if *typeOfHorizontalCRS* = 1 (Geodetic CRS 2D): • 6422 (Lat, Lon – degree) Allowed Values if *typeOfHorizontalCRS* = 2 (Projected CRS): • 4400 (Easting, Northing – Metres) • 4500 (Northing, Easting – Metres)
Horizontal Datum	horizontalDatum	0..1	Integer	Mandatory if *horizontalCRS* = -1 EPSG code or -1 if user defined
Name of Horizonal Datum	nameOfHorizontalDatum	0..1	String	Mandatory if *horizontalDatum* = -1
Prime Meridian	primeMeridian	0..1	Integer	Mandatory if *horizontalDatum* = -1; EPSG Code
Spheroid	spheroid	0..1	Integer	Mandatory if *horizontalDatum* = -1; EPSG Code
Projection Method	projectionMethod	0..1	Integer	Mandatory if *typeOfHorizontalCRS* = 2; EPSG Code, see Table 10c-X.
Projection Parameter 1	projectionParameter1	0..1	Float	Only if *projectionMethod* is used. See Table 10c-X
Projection Parameter 2	projectionParameter2	0..1	Float	Only if *projectionMethod* is used. See Table 10c-X

Projection Parameter 3	projectionParameter3	0..1	Float	Only if *projectionMethod* is used. See Table 10c-X
Projection Parameter 4	projectionParameter4	0..1	Float	Only if *projectionMethod* is used. See Table 10c-X
Projection Parameter 5	projectionParameter5	0..1	Float	Only if *projectionMethod* is used. See Table 10c-X
False Northing	falseNorthing	0..1	Float	Only if *projectionMethod* is used. To be applied to the coordinates at axis Northing. [m]
False Easting	falseEasting	0..1	Float	Only if *projectionMethod* is used. To be applied to the coordinates at axis Easting. [m]

Add the notes below to the notes following Table 10c-6:

1) If the CRS is user defined only the following coordinate systems are supported:
   Geodetic CS (Latitude, Longitude) – Degrees
   Cartesian CS (Northing, Easting or Easting, Northing) – Metres
2) For the horizontal Datum all EPSG predefined Datum are allowed or any combination of predefined Prime Meridians or predefined Spheroids.
3) The projection methods are limited to the one given in Table 10c-X.
4) If the horizontal CRS is defined by the EPSG code, the defined CRS should not use any other elements than the one allowed for user defined CRSs. (e.g. no projection method that is not in the table).

Add the following table of projection methods to Clause 10c-10 (Common enumerations). Since this new table is a list (technically a "closed dictionary" – see S-100 clauses 1-4.8, 3-6.7 and App. 11-C) the head of clause 10c-10 should be revised accordingly to "Common Enumerations and Dictionaries".

Table 2. Projection methods and their parameters

Name	EPSG Code	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5
Mercator	9805	Latitude of 1st standard parallel[1]	Longitude of natural origin	-	-	-
Transverse Mercator	9807	Latitude of natural origin	Longitude of natural origin	Scale factor at natural origin	-	-
Oblique Mercator	9815	Latitude of projection centre	Longitude of projection centre	Azimuth of initial line	Angle from Rectified to Skew Grid	Scale factor on initial line
Hotine Oblique Mercator	9812	Latitude of projection centre	Longitude of projection centre	Azimuth of initial line	Angle from Rectified to Skew Grid	Scale factor on initial line
Lambert Conic Conformal (1SP)	9801	Latitude of natural origin	Longitude of natural origin	Scale factor at natural origin	-	-

[1] Latitude of true scale

Lambert Conic Conformal (2SP)	9802	Latitude of false origin	Longitude of false origin	Latitude of 1st standard parallel[2]	Latitude of 2nd standard parallel[3]	-
Oblique Stereographic	9809	Latitude of natural origin	Longitude of natural origin	Scale factor at natural origin	-	-
Polar Stereographic	9810	Latitude of natural origin[4]	Longitude of natural origin	Scale factor at natural origin	-	-
Krovak Oblique Conic Conformal	9819	Latitude of projection centre	Longitude of projection centre	Azimuth of initial line	Latitude of pseudo standard parallel	Scale factor on pseudo standard parallel
American Polyconic	9818	Latitude of natural origin	Longitude of natural origin	-	-	-
Albers Equal Area	9822	Latitude of false origin	Longitude of false origin	Latitude of 1st standard parallel[2]	Latitude of 2nd standard parallel[3]	
Lambert Azimuthal Equal Area	9820	Latitude of natural origin	Longitude of natural origin	-	-	-

NOTE: All latitudes and longitudes of the projection parameters must be given in degrees (south and west negative). Azimuths are given in degrees. For detailed description of the projection method refer to the EPSG documentation.

Item 2:

The following table shows the attributes for defining the vertical CRS.

They define a coordinate system and if vertical coordinates are based on a vertical datum this datum. Vertical datums can be defined from the S-100_VerticalAndSoundingDatum list or by an EPSG Code.

The definition of the coordinate systems is limited to those that using Metres as units of measure.

All values may be overwritten in any feature instance group as before. This is different from the horizontal CRS where the root group is the one and only place to define it.

Note that these attributes have only to be encoded when the data set contains vertical coordinates.

Table 3. Attributes describing the vertical coordinate system

Name	CameCase	Mult	DataType	Remarks
Vertical Coordinate System	*verticalCS*	0..1	Integer	EPSG Code; Allowed Values • 6498 (Depth – Metres – Orientation Down) • 6499 (Height – Metres – Orientation Up)
Vertical Coordinate Base	*verticalCoordinateBase*	0..1	Enumeration	*1: Sea Surface* *2: Vertical Datum* *3: Sea Bottom*

[2] Standard parallel nearer to equator

[3] Standard parallel farther from equator

[4] Must be either 90 degrees or -90 degrees

				(To be replaced with reference to new enumeration in 10c-10).
Vertical Datum Reference	*verticalDatumReference*	0..1	Enumeration	Only if verticalCoordinateBase = 2 *1 – S-100 vertical datum* *2 – EPSG* *(To be replaced with reference to new enumeration in 10c-10).*
Vertical Datum	*verticalDatum*	0..1	Integer	Only if verticalCoordinateBase = 2 If verticalDatumReference = 1 this is a value from S100_VerticalAndSoundingDatum If verticalDatumReference == 2 this is an EPSG code for vertical datum

Enumerations for verticalDatumReference, verticalCoordinateBase, and typeOfHorizontalCRS should be added to clause 10c-10.

Proposed definitions of the members of the new enumerations are in the table below. There will be 3 separate tables added to 10c-10, one for each enumeration, in the same style as the existing tables 10c-19–10c-21.

Table 4. Information about new enumerations to be added to clause 10c-10

Code of new enumeration	***Name***	***Description***	***Remarks***
typeOfHorizontalCRS	*Geodetic CRS 2D*	*Two-dimensional geodetic CRS*	--
typeOfHorizontalCRS	*Projected CRS*	*Projected CRS*	--
verticalCoordinateBase	*Sea Surface*	*The base of the vertical coordinate system is the sea surface.*	*(TBD: How is this determined?)*
verticalCoordinateBase	*Vertical Datum*	*The base of the vertical coordinate system is a defined vertical datum.*	--
verticalCoordinateBase	*Sea Bottom*	*The base of the vertical coordinate system is the sea floor.*	*(TBD: How is this determined?)*
verticalDatumReference	*S-100 vertical datum*	*The vertical datum is one of those listed in S100_VerticalAndSoundingDatum*	--
verticalDatumReference	*EPSG*	*The vertical datum is one of those listed in the EPSG registry.*	--

Change Proposal Justification

The encoding of coordinate reference systems in the S-100 HDF5 format in Part 10c needs to be extended to include provisions for projected and user-defined CRS and datums.

What parts of the S-100 Infrastructure will this proposal affect?

☐ S-100 Feature Concept Dictionary Interface or Database

☐ S-100 Portrayal Register

☐ S-100 Feature Catalogue Builder

☐ S-100 Portrayal Catalogue Builder

☐ S-100 UML Models

Please send completed forms and supporting documentation to the secretary S-100WG.

Appendix A.

Examples

The first example specifies a geodetic CRS (WGS84) and a vertical CRS for depth (Mean Sea Level).

Attribute	**Value**	**Comment**
horizontalCRS	4326	WGS84
verticalCS	6498	Depth – Metres – Orientation down
verticalCoordinateBase	2	Vertical datum
verticalDatumReference	1	S-100
verticalDatum	3	Mean Sea Level

The next example shows how a projected CRS is encoded. In addition, the vertical coordinates are based on the vertical datum 'Fehmarnbelt Vertical Reference 2010'.

Attribute	**Value**	**Comment**
horizontalCRS	32632	WGS84 / UTM zone 32N
verticalCS	6498	Depth – Metres – Orientation down
verticalCoordinateBase	2	Vertical Datum
verticalDatumReference	2	EPSG
verticalDatum	1079	Fehmarnbelt Vertical Reference 2010'

The last example shows the use of a user defined horizontal CRS.

Attribute	Value	Comment
horizontalCRS	-1	User Defined
nameOfHorizontalCRS	LAEA Europe	
typeOfHorizontalCRS	2	Projected CRS
horizontalCS	4532	Cartesian Northing, Easting (Y, X) – Metres
horizontalDatum	6326	WGS84
projectionMethod	9820	Lambert Azimuthal Equal Area
projectionParameter1	52	Latitude of natural origin - Degrees
projectionParameter2	10	Longitude of natural origin - Degrees
falseNorthing	3210000	Metres
falseEasting	4321000	Metres