TSMAD22/DIPWG3-03C

Paper for Consideration by TSMAD and DIPWG

Modifications to the ISO/IEC 8211Encoding of S-100

Motivation:
The motivation for the change in the ISO/IEC 8211encoding was the change of the General Feature Model, especially the fact that associations can have attributes.

Background:
The GFM in S-100 Version 1.0.0 does not allow to associate information types by means of association types. In addition the feature association types are not allowed to carry thematic attributes. Both are required for the modeling of nautical publications. The proposed changes in the GFM requires also a change in the feature catalogue model and in the ISO/IEC 8211 encoding, This document describes the proposed changes of the encoding.

Proposed changes (brief):

As a reminder: There were two changes in the GFM

1. we have codes for the information association
2. both information and feature associations can have thematic attributes

The main changes in this proposal are:

- Each Association needs an own field now (One cannot have multiple associations encoded in one field; the reasons is explained in the next point)
- The attributes are encoded with the same subfields then in the ATTR field. But instead using a separate field I have put them in the Association fiels (INAS and FEAS)
  This makes it clear which attributes belongs to which association and we have not the same field in a record with different meaning.
  As a consequence of this each association needs an own field.
- Some subfields are renamed to be inline with the new GFM
- The update instructions for the INAS and FEAS field (INUI and FAUI subfield) can have the value 3 (Modify) now. This will be the case when the attributes for the association change.

The rest of this document is the S-100 part on Encoding with the proposed changes (Track changes are used).

S-100 – Part 10a

ISO/IEC 8211 Encoding

Contents

10a-1 Scope

The international standard ISO/IEC 8211 - *Specification for a data descriptive file for information interchange*, is a means of encapsulating data; it provides a file based mechanism for the transfer of data. This Part specifies an interchange format to facilitate the moving of files containing data records between computer systems. It defines a specific structure which can be used to transmit files containing data type and data structures specific to S-100.

10a-2 Conformance

This profile conforms to level 2 of ISO 19106:2004.

10a-3 Normative References

ISO/IEC 8211:1994, *Specification for a data descriptive file for information interchange Structure implementations*.

10a-3.1 Introduction

This chapter specifies the structure of an exchange set at the record and field levels. It further specifies the contents of the physical constructs required for their implementation as ISO/IEC 8211 data records, fields, and subfields. The grouping of records into ISO/IEC 8211 files is considered application specific and is, therefore, described in the relevant product specification. For the encoding only the binary ISO/IEC 8211 format is used.

10a-3.2 Notations used in this clause

The specification of the structure of a record is given as a tree structure diagram which comprises the names, linkages and repetition factors of the physical constructs. The detailed specifications of fields and subfields are given in tabular form. Additionally for each field the Data Descriptive field is given. Those fields are used in the Data Descriptive Record (DDR) of an ISO/IEC 8211 conformal data set.

10a-3.3 Tree structure diagrams

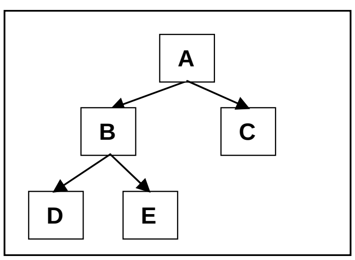

Figure 10a-1

Where A is the root node and parent of node B and node C. Node B is the root of a sub-tree and the parent of nodes D and E.

Nodes are also referred to as the offspring or child of their parents. E.g. node B is the offspring of node A.

The tree structure diagrams must be interpreted in a preordered traversal sequence (top down, left branch first).

For ease of annotation these diagrams are presented vertically in this standard using ASCII characters. In this notation the above diagram becomes:

```
A
|
|-<r>--B (n): nameOfFieldB
|      |
|      *--D (n*m): nameOfFieldD
|      |
|      *--E (*n): nameOfFieldE
|
|-<r>--C (k\\*n): nameOfFieldC
```

Where:

A, B, C, ...	ISO/IEC 8211 field tags
<r>	r is the sub-tree cardinality (if missing, r=1) possible values: <0.. 1> zero or one <0 .. *> any number including zero <1.. *> at least one
(n)	the number of subfields is n (fixed number)
(n*m)	subfields are stored as an m by n array with m rows and n colums (n subfields are repeated m times)
(*n)	subfields are stored as a n-column table with an arbitrary number of rows (n subfields are repeating)
(k*n)	A concatenation of k subfields and a n-column table (k subfields are followed by n repeating subfields)

The tree structure diagrams define which fields are allowed to be repeated. However, within a record, the degree of repetition of fields will depend on the data that is being encoded. In some cases a particular field may not be required and so will be absent (see clause 2.1). However, in all cases, the pre-order traversal sequence of a data record will be the same as shown in the generic tree structure diagram for that record type.

10a-3.4 Field Tables

Each table is preceded by a row in bold outline indicating the field name and field tag. The body of the table specifies the subfield names and labels as well as the ISO/IEC 8211. The subfield specification may include a required value or range constraint. The following is an example of a field table using the Data Set Identification field.

Field Tag: **DSID** [Upd] *)	Field Name: Data Set Identification

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{10} **)
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Encoding specification	ENSP	A()	Encoding specification that defines the encoding
Encoding specification edition	ENED	A()	Edition of the encoding specification
Product identifier	PRSP	A()	Unique identifier for the data product as specified in the product specification
Product edition	PRED	A()	Edition of the product specification
Application profile	PROF	A()	Identifier that specifies a profile within the data product
Data set name	DSNM	A()	The name of the data set
Edition number	EDTN	b12	The edition number of the data set
Update number	UPDN	b12	The update number of the data set
Issue date	ISDT	A(8)	The issue date Format: YYYYMMDD according to ISO 8601

*) [Upd] indicates that the field is only used for updating (for the DSID field this is used as an example)
**) Required binary values are enclosed in {...}

Where:

1) **Label** is the ISO/IEC 8211 subfield label, present only in the data descriptive record and required to identify the subfields within a field. A label preceded by "*" signifies that the subfield and the subsequent ones, repeat within the field. This, therefore, indicates the presence of a 2-D array or table for which the subfield labels provide the column headings (the vector labels of a cartesian label).

2) **Format** is the ISO/IEC 8211 binary subfield data format

10a-3.5 Data formats

Subfield data formats are specified by ISO/IEC 8211. The allowable data formats are as follows:

Format	Data Type	Omitted values	Rema
A(n)	Character Data	If the subfield has a fixed length the subfield will be filled with blanks (space character) If the subfield length is variable only the unit terminator must be encoded.	n specified the length of the subfield (numb A() indicates a sub field of variable lengt delimiter (UT). The encoding of Character implementation level 1. The appropriate Escape Sequence is: (2/5)
b1w	Unsigned Integer (LSBF) *)	The binary value with all bits set to 1 must be used.	w specifies the number of Bytes used. Permissible values are: 1,2,4
b2w	Signed Integer (LSBF)	The binary value with all bits set to 1 must be used.	w specifies the number of Bytes used. Permissible values are: 1,2,4
b48	Signed Floating Point (LSBF)	The value for 'Not A Number' (NaN) must be used	according to IEC 559 or IEEE 754

*) LSBF or "little-endian" is the byte order for multi-byte types. The least significant byte is placed closest to the beginning of a file.

10a-3.6 Data Descriptive Fields

Data Descriptive fields are fields of the Data Descriptive Record (DDR) of an ISO/IEC 8211 conformal data file. These fields describe the format of each field in a Data record (DR) of such a file. A Data Descriptive field comprises the Field Control, the Data Field Name, the Array Descriptor, and the Format Controls. More details on Data Descriptive Fields are in ISO/IEC 8211 (1994) Clause 6.4.

Data Descriptive Fields contain non printable characters. In this document they are replaced with graphical symbols as the following table defines:

Character	Code	Graphic
Space	(2/0)	□
UT (Unit Terminator)	(1/15)	▲
FT (Field Terminator)	(1/14)	▼

The Data Descriptive Field is given in a bold text box following the table describing the format of the field.

10a-4 Common fields

10a-4.1 Attribute field

10a-4.1.1 Encoding rules

In S-100 attributes can be either simple or complex. Simple attributes have values whereas complex attributes are an aggregation of other attributes, either simple or complex. The following diagram shows an example of a feature type with both simple and complex attributes.

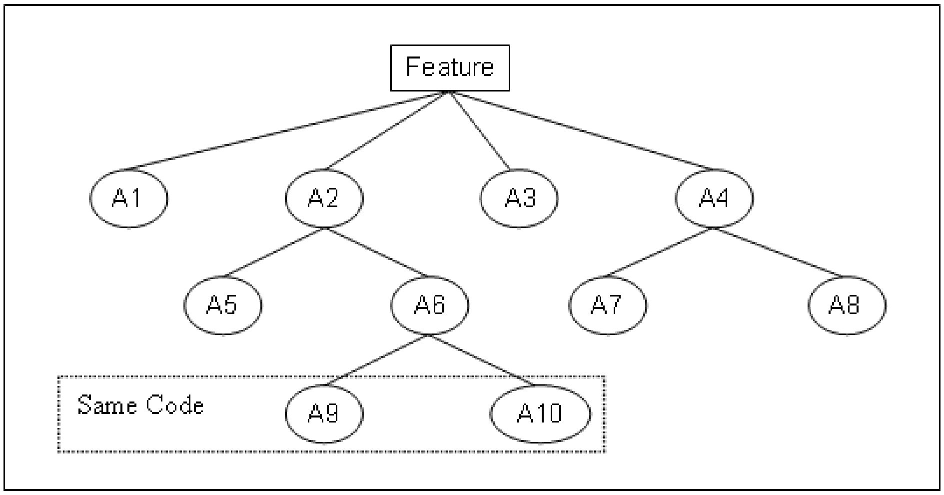

Figure 10a-2

The feature has four attributes: A1, A2, A3, and A4. A1 and A3 are simple attributes; A2 and A4 are complex attributes. A2 comprises two attributes (A5 and A6) where A5 is a simple one and A6 is another complex attribute. A4 and A6 are two complex attributes; both consist of two simple attributes.

Another characteristic of attributes is the cardinality. This indicates how many attributes of the same kind (the same code in a feature catalogue) are used at the same parent. The same parent means that they are all top level attributes or belonging to the same instance of a complex attribute. In the example above A9 and A10 are assumed to have the same code.

With the concept of cardinalities larger than one, an attribute can be seen as an array of attributes. To access an attribute in such an array one needs not only the code of that attribute but also the index of that attribute. Note that the order in such an array may be meaningful and must be maintained by the encoding.

Taking all of the above into account an attribute can be uniquely addressed by three values:

1. The attribute code
2. The index of the attribute (starting with 1)
3. The parent of the attribute

To complete the example above, the following table defines codes and values of the attributes:

Attribute	Code	Attribute Index	Value	Remarks
A1	21	1	Vachon	
A2	22	1		complex
A3	23	1	12	
A4	24	1		complex
A5	25	1	42.0	

A6	26	1		complex
A7	27	1	123	
A8	28	1	Canada	
A9	29	1	17	same code as A10
A10	29	2	43	same code as A9

To encode an attribute a set of five items is necessary: the three mentioned above plus an update instruction and the value of the attribute. To specify the parent of the attribute an index is used. This index points to the n^{th} tuple in the ATTR field starting with 1. The following table shows the encoding of the example:

Index	ATLB	ATIX	PAIX	ATIN	ATVL	Remark
1	21	1	0	Insert	Vachon	A1
2	22	1	0	Insert		A2 - composite
3	25	1	2	Insert	42.0	A5
4	26	1	2	Insert		A6 - composite
5	29	1	4	Insert	17	A9
6	29	2	4	Insert	43	A10
7	23	1	0	Insert	12	A3
8	24	1	0	Insert		A4 - composite
9	27	1	8	Insert	123	A7
10	28	1	8	Insert	Canada	A8

Note that here the preorder traversing is used to define the order of tuples in the field. This keeps all part of a complex attribute together and guarantees that the parent is always stored before the child. The preorder traversing is defined as follows:

1) Encode the root
2) Than encode the sub-trees from left to right.

This traversing order is mandatory within this standard.

Note also that the ATIN subfield (Attribute update Instruction) will always be ‘Insert’ for encoding base data attributes. The other ATIN values (Modify, Delete) are only needed for updating the ATTR field.

All values of attribute are stored as character strings even if the value domain is a numeric type. UTF-8 will be the only encoding allowed in S-100 for such character strings. This allows the encoding of all characters of the first multilingual plane of ISO 10646. There is no other encoding for national character sets necessary.

10a-4.2 Updating of the Attribute field

To update an attribute the attribute must be uniquely identifiable and once identified instructions are needed to affect that attribute. The Attribute Update Instruction indicates whether an attribute is to be deleted from the field; modified, or inserted. Deletion and modification implies that the attribute exists. Deletion and insertion may change the indices of other attributes in an array of attributes and therefore must be taken into account when the attribute field is updated. Instructions must be applied in sequence in order that the indices used are identifying the correct attributes components on subsequent updates.

To demonstrate the updating of attributes the example above should be modified as shown in the following figure.

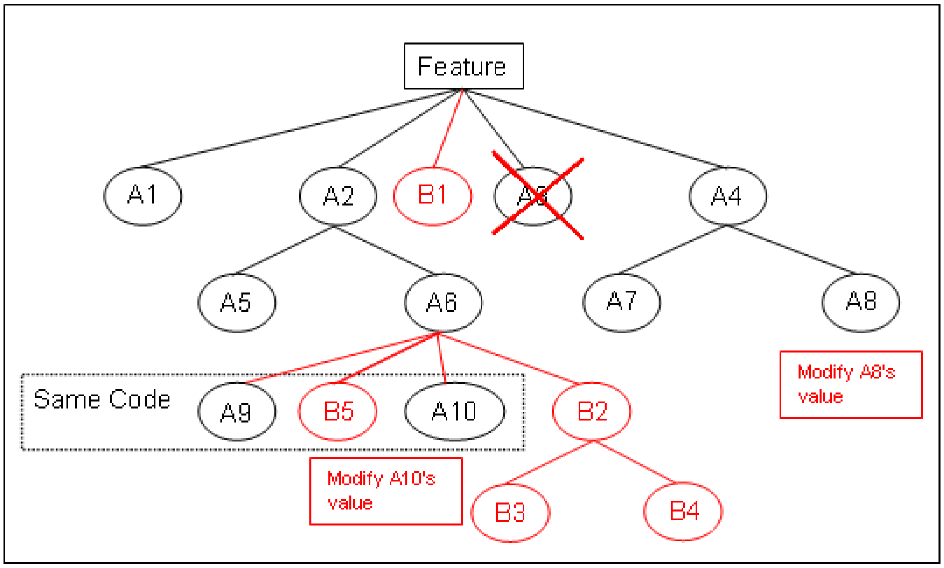

Figure 10a-3

The details are:

Attribute	Code	Attribute Index	Value	Update Instruction	Remarks
B5	29	2	32	Insert	Will change A10's index to 3
A10	29	3	7	Modify	
B2	35	1		Insert	complex
B3	36	1	32	Insert	
B4	37	1	123	Insert	
B1	32	1	abc	Insert	
A3	23	1	1,2	Delete	
A8	28	1	Germany	Modify	

In order to identify B5, A10 and B2 the entries for A2 and A6 must be inserted. The same is true for A4 (to identify A8). The complete field will look like:

Index	ATLB	ATIX	PAIX	ATIN	ATVL	Remark
1	22	1	0	Modify		A2 - complex
2	26	1	1	Modify		A6 - complex
3	29	2	2	Insert	32	B5 - Will increase the ATIX of A10
4	29	3	2	Modify	7	A10 - now with ATIX 2
5	35	1	2	Insert		B2 - complex
6	36	1	5	Insert	22	B3
7	37	1	5	Insert	123	B4
8	32	1	0	Insert	abc	B1
9	23	1	0	Delete		A3
10	24	1	0	Modify		A4 - complex
11	28	1	10	Modify	Germany	A8

Note that in order to delete a complex attribute it will be adequate to delete the root entry of that attribute. E.g. to delete A2 only one entry (22, 1, 0, Delete) has to be encoded.

10a-4.3 Attribute field structure

Field Tag: **ATTR**	Field Name: Attribute

Subfield name	Label	Format	Subfield content and specification
Attribute label/code	*ATLB	b12	A valid attribute code
Attribute index	ATIX	b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1).
Parent index	PAIX	b12	Index (position) of the parent complex attribute within this ATTR field (starting with 1). If the attribute has no parent (top level attribute) the value is 0.
Attribute Instruction	ATIN	b11	{1} - Insert {2} - Delete {3} - Modify
Attribute value	ATVL	A()	A string containing a valid value for the domain of the attribute specified by the subfields above.

Data Descriptive Field

```
2600;&%/GAttribute▲*ATLB!ATIX!PAIX!ATIN!ATVL▲(3b12,b11,A)▼
```

10a-4.4 Information Association field

10a-4.4.1 Encoding rules

An Information association is a link from one record to an information type record. An information type record can be referenced from any number of other records but at least one record should have an association to an information type record. Such associations will be encoded by means of the Information Association field (INAS). For each association a separate field has to be used. The association itself can have attributes. The attributes are encoded in the field by the same mechanism as described for the ATTR field. The same subfileds are used at the end of the association field.~~The order of associations in the INAS field is arbitrary; e~~Each association is uniquely addressed ~~only~~ by the combination of the RRNM, ~~and~~ RRID, IASS, and ROLE subfields.

The RRNM subfield is referencing the record name subfield (RCNM) and the RRID subfield is referencing the record id subfield (RCID) of the target record.

The Information Association Update Instruction INUI subfield is used to indicate if an association is to be inserted or deleted on update. For a base data set this field must have the value ‘Insert’.

10a-4.4.2 Information Association field structure

Field Tag: **INAS**	Field Name: Information Association

Subfield name	Label	Format	Subfield content and specification
Referenced Record name	*RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Information Association	IASS	b12	A valid code for the information association
~~Information~~ Role	~~IROL~~ROLE	b12	A valid code for the ~~information~~ role ~~or 65535 if not applicable~~
Information Association Update Instruction	IUIN	b11	{1} - Insert {2} ~~-~~ - Delete {3} - Modify
Attribute label/code	*ATLB	b12	A valid attribute code
Attribute index	ATIX	b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1).

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Parent index	PAIX	b12	Index (position) of the parent complex attribute within this ATTR field (starting with 1). If the attribute has no parent (top level attribute) the value is 0.
Attribute Instruction	ATIN	b11	{1} - Insert {2} - Delete {3} - Modify
Attribute value	ATVL	A()	A string containing a valid value for the domain of the attribute specified by the subfields above.

Data Descriptive Field

```
~~2100~~3600~~;&□□□~~;&%/GInformation□Association▲~~*~~RRNM!RRID!IASS!~~IROL~~ROLE!IUIN\\*
ATLB!ATIX!PAIX!ATIN!ATVL▲(b11,b14,2b12,b11,3b12,b11,A)▼
```

10a-5 Data Set Descriptive records

10a-5.1 Data Set General Information record

10a-5.1.1 Encoding rules

This record encodes general information about the data set. This information includes identification, structural information and Metadata.

The Data Set Identification field contains information to identify the data set. This information is divided into three groups:

1) Information about the encoding
2) Information about the data product
3) Information about the data set itself

The first group specifies the encoding specification on which the encoding is based and what version of that specification is applicable.

The second group defines the data product, the edition of the product specification and the profile used within the product. The product itself is specified by a unique identifier. Edition and Profile depend on the product specification and will be encoded as character strings.

The third group contains:

1) A file identifier of the data set
2) A title of the data set
3) The reference (issue) date of the data set
4) The (default) language used in the data set
5) An abstract about the data set
6) The edition of the data set (may contain subversion/update number)
7) A list of topic categories according to ISO/IEC 19115 (see list)

Value of DSTC subfield	Topic Category
1	farming
2	biota
3	boundaries
4	climatologyMeterologyAtmosphere
5	economy
6	elevation
7	environment
8	geoscientificInformation
9	health

10	imageryBaseMapsEarthCover
11	intelligenceMilitary
12	inlandWaters
13	location
14	oceans
15	planningCadastre
16	society
17	structure
18	transportation
19	utilitiesCommunication

All other Metadata will be encoded as attributes in the Attribute field(s) of this record. For this reason the respective attributes must be defined in the feature catalogue of the data product.

The Data Set Structure Information field contains some structural information. These are:

1) An origin offset used to shift the coordinate data being encoded such that higher precision can be carried in the region of the dataset.
2) The multiplication factors for the separate coordinate axes
3) The number of the different kinds of records in the data file

10a-5.1.2 Data Set General Information record structure

```
Data Set General Information record
   |
   |--DSID (1113\\*1): Data Set Identification field
      |
      |--DSSI (13): Data Set Structure Information field
      |
      |-<0..*>-ATTR (*5): Attribute field (Metadata)
```

10a-5.1.2.1 Data Set Identification field structure

Field Tag: **DSID**	Field Name: Data Set Identification

Subfield name	**Label**	**Format**	**Subfield content and specification**
Record name	RCNM	b11	{10} - Data Set Identification
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Encoding specification	ENSP	A()	Encoding specification that defines the encoding
Encoding specification edition	ENED	A()	Edition of the encoding specification
Product identifier	PRSP	A()	Unique identifier for the data product as specified in the product specification
Product edition	PRED	A()	Edition of the product specification
Application profile	PROF	A()	Identifier that specifies a profile within the data product
Dataset file identifier	DSNM	A()	The file identifier of the dataset
Dataset title	DSTL	A()	The title of the dataset
Dataset reference date	DSRD	A(8)	The reference date of the dataset Format: YYYYMMDD according to ISO 8601
Dataset language	DSLG	A()	The (primary) language used in this dataset
Dataset abstract	DSAB	A()	The abstract of the dataset
Dataset edition	DSED	A()	The edition of the dataset
Dataset topic category	*DSTC	b11	A set of topic categories

Data Descriptive Field

```
3600;&%/GData□Set□Identification▲RCNM!RCID!ENSP!ENED!PRSP!PRED!PROF!DSNM!D
STL!DSRD!DSLG!DSAB!DSED\\*DSTC▲(b11,b14,7A,A(8),3A,b11)▼
```

10a-5.1.2.2 Data Set Structure Information field structure

Field Tag: **DSSI**	Field Name: Data Set Structure Information

Subfield name	Label	Format	Subfield content and specification
Dataset Coordinate Origin X	DCOX	b48	Shift used to adjust x-coordinate before encoding
Dataset Coordinate Origin Y	DCOY	b48	Shift used to adjust y-coordinate before encoding
Dataset Coordinate Origin Z	DCOZ	b48	Shift used to adjust z-coordinate before encoding
Coordinate multiplication factor for x-coordinate	CMFX	b14	Floating point to integer multiplication factor for the x-coordinate or longitude
Coordinate multiplication factor for y-coordinate	CMFY	b14	Floating point to integer multiplication factor for the y-coordinate or latitude
Coordinate multiplication factor for z-coordinate	CMFZ	b14	Floating point to integer multiplication factor for the z-coordinate or depths or height
Number of Information Type records	NOIR	b14	Number of information records in the data set
Number of Point records	NOPN	b14	Number of point records in the data set
Number of Multi Point records	NOMN	b14	Number of multi point records in the data set
Number of Curve records	NOCN	b14	Number of curve records in the data set
Number of Composite Curve records	NOXN	b14	Number of composite curve records in the data set
Number of Surface records	NOSN	b14	Number of surface records in the data set
Number of Feature Type records	NOFR	b14	Number of feature records in the data set

Data Descriptive Field

```
1600;&□□□Data□Set□Structure□Information▲DCOX!DCOY!DCOZ!CMFX!CMFY!CMFZ!NOIR
!NOPM!NOMN!NOCN!NOXN!NOSN!NOFR▲(3b48,10b14)▼
```

10a-5.2 Data Set Coordinate Reference System record

10a-5.2.1 Encoding rules

All two-dimensional coordinates in a dataset refer to one horizontal CRS. Three-dimensional coordinates refer to a compound CRS which consists of the horizontal CRS and a vertical CRS. There can be more than one vertical CRSs in a dataset one for each compound CRS.

The CRSH field contains the following information about the (single) CRS.

- The type of CRS (this implies the dimension of the coordinate system)
- The type of the associated coordinate system
- The name of the CRS
- An identifier in an external source (if the CRS is defined by referencing)
- An indication which external source is referenced
- Information about this source (if it is not one from a predefined list)

If the CRS is not defined by referencing all details of the coordinate axes, the datum and if necessary about the used projection must be encoded. This has to done by means of the appropriate fields. In this case the CRSI subfield must be encoded empty and the CRSS subfield must have the value 255 (Not Applicable).

For more details on CRS refer to the Coordinate Reference System Component of this standard.

This encoding specification supports the following types of CRS's:

CRS Type	Dimension	CS Type	Axes	Type of Datum	CRST value	Remarks
2D Geographic	2	Ellipsoidal	Geodetic Latitude Geodetic Longitude	Geodetic	1	can combined with a vertical CRS
3D Geographic	3	Ellipsoidal	Geodetic Latitude Geodetic Longitude Ellipsoidal Height	Geodetic	2	
Geocentric	3	Cartesian	Geocentric X Geocentric Y Geocentric Z	Geodetic	3	
Projected	2	Cartesian	Easting / Westing Northing / Southing	Geodetic	4	can combined with a vertical CRS
Vertical	1	Vertical	Gravity Related Height or Gravity related Depth	Vertical	5	

The next table shows the supported coordinate axes.

Axis Type	Axis direction	AXTY value	Remarks
Geodetic Latitude	North	1	
Geodetic Longitude	East	2	
Ellipsoidal Height	Up	3	
Easting	East	4	
Northing	North	5	
Westing	West	6	
Southing	South	7	
Geocentric X	Geocentric X	8	
Geocentric Y	Geocentric Y	9	
Geocentric Z	Geocentric Z	10	
Gravity Related Height	Up	11	
Gravity Related Depth	Down	12	

This table shows the supported projections together with their set of parameters

Name	PROM value	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	EPSG code
Mercator	1	Latitude of 1st standard parallel [1])	Longitude of natural origin	-	-	-	9805
Transverse Mercator	2	Latitude of natural origin	Longitude of natural origin	Scale factor at natural origin	-	-	9807
Oblique Mercator	3	Latitude of projection centre	Longitude of projection centre	Azimuth of initial line	Angle from Rectified to Skew Grid	Scale factor on initial line	9815
Hotine Oblique Mercator	4	Latitude of projection centre	Longitude of projection centre	Azimuth of initial line	Angle from Rectified to Skew Grid	Scale factor on initial line	9812
Lambert Conic Conformal (1SP)	5	Latitude of natural origin	Longitude of natural origin	Scale factor at natural origin	-	-	9801
Lambert Conic Conformal (2SP)	6	Latitude of false origin	Longitude of false origin	Latitude of 1st standard	Latitude of 2nd standard	-	9802

Name	PROM value	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5	EPSG code
				parallel [2])	parallel [3])		
Oblique Stereographic	7	Latitude of natural origin	Longitude of natural origin	Scale factor at natural origin	-	-	9809
Polar Stereographic	8	Latitude of natural origin [4])	Longitude of natural origin	Scale factor at natural origin	-	-	9810
Krovak Oblique Conic Conformal	9	Latitude of projection centre	Longitude of projection centre	Azimuth of initial line	Latitude of pseudo standard parallel	Scale factor on pseudo standard parallel	9819
American Polyconic	10	Latitude of natural origin	Longitude of natural origin	-	-	-	9818
Albers Equal Area	11	Latitude of false origin	Longitude of false origin	Latitude of 1st standard parallel [2])	Latitude of 2nd standard parallel [3])	-	9822
Lambert Azimuthal Equal Area	12	Latitude of natural origin	Longitude of natural origin	-	-	-	9820
New Zealand Mapgrid	13	Latitude of natural origin	Longitude of natural origin	-	-	-	9811

[1]) Latitude of true scale
[2]) Standard parallel nearer to equator
[3]) Standard parallel farther from equator
[4]) Must be either 90 degrees or -90 degrees

All latitudes and longitudes must be given in degrees (south and west are negative). Azimuths are given in degrees. For the detailed formulas of the projections refer to the EPSG documentation.

In case that both two-dimensional and three-dimensional coordinates are used in the same data set the three-dimensional coordinates must be described by a compound CRS. The two-dimensional coordinates refer to the first component (usually a 2D Geographic or Projected CRS).

Although all coordinates in a data set must refer to the same CRS different Vertical Datums can be used for the height or depth component of a coordinate tuple. Therefore the VDAT field can be repeated. For each Vertical Datum a unique identifier is defined. Those identifiers will be used in the 3D - coordinate fields to indicate which Vertical Datum is used. The encoding of the Coordinate Reference System record will be demonstrated with two examples. The first example specifies a compound CRS. The first component is a 2D Geographic CRS (WGS84) and the second component is a Vertical CRS for depth using the Vertical Datum: Mean Sea Level.

```
CSID: RCNM{15}!RCID{1}!NCRC{2}!
CRSH: CRIX{1}!CRST{1}!CSTY{1}!CRNM’WGS
      84’!CRSI’4326’!CRSS{2}!SCRI!
CRSH: CRIX{2}!CRST{5}!CSTY{3}!CRNM’Mean Sea Level Depth’!
      CRSI!CRSS{255}SCRI!
CSAX: AXTY{12}!AXUM{4}!
VDAT: DTNM’Mean Sea Level’!DTID’VERDAT3’!DTSR{2}!SCRI!
```

The second example encodes a projected CRS by defining the details.

```
CSID: RCNM{15}!RCID{1}!NCRS{1}!
CRSH: CRIX{1}!CRST{4}!CSTY{2}!CRNM'WGS84/UTM
      32N'!CRSI!CRSS{255}SCRI!
CSAX: AXTY{4}!AXUM{4}!AXTY{5}!AXUM{4}!
PROJ: PROM{2}!PRP1{0}!PRP2{9}!PRP3{0.9996}!PRP4{0}!PRP5{0}!
      FEAS{500000}!FNOR{0}!
GDAT: DTNM'World Geodetic System 1984'!ELNM'WGS 84'!ESMA{6378137}!
      ESPT{2}!ESPM{298.257223563}!CMNM'Greenwich'!CMGL{0}!
```

10a-5.2.2 Data Set Coordinate Reference System record structure

```
Data Set Coordinate Reference System record
  |
  |--CSID (3): Coordinate Reference System Record Identifier field
    |
    |-<1..*>-CRSH (7): Coordinate Reference System Header field
      |
      |-<0..1>-CSAX (*2): Coordinate System Axes field
      |
      |-<0..1>-PROJ (8): Projection field
      |
      *-<0..1>-GDAT (7): Geodetic Datum field
      |
      *-<0..1>-VDAT (4): Vertical Datum field
```

10a-5.2.2.1 Coordinate Reference System Record Identifier field structure

Field Tag: **CSID**	Field Name: Coordinate Reference System Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{15} - Coordinate Reference System Identifier
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Number of CRS Components	NCRC	b11	

Data Descriptive Field

```
1100;&□□□Coordinate□Reference□System□Record□Identifier▲RCNM!RCID!NCRC▲(b11
,b14,b11)▼
```

10a-5.2.2.2 Coordinate Reference System Header field structure

Field Tag: **CRSH**	Field Name: Coordinate Reference System Header

Subfield name	Label	Format	Subfield content and specification
CRS Index	CRIX	b11	Internal identifier of the CRS (Used for identifying the vertical CRS in C3DI or C3DF)
CRS Type	CRST	b11	see table
Coordinate System Type	CSTY	b11	{1} - Ellipsoidal CS {2} - Cartesian CS {3} - Vertical CS
CRS Name	CRNM	A()	Name of the Coordinate Reference System
CRS Identifier	CRSI	A()	Identifier of the CRS from an external source.

			Empty if not defined by reference
CRS Source	CRSS	b11	{1} - IHO CRS Register {2} - EPSG {254} - Other Source {255} - Not Applicable
CRS Source Information	SCRI	A()	Information about the CRS source if CRSS = 'Other Source'

Data Descriptive Field

```
1600;&%/GCoordinate□Reference□System□Header▲CRIX!CRST!CSTY!CRNM!CRSI!CRSS!
SRCI▲(3b11,2A,b11,A)▼
```

10a-5.2.2.3 Coordinate System Axes field structure

Field Tag: **CSAX**	Field Name: Coordinate System Axes

Subfield name	Label	Format	Subfield content and specification
Axis Type	*AXTY	b11	see table
Axis Unit of Measure	AXUM	b11	{1} - Degree {2} - Grad {3} - Radian {4} - Metre {5} - International foot {6} - US survey foot

Data Descriptive Field

```
2100;&□□□Coordinate□System□Axes▲*AXTY!AXUM▲(2b11)▼
```

10a-5.2.2.4 Projection field structure

Field Tag: **PROJ**	Field Name: Projection

Subfield name	Label	Format	Subfield content and specification
Projection Method	PROM	b11	see table
Projection Parameter 1	PRP1	b48	see table
Projection Parameter 2	PRP2	b48	see table
Projection Parameter 3	PRP3	b48	see table
Projection Parameter 4	PRP4	b48	see table
Projection Parameter 5	PRO5	b48	see table
False Easting	FEAS	b48	False easting (Units of measurement according to the coordinate axis 'Easting'
False Northing	FNOR	b48	False northing (Units of measurement according to the coordinate axis 'Northing'

Data Descriptive Field

```
1600;&□□□Projection▲PROM!PRP1!PRP2!PRP3!PRP4!PRP5!FEAS!FNOR!▲(b11,7b48)▼
```

10a-5.2.2.5 Geodetic Datum field structure

Field Tag: **GDAT**	Field Name: Geodetic Datum

Subfield name	Label	Format	Subfield content and specification
Datum Name	DTNM	A()	Name of the geodetic datum
Ellipsoid Name	ELNM	A()	Name of the ellipsoid
Ellipsoid semi major axis	ESMA	b48	Semi major axis of the ellipsoid in metre
Ellipsoid second parameter type	ESPT	b11	{1} - Semi minor axis in metres {2} - Inverse Flattening
Ellipsoid second parameter	ESPM	b48	The second defining parameter of the ellipsoid
Central Meridian Name	CMNM	A()	Name of the central meridian
Central Meridian Greenwich Longitude	CMGL	b48	Greenwich longitude of the central meridian in degrees

Data Descriptive Field

```
1600;&%/GGeodetic□Datum▲DTNM!ELNM!ESMA!ESPT!ESPM!CMNM!CMGL!▲(2A,b48,b11,b4
8,A,b48)▼
```

10a-5.2.2.6 Vertical Datum field structure

Field Tag: **VDAT**	Field Name: Vertical Datum

Subfield name	Label	Format	Subfield content and specification
Datum Name	DTNM	A()	Name of the Vertical datum
Datum Identifier	DTID	A()	Identifier of the datum in an external source
Datum Source	DTSR	b11	{1} - IHO CRS Register {2} - Feature Catalogue {3} - EPSG {254} - Other Source {255} - Not Applicable
Datum Source Information	SCRI	A()	Information about the CRS source if DTSR = 'Other Source'

Data Descriptive Field

```
1600;&%/GVertical□Datum▲ DTNM!DTID!DTSR!SCRI!▲( 2A,b11,A)▼
```

10a-5.3 Information Type record

10a-5.3.1 Encoding rules

Information types are pieces of information in a data set that can be shared between objects. They have attributes like feature types but are not related to any geometry. Information types may reference other information types. For the encoding it is important that an information type record must be stored prior to any record that references this record.

The object code must be a valid code in the feature catalogue that is defined for the data product. The record version will be initialized with 1 and will be incremented for any update of this record. The record update instruction indicates if an information type will be inserted, modified or deleted in an update. In a base data set the value will always be 'Insert'.

10a-5.3.2 Information Type record structure

```
Information Type record
   |
   |--IRID (5): Information Type Record Identifier field
      |
      |-<0..*>-ATTR (*5): Attribute field
      |
      |-<0..*>-INAS (5\\*5*4): Information Association field
```

10a-5.3.3 Information Type Identifier field structure

Field Tag: **IRID**	Field Name: Information Type Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{150} - Information Type
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Object code	OBJC	b12	A valid object code
Record version	RVER	b12	RVER contains the serial number of the record edition
Record update instruction	RUIN	b11	{1} - Insert {2} - Delete {3} - Modify

Data Descriptive Field

```
1100;&□□□Information□Type□Record□Identifier▲RCNM!RCID!OBJC!RVER!RUIN▲(b11,
b14,2b12,b11)▼
```

10a-5.4 Spatial type records

10a-5.4.1 Coordinates

10a-5.4.1.1 Encoding rules

Coordinates in a dataset are defined by the coordinate reference system (CRS). The CRS is defined in the Coordinate Reference System record. This record also defines the units of the coordinates.

The DSSI field of the Data Set General Information record can carry a local origin for the coordinates in a Data Set. When storing coordinates the Origin needs to be subtracted from the value, when reading coordinates from a dataset the Origin needs to be added back on to restore the CRS defined value.

Coordinates can be stored in two ways as floating point numbers or as integer numbers. In the latter case the stored integer value is calculated by the multiplication of the real coordinate and a multiplication factor. Those factors are defined for each coordinate axis in the DSSI field of the Data Set General Information record. With these factors the stored value can be transformed into the real coordinate according to the coordinate reference system (CRS).

The coordinates are transformed as follows:

```
x = DCOX + XCOO / CMFX
y = DCOY + YCOO / CMFY
z = DCOZ + ZCOO / CMFZ
```

Note that the values of (CMFX, CMFY and CMFZ) should be set to 1 if the coordinates are stored as floating point values.

If the coordinate field allows more than one coordinate tuple the update must maintain the order of the coordinates. Each update of a coordinate stream is therefore defined by an index into the coordinate field(s) of the target record, an update instruction and the number of coordinates in the coordinate field(s) of the update record.

Note that the index and the number refer to coordinate tuples, not to single coordinates. The index will start with 1.

10a-5.4.1.2 Coordinate Control field structure

Field Tag: **COCC** [Upd	Field Name: Coordinate Control

Subfield name	Label	Format	Subfield content and specification
Coordinate Update Instruction	COUI	b11	{1} - Insert {2} - Delete {3} - Modify
Coordinate Index	COIX	b12	Index (position) of the addressed coordinate tuple within the coordinate field(s) of the target record
Number of Coordinates	NCOR	b12	Number of coordinate tuples in the coordinate field(s) of the update record

Data Descriptive Field

```
1100;&□□□Coordinate□Control▲COUI!COIX!NCOR▲(b11,2b12)▼
```

10a-5.4.2 2-D Integer Coordinate field structure

Field Tag: **C2DI**	Field Name 2-D Integer Coordinate

Subfield name	Label	Format	Subfield content and specification
Coordinate in Y axis	*YCOO	b24	Y-coordinate or latitude
Coordinate in X axis	XCOO	b24	X-coordinate or longitude

Data Descriptive Field

```
2100;&□□□2-D□Integer□Coordinate▲*YCOO!XCOO▲(2b24)▼
```

10a-5.4.3 3-D Integer Coordinate field structure

Field Tag: **C3DI**	Field Name: 3-DInteger Coordinate

Subfield name	Label	Format	Subfield content and specification
Vertical CRS Id	VCID	b11	Internal identifier of the Vertical CRS
Coordinate in Y axis	*YCOO	b24	Y- coordinate or latitude
Coordinate in X axis	XCOO	b24	X- coordinate or longitude
Coordinate in Z axis	ZCOO	b24	Z - coordinate (depth or height)

Data Descriptive Field

```
3100;&□□□3-D□Integer□Coordinate▲VCID\\*YCOO!XCOO!ZCOO▲(b11,3b24)▼
```

10a-5.4.4 2-D Floating Point Coordinate field structure

Field Tag: **C2DF**	Field Name 2-D Floating Point Coordinate

Subfield name	Label	Format	Subfield content and specification
Coordinate in Y axis	*YCOO	b48	Y-coordinate or latitude
Coordinate in X axis	XCOO	b48	X-coordinate or longitude

Data Descriptive Field

```
2200;&□□□2-D□Floating□Point□Coordinate▲*YCOO!XCOO▲(2b48)▼
```

10a-5.4.5 3-D Floating Point Coordinate field structure

Field Tag: **C3DF**	Field Name: 3-D Floating Point Coordinate

Subfield name	Label	Format	Subfield content and specification
Vertical CRS Id	VCID	b11	Internal identifier of the Vertical CRS
Coordinate in Y axis	*YCOO	b48	Y- coordinate or latitude
Coordinate in X axis	XCOO	b48	X- coordinate or longitude
Coordinate in Z axis	ZCOO	b48	Z - coordinate (depth or height)

Data Descriptive Field

```
3600;&□□□3-D□Floating□Point□Coordinate▲VCID\\*YCOO!XCOO!ZCOO▲(b11,3b48)▼
```

10a-5.5 Point record

10a-5.5.1 Encoding rules

A point is a zero-dimensional spatial object. It will be encoded with the Point record. This record contains the Point Record Identifier field. With the RCNM and RCID subfields every point must be uniquely identifiable within a data set. A point can have attributes and associations to information types.

Each point has exactly one coordinate field with exactly one coordinate tuple. Points can have both 2D or 3D coordinates.

Since there is only one coordinate tuple no special mechanism is necessary to address a coordinate for updating. When the coordinate of a point is to be updated the update record will contain a coordinate field with the new coordinate. The dimension of the coordinate in the update record must be the same as in the target record.

10a-5.5.2 Point record structure

```
Point record
  |
  |--PRID (4): Point Record Identifier field
    |
    |-<0..*>-INAS (*45\\*5): Information Association field
    |
    |alternate coordinate representations
    |
    *--C2DI (2): 2-D Integer Coordinate field
    |
    *--C3DI (4): 3-D Integer Coordinate field
    |
    *--C2DF (2): 2-D Floating Point Coordinate field
    |
    *--C3DF (4): 3-D Floating Point Coordinate field
```

10a-5.5.2.1 Point Record Identifier field structure

Field Tag: **PRID**	Field Name: Point Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{110} - Point
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Record version	RVER	b12	RVER contains the serial number of the record edition
Record update instruction	RUIN	b11	{1} - Insert {2} - Delete {3} - Modify

Data Descriptive Field

1100;&□□□Point□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b11)▼

10a-5.6 Multi Point record

10a-5.6.1 Encoding rules

A Multi Point is an aggregation of zero-dimensional spatial objects. It will be encoded with the Multi Point record. Each Multi Point must have a unique identifier (RCNM + RCID) stored in the Multi Point Record Identifier field. Like any other spatial object Multi Points can have attributes and associations to information types.

Coordinates will be stored by one type of the coordinate fields. The field can be repeated and in one field can be multiple coordinate tuples. If multiple coordinate fields are used they must be all of the same type. If 3D-coordinates are used for the Multi Point they must all refer to the same Vertical Datum.

On updating the Coordinate control field defines which coordinates in the target record will be updated. Three kinds of updates are possible as defined by the Coordinate Update Instruction subfield (COUI):

1) Insert
   Coordinates encoded in the coordinate field(s) of the update record must be inserted in the coordinate field(s) of the target record. The Coordinate Index subfield (COIX) indicates the index where the new coordinates are to be inserted. The first coordinate has the index 1. The number of coordinates to be inserted is given in the Number of Coordinates subfield (NCOR).

2) Delete
   Coordinates must be deleted from the coordinate field(s) of the target record. The deletion must start at the index specified in the COIX subfield. The number of coordinates to be removed is given in the NCOR subfield.
3) Modify
   Coordinates encoded in the coordinate field(s) of the update record must replace the addressed coordinate(s) in the coordinate field(s) of the target record. The replacement must start at the index given in the COIX subfield. The number of coordinates to be replaced is given in the NCOR subfield.
4)

Note that the index and number as given in the COIX and NCOR subfields are regarded to coordinate tuples not to single coordinates.

If several operations are necessary to update the coordinates of one target record each operation shall be encoded in a separate update record. Note that indices always refer to the latest version of the record i.e. if the indices of coordinates have changed by one update record these changes have to be taken into account in every subsequent update record.

All coordinates in an update record must be stored in the same type of Coordinate field that is used in the target record and for 3D-coordinates the must refer to the same Vertical Datum as the coordinates in the target record.

10a-5.6.2 Multi Point record structure

```
Multi Point record
   |
   |--MRID (4): Multi Point Record Identifier field
      |
      |-<0..*>-INAS (*45\\*5): Information Association field
      |
      |-<0..1>-COCC (3): Coordinate Control field
      |
      |alternate coordinate representations
      |
      *-<0..*>-C2DI (*2): 2-D Integer Coordinate field
      |
      *-<0..*>-C3DI (1\\*3): 3-D Integer Coordinate field
      |
      *-<0..*>-C2DF (*2): 2-D Floating Point Coordinate field
      |
      *-<0..*>-C3DF (1\\*3): 3-D Floating Point Coordinate field
```

10a-5.6.2.1 Multi Point Record Identifier field structure

Field Tag: **MRID**	Field Name: Multi Point Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{115} - Multi Point
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Record version	RVER	b12	RVER contains the serial number of the record edition
Record update instruction	RUIN	b11	{1} - Insert {2} - Delete {3} - Modify

Data Descriptive Field

```
1100;&□□□Multi□Point□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b1
1)▼
```

10a-5.7 Curve record

10a-5.7.1 Encoding rules

A Curve is a one-dimensional spatial object. It consists of one or more segments which define the geometry of the curve. All segments of one curve define one contiguous path. The geometry of a segment is given by a set of control points (coordinates) and an interpolation method. As with any other spatial object, curves can have attributes and associations to information types. A curve can have associations to points which define the topological boundaries (the ends) of the curve. Those points must be coincident with the start of the first segment or with the end of the latest segment respectively. The association with such points will be encoded by means of the Point Association field (PTAS).

For each segment, one Segment Header field (SEGH) has to be encoded followed by the Coordinate Control field (update records only) and Coordinate fields.

Control points of a segment will be stored by one type of coordinate field. A coordinate field can be repeated and can carry multiple coordinate tuples. If multiple coordinate fields are used they must be all of the same type. If 3D-coordinates are used for the Segment they must all refer to the same Vertical Datum.

For the Point Association field no special update instruction is needed. The association defined in the update record will replace the respective association in the target record.

For segments the order is important and must be maintained during the update. Therefore a special control field for segments will be used during update. The order of segments in a curve is defined by the sequence of Segment Header fields in the record. To update this sequence the Segment Control field (SECC) is used.

Three instructions can be defined in the SEUI subfield:

1) Insert
   Segments of the update record has to be inserted into the target record. The SEIX subfield specifies the index (position) where the segments are to be inserted. The subfield NSEG subfield gives the number of segments to be inserted.
2) Delete
   Segments must be deleted from the target record. The subfields SEIX and NSEG specify where and how many segments are to be deleted.
3) Modify
   Segments of the target record must be modified according to the encoded instructions in the update record. Each segment that is to be modified must have at a Segment Header filed, a Coordinate Control field and if necessary the appropriate Coordinate fields. The SEIX subfield indicates the first segment to be modified and the NSEG subfield gives the number of segments to be modified. All segments to be modified with one update record must be contiguous in the target record. Otherwise more than one update record has to be used.

When the coordinates of the control points of a segment are to be modified, this has to be done by means of the Coordinate Control field. It defines which coordinates in the target record will be updated. Three kinds of updates are possible and are defined by the Coordinate Update Instruction subfield (COUI):

1) Insert
   Coordinates encoded at the coordinate field(s) of the update records segment must be inserted in the coordinate field(s) of the corresponding target records segment. The Coordinate Index subfield (COIX) indicates the index where the new coordinates are inserted. The first coordinate has the index 1. The number of coordinates to be inserted is given in the Number of Coordinates subfield (NCOR).
2) Delete
   Coordinates must be deleted from the coordinate field(s) of the corresponding target records segment. The deletion must start at the index specified in the COIX subfield. The number of coordinates to be removed is given in the NCOR subfield.
3) Modify
   Coordinates encoded in the coordinate field(s) of the update records segment must be replace the addressed coordinate(s) in the coordinate field(s) of the corresponding target records segment. The replacement must start at the index given in the COIX subfield. The number of coordinates to be replaced is given in the NCOR subfield.
4)

Note that the index and number as given in the COIX and NCOR subfields refer to coordinate tuples not to single coordinates.

All coordinates in an update record must be stored in the same type of Coordinate field that is used in the target record and for 3D-coordinates the must refer to the same Vertical Datum as the coordinates in the target record.

10a-5.7.2 Curve record structure

```
Curve record
  |
  |--CRID (4): Curve Record Identifier field
     |
     |-<0..*>-INAS (*45\\*5): Information Association field
     |
     |-<0..1>-PTAS (*3): Point Association field
     |
     |-<0..1>-SECC (3): Segment Control field
     |
     |-<0..*>-SEGH (1): Segment Header field
        |
        |-<0..1>-COCC (3): Coordinate Control Field
        |
        |alternate coordinate representations
        |
        *-<0..*>-C2DI (*2): 2-D Integer Coordinate field
        |
        *-<0..*>-C3DI (1\\*3): 3-D Integer Coordinate field
        |
        *-<0..*>-C2DF (*2): 2-D Floating Point Coordinate field
        |
        *-<0..*>-C3DF (1\\*3): 3-D Floating Point Coordinate field
```

10a-5.7.2.1 Curve Record Identifier field structure

Field Tag: **CRID**	Field Name: Curve Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{120} - Curve
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Record version	RVER	b12	RVER contains the serial number of the record edition
Record update instruction	RUIN	b11	{1} - Insert {2} - Delete {3} - Modify

Data Descriptive Field

```
1100;&□□□Curve□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b11)▼
```

10a-5.7.2.2 Point Association field structure

Field Tag: **PTAS**	Field Name: Point Association

Subfield name	Label	Format	Subfield content and specification
Referenced Record name	*RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Topology indicator	TOPI	b11	{1} - Beginning point {2} - End point {3} - Beginning & End point

Data Descriptive Field

```
2100;&□□□Point□Association▲*RRNM!RRID!TOPI▲(b11,b14,b11)▼
```

10a-5.7.2.3 Segment Control field structure

Field Tag: **SECC** [Upd	Field Name: Segment Control

Subfield name	Label	Format	Subfield content and specification
Segment update instruction	SEUI	b11	{1} - Insert {2} - Delete {3} - Modify
Segment index	SEIX	b12	Index (position) of the addressed segment in the target record
Number of segments	NSEG	b12	Number of segments in the update record

Data Descriptive Field

```
1100;&□□□Segment□Control▲SEUI!SEIX!NSEG▲(b11,2b12)▼
```

10a-5.7.2.4 Segment Header field structure

Field Tag: **SEGH**	Field Name: Segment Header

Subfield name	Label	Format	Subfield content and specification
Interpolation	INTP	b11	{1} - Linear {2} - Arc3Points {3} - Geodesic {4} - Loxodromic

Data Descriptive Field

```
1100;&□□□Segment□Header▲INTP▲(b11)▼
```

10a-5.8 Composite Curve record

10a-5.8.1 Encoding rules

Composite Curves are one-dimensional spatial objects that are composed of other curves. A composite curve itself is a contiguous path, i.e. the end of one component must be coincident with the start of the next component. Components are curves, although the direction in which they are used may be opposite to the direction in which the curve is defined originally. Which direction is used will be encoded in the ORNT subfield of the Curve Component field (CUCO).

The topological boundaries are not encoded explicitly. The beginning node is taken from the first component and the end node is taken from the last component. Which boundary is taken depends on the ORNT subfield.

Attributes and associations to information types can be encoded as for all other spatial objects.

Composite curves can have other composite curves as components. In this case the record of the component must be stored prior to the record which references the component.

Since the order of components is essential for the definition of the composite curve it must be maintained during an update. Therefore a special control field is used to update the sequence of components. This field contains an update instruction subfield (CCUI) that can have three values:

1) Insert:
   The components of the update record must be inserted in the sequence of components defined in the target record. The CCIX will define the index (position) where the components are to be inserted. The first component has the index 1. The NCCO subfield gives the number of components in the update record. The new components must be added to the dataset before references to them can be inserted into the composite curve.
2) Delete:
   Components must be deleted from the target record. The CCIX subfield will specify the index (position) of the first components to be deleted, The NCCO subfield gives the number of components to be deleted. Note that the component is only deleted from the sequence of components of the composite curve not from the data set.
3) Modify:
   The components in the target record will be replaced by the components in the update record. The first component to be replaced is given by the subfield CCIX, the number of components to be replaced is specified by the subfield NCCO. New components must be added to the dataset before references to them can be applied to the composite curve.

If more than one instruction is necessary to update the sequence of components multiple update records have to be encoded. Note that indices always refer to the latest version of the record i.e. if the indices of components have changed by one update record these changes have to be taken into account in every subsequent update record.

10a-5.8.2 Composite Curve record structure

```
Composite Curve record
   |
   |--CCID (4): Composite Curve Record Identifier field
     |
     |-<0..*>-INAS (5\\*45): Information Association field
     |
     |-<0..1>-CCOC (3): Curve Component Control field
     |
     |-<0..*>-CUCO (*3): Curve Component field
```

10a-5.8.2.1 Composite Curve Record Identifier field structure

Field Tag: **CCID**	Field Name: Composite Curve Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{125} - Composite Curve
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Record version	RVER	b12	RVER contains the serial number of the record edition
Record update instruction	RUIN	b11	{1} - Insert {2} - Delete {3} - Modify

Data Descriptive Field

```
1100;&□□□Composite□Curve□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b1
2,b11)▼
```

10a-5.8.2.2 Curve Component Control field structure

Field Tag: **CRPC** [Upd]	Field Name: Curve Component Control

Subfield name	Label	Format	Subfield content and specification
Curve Component update instruction	CCUI	b11	{1} - Insert {2} - Delete {3} - Modify
Curve Component index	CCIX	b12	Index (position) of the addressed Curve record pointer within the CRPT field(s) of the target record
Number of Curve Components	NCCO	b12	Number of Curve record pointer in the CRPT field(s) of the update record

Data Descriptive Field

```
1100;&□□□Curve□Component□Control▲CCUI!CCIX!NCCO▲(b11,2b12)▼
```

10a-5.8.2.3 Curve Component field structure

Field Tag: **CUCO**	Field Name: Curve Component

Subfield name	Label	Format	Subfield content and specification
Referenced Record name	*RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Orientation	ORNT	b11	{1} - Forward {2} - Reverse

Data Descriptive Field

```
2100;&□□□Curve□Component▲*RRNM!RRID!ORNT▲(b11,b14,b11)▼
```

10a-5.9 Surface Record

10a-5.9.1 Encoding rules

A surface is a two-dimensional spatial object. It is defined by its boundaries. Each boundary is a closed curve. Closed means that the start and the end point of that curve are coincident. A surface has exactly one exterior boundary and can have zero or more interior boundaries (holes in the surface).

All interior boundaries must be completely inside the exterior boundary and no interior boundary must be inside another interior boundary. Boundaries must not intersect but a tangential touch is allowed. Those boundaries, also called rings, are encoded with the Ring Association field. Each ring will be encoded by a reference to a curve record (RRNM and RRID), the orientation (ORNT) in which the curve is used and the indication whether this ring is exterior or interior (USAG). In Addition each ring is encoded with an update instruction (RAUI). Since the order how the ring associations are encoded is arbitrary there is no special update field to add or remove rings from a surface definition. This will be made with the Ring Association field and the appropriate Ring Association Update Instruction (RAUI) subfield.

10a-5.9.2 Surface Record structure

```
Surface record
   |
   |--SRID (4): Surface Record Identifier field
      |
      |-<0..*>-INAS (5\\*45): Information Association field
      |
      |-<1..*>-RIAS (*5): Ring Association field
```

10a-5.9.2.1 Surface Record Identifier field structure

Field Tag: **SRID**	Field Name: Surface Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{130} - Surface
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Record version	RVER	b12	RVER contains the serial number of the record edition
Record update instruction	RUIN	b11	{1} - Insert {2} - Delete {3} - Modify

Data Descriptive Field

```
1100;&□□□Surface□Record□Identifier▲RCNM!RCID!RVER!RUIN▲(b11,b14,b12,b11)▼
```

10a-5.9.2.2 Ring Association field structure

Field Tag: **RIAS**	Field Name: Ring Association

Subfield name	Label	Format	Subfield content and specification
Referenced Record name	*RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Orientation	ORNT	b11	{1} - Forward {2} - Reverse
Usage indicator	USAG	b11	{1} - Exterior {2} - Interior
Ring Association update instruction	RAUI	b11	{1} - Insert {2} - Delete

Data Descriptive Field

```
2100;&□□□Ring□Association▲RRNM!RRID!ORNT!USAG!RAUI▲(b11,b14,3b11)▼
```

10a-5.10 Feature Type record

10a-5.10.1 Encoding rules

An instance of a feature type is implemented in the data structure as a feature record. Feature types are listed in the feature catalogue of the data product. For each feature type the feature catalogue defines permissible attributes and associations. The feature catalogue defines also the two roles for each feature to feature association.

An S-100 compliant feature catalogue identifies 5 categories of feature types:

1) Meta feature
2) Cartographic feature
3) Geographic feature
4) Aggregated feature
5) Theme feature

Each category is implemented in the structure as a feature record and encoded in the same manner.

In the FRID field the code of the feature type is encoded. It must be a valid type from the feature catalogue of the data product. Note that for products using this encoding the feature catalogue must provide a 16-bit integer code.

The FOID field encodes a unique identifier for the instance of a feature type. Instances that are split into separate parts can have the same Feature Object Identifier indicating that this is the same feature object. This is possible for parts in the same data set but also for feature objects in different data sets. The latter case allows to identify parts of the same feature object in adjacent data sets or to determine identical feature objects in different scale bands.

The Feature Object Identifier is only used for implicit relationships not for referencing records directly. That is always done by the combination of the Referenced Record Name (RRNM) and Referenced Record Identifier (RRID).

Feature types are characterised by attributes and can have additional information associated by means of information types. Attributes are encoded by the Attribute field (ATTR) whereas the Information Association field is used for encoding the associations to information types.

The location of a feature object is defined by spatial objects. The association to these spatial objects is encoded with the Spatial Association field. It consists of a reference to the spatial object, an orientation flag, and two values which specifies the scale range for depicting the feature with the referenced geometry. The orientation flag is only necessary if the direction (of a curve) is meaningful for the feature object (e.g. a one-way street).

Feature types can have associations to other feature types. These associations including their roles are defined in the feature catalogue and must be encoded in the Feature Association field. Each relationship to another feature object is defined by:

1) The reference to the other feature object
2) The association used for the relationship (Given by the code from the Feature catalogue)
3) The code of the role used within the association. Each association between the objects A and B has two roles, one for the relationship from A to B and one from the relationship from B to A.
   E.g. the association 'Aggregation' has the roles: 'Consists of' and 'Is part of'.

Note that only one direction of the relationship has to be encoded explicitly, the other direction is always implicit. E.g. an aggregation object has encoded the relationships to its parts but there is no explicit encoding for the relationships from the parts to the aggregation object. For each association a separate field has to be used. The association itself can have attributes. The attributes are encoded in the field by the same mechanism as described for the ATTR field. The same subfileds are used at the end of the association field

Theme objects are a special kind of aggregation objects. They do not define an object itself, but group other objects together. The reasons for the grouping are mostly thematic; other reasons are possible. Each feature object may belong to more than one theme. Themes are therefore not mutually exclusive. Since the kind of association from a theme object to its members (and vice versa) is not variable, the encoding of this type of association is different from the other feature associations. A separate field, the Theme Association field is used. The association is always encoded from the feature object that belongs to the theme to the theme object itself.

If parts of the geometry are intended not to be used for the depiction of a feature object these spatial objects can be specified in the Masked field. Note that spatial objects may not to be used directly by the feature object. E.g. If a feature object is defined by a surface only, a curve that forms a part of the surface boundary can be masked.

The MASK field consists of a reference to a record and an update instruction.

Note: When updating associations to other records, the other records must already exist in the target (base data or added by the appropriate update record).

10a-5.11 Feature Type record structure

```
Feature Type record
   |
   |--FRID (5): Feature Type Record Identifier field
      |
      |-<0..1>-FOID (3): Feature Object Identifier field
      |
      |-<0..*>-ATTR (*5): Attribute field
      |
      |-<0..*>-INAS (5\\*45): Information Association field
      |
      |-<0..*>-SPAS (*6): Spatial Association field
      |
      |-<0..*>-FEAS (5\\*5): Feature Association field
      |
      |-<0..*>-THAS (*3): Theme Association field
      |
      |-<0..*>-MASK (*4): Masked Spatial Type field
```

10a-5.11.1 Feature Type Record Identifier field structure

Field Tag: **FRID**	Field Name: Feature Type Record Identifier

Subfield name	Label	Format	Subfield content and specification
Record name	RCNM	b11	{100} - Feature type
Record identification number	RCID	b14	Range: 1 to 2^{32}-2
Object code	OBJC	b12	A valid object code
Record version	RVER	b12	RVER contains the serial number of the record edition
Record update instruction	RUIN	b11	{1} - Insert {2} - Delete {3} - Modify

Data Descriptive Field

```
1100;&□□□Feature□Type□Record□Identifier▲RCNM!RCID!OBJC!RVER!RUIN▲(b11,b14,
2b12,b11)▼
```

10a-5.11.2 Feature Object Identifier field structure

Field Tag: **FOID**	Field Name: Feature Object Identifier

Subfield name	Label	Format	Subfield content and specification
Producing agency	AGEN	b12	Agency code
Feature identification number	FIDN	b14	Range: 1 to 2^{32}-2
Feature identification subdivision	FIDS	b12	Range: 1 to 2^{16}-2

Data Descriptive Field

```
1100;&□□□Feature□Object□Identifier▲AGEN!FIDN!FIDS▲(b12,b14,b12)▼
```

10a-5.11.3 Spatial Association field structure

Field Tag: **SPAS**	Field Name: Spatial Association

Subfield name	Label	Format	Subfield content and specification

Referenced Record name	*RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Orientation	ORNT	b11	{1} Forward {2} Reverse {255} NULL (Not Applicable)
Scale Minimum	SMIN	b14	Denominator of the largest scale for which the feature type can be depicted by the referenced spatial object. If the value is 0 it does not apply.
Scale Maximum	SMAX	b14	Denominator of the smallest scale for which the feature type can be depicted by the referenced spatial object. If the value is 2^{32}-1 it does not apply.
Spatial Association Update Instruction	SAUI	b11	{1} - Insert {2} - Delete

Data Descriptive Field

2100;&□□□Spatial□Association▲*RRNM!RRID!ORNT!SMIN!SMAX!SAUI!▲(b11,b14,b11,2b14,b11)▼

10a-5.11.4 Feature Association field

Field Tag: **FEAS**	Field Name: Feature Association

Subfield name	Label	Format	Subfield content and specification
Referenced Record name	~~*~~RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Association Code	~~ASCD~~FASS	b12	A valid code for the association
Role Code	~~RLCD~~ROLE	b12	A valid code for the role
Feature Association Update Instruction	FAUI	b11	{1} - Insert {2} ~~-~~ - Delete {3} - Modify
Attribute label/code	*ATLB	b12	A valid attribute code
Attribute index	ATIX	b12	Index (position) of the attribute in the sequence of attributes with the same code and the same parent (starting with 1).
Parent index	PAIX	b12	Index (position) of the parent complex attribute within this ATTR field (starting with 1). If the attribute has no parent (top level attribute) the value is 0.
Attribute Instruction	ATIN	b11	{1} - Insert {2} - Delete {3} - Modify
Attribute value	ATVL	A()	A string containing a valid value for the domain of the attribute specified by the subfields above.

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Data Descriptive Field

~~2100~~3600~~;&□□□~~;&%/GFeature□Association▲~~*~~RRNM!RRID!~~ASCD~~FASS!~~RLCD~~ROLE!APUI*ATLB!ATIX!PAIX!ATIN!ATVL ▲(b11,b14,2b12,b11,3b12,b11,A)▼

10a-5.11.5 Theme Association field

Field Tag: **THAS**	Field Name: Theme Association

Subfield name	Label	Format	Subfield content and specification
Referenced Record name	*RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Theme Association Update Instruction	TAUI	b11	{1} - Insert {2} - Delete

Data Descriptive Field

```
2100;&□□□Theme□Association▲*RRNM!RRID!TAUI▲(b11,b14,b11)▼
```

10a-5.11.6 Masked Spatial Type field structure

Field Tag: **MASK**	Field Name: Masked Spatial Type

Subfield name	Label	Format	Subfield content and specification
Referenced Record name	*RRNM	b11	Record name of the referenced record
Referenced Record identifier	RRID	b14	Record identifier of the referenced record
Mask Indicator	MIND	b11	{1} – Truncated by the dataset limit {2} – Supress portrayal
Mask Update Instruction	MUIN	b11	{1} - Insert {2} - Delete

Data Descriptive Field

```
2100;&□□□Masked□Spatial□Record▲*RRNM!RRID!MIND!MUIN▲(b11,b14,2b11)▼
```