S-100 – Part 10a

ISO/IEC 8211 Encoding

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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

The following referenced documents are required for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including amendments) applies.

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

10a-4 Structural Implementations

10a-4.1 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-4.2 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-4.3 Tree structure diagrams

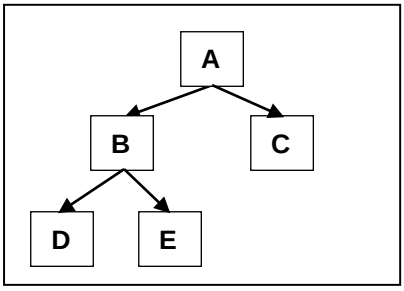

Figure 10a-1

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. For example node B is the offspring of node A.

The tree structure diagrams must be interpreted in a pre-ordered 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 columns (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. 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-4.4 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**	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: YYYMMDD 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

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-4.5 Data formats

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

Format	Data Type	Omitted values	Remark
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 (number of character) A() indicates a sub field of variable length which must be terminated by the unit delimiter (UT). The encoding of Character Data within this standard must be UTF8 implementation level 1 The appropriate Escape Sequence is: (2/5) (2/15) (4/7) "%/G"
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-4.6 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-4.7 Order of records

The order of records will enable the import software to check that a referenced record exists each time it is referenced.

Exists means either:

- The record is inserted in this data set file prior to the record that reference it; or
- It is inserted by the base data set file or an earlier update file and not deleted between the insertion and the record that reference it.

In addition, when a record is going to be deleted it must not be referenced by any other record.

The record order is:

1. Data Set General Information record
2. Data Set Coordinate Reference System record
3. Information Type records (RUIN=Insert) (for the order inside this group see the encoding rules for Information Type records)
4. Point records (RUIN=Insert)
5. Multi Point records (RUIN=Insert)
6. Curve records (RUIN=Insert)
7. Composite Curve records (RUIN=Insert) (for the order inside this group see the encoding rules for Composite Curve records)
8. Surface records (RUIN=Insert)
9. Feature Type records (RUIN=Insert) (for the order inside this group see the encoding rules for Feature Type records)
10. Information Type records (RUIN=Modify)
11. Point records (RUIN=Modify)
12. Multi Point records (RUIN=Modify)
13. Curve records (RUIN=Modify)
14. Composite Curve records (RUIN=Modify)
15. Surface records (RUIN=Modify)
16. Feature Type records (RUIN=Modify)
17. Feature Type records (RUIN=Delete) (reverse order as for Insert)
18. Surface records (RUIN=Delete)
19. Composite Curve records (RUIN=Delete) (reverse order as for Insert)
20. Curve records (RUIN= Delete)
21. Multi Point records (RUIN= Delete)
22. Point records (RUIN= Delete)
23. Information Type records (RUIN= Delete) (reverse order as for Insert)

Note that Product Specifications can omit entries they don't use but not change the order. They might further define a more specific order within each group if the general rule regarding references is not broken.

If several records for the modification of one record are required in one dataset, they must be using increasing record version numbers and the order must be according to these numbers.

10a-4.8 ISO/IEC 8211 file structure

10a-4.8.1 General structure

This clause does not replace ISO/IEC 8211, nor does it give a comprehensive overview of ISO/IEC 8211. The reader is referred to ISO/IEC 8211:1994 for a complete description and explanation.

The clause will give a short overview of ISO/IEC 8211 by explaining those parts of the encapsulation structure which are of relevance to S-100.

ISO/IEC 8211 files are organized by Logical Records (LR), the first record is the Data Descriptive Record (DDR) and all subsequent records are Data Records (DR).

The DDR contains information on the hierarchy and structure of the remaining part of the file. It does not define the semantic of the data.

Each Logical Record (both DDR and DR) contains three basic elements:

- Leader

- Directory
- Field Area

10a-4.8.2 The Leader

The Leader of a Logical Record contains the parameters necessary to read records and to disaggregate the directory into its entries. In addition, the DDR Leader contains a few data descriptive parameters applicable to the entire file. It has a fixed length of 24 bytes.

The first five bytes in any Leader will contain the length of the complete Record in bytes encoded as a decimal number in ASCII representation (for example, a Record of 242 bytes will have a record length entry of “00242”). If a Record has a size of 100000 bytes or larger then the value must be set to “00000”. In this case the software must be able to calculate the Record size from the information in the directory.

10a-4.8.2.1 The DDR Leader

The structure of the DDR Leader:

RP	Len	Entry name	Content
0	5	Record length	Number of bytes in the Record
5	1	Interchange level	"3"
6	1	Leader identifier	"L"
7	1	In line code extension indicator	"E"
8	1	Version number	"1"
9	1	Application indicator	SPACE
10	2	Field control length	"09"
12	5	Base address of Field Area	Start address of Field Area (number of bytes in the Leader and Directory)
17	3	Extended character set indicator	" ! " (SPACE,!,SPACE)
20	4	Entry map	(See below)

The entry map of the DDR Leader:

RP	Sub-entry name	Length	Content
20	Size of field length field	1	Variable "1"-"9" (defined by encoder)
21	Size of field position field	1	Variable "1"-"9" (defined by encoder)
22	Reserved	1	"0"
23	Size of field tag field	1	"4"

10a-4.8.2.2 The DR Leader

The structure of the DR Leader:

RP	Len	Entry name	Content
0	5	Record length	number of bytes in the Record
5	1	Interchange level	SPACE
6	1	Leader identifier	"D"
7	1	In line code extension indicator	SPACE
8	1	Version number	SPACE
9	1	Application indicator	SPACE
10	2	Field control length	2 SPACEs
12	5	Base address of Field Area	Start address of Field Area (number of bytes in the Leader and Directory)

17	3	Extended character set indicator	3 SPACEs
20	4	Entry map	(See below)

The entry map of the DR Leader:

RP	Sub-entry name	Length	Content
20	Size of field length field	1	Variable "1"-"9" (defined by the encoder)
21	Size of field position field	1	Variable "1"-"9" (defined by the encoder)
22	Reserved	1	"0"
23	Size of field tag field	1	"4"

10a-4.8.3 The Directory

The Directory of a Logical Record contains the parameters necessary to identify and locate each field in the Field Area. The Directory consists of repeated Directory entries containing the:

- field tag;
- field length; and
- field position.

The Directory ends with the field terminator (1/14). The field positions are relative to the beginning of the Field Area. The position of the first field following the Directory is 0. The number of bytes used for the three elements (the field entry) is defined by the entry map in the Leader of the Logical Record.

10a-4.8.4 The Field Area

The Field Area is different for the DDR and DR. In the first Record only, the DDR, the Field Area contains data descriptive fields. Each data descriptive field contains information necessary to decode the user data in the Field Area of the DR('s). The fact that the data description is contained in the interchange file makes it possible to exchange data without an external description, though the semantic of the elements is not known. The S-100 Standard and the Product Specifications that use an ISO/IEC 8211 data encoding does contain an external data description used for the exchange of the data. However, the data descriptive fields can only be omitted from the DDR if they are not used in the current file; not because of the existence of an external data description. The data descriptive fields of the DDR form an integral part of an ISO/IEC 8211 conforming file.

The limitation to the used fields is a minimum requirement and other fields may be defined by data descriptive fields in the DDR. However, this adds unnecessary data to the data set and should be avoided.

The Field Area of the DR contains the actual data to be transferred.

10a-4.8.4.1 The Field Area of the DDR

a. Field control field

The first field of the DDR is the field control field. The field tag for the field control field is "0000". The field control field contains a list of field tag pairs. The list defines the hierarchy of all the fields described in the DDR. The list contains pairs of partent/child tags and together with the preorder traversal sequence of the field descriptions in the DDR describes a generic tree structure for the exchange file. The pairs may be placed in the list in any sequence and must be contiguous. The following Figure gives an example of a tree. The set of field tag pairs is HE, EA, EB, HF, HG, GC and GD.

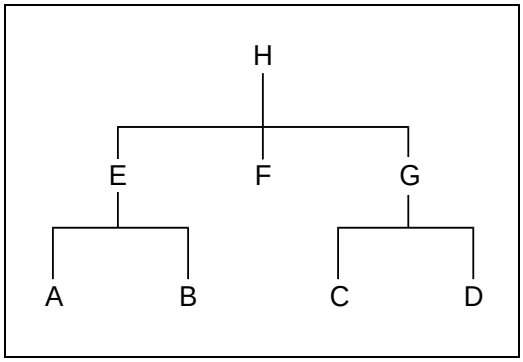

Figure 10a-2

The structure of the field control field is as follows:

Field controls	External file title (Optional for S-100)	UT	List of field tag pairs	FT

The field controls of the field control field are : "0000;&" + 3 SPACEs.

b. Data descriptive fields

The successive fields of the field area contain the data descriptive fields. The data descriptive fields are encoded in the DDR in a preorder traversal sequence. The preorder traversal sequence of the tree shown above is HEABFGCD.

The structure of a data descriptive field is as follows:

Field controls	Field name	UT	Array descriptor	UT	Format controls	FT

The field controls describe the level and data type of the data fields defined by the data descriptive fields. The structure of the field controls is shown in the following Table.

RP	Len	Entry name	Content
0	1	Data structure code	"1" – linear structure "2" – multi-dimensional structure "3" – concatenated structure
1	1	Data type code	"1" – implicit point (integer) "2" – implicit point (float) "6" – mixed data types
2	2	Auxiliary controls	"00"
4	2	Printable graphics	";&"
6	3	Truncated escape sequence	" " (3 SPACEs) – ASCII Encoding ISO 646 "%/G" – UTF8 Encoding implementation level 1

The field name contains the long description of the data fields as defined in the tree structures given in this Part of S-100. The Array descriptor and Format controls define the inner field structure for the associated data fields. Refer to ISO/IEC 8211 for a complete description.

10a-4.8.4.2 The Field Area of the DR's

The data fields in the DR's must be encoded in the preorder traversal sequence as defined in the DDR. The structure of the data fields is defined by the data descriptive fields in the DDR.

10a-4.8.5 An example

The following rather simple example shows an S-100 conformal ISO/IEC 8211 conformal dataset file.

It contains a single feature type (*BuoySafeWater*) with the following attribute set:

Attribute Code	Value	Remarks
buoyShape	“4”	Pillar
colour[1]	“3”	Red
colour[2]	“1”	White
colourPattern	“3”	Diagonal Stripes
featureName[1].language	“eng”	English
featureName[1].name	“Example buoy”	
featureName[2].language	“deu”	German
featureName[2].name	“Beispiel Tonne”	

The Feature Object Id is:

Sub-Field	Integer value	Hexadecimal representation
Producing agency	31868	7C7C
Feature identification number	12345678	00BC614E
Feature identification subdivision	42	002A

The position is:

	Geo position	Integer value	Hexadecimal representation
Latitude	42.42° N	424200000	1948C740
Longitude	12.1234° W	-121234000	F8C61DB0

The example contains non-printable characters and binary codes. They are replaced with the denotation as defined in the following Table:

Character	Code	Denotation	Remarks
Space	Hex 20	□	
UT (Unit Terminator)	Hex 1F	▲	
FT (Field Terminator)	Hex 1E	▼	
Binary code b11	Hex xx	[xx]	
Binary code b12	Hex xxyy	[xxyy]	Due to the LSBF encoding this is equivalent to [yy][xx]
Binary code b14	Hex wwxxyyzz	[wwxxyyzz]	Due to the LSBF encoding this is equivalent to [zz][yy][xx][ww]
Binary code b24	Hex wwxxyyzz	[wwxxyyzz]	For negative numbers the two complement is encoded LSBF
Binary code b48	x.y	[x.y]	Encoded as defined by the IEEE 754 double precision encoding LSBF

DDR Leader

```
011803LE1□0900155□!□3304
```

DDR Directory

```
0000090000DSID132090DSSI118222ATCS044340FTCS047384CSID084431CRSH095515PRID0
71610C2IT055681FRID084736FOID064820ATTR058884SPAS083942▼
```

DDR Field Area

```
0000;&□□□S100Example.000▲DSIDDSSIDSIDATCSDSIDFTCSCSIDCRSHPRIDC2ITFRIDFOIDFR
IDATTRFRIDSPAS▼
```

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

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

2600;&□□□Attribute□Codes▲*ATCD!ANCD▲(A,b12)▼

2600;&□□□Feature□Type□Codes▲*FTCD!FTNC▲(A,b12)▼

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

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

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

1100;&□□□2-D□Integer□Coordinate□Tuple▲YCOO!XCOO▲(2b24)▼

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

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

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

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

DR 1 Leader (Data Set General Information record)

```
00321□D□□□□□00065□□□3304
```

DR 1 Directory

```
DSID104000DSSI065104ATCS070169FTCS017239▼
```

DR 1 Field Area

```
[0A][00000001]S-100□Part□10a▲5.0▲INT.IHO.S-101.1.1▲1.1▲1▲S100Example.000▲S-
100□Encoding□example▲20221019EN▲▲1▲[0E][12]▼

[0.0][0.0][0.0][00989680][00989680][00000064][00000000][00000001][00000000]
[00000000][00000000][00000000][00000001]▼

buoyShape▲[0001]colour▲[0002]colourPattern▲[0003]featureName▲[0004]language
▲[0005]name▲[0006]▼

BuoySafeWater▲[0001]▼
```

DR 2 Leader (Data Set Coordinate Reference System record)

```
00064□D□□□□□00039□□□2104
```

DR 2 Directory

```
CSID070CRSH187▼
```

DR 2 Field Area

```
[0F][00000001][01]▼

[01][01][01]WGS□84▲4326▲[02]▲▼
```

DR 3 Leader (Point Record)

```
00055□D□□□□□00037□□□1104
```

DR 3 Directory

```
PRID90C2IT99▼
```

DR 3 Field Area

```
[6E][00000001][0001][01]▼

[1948C740][F8C61DB0]▼
```

DR 4 Leader (Feature Type Record)

```
00218□D□□□□□□00065□□□3304
```

DR 4 Directory

```
FRID011000FOID009011ATTR117020SPAS016137▼
```

DR 4 Field Area

```
[64][00000001][0001][0001][01]▼

[7C7C][00BC614E][002A]▼

[0001][0001][0000][01]4▲
[0002][0001][0000][01]3▲
[0002][0002][0000][01]1▲
[0003][0001][0000][01]3▲
[0004][0001][0000][01]▲
[0005][0001][0005][01]eng▲
[0006][0001][0005][01]Example□buoy▲
[0004][0002][0000][01]▲
[0005][0001][0008][01]deu▲
[0006][0001][0008][01]Beispiel□Tonne▲▼

[6E][00000001][FF][FFFFFFFF][00000000][01]▼
```

10a-5 Common Fields

10a-5.1 Attribute field

10a-5.1.1 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.

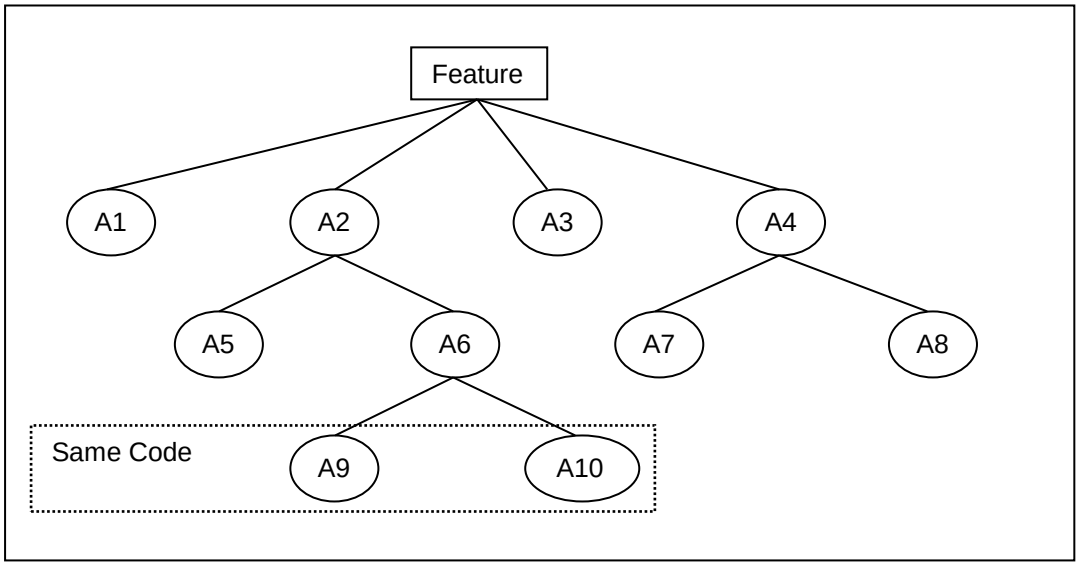

Figure 10a-3

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 – encoded with the sub-field NATC;
2. The index of the attribute (starting with 1) – encoded with the sub-field ATIX;
3. The parent of the attribute – encoded with the sub-field PAIX.

The Parent Index (PAIX) is solely used for defining the tree inside the field only, and there is no need to preserve it in an internal system (for example, System Database) structure.

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	NATC	ATIX	PAIX	ATIN	ATVL	Remark
1	21	1	0	Insert	Vachon	A1
2	22	1	0	Insert		A2 - complex
3	25	1	2	Insert	42.0	A5
4	26	1	2	Insert		A6 - complex
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 - complex
9	27	1	8	Insert	123	A7
10	28	1	8	Insert	Canada	A8

Note that here the pre-order 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 pre-order traversing is defined as follows:

1) Encode the root;

2) Then 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-5.1.2 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 identifiaction of an attribute is defined by the Numeric Attribute Code (NATC) and the Attribute Index (ATIX).

The Attribute Update Instruction indicates whether an attribute is to be deleted from the field; modified, or inserted. Deletion and modification imply 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, thus the ATIX sub-field must use then the corrected value. 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. Note that to identify a node in the attribute tree it is necessary to specify all nodes from the root of the tree. In order to insert the attribute B5 both the nodes A6 and A2 must be encoded before and marked as modified.

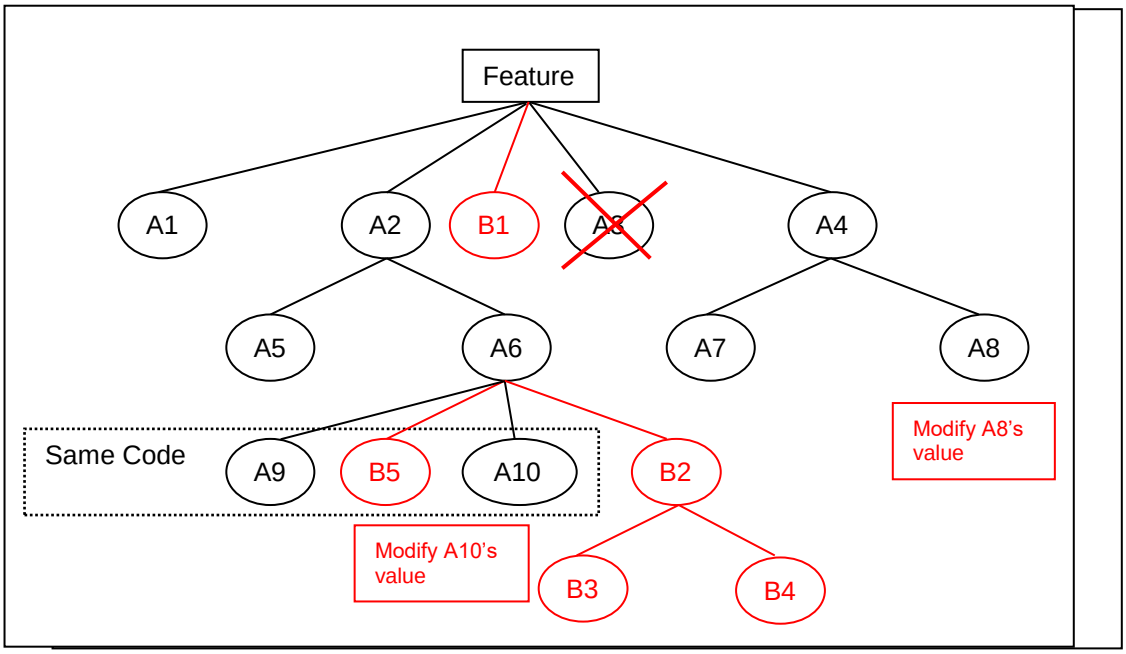

Figure 10a-4

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	12	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	NATC	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 3
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. For example, to delete A2 only one entry (22, 1, 0, Delete) has to be encoded.

10a-5.1.3 Unknown attribute values

An attribute value is unknown whenever the attribute code is present, but the attribute value is missing (encoded as an empty string).

Updating of the attribute field with a missing attribute value:

- Insert - create the attribute with an initial value of unknown.
- Modify - change the attribute value to unknown.
- Delete - delete the attribute (in this case the attribute value should always be encoded as ‘unknown’).

10a-5.1.4 Encoding of attribute values

The following rules must be used to encode attribute values in the ATVL sub-field:

Attribute Type [Value Type]	Format	Remarks	Examples
S100_GF_TextAttributeType [CharacterString]	Any characters that are supported by the encoding (here - UTF8).	Byte order marks are not permitted since the encoding does not require them (UTF8 is not a multi byte encoding).	whiskey водка
S100_GF_IntegerAttribute [Integer]	Signed Integer numbers of arbitrary length. The numbers must be in the decimal system.	Positive numbers should not use the ‘+’ sign. Negative numbers must have a leading ‘-‘ sign. There must be no whitespaces between the sign and the number. There must be no characters other than the digits ‘0’ to ‘9’ in the number. Non-significant zeros are prohibited.	Valid: 42 -1224566 Not Valid: 0012 123,234 - 12
S100_GF_RealAttribute [Real]	Decimal floating-point numbers in the value domain of double precision numbers (IEEE 64-Bits).	The decimal separator is always a point (‘.’) and there must be no thousands separator used. Positive numbers should not use the ‘+’ sign. Negative numbers must have a leading ‘-‘ sign. The exponential form is permitted. Non-significant zeros are prohibited. If there are only zeros to the right of the decimal point the decimal point should be omitted. The values INF, -INF, and NaN are prohibited.	123.456 -42 1E-5 -2.45E7
S100_BooleanAttributeType [Boolean]	1 (true) or 0 (false)		1 0

S100_EnumerationAttributeType [Positive Integer]	Integer numbers > 0 in the decimal system.	Non-significant zeros are prohibited. The '+' sign should not be used.	
S100_DateAttributeType [Date]	CCYYMMDD Complete representation, basic format according to ISO 8601.	Representation with reduced resolution or truncated representations are prohibited.	20211223
S100_TimeAttributeType [Time]	HHmmss Complete representation, basic format according to ISO 8601.	Optionally a time zone can be added. Fractions of a second are permitted but should be omitted if all zero.	173500 183942+Z 201700-0500
S100_DateTimeAttributeType [DateTime]	Combination of date and time representation as above.	The character 'T' must be used as the separator between the date and the time part.	20211223T170000
S100_URIAttributeType [URI]	A URI according to the RFC 3986.	URI must not contain white spaces; and must start with a 'scheme' followed by a ':'.	tel:+1-816-555-1212
S100_URLAttributeType [URL]	A URL according to the RFC 3986.		http://registry.iho.int
S100_URN_AttributeType [URN]	A URN as specified in RFC 2141	'scheme' = urn	urn:mrn:iala:aton:us:1234.5
S100_TruncatedDateAttributeType [S100_TruncatedDate]	A truncated version of a date.	CCYYMMDD All unspecified components are replaced by as many hyphens as the component has characters. Hence, the length of the encoding must be always 8 characters.	------01 ----1224
S100_CodelListAttributeType [CharacterString]	A code list value, represented as a CharacterString.	The URI of the code list dictionary is defined by the Feature Catalogue. See Parts 3 and 5 for more details.	eng

10a-5.1.5 Attribute field structure

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

Subfield name	Label	Format	Subfield content and specification
Numeric attribute code	*NATC	b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
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▲*NATC!ATIX!PAIX!ATIN!ATVL▲(3b12,b11,A)▼
```

10a-5.2 Information Association field

10a-5.2.1 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 subfields are used at the end of the association field. Each association is uniquely addressed by the combination of the RRNM, 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-5.2.2 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
Numeric Information Association Code	NIAC	b12	A valid code for the information association as defined in the IACS field of the Dataset General Information Record
Numeric Association Role code	NARC	b12	A valid code for the role as defined in the ARCS field of the Dataset General Information Record
Information Association Update Instruction	IUIN	b11	{1} – Insert {2} – Delete {3} – Modify
Numeric attribute code	*NATC	b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
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 INAS 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

```
3600;&%/GInformation□Association▲RRNM!RRID!NIAC!NARC!IUIN\\*NATC!ATIX!PAIX
!ATIN!ATVL▲(b11,b14,2b12,b11,{3b12,b11,A})▼
```

10a-6 Data Set Descriptive records

10a-6.1 Data Set General Information record

10a-6.1.1 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 19115-1 (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
21	disaster

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.

In an S-100 Feature catalogue all items are uniquely identifiable using the S100_FC_Item code which is a character string. This applies to Attributes, Information Types, Feature Types, Information Associations, Feature Associations and Association roles. In the interest of space and efficiency of the 8211 encoding it is desirable to use numeric identifiers for these items. To support this capability,

the 8211 encoding includes a table for each item type that holds a listing of the S100_FC_Item codes used in the dataset. Each entry in the table carries the item code and the associated numeric code which will be used within the dataset everywhere that item type is referenced. These numeric codes are only guaranteed to be unique within one instance of a dataset. For example a Feature with code Coastline could be recorded in the Feature Type Codes field with a numeric code of 10. Then all the Coastline Features in the dataset would carry the numeric code of 10. In another dataset the numeric code for Coastline could be 15.

10a-6.1.2 Data Set General Information record structure

```
Data Set General Information record
   |
   |--DSID (13\\*1): Data Set Identification field
      |
      |--DSSI (13): Data Set Structure Information field
      |
      |-<0..1>-ATCS (*2): Attribute Codes field
      |
      |-<0..1>-ITCS (*2): Information Type Codes field
      |
      |-<0..1>-FTCS (*2): Feature Type Codes field
      |
      |-<0..1>-IACS (*2): Information Association Codes field
      |
      |-<0..1>-FACS (*2): Feature Association Codes field
      |
      |-<0..1>-ARCS (*2): Association Role Codes field
```

10a-6.1.2.1 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-6.1.2.2 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 dataset
Number of Point records	NOPN	b14	Number of point records in the dataset
Number of Multi Point records	NOMN	b14	Number of multi point records in the dataset
Number of Curve records	NOCN	b14	Number of curve records in the dataset
Number of Composite Curve records	NOXN	b14	Number of composite curve records in the dataset
Number of Surface records	NOSN	b14	Number of surface records in the dataset
Number of Feature Type records	NOFR	b14	Number of feature records in the dataset

Data Descriptive Field

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

10a-6.1.2.3 Attribute Codes field structure

Field Tag: **ATCS**	Field Name: Attribute Codes

Subfield name	Label	Format	Subfield content and specification
Attribute Code	*ATCD	A	The code as defined in the Feature Catalogue
Attribute Numeric Code	ANCD	b12	The code used within the NATC subfield

Data Descriptive Field

```
2600;&□□□Attribute□Codes▲*ATCD!ANCD▲(A,b12)▼
```

10a-6.1.2.4 Information Type Codes field structure

Field Tag: **ITCS**	Field Name: Information Type Codes

Subfield name	Label	Format	Subfield content and specification
Information Type Code	*ITCD	A	The code as defined in the Feature Catalogue
Information Type Numeric Code	ITNC	b12	The code used within the NITC subfield

Data Descriptive Field

```
2600;&□□□Information□Type□Codes▲*ITCD!ITNC▲(A,b12)▼
```

10a-6.1.2.5 Feature Type Codes field structure

Field Tag: **FTCS**	Field Name: Feature Type Codes

Subfield name	Label	Format	Subfield content and specification
Feature Type Code	*FTCD	A	The code as defined in the Feature Catalogue
Feature Type Numeric Code	FTNC	b12	The code used within the NFTC subfield

Data Descriptive Field

```
2600;&□□□Feature□Type□Codes▲*FTCD!FTNC▲(A,b12)▼
```

10a-6.1.2.6 Information Association Codes field structure

Field Tag: **IACS**	Field Name: Information Association Codes

Subfield name	Label	Format	Subfield content and specification
Information Association Code	*IACD	A	The code as defined in the Feature Catalogue
Information Association Numeric Code	IANC	b12	The code used within the NIAC subfield

Data Descriptive Field

```
2600;&□□□Information□Association□Codes▲*IACD!IANC▲(A,b12)▼
```

10a-6.1.2.7 Feature Association Codes field structure

Field Tag: **FACS**	Field Name: Feature Association Codes

Subfield name	Label	Format	Subfield content and specification
Feature Association Code	*FACD	A	The code as defined in the Feature Catalogue
Feature Association Numeric Code	FANC	b12	The code used within the NFAC subfield

Data Descriptive Field

```
2600;&□□□Feature□Association□Codes▲*FACD!FANC▲(A,b12)▼
```

10a-6.1.2.8 Association Role Codes field structure

Field Tag: **ARCS**	Field Name: Association Role Codes

Subfield name	Label	Format	Subfield content and specification
Association Role Code	*ARCD	A	The code as defined in the Feature Catalogue
Association Role Numeric Code	ARNC	b12	The code used within the NARC subfield

Data Descriptive Field

```
2600;&□□□Association□Role□Codes▲*ARCD!ARNC▲(A,b12)▼
```

10a-6.2 Data Set Coordinate Reference System record

10a-6.2.1 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 be 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 be 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 parallel [2])	Latitude of 2nd standard parallel [3])	-	9802
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-6.2.2 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-6.2.2.1 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-6.2.2.2 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!
SCRI▲(3b11,2A,b11,A)▼
```

10a-6.2.2.3 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-6.2.2.4 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-6.2.2.5 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-6.2.2.6 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-7 Object Records

10a-7.1 Information Type record

10a-7.1.1 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 this 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-7.1.2 Information Type record structure

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

10a-7.1.2.1 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
Numeric Information Type Code	NITC	b12	A valid information type code as defined in the ITCS field of the Dataset General Information Record
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!NITC!RVER!RUIN▲(b11,
b14,2b12,b11)▼
```

10a-7.2 Spatial type records

10a-7.2.1 Coordinate fields

10a-7.2.1.1 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-7.2.1.2 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-7.2.1.3 2-D Integer Coordinate Tuple field structure

Field Tag: **C2IT**	Field Name 2-D Integer Coordinate Tuple

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

```
1100;&□□□2-D□Integer□Coordinate□Tuple▲YCOO!XCOO▲(2b24)▼
```

10a-7.2.1.4 3-D Integer Coordinate Tuple field structure

Field Tag: **C3IT**	Field Name: 3-DInteger Coordinate Tuple

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

```
1100;&□□□3-D□Integer□Coordinate□Tuple▲VCID!YCOO!XCOO!ZCOO▲(b11,3b24)▼
```

10a-7.2.1.5 2-D Floating Point Coordinate Tuple field structure

Field Tag: **C2FT**	Field Name 2-D Floating Point Coordinate Tuple

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□Tuple▲YCOO!XCOO▲(2b48)▼
```

10a-7.2.1.6 3-D Floating Point Coordinate Tuple field structure

Field Tag: **C3FT**	Field Name: 3-D Floating Point Coordinate Tuple

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□Tuple▲VCID!YCOO!XCOO!ZCOO▲(b11,3b48)▼
```

10a-7.2.1.7 2-D Integer Coordinate List field structure

Field Tag: **C2IL**	Field Name 2-D Integer Coordinate List

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□List▲*YCOO!XCOO▲(2b24)▼
```

10a-7.2.1.8 3-D Integer Coordinate List field structure

Field Tag: **C3IL**	Field Name: 3-DInteger Coordinate List

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□List▲VCID\\*YCOO!XCOO!ZCOO▲(b11,{3b24})▼
```

10a-7.2.1.9 2-D Floating Point Coordinate List field structure

Field Tag: **C2FL**	Field Name 2-D Floating Point Coordinate List

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□List▲*YCOO!XCOO▲(2b48)▼
```

10a-7.2.1.10 3-D Floating Point Coordinate List field structure

Field Tag: **C3FL**	Field Name: 3-D Floating Point Coordinate List

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□Coordinate□List▲VCID\\*YCOO!XCOO!ZCOO▲(b11,{3b24})▼
```

10a-7.2.1.11 Knots

Knots are parameters used in spline curves to control the shape of the curve. Each knot defines a value in parameter space of the spline, which will be used to define the spline basis functions. The knot data type holds information on knot multiplicity. The parameter values in the knot array must be monotonic and strictly increasing; that is, each value must be greater than its predecessor.

Field Tag: **KNOT**	Field Name Knots

Subfield name	Label	Format	Subfield content and specification
Knot multiplicity	*KMUL	b11	The multiplicity of the knot
Knot value	KVAL	b48	The value of the knot

Data Descriptive Field

```
1600;&□□□Knot▲KMUL!KVAL▲(b11,b48)▼
```

10a-7.2.1.12 Derivatives

The derivatives field encodes the derivatives of a curve at a point. Any missing values must be encoded as ‘omitted’ values (see clause 10a-3.5). Derivatives are encoded in order beginning with the first-order derivative.

The derivatives are given in terms of their X and Y components. In this edition of S-100 derivatives are defined only in 2-D because splines are only in 2-D.

The derivatives are defined in floating-point and integer formats to be used with the corresponding types of coordinate fields.

Field Tag: **DRVF**	Field Name 2-D Derivative List Float

Subfield name	Label	Format	Subfield content and specification
Y component of point at which defined	YCOO	b48	The Y component of the point at which the derivatives are defined
X component of point at which defined	XCOO	b48	The X component of the point at which the derivatives are defined
Highest order of derivative	DRVO	b11	The highest order derivative in the list
Y offset	*YDRV	b48	The Y component of the n'th derivative.
X offset	XDRV	b48	The X component of the n'th derivative.

Data Descriptive Field

```
3600;&□□□2-D□Derivative□List□Float▲YCOO!XCOO!DRVO!\\*YDRV!XDRV▲(2b48,b11,2
b48)▼
```

Field Tag: **DRVI**	Field Name 2-D Derivative List Integer

Subfield name	Label	Format	Subfield content and specification
Y component of point at which defined	YCOO	b24	The Y coordinate of the point at which the derivatives are defined
X component of point at which defined	XCOO	b24	The X coordinate of the point at which the derivatives are defined
Highest order of derivative	DRVO	b11	The highest order derivative in the list
Y component of derivative	*YDRV	b24	The Y component of the n'th derivative.
X component of derivative	XDRV	b24	The X component of the n'th derivative.

Data Descriptive Field

```
3600;&□□□2-D□Derivative□List□Integer▲YCOO!XCOO!DRVO!\\*YDRV!XDRV▲(2b24,b11
,2b24)▼
```

10a-7.2.2 Point record

10a-7.2.2.1 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.

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'.

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-7.2.2.2 Point record structure

```
Point record
   |
   |--PRID (4): Point Record Identifier field
      |
      |-<0..*>-INAS (5\\*5): Information Association field
```

```
|
|alternate coordinate representations
|
*--C2IT (2): 2-D Integer Coordinate Tuple field
|
*--C3IT (4): 3-D Integer Coordinate Tuple field
|
*--C2FT (2): 2-D Floating Point Coordinate Tuple field
|
*--C3FT (4): 3-D Floating Point Coordinate Tuple field
```

10a-7.2.2.2.1 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-7.2.3 Multi Point record

10a-7.2.3.1 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.

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'.

Coordinates will be stored by one type of the coordinate list fields. The field can be repeated and in one field can be multiple coordinate tuples. If multiple coordinate list 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.

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; that is 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-7.2.3.2 Multi Point record structure

```
Multi Point record
   |
   |--MRID (4): Multi Point Record Identifier field
      |
      |-<0..*>-INAS (5\\*5): Information Association field
      |
      |-<0..1>-COCC (3): Coordinate Control field
      |
      |alternate coordinate representations
      |
      *-<0..*>-C2IL (*2): 2-D Integer Coordinate List field
      |
      *-<0..*>-C3IL (1\\*3): 3-D Integer Coordinate List field
      |
      *-<0..*>-C2FL (*2): 2-D Floating Point Coordinate List field
      |
      *-<0..*>-C3FL (1\\*3): 3-D Floating Point Coordinate List field
```

10a-7.2.3.2.1 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-7.2.4 Curve record

10a-7.2.4.1 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 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).

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'.

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

- For segments with the INTP subfield set to 7 (CircularArcCenterPointWithRadius) a parameter field (CIPM or ARPM) must follow the Coordinate field to define the additional parameter of such segments. The CIPM (Circle Parameter field) must be used if the segment is a full circle and the ARPM (Arc Parameter field) must be used for circular arcs. Note that for such segments there is exactly one control point.
- For segments with the INTP field set to 8 (polynomialSpline) or 9 (bezierSpline), the polynomial spline parameter field (PSPL) must follow the Coordinate field to define the additional parameter for such segments. The Knot fields are required only if the knots are not uniform (knotSpec is other than 1).
- For segments with the INTP field set to 10 (bSpline), the spline parameter field (SPLI) must follow the Coordinate field to define the additional parameters for spline segments. The Knot fields are required only if the knots are not uniform (knotSpec is other than 1).
- For segments with the INTP field set to 11 (blendedParabolic) no additional parameters are needed. The control (data) points given in the Coordinate fields and the interpolation type suffice to define the curve segment. Note that for closed segments the start and end points of the segment must overlap in order to produce a smooth closed curve (see Part 7 clause 7-4.2.2.2).

Coordinates of control points can be stored in the following fields: C2IL, C2FL, C3IL, or C3FL. Those fields, coordinate list fields, can be repeated and can carry multiple coordinate tuples (exept for INTP equal to 7 see above).

If multiple coordinate list 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.

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-7.2.4.2 Curve record structure

```
Curve record
   |
   |--CRID (4): Curve Record Identifier field
      |
      |-<0..*>-INAS (5\\*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..*>-C2IL (*2): 2-D Integer Coordinate List field
        |
        *-<0..*>-C3IL (1\\*3): 3-D Integer Coordinate List field
        |
        *-<0..*>-C2FL (*2): 2-D Floating Point Coordinate List field
        |
        *-<0..*>-C3FL (1\\*3): 3-D Floating Point Coordinate List
      |
        |alternate parameter for circle and arc segments
        |
        *-<0..1>-CIPM (6): Circle Parameter field
        |
        *-<0..1>-ARPM (6): Arc Parameter field
        |
        |alternate parameters for spline segments
        |
        *-<0..1>-SPLI (1): Spline Parameter field
        |  |
        |  *-<0..1>-KNOT (*2) Knots array field
        |
        *-<0..1>-PSPL (1): Polynomial Spline Parameter field
```

```
|
*-<0..1>-KNOT (*2) Knots array field
|
|alternate coordinate representations
|
*-<0..1>-DRVF (*4) Derivatives field (floating point)
|
*-<0..1>-DRVI (*4) Derivatives field (Integer)
```

10a-7.2.4.2.1 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-7.2.4.2.2 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-7.2.4.2.3 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-7.2.4.2.4 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 {5} – Elliptical {6} – Conic {7} – CircularArcCenterPointWithRadius {8} – polynomialSpline {9} – bezierSpline {10} – bSpline {11} – blendedParabolic

Data Descriptive Field

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

10a-7.2.4.2.5 Circle Parameter field structure

Field Tag: **CIPM**	Field Name: Circle Parameter

Subfield name	Label	Format	Subfield content and specification
Radius	RADI	b48	Radius of the circle
Unit of Radius	RADU	b11	{1} – Metres {2} – Yards {3} – Kilometres {4} – Statute miles {5} – Nautical miles

Data Descriptive Field

```
1100;&□□□Circle□Parameter▲RADI!RADU▲(b48,b11)▼
```

10a-7.2.4.2.6 Arc Parameter field structure

Field Tag: **ARPM**	Field Name: Arc Parameter

Subfield name	Label	Format	Subfield content and specification
Radius	RADI	b48	Radius of the circle
Unit of Radius	RADU	b11	{1} – Metres {2} – Yards {3} – Kilometres {4} – Statute miles {5} – Nautical miles
Start Bearing Angle	SBRG	b48	In decimal degrees, range [0.0, 360.0]
Angular distance	ANGL	b48	In decimal degrees [-360.0, 360.0

Data Descriptive Field

```
1100;&□□□Arc□Parameter▲RADI!RADU!SBRG!ANGL▲(b48,b11,2b48)▼
```

10a-7.2.4.2.7 Spline Parameter field structure

Field Tag: **SPLI**	Field Name: Spline Parameter

Subfield name	Label	Format	Subfield content and specification
Degree	DEGR	b11	The degree of the interpolating polynomial.
KnotSpec	KSPC	b11	{1} – uniform {2} – quasiUniform {3} – piecewiseBezier {4} – nonUniform
Is Rational	RTNL	b11	{1} – the spline is a rational spline {2} – the spline is not a rational spline

Data Descriptive Field

```
1100;&□□□Spline□Parameter▲DEGR!KSPC!RTNL▲(3b11)▼
```

10a-7.2.4.2.8 Polynomial Spline Parameter field structure

Field Tag: **PSPL**	Field Name: Polynomial Spline Parameter

Subfield name	Label	Format	Subfield content and specification
Degree	DEGR	b11	Radius of the circle
KnotSpec	KSPC	b11	{1} – uniform {2} – quasiUniform {3} – piecewiseBezier {4} – nonUniform
Is Rational	RTNL	b11	{1} – the spline is a rational spline {2} – the spline is not a rational spline
Number of derivatives at start and end	NDRV	b11	The number or derivatives at each end. The number of derivatives at the start and end must be the same. If the start and end have different numbers of derivatives the missing values must be encoded as ‘omitted’ values (see 10a-3.5)
Number derivatives Interior	NDVI	b11	The number of interior derivatives required to be continuous. E.g., “2” means the first and second interior derivatives must be continuous

Data Descriptive Field

```
1100;&□□□Polynomial□Spline□Parameter▲DEGR!KNUM!KSPC!RTNL!NDRV!NDVI▲(5b11)▼
```

10a-7.2.5 Composite Curve record

10a-7.2.5.1 Encoding rules

Composite Curves are one-dimensional spatial objects that are composed of other curves. A composite curve itself is a contiguous path; that is, 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.

As with any other spatial object, composite curves can have associations to information types. ~~Attributes and associations to information types can be encoded as for all other spatial objects.~~

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'.

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, that is 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-7.2.5.2 Composite Curve record structure

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

10a-7.2.5.2.1 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,b12,b11)▼
```

10a-7.2.5.2.2 Curve Component Control field structure

Field Tag: **CCOC** [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 CUCO field(s) of the target record
Number of Curve Components	NCCO	b12	Number of Curve record pointer in the CUCO field(s) of the update record

Data Descriptive Field

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

10a-7.2.5.2.3 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-7.2.6 Surface record

10a-7.2.6.1 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.

As with any other spatial object, surfaces can have associations to information types.

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-7.2.6.3~~10a-7.2.6.2 Surface record structure

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

~~10a-7.2.6.3.1~~10a-7.2.6.2.1 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-7.2.6.3.2~~10a-7.2.6.2.2 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-7.3 Feature Type record

10a-7.3.1 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 4 categories of feature types:

1) Meta feature;
2) Cartographic feature;
3) Geographic feature;
4) 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).

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'.

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 (for example 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.
   For example, 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. For example 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 subfields 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 not intended to be used for the depiction of a feature object these spatial objects can be specified in the MASK field. Note that spatial objects may not be used directly by the

feature object. For example, 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.

Feature types may reference other feature types. For this encoding it is important that a Feature Type record must be stored prior to any record that references this record.

10a-7.3.2 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\\*5): Information Association field
      |
      |-<0..*>-SPAS (*6): Spatial Association field
      |
      |-<0..*>-FASC (5\\*5): Feature Association field
      |
      |-<0..*>-THAS (*3): Theme Association field
      |
      |-<0..*>-MASK (*4): Masked Spatial Type field
```

10a-7.3.2.1 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
Numeric Feature Type Code	NFTC	b12	A valid feature type code as defined in the FTCS field of the Dataset General Information Record
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!NFTC!RVER!RUIN▲(b11,b14,
2b12,b11)▼
```

10a-7.3.2.2 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-7.3.2.3 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	The denominator of the smallest scale for which the referenced geometry can be used for the instance of the feature type (for example, for depiction) {2^{32}-1} NULL (Not Applicable) (See Note)
Scale Maximum	SMAX	b14	The denominator of the largest scale for which the referenced geometry can be used for the instance of the feature type (for example, for depiction) {2^{32}-1} NULL (Not Applicable) (See Note)
Spatial Association Update Instruction	SAUI	b11	{1} – Insert {2} – Delete

Note: For a correct handling of older data, robust parsers should consider both 0 and 2^{32}-1 as 'Not Applicable' for the SMIN and the SMAX sub-field*.*

Data Descriptive Field

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

10a-7.3.2.4 Feature Association field

Field Tag: **FASC**	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
Numeric Feature Association Code	NFAC	b12	A valid code for the feature association as defined in the FACS field of the Dataset General Information Record
Numeric Association Role Code	NARC	b12	A valid code for the role as defined in the ARCS field of the Dataset General Information Record
Feature Association Update Instruction	FAUI	b11	{1} – Insert {2} – Delete {3} – Modify
Numeric Attribute Code	*NATC	b12	A valid attribute code as defined in the ATCS field of the Dataset General Information Record
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 FASC 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

```
3600;&%/GFeature□Association▲RRNM!RRID!NFAC!NARC!FAUI\\*NATC!ATIX!PAIX!ATI
N!ATVL ▲(b11,b14,2b12,b11,{3b12,b11,A})▼
```

10a-7.3.2.5 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-7.3.2.6 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} – Suppress portrayal
Mask Update Instruction	MUIN	b11	{1} – Insert {2} – Delete

Data Descriptive Field

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

The *Referenced Record identifier* field corresponds to the *spatialRef* attribute of S100_GF_MaskReference (Part 3, Table 3-14). The *Mask Indicator* field corresponds to the *maskIndicator* attribute of S100_GF_MaskReference.

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