The Digital Geographic Information Exchange Standard (DIGEST)

Part 4
FEATURE and ATTRIBUTE CODING CATALOGUE (FACC)

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DIGEST Part 4

Feature and Attribute Coding Catalogue (FACC)

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NOTICE TO USERS

Refer to the Notice to Users/Record of Amendments in DIGEST Part 1.

RECORD OF AMENDMENTS

NUMBER	DATE	ENTERED BY	REMARKS

FOREWORD

Refer to the Foreword in DIGEST Part 1.

1 SCOPE, PURPOSE, AND FIELD OF APPLICATION

1.1 Scope

This part of DIGEST defines the FACC Data Dictionary of features and attributes for Digital Geographic Information (DGI). It does not specify a data model. It is not applicable to the representation of individual instances of each feature, and excludes spatial referencing, temporal referencing, portrayal parameters, and feature instance collection criteria. The dictionary is intended to be implementation independent and is not limited to DIGEST implementations.

The FACC Data Dictionary document is structured as follows:

- The first four clauses provide the scope, purpose, and field of application; conformance; references; and terminology.
- The fifth clause explains in detail the coding structure for features, attributes and their values. It also provides rules for documenting new features and attributes.
- Annex A lists features and their codes.
- Annex B lists attributes, their codes, as well as values and additional actual value information.
- Annex C is an alphabetize content listing of all features and attributes.

The official normative FACC Data Dictionary document is that published by DGIWG in paper form, produced from a PDF softcopy which is also normative.

The FACC Data Dictionary elements are also published, for informative purposes, in softcopy database form. The elements within the informative database may be available in several languages.

The DIGEST Web Site is at (http://www.DIGEST.org).

1.2 Purpose

Refer to the Scope, Purpose, and Field of Application in DIGEST Part 1.

1.3 Field Of Application

Refer to the Scope, Purpose, and Field of Application in DIGEST Part 1.

1.3.1 Organizational Applicability

Refer to the Scope, Purpose, and Field of Application in DIGEST Part 1.

1.3.2 Geo-Scientific Applicability

Refer to the Scope, Purpose, and Field of Application in DIGEST Part 1.

1.3.3 Regional and Thematic Applicability

Refer to the Scope, Purpose, and Field of Application in DIGEST Part 1.

1.4 Compatibility with Other Geographic Information Standards

Refer to the Scope, Purpose, and Field of Application in DIGEST Part 1.

2 CONFORMANCE

An implementation claiming conformance with the FACC Data Dictionary shall pass all the requirements described in the FACC conformance tests in Part 4 Clause 2.1.1. It is not a mandatory requirement that implementations use the totality of the FACC Data Dictionary, neither is there a mandatory minimum subset.

The FACC Data Dictionary allows for individual nations to define "national" features and attributes (See Part 4 Clause 5.3.1). National Extensions are not specified within the normative FACC Data Dictionary, and may not, therefore, support interoperability. National Extensions may, if proposed and approved, be incorporated into future editions of the normative FACC Data Dictionary, at which point, they are no longer considered to be National Extensions.

An implementation which uses National Extensions shall be permitted to claim a special "FACC with National Extensions" level of conformance. The requirements for this level of conformance are:

- Features, attributes and attribute values implemented, which exist within the normative FACC Data Dictionary, shall pass the requirements at Part 4 Clause 2.1.1.

- Features, attributes and attribute values implemented, which do not exist within the normative FACC Data Dictionary (National Extensions), shall pass the requirements at Part 4 Clause 2.1.2.

- The conformance statement shall include a statement that National Extensions have been implemented.

All statements of conformance shall include reference to the normative edition of the FACC Data Dictionary to which conformance is claimed.

There have been no significant changes to the FACC Data Dictionary (except additions) up to Edition 2.0. It is therefore probable that an implementation with an earlier edition also conforms to Edition 2.0.

Effective from FACC Data Dictionary Edition 2.1, all changes shall be documented within the data dictionary element descriptions, to enable development of mappings between the old and new editions of the dictionary, or at a low level the old and new versions of features / attributes / values. This mapping is what users need to successfully:

- migrate databases to conform with future editions of the FACC Data Dictionary.

- extract data which conforms to future editions of the FACC Data Dictionary from databases which are conformant with previous editions.

- exchange data between databases that conform to different editions of the FACC Data Dictionary.

- import data which conform to previous editions of the FACC Data Dictionary.

2.1 Test Module for Implementations of FACC Data Dictionary

Test Purpose: verify the implementation's conformance with the content of the FACC Data Dictionary (FACC Annex A and B).

Test method: check whether the implementation of the FACC Data Dictionary contains the required elements (Part 4 Clause 2.1.1); check whether the implementations of National Extensions conform to FACC Data Dictionary proposal acceptance criteria specified at Part 4 Clause 5.3.2 (Part 4 Clause 2.1.2).

2.1.1 Test Module for Presence of Required Elements

Test Purpose: verify that the implementation's data dictionary elements are as specified by the FACC Data Dictionary.

Test method: check whether the implementation's data dictionary elements Feature Codes and Feature Descriptions (Part 4 Clause 2.1.1.1), Attribute Codes, Attribute Descriptions and Attribute Values (Part 4 Clause 2.1.1.2) are as specified within the FACC Data Dictionary.

2.1.1.1 Test Case for Feature Encoding

Test Purpose: verify that the implementation's Feature Codes and Feature Descriptions are as specified by the FACC Data Dictionary.

Test method: check whether the Feature Code is specified within FACC Annex A; check whether the Feature Description is specified within FACC Annex A (Edition mapping information is not required); check whether the combination of Feature Code and Feature Description is a valid combination as specified within FACC Annex A.

2.1.1.2 Test Case for Attribute Encoding

Test Purpose: verify that the implementation's Attribute Codes, Attribute Descriptions and Attribute Values are as specified by the FACC Data Dictionary.

Test method: check whether the Attribute Code is specified within FACC Annex B; check whether the Attribute Description is specified within FACC Annex B (Edition mapping information is not required); check whether the combination of Attribute Code and Attribute Description is a valid combination as specified within FACC Annex B; check whether the Attribute Value (if coded) and Value Description is as specified for the Attribute within FACC Annex B; check whether the Attribute Value's (if actual) format, units, range and limits are as specified for the Attribute within FACC Annex B; check

whether matching pairs of upper and lower bounding range attributes (if present) are implemented as specified in FACC Annex B.

2.1.2 Test Module for National Extensions

Test Purpose: verify that the implementation's National extension data dictionary elements meet the requirements of the FACC Data Dictionary proposal acceptance criteria (see Part 4, 5.3.2).

Test method: check whether the implementation's National extension Feature Codes and Feature Descriptions (Part 4 Clause 2.1.2.1), Attribute Codes, Attribute Descriptions and Attribute Values (Part 4 Clause 2.1.2.2), have been specified in accordance with the FACC Data Dictionary proposal acceptance criteria (see Part 4 Clause 5.3.2).

2.1.2.1 Test Case for National Feature Encoding Extensions

Test Purpose: verify that the implementation's National Feature extensions have been specified in accordance with the FACC Data Dictionary proposal acceptance criteria (see Part 4 Clause 5.3.2).

Test method: check whether the feature encoding conforms to the proposal acceptance criteria at Part 4 Clause 5.3.2.

2.1.2.2 Test Case for National Attribute Encoding Extensions

Test Purpose: verify that the implementation's National Attribute extensions have been specified in accordance with the FACC Data Dictionary proposal acceptance criteria (see Part 4 Clause 5.3.2).

Test method: check whether the attribute encoding conforms to the proposal acceptance criteria at Part 4 Clause 5.3.2.

3 REFERENCES

Refer to the References in DIGEST Part 1.

4 TERMINOLOGY

Refer to the Terminology in DIGEST Part 1.

5 FACC DATA DICTIONARY

FACC provides a means for encoding real-world entities or objects and concepts, including those which are not necessarily visible or have a tangible physical form (e.g., airspace). FACC describes the world in terms of features, attributes and attribute values. FACC does not specify the delineation or geometry of features. Attributes are the properties or characteristics associated with features. A standardized dictionary is required to support encoding in order to maximize interoperability and to understand the production, exchange, distribution, and exploitation of digital geographic data.

5.1 Use of FACC

FACC is a dictionary of features, attributes and attribute values organized in a standardized coding system. Feature codes are in Annex A, attribute codes are in Annex B. Annex B also provides information as to the Units, Formats, Ranges, Increments, and Maximum Text Characters, typically associated with each actual value attribute.

FACC has not been developed to satisfy the requirements of any single application, product, or database. It is intended to be independent from level of resolution (scale), representation, or portrayal. The appropriate selection of FACC features and attributes are intended to be implemented as part of the overall solution for an application, by means of a database (supported by a data schema or model), a product, or dataset (defined according to a format specification and a data model).

Users of FACC are advised that, as with any dictionary, there may be more than one way to encode geographic entities, either by offering a choice of features or a combination of features and attributes. A heliport is listed as feature GB035 (Heliport), but could also be encoded as feature code GB006 (Airfield) associated with the attribute APT (Airfield type) containing a coded value of 009 (Heliport). Another example would be AK090 (Fairgrounds) and AK091 (Exhibition Grounds), which could be interchanged depending on the user's own interpretation.

This provides flexibility for product designers to model geographic features in a way which is most efficient and suitable for a given application, regardless of the format or encapsulation. If applications or databases have encoded geographic entities using different combinations of FACC features and attributes, a review of the full content of FACC should enable the development of a mapping between the two views. Similarly, a database can support the output of many different datasets using different encoding options, but re-encoding the data during the extraction process.

An informative partial table of options for encoding geographic entities (Table 5.1), demonstrates some of the various ways to encode the same or similar geographical entities. It should be noted that the selection of the appropriate code or combination of codes is highly dependent upon the context in which it is to be used. A more detailed listing of possible encodings can be found on the DIGEST Web Site (http://www.DIGEST.org) as a Support Document.

Table 5.1 Options for Encoding Geographic Entities

Geographic Entity (Feature Name)	Feature Code	Attribute Code	Alternate Feature Code(s)	Alternate Feature + Attribute Code(s)
Heliport	GB035			GB006 Airfield + APT 009 Heliport
Fairgrounds	AK090		AK091 Exhibition Grounds	
Lighthouse	BC050			AL015 Building + BFC082 Lighthouse
Rock Strata/Rock Formation	DB160			DA010 Ground Surface Element + SMC007 Bedrock *OR* SMC084 Rock/Rocky

5.1.1 Portrayal and Symbolization

The portrayal and symbolization of digital geographic data is beyond the scope of FACC and is the subject of other standards and service development activities. The feature and attribute content of FACC is intended to be scale and use independent, merely providing the means for data models and product specifications to model the world. Therefore, portrayal and symbolization issues should be addressed by product specifications and data exploitation tools and services.

FACC uses the terms volume, area, line or point to describe the real world nature of the feature, irrespective of its delineation or geometric construction within an implementation. For example, a built-up area (al020, maybe delineated as an area or point within a relationship database).

It is worth noting, however, that an implementation of portrayal or symbolization may make extensive use of the feature and attribute conditions within a dataset as a means of selecting data which meets specified criteria.

Nevertheless, there is sometimes a requirement for certain portrayal and symbolization criteria (such as feature colour) to be “hard-wired” into a dataset, to ensure that the data integrity is preserved when viewed in different environments. In some cases, FACC has included a provision for this, although it is normally to be avoided. The use of such attributes within FACC, is at the discretion of data modellers and product developers. Users of FACC should note, however, that the inclusion of such attributes within a dataset does not guarantee their use by application software.

5.1.2 Country Codes

It is not possible for FACC to recommend the use of a single standard for country or geopolitical codes. The choice of a standard for country codes is dependent on the interoperability requirements for each specific user community.

FACC does not, therefore, recommend a standard. However, certain attributes within FACC refer to certain country code standards. These have been added in response to specific producer and user community requirements. There may be several attributes for country codes, each of which references a different standard. This enables a data model or schema to capture country codes in compliance with several standards in order to support multiple requirements.

5.1.3 References to External Standards

As in the case of country codes, there may be features, attributes or attribute values within FACC which are based upon or refer to other external standards. In instances where several potential external standards for a given purpose exist, FACC is not necessarily recommending that any one of the referenced standards are mandated. They are mandated for those attributes that reference them, but there may be additions to future editions of FACC which may reference additional (possibly competing) external standards.

The selection of the attributes and external standards is therefore an issue to be considered by those designing data models and specifications. However, where FACC refers to an external standard or authority, users should not assume that FACC fully describes the use and context. Users should refer to the external standards or authorities for a complete authoritative description.

5.1.4 Cultural and Linguistic Adaptability (Languages)

FACC is a language-independent data dictionary. The officially recognized and published document that has been agreed to by all DGIWG nations is maintained in the English language. The official FACC document reflects both British and United States usage of the English language. Where there are differences, they are identified.

In recognition of the benefit to the cultural and linguistic adaptability of FACC, many nations have provided the FACC Custodian with translations of feature and attribute names (including those which were in Annex A, Annex B Appendix 1 and 2 in earlier editions of FACC). The provision and maintenance of language translations from DGIWG nations to the FACC Custodian is voluntary for informative purposes. The translations are available as part of the electronic informative database version of FACC, hosted on the DIGEST Web Site (http://www.DIGEST.org).

The custodians recommend that linguistic translations should be based upon the full definition of features and attributes, not only the feature or attribute names. This is essential to support accurate and robust translations. The custodians will support this by ensuring that future feature and attribute definitions are concise and explicit enough to meet the requirements of cultural and linguistic adaptability.

5.2 Coding Structure

FACC Data Dictionary elements implement a specific coding structure. The coding structure does not specify criteria for feature and attribute selection or collection (e.g., positional accuracy, feature granularity).

Selection and collection criteria are dependent upon user requirements, and determined by product specifications, data models, and database schemas.

5.2.1 Features

Within FACC, each feature is identified by a unique five-character code. The first character corresponds to the feature category and may have an alphabetic value from A to Z. Currently there are ten feature categories, including one category, S, which has been reserved for dataset-specific features. The categories are as follows:

1st Character	Category
A	Culture
B	Hydrography
C	Hypsography
D	Physiography
E	Vegetation
F	Demarcation
G	Aeronautical Information
I	Cadastral
S	Special Use (Dataset-specific)
Z	General

Each major category is further divided into subcategories which are identified by the second character of the five-digit code containing an alphabetic value from A to Z. The subcategories that have currently been defined for each major category are as follows:

A — Culture

AA	Extraction	AK	Recreational
AB	Disposal	AL	Miscellaneous Features
AC	Processing Industry	AM	Storage
AD	Power Generation	AN	Transportation — Railroad
AE	Fabrication Industry	AP	Transportation — Road
AF	Associated Industrial Structures	AQ	Associated Transportation
AG	Commercial	AR	Air Traffic Services
AH	Institutional/Governmental	AT	Communication/Transmission
AI	Residential	AU	Airport
AJ	Agriculture		

B — Hydrography

BA	Coastal Hydrography	BG	Tide and Current Information
BB	Ports and Harbors	BH	Inland Water
BC	NAVAIDS	BI	Miscellaneous Inland Water
BD	Dangers/Hazards	BJ	Snow/Ice
BE	Depth Information	BK	Oceanographic or Geophysical
BF	Bottom Features		

C — Hypsography
- CA Relief Portrayal

D — Physiography
- DA Exposed Surface Material
- DB Landforms

E — Vegetation
- EA Cropland
- EB Rangeland
- EC Woodland
- ED Wetlands
- EE Miscellaneous Vegetation

F — Demarcation
- FA Boundaries/Limits/Zones (Topographic)
- FB Boundaries/Limits/Zones (Aeronautical)
- FC Boundaries/Limits/Zones (Hydrographic)

G — Aeronautical Information
- GA Air Route
- GB Aerodrome

I — Cadastral
- IA Areas
- ID Reference Points
- IE Special Characteristics

S — Special Use (Dataset-specific)
- SA Terrain Analysis Dataset
- SB Background Display Dataset
- SC Transportation and Logistics Dataset
- SD Aeronautical Information Dataset
- SE Toponymic Dataset
- SF Simulation Dataset
- SU Dataset Development

Z — General
- ZA Annotation
- ZB Control Points
- ZC Magnetic Variation
- ZD Miscellaneous
- ZE Background Features

Finally, the third, fourth, and fifth characters of the five-character feature code form a number in the range 000 to 999. This value provides unique feature type identification within categories, yet allows flexibility. All features must be identified by all five alphanumeric characters (e.g., the feature "Building" is represented by AL015). Feature codes are listed in Annex A of FACC.

Each Feature Code is associated with a textual description, which provides a human readable dictionary definition for the feature. Each Feature Code is also associated with a short human readable name.

5.2.2 Attributes

Attributes are used to describe characteristics of a feature. Each attribute is described by using attribute codes to represent the category of information. Each attribute is associated with a textual description, which provides a human readable dictionary definition for the attribute. Attribute value format statements provide a computer interpretation for the attribute value data type (e.g., real, alphanumeric). Attribute values give quantitative/qualitative meaning to the attribute code.

5.2.2.1 Attribute Codes

Each attribute is identified by a unique three-character alphanumeric code (label). For example, the attribute "Building Function Code" has the code BFC, and the attribute "Total Usable Width" has the code WD2.

5.2.2.2 Attribute Values

There are two types of attribute values: coded and actual. A given attribute has only one type of value, which is specified in Annex B. Coded values may range from 0 to 999. Each value is given meaning by descriptive text, which may, for example, be implemented by means of a look-up table. Real values are typically measurements like height, width, etc. The units of measurement associated with an attribute are abbreviated according to the units of measurement codes as detailed in Part 3 Clause 7. An attribute value may be logically coded as shown below:

Attribute Code	Attribute Value Format	Attribute Value
BFC	I	6

where "BFC" represents a Building Function Category;
"I" represents the datatype of the coded value (e.g., a 4-byte integer); and
"6" represents the coded value of the BFC attribute (e.g., a hospital).

Certain generic attribute concepts are often useful for value adding, or explaining missing attribution, and are pre-defined in FACC in a consistent manner for all types of attributes. These concepts are:

- Null
- Unknown
- Unpopulated
- Not Applicable
- Multiple
- Other

The following table illustrates these special reserved values for Null, Unknown, Unpopulated, Not Applicable, Multiple, and Other (Table 5.2).

Table 5.2 Special Reserved Values

Attribute Type	Null/No Value	Unknown	Multiple	Unpopulated	Not Applicable	Other
Text (T)						
Fixed Length	N/A[1]	UNK	MUL	N_P	N_A	OTH
Variable Length	0 Length	UNK	MUL	N_P	N_A	OTH
Coded	-32768[2]	0	989	997	998	999
Integer						
Short Integer	-32768[2]	-32768	-32768	-32768	-32768	-32768
Long Integer	-2147483648[3]	-2147483648	-2147483648	-2147483648	-2147483648	-2147483648
Floating Point						
Single Precision	NaN	NaN	NaN	NaN	NaN	NaN
Double Precision	NaN	NaN	NaN	NaN	NaN	NaN

Notes: The value for "Null" for each data type is defined in Part 2, Annex C, Table C-67.

1. If the length is one or two "-" or "--" should be used instead (refer to Part 2, Annex C, Clause C.2.5.4)
2. The Null value for a short integer is defined to be the bit pattern 10000000 00000000, which is equivalent to the maximum negative number in "two's complement number format." Therefore for a 16-bit length number, the corresponding value for Null is -32768.
3. The Null value for a long integer is defined to be the bit pattern 10000000 00000000 0000000 0000000, which is equivalent to the maximum negative number in "two's complement number format." Therefore for a 32-bit length number, the corresponding value for Null is -2147483648.

The Coded Attribute values from 985 to 999 are reserved and should not be used for future development.

For coded and text attributes these concepts are assigned the specific standard values. In certain cases pre-existing attribute values may conflict with these standard values. In these cases, the pre-existing values will take precedence over the standard coded values.

The same concepts may be assigned to numeric attributes. However, numeric attributes must be handled differently. In their case, the Null (Empty) case will be used as a flag to indicate the need for a special interpretation.

DIGEST Part 2, Annex C, Clause C.2.3.4.4 describes the implementation of this concept.

Actual values can have a format (datatype) of either A (Alphanumeric), I (Integer), L (Lexical), R (Real Number) or S (Structured Text). For example, a four lane, 19.5 metre wide road (feature code AP030), having the name "M-4", would be attributed as follows:

Attribute Code	Attribute Value Format	Attribute Value
RTN (route number)	A	M-4
LTN (track/lane number)	I	4
WD2 (total usable width in decimetres)	I	195

Data types or values for lexical default to Lexical level 0 or ASCII. However, when a LEX flag is present, a much wider range of character sets is available and it follows the ISO 10646 set of characters. Lexical values are detailed in DIGEST Part 3 Clause 5.

The values for structured text are relegated to a few “low frequency of occurrence” attributes which must be expressed in a non-standard unit. The format for structured text is:

number(unit)[qualifier], where

number	is the numeric quantity of the attribute,
unit (see Part 3 -7)	is enclosed in parentheses ( ), and
qualifier	is an expression (such as a rate) which qualifies "unit" and is enclosed in brackets [ ]

For instance, the rate at which aircraft can safely fly according to Minimum Enroute Altitude (MEA) would be attributed as follows:

Attribute Code	Attribute Value Format	Attribute Value
MEA	S	6000[ft](AMSL)

where ft is the code for Feet (Reference DIGEST Part 3 Clause 7), and
AMSL equates to “Above Mean Sea Level”

Specific information for actual value attributes is contained in Annex B.

5.2.2.3 Range Value Attributes

Normally, attributes are single-valued text strings, numbers, or enumerated values. However, at times it is necessary to assign values that fall within ranges. Different requirements may result in a conflicting requirement to capture values as actual values, flexible variable ranges, or fixed standardized ranges.

Where the data provider is unable to determine the measurement to a required level of precision, it might be possible to determine it as somewhere within a “range” of possible values (if the database schema or data specification permits). This may be preferable to not capturing the measurement at all.

The producer needs the flexibility to vary the range for each instance of the measurement or represent that some instances are actually captured to the specified precision.

Where the data provider captures aggregations of features (such as capturing trees as an area feature), there may be a need to capture average or aggregated measurements. Using the tree analogy, there may be a need to capture the actual variation, or average, of the diameter of tree stems. Another analogy is the characteristics pertaining to the slope of a road. It may be inefficient to capture the exact slope angle for every segment or profile of the road; the provider may allocate a "slope between n and n" measure to an aggregation of road segments.

Where a data provider is capturing measurements in support of certain standardized models of analysis, it may be mandatory to capture measurements within certain groups of ranges.

FACC aims to meet all three types of requirements where appropriate. However, FACC seeks to maximize flexibility and applicability when possible and therefore, limits the use of fixed ranges. Users will notice that there are numerous fixed ranges currently available within FACC and several slightly different variants of the same kind of attribute. Such attributes are a legacy of early editions of FACC and are gradually being phased out where appropriate.

FACC defines range value attributes in one or two ways. The choice and method of implementation in a model or product specification depends on the requirement and may affect the way in which the resultant data are exploited by application software.

5.2.2.3.1 Coded Range Value Attributes

Coded range value attributes rigidly define the range maximum, minimum and increment by means of coded attribute values:

000	Unknown
001	< 10
002	10 - < 20
003	20 - < 30
004	30 - < 40
005	40

They are only suitable for attributes that are based on stable, established standards, or to support special requirements which either prohibit or have no practical use for flexibility in range value definitions. Where present in FACC, they force the user to implement the specified range values, irrespective of the requirement – variations in requirements may result in proposals for new attributes.

Where new attributes of this type are added to FACC, it is a requirement that the authority (or external reference) for the range value definitions be cited within the attribute definition.

5.2.2.3.2 Flexible Range Value (Upper and Lower Bounding) Attributes

This method uses two attributes to implement the range value. The "upper bounding value" and the "lower bounding value" are captured as actual values. The two attributes must always be used together.

The lower bounding attribute shall in every case be interpreted as representing a "greater than" condition (>), except where the upper and lower bounding attributes contain the same value.

The upper bounding value shall in every case be interpreted as representing a "less than or equal to" condition (<=), except where the upper and lower bounding attributes contain the same value.

An instance of upper and lower bounding attributes has yet to be implemented in FACC Annex B, the following is presented as a fictional example for illustrative purposes only.

Assume that FACC defines a matching pair of upper and lower bounding attributes for stem diameters in centimetres (SC1 and SC2):

To represent a stem diameter range of greater than 0 but less than or equal to 5 centimetres:

SC1 (stem diameter lower bounding attribute) = Null
SC2 (stem diameter upper bounding attribute) = 5

To represent a stem diameter range of greater than 5 but less than or equal to 10 centimetres:

SC1 (stem diameter lower bounding attribute) = 5
SC2 (stem diameter upper bounding attribute) = 10

To represent a stem diameter range of greater than 10 centimetres:

SC1 (stem diameter lower bounding attribute) = 10
SC2 (stem diameter upper bounding attribute) = Null

To represent a precisely known stem diameter of 30 centimetres:

SC1 (stem diameter lower bounding attribute) = 30
SC2 (stem diameter upper bounding attribute) = 30

This technique provides significant flexibility for the capture of range and actual values. It is possible that for many instances of a feature, no two range definitions may be the same. This is because the analyst has the flexibility to vary the range limits according to the accuracy of the source material and the precision of the measurements.

If it is necessary to control the amount of flexibility, constraints on the value ranges should be defined within the data model or specification. The constraints may include allowable range minima, maxima, increments, and the conditions in which an exact value may be captured (if permitted).

The essence of this type of implementation is that, depending on the data format, the ranges are self-describing. There is greater flexibility for different types of dataset to capture ranges at different resolutions and granularity using the same compatible attributes. This will enable the aggregation of data from different sources, which may have implemented different ranges, but with minimum loss of meaning.

Where “product neutral” data is being collected, using flexible ranges with the ability to capture actual values where known, databases will be able to store data collected to the best possible precision available from many different sources. If a dataset generated for a specific use requires specific fixed value ranges, these may be interpolated and re-encoded as part of the process used to extract the dataset from the database.

5.2.2.4 Multi-Value Attributes

Normally, when capturing a value for a given attribute of a feature instance there is only one possible value. A road segment may contain "x" lanes (in which case a single attribute value is sufficient). There are, however, cases where multiple values may be possible, therefore requiring the capture of more than a single value for a chosen attribute.

Consider a fuel depot, which may store several types of fuel (gasoline, diesel, fuel oil, kerosene, etc.). There may be a requirement to capture all of these available fuel facilities using several values for the attribute FFA. Other features such as buoys and lights may also generate a requirement for more than one value to be captured (e.g., colour).

Some users of earlier editions of FACC assumed that FACC imposed a limit of only one value per attribute for an instance of a feature. Consequently, additional (almost duplicate) attributes were added to FACC to meet the requirement. Where a data model or specification required that more than one value be captured for an attribute of a single instance of a feature, each value was captured as a distinct attribute. In the case of the FFA attribute, if this approach had been taken FACC would define several attributes with duplicate value lists (FF1, FF2, FF3,…FF9). The implementation of this in a dataset would require that a feature type be described by all of these attributes in order to meet the requirement for multiple attribute values.

The duplication of attributes in this way is not an efficient solution for the requirement for the capture of multiple attribute values for feature instances. There is also a low and inflexible limit on the number of values which can be encoded. This is a legacy within FACC and users may notice several attributes of this type.

The number of values which may be captured for an attribute and the method of implementation is determined by the data format, data model, and application, and is therefore, beyond the scope of FACC. For an example of how multiple attribute values may be implemented, see Part 2, Annex C, C.2.3.3.6.

5.2.2.5 Unique Feature Identifiers (UID)

FACC does not specify a standard for the implementation of Unique Feature Identifiers (UID). Although the concept is relatively simple, the practicalities and consequences are difficult to resolve. The implementation of UIDs is dependent upon users' data acquisition policies, requirements, system architectures, data formats, and application implementations. A standard for the specification of UIDs is therefore, currently outside the scope of FACC.

In the future, individual organizations may develop their own solution for UIDs, or may collaborate with other organizations to develop standards and agreements for UID implementation. One of the questions to be addressed in that case would be the scope of the UID itself - should it be a UID within a single version of a product or dataset, or a globally unique UID such that an actual feature is allocated a single UID for reference by all agreeing users. Another question is whether UIDs should be random unique numbers, or formatted numbers with meaning. Future UID agreements may even require the use of text characters as well as numbers.

In the interim, recognizing that there are immediate requirements for UIDs at the dataset level, FACC provides a UID attribute. It is called a "Feature Identification Number", defined as a long integer, and a "Unique numeric feature identifier within a dataset". FACC does not specify the structure or implementation of the UID. The restriction that it describes a UID only within datasets is intended to prevent it from being misinterpreted as an attribute intended for globally unique feature identifiers.

The use and method of implementation of the UID attribute is entirely at the discretion of users. It is possible that each user may implement a different UID solution for each product and dataset. The UID attribute is therefore of limited use for exchange purposes unless the users involved have prior agreement on the implementation of UIDs.

5.3 Procedures for Extending and Modifying FACC

FACC provides Data Dictionary elements of a geographic nature to support the development of database schemas and product specifications. In response to dynamic technology and evolving requirements, the FACC Custodian will consider proposals from users for extending, updating, and modifying FACC Data Dictionary elements. All proposals are subject to review and approval by National DGIWG FACC representatives.

5.3.1 Proposals Procedure

Users may submit proposals through:

- Their National DGIWG Point of Contact for DIGEST (see DIGEST Part 1 Clause 5.2)

- The DIGEST Web Site (http://www.DIGEST.org)

As FACC is intended to be an independent and widely applicable application, proposals are rigorously reviewed to ensure that they conform to FACC inclusion criteria and result in elements which are widely applicable and suitable for use in many applications. Consequently, users should expect that the FACC Custodian may modify a proposal before it is approved as a change to the FACC Data Dictionary.

The likelihood of a proposal being modified will be reduced if users making proposals follow the guidance given in the Review Procedures described below. However, users should generally not attempt to propose a fully encoded solutions (selecting a feature code, attribute code, value codes, etc.). Users should instead submit the proposal in the form of a requirement to describe something, in a particular way, for a particular purpose, and allow the FACC Custodian to develop a suitable encoding. Neither should users attempt to implement a proposed encoding prior to FACC Custodian review and approval, without being prepared to subsequently modify the implementation if necessary. The FACC Custodian shall consult the originator if the proposal cannot be approved, or if it requires modification.

Previous editions of FACC described the concept of "National Extensions to FACC". Certain feature codes (XX500), attribute codes (XXX) and enumerated values (NNN) were reserved for "private" use within DGIWG member nations. The implementation of National Extensions is detrimental to interoperability, as they are not agreed to by the other National FACC representatives and are not published as part of the FACC Data Dictionary. The FACC Data Dictionary, however, recognizes that the National Extensions are justified in some circumstances, and that a member nation is entitled to make its own assessment and judgement, if it decides to implement a National Extension.

In recognition of the possibility that a National Extension may in the future be proposed for inclusion in the normative FACC Data Dictionary and in order to improve future interoperability, FACC no longer requires (from Edition 2.1) National Extensions to be implemented using a range of reserved values. National Extensions previously implemented using the reserved values are not affected by this change and do not need to be modified - backward compatibility is, therefore, preserved.

The reserved values in previous editions of FACC did not prevent the possibility of two nations using the same codes to implement different National Extensions, thereby increasing the likelihood of future conflicts. In the future, new National Extensions shall be implemented using unique codes, provided on request by the FACC Custodian. The use of a unique code provided by the FACC Custodian is a mandatory requirement. The provision of National Extension names and definitions is recommended, but optional.

The information indicating the assignment of codes for National Extensions shall be retained by the FACC Custodian for internal DGIWG informative purposes only, and shall not be part of the normative FACC Data Dictionary.

Even though they may not be intended for inclusion into the normative FACC Data Dictionary, National Extensions should be developed to conform to the FACC proposal acceptance criteria (see Part 4 Clause 5.3.2.1). This is a mandatory requirement for claim of "Conformance with FACC with National Extensions." (See Part 4 Clause 2.1.2). Conformance with the acceptance criteria will also increase the likelihood of a National Extension being approved for inclusion in the normative FACC Data Dictionary in the future.

Use of the slash character to describe an "either / or" situation in feature, attribute and attribute value shall be discouraged (see Part 4 Clause 5.5.2). Use of the slash character shall be permitted when used to indicate a synonym situation, where it is present in a name or definition from an authoritative source for a specific domain, where it forms part of a mathematical notation, or where it indicates a fraction value.

A feature or attribute name or description shall not imply how a feature is to be delineated. In the real world, any given feature is only one of either a volume, area, line or point. However, the representation and delineation of such features is a data model dependent. Where the terms volume, area, line or point are used in FACC, they shall not represent delineation. A cemetery may be defined as an area containing burial plots - it is an area in reality, irrespective of its delineation (see Part 4 Clauses 5.1 and 5.1.1).

5.3.2 Review Procedure

The FACC Custodian and National DGIWG FACC representatives shall review and agree to decisions by correspondence and meeting formally when necessary. Review by correspondence ensures that the time-lag between proposals and decisions is reduced.

The FACC Custodian shall consult the requestor if the proposal cannot be approved, or if it requires modification.

The FACC Custodian shall notify the requestor when the proposal is approved.

Proposals shall be reviewed against the acceptance criteria below. Exceptions are permitted only at the discretion and with the full agreement of the FACC Custodian and National DGIWG FACC representatives. It is recognized that elements available from previous editions of FACC (up to Edition 2.0) do not always adhere completely to these criteria.

5.3.2.1 Criteria for Proposed Additions to FACC

Proposed additions to the FACC Data Dictionary shall be reviewed for conformance with the following acceptance criteria:

- Features, attributes, and attribute values shall only be added or modified if suitable elements are not already defined within FACC (see Part 4 Clause 5.1).

- Multiple distinct attributes describing similar concepts shall be permitted where concepts have not been subject to successful standardisation within the wider standards community (see Part 4 Clauses 5.1.2. and 5.1.3).

- The introduction of an attribute which duplicates an existing attribute shall not be permitted (see Part 4 Clause 5.2.2.4).

- Requirements for range value attribution shall be provided for through the creation and implementation of flexible upper and lower bounding numeric attributes. Pre-defined coded range value attributes shall only be permitted in exceptional circumstances, typically where a stable external standard defines the ranges (see Part 4 Clause 5.2.2.3).

- Upper and lower bounding numeric attributes shall be encoded and implemented as matching pairs (see Part 4 Clause 5.2.2.3.2).

- Feature and attribute names shall be unique. No feature and attribute shall be permitted to have the same name (see Part 4 Clauses 5.2.1. and 5.2.2).

- Feature and attribute names shall be concise, unambiguous and provide the most widely understood English name for the element documented in the feature or attribute description (see Part 4 Clause 5.1.4).

- Use of the slash character to describe an “either / or” situation in feature, attribute and attribute value name shall be discouraged (see Part 4 Clause 5.5.2).

- Features, attributes, and attribute values with broad, non-technical usage, such as a road or bridge, shall be defined as broadly as possible. The Oxford English Dictionary should be consulted first while also consulting other available sources such as Webster’s and NATO AAP-6 (a Glossary of Terms and Definitions (English and French)) to ensure consistency. For technical terms pertaining to a particular non-scientific field such as marine navigation, publications of the appropriate international governing body, the International Hydrographic Organization (IHO) in this case, should be consulted first. For technical terms pertaining to particular scientific fields such as geology, appropriate references specific to that scientific field should be consulted first (see Part 4 Clauses 5.1.3 and 5.5.3).

- A feature name or description shall not restrict its use to only complex feature implementations (see Part 4 Clause 5.1).

- A feature or attribute name or description shall not imply how a feature is to be delineated. Use of the terms “area”, “line”, “point” and “volume” shall be permitted in feature and attribute descriptions to describe real-world concepts where they are not scale, resolution, and representation dependent. A cemetery may be defined as an area containing burial plots – it is an area in reality, irrespective of its delineation (see Part 4 Clauses 5.1 and 5.1.1).

- A feature or attribute name shall not be used as its description (see Part 4 Clauses 5.2.2 and 5.5.3).

- A feature or attribute description shall be concise, unambiguous, and should support cultural and linguistic adaptability (see Part 4 Clause 5.1.4).

- A feature or attribute description should not imply or specify an implementation or application dependency (see Part 4 Clause 5.1).

- A feature or attribute description should not imply or specify a locational restriction such as underwater, above ground, etc. (see Part 4 Clause 5.5.3).

- Where feature, attribute, or attribute value meaning and implementation is dependent upon knowledge of an external document or authority (especially for coded range value attributes), descriptions shall include references to the appropriate document or document authority (see Part 4 Clauses 5.1.2 and 5.1.3).

- Attribute values shall be meaningful and self-describing (see Part 4 Clause 5.2.2).

- Attributes for actual numeric values shall specify datatype, units, increments (see Part 4 Clause 5.2.2.2).

- Coded attribute value lists shall not be permitted to mix concepts, and shall only include values which are relevant to the single concept being described, as specified by the attribute description (see Part 4 Clause 5.5.1).

- The following coded attribute values are reserved (see Part 4 Clause 5.2.2.2):

  000

  985 to 999

- The following coded attribute values shall be defined within the value lists for all coded attributes (see Part 4 Clauses 5.2.2.2):

  000

  989

  997 to 999

5.3.2.2 Criteria for Proposed Modifications to FACC

When reviewing proposed modifications to existing FACC Data Dictionary elements, preservation of backward compatibility shall be the primary objective. Proposed modifications shall be reviewed for conformance with the criteria in Part 4 Clause 5.3.2.2, and the additional criteria specified below:

- Modifications to existing elements shall not result in narrower applicability, although broader applicability may be permitted (see Part 4 Clauses 5.5.1 and 5.5.3).

- Modifications to existing elements shall not introduce mixed concepts (see Part 4 Clause 5.5.1).

- Units of measure specified for existing elements shall not be changed (see Part 4 Clause 5.2.2.2).

- The format (datatype) specified for existing elements shall not be changed (see Part 4 Clause 5.2.2.2).

5.3.4 Backward Compatibility

The FACC Custodians strive to reduce the impact of change on those who use and need to comply with FACC by applying a rigorous backward compatibility philosophy. Users of the FACC Data Dictionary should note and understand the FACC backward compatibility philosophy and provisions.

5.3.4.1 Documenting Changes to FACC

Backward compatibility up to and including FACC Data Dictionary Edition 2.0 Amendment 1 was preserved by only permitting additions to FACC. Edition 2.1 implements new procedures for maintaining backward compatibility information. These procedures permit additional flexibility for changing the content of the FACC Data Dictionary. Possible changes include additions, modifications, corrections (typographic or otherwise) and deletions.

No information shall be physically removed from FACC. Deleted features or attributes shall remain in the original location within the Data Dictionary. If the FACC Custodian implements a change (deletion, replacement, addition, modification) to FACC Data Dictionary elements, the nature, details, and effective edition of the change shall be described in a statement appended to the:

- Feature Description

- Attribute Description

- Attribute Value Description

Additional information shall be included in the following special cases:

- When the FACC Custodian considers appropriate, the justification or reasons shall be included (e.g., to indicate support for a specific mapping).

- When an element is "deleted", the description shall include a reference to its replacement, and the replacement shall refer back to the "deletion".

- When an element is modified, the description shall specify the state before and after modification.

- When a word or short string of words is changed, the description shall state "xxx changed to xxx".

- When a complete description is changed, the original description shall be preserved in its complete form.

Examples of typical backward compatibility information are:

- "Version 2.1: New feature"

- "Version 2.1: Added cross reference to …"

- "Version 2.1: Replace 'An area' with 'A site' "

- "Version 2.1: New feature to permit mapping of S-57 attribute value … to FACC"

- "Version 2.1: Removed range limits of +/- 90%"

- "Version 2.1: Removed duplicate attribute value"

- "Version 2.1: Replaced with [attribute code and values] to map … to FACC"

- "Version 2.1: Changed <= 3 percent to => 3 percent"

- "Version 2.1: Replaces previous description of '…' "

FACC Data Dictionary elements which do not have a FACC edition number pre-date Edition 2.1.

Users shall note that the backward compatibility information attached to the descriptions of the FACC Data Dictionary elements is informative text. It is not mandatory to include it in any implementations of the features or attributes.

5.4 Data Dictionary Implementation for non-FACC Elements

The FACC Data Dictionary defines a specific catalogue of features, attributes, and attribute values. Exceptionally, it may be possible for users to define and implement features and attributes, which are not defined within FACC. Possible exceptions include a requirement for a specialized element which it is thought may not be appropriate for FACC, a National extension (see Part 4 Clause 5.3.1), or when there is an urgent requirement which cannot be put through the formal proposal process for contributing to FACC.

The implementation of such elements is dependent upon the data format used. DIGEST includes provision for a "data dictionary" for this purpose. Users shall note that the implementation of elements in this way, while possible, may have an impact on interoperability.

5.5 Future FACC Initiatives

There is an ongoing FACC enhancement and improvement process. Examples of initiatives being studied for future inclusion into FACC are described below. Not all initiatives will necessarily be implemented, this being driven by several factors, including user requirements.

5.5.1 More Specific Attribution

During the long period over which FACC has evolved, changing and evolving philosophies and requirements have resulted in some coded attributes (e.g., USE and EXS) becoming less specific than they should be. Specific areas of concern include long lists of possible values, concepts becoming mixed within attributes, and unnecessary duplication of values between different attributes, beyond that justified by the requirement for alternative encodings.

As FACC continues to develop, the custodians may rectify this through the creation of additional more specific attributes to be used in place of those that cause concern. Backward compatibility will be documented to minimize the impact of changes. Changes will be requirements driven and users are encouraged to offer proposals for improving FACC in this context.

5.5.2 The Use of Slash '/'

During the long period over which FACC has evolved, changing and evolving philosophies and requirements have resulted in some features, attributes and attribute values which use a slash "/" to implement the concept of "and/or". This was originally intended as a means of clarification, which would allow for the use of multiple terms or names that had the same meaning. However, there are instances where a poorly defined requirement has resulted in the creation of FACC content, which has combined concepts that are now understood to be very different.

As an example, a previous edition of FACC created a single feature AQ040 (Bridge/Overpass/Viaduct). While combining objects into a single category may be appropriate for use where either the precise nature of the object is not known, or is not considered significant, it is clearly of little use where the specific nature is precisely known, or is significant. In such instances, it would only be possible to distinguish the feature using an attribute to distinguish between the objects. It might be more efficient to have distinct and separate features, or possibly add a more generic feature combined with a distinguishing attribute.

As FACC is a dictionary, it allows for alternative encodings according to requirements, but in the future, the FACC Custodians will seek to remove ambiguities caused by inappropriate use of the slash. Backward compatibility will be documented to minimize the impact of changes. Changes will be requirements driven and users are encouraged to offer proposals for improving FACC in this context.

5.5.3 Feature and Attribute Definitions

There are instances in which FACC lacks explicit definitions at both the feature and attribute levels. It is possible that some feature and attribute definitions may not contain enough detail to enable all users to understand exactly what the features are intended to be. There are also some instances of the opposite case, where some definitions are too specific. This may affect the accuracy of linguistic translations and the ability of the user to identify appropriate features, attributes, and attribute values, resulting in some being used inappropriately.

In future editions of FACC, the custodians will rectify this by modifying definitions (to strict guidelines) and by creating new features and attributes. Backward compatibility will be documented to minimize the impact of changes. Changes will be requirements driven and users are encouraged to offer proposals for improving FACC in this context. Users should note, however, that there is currently no place in FACC for definitions of coded attribute values, which are intended to be self-explanatory.

5.5.4 Multimedia Attributes

FACC does not currently define attributes specifically for multimedia properties or for the capture of multimedia information to support geospatial data in products and databases. Users may store file names and directory paths as values for certain textual attributes, but the format of such free text is outside the current scope of FACC. Consequently, implementation is system dependent. Future multimedia requirements may include the provision of pictures of features, plans, video sequences, sound samples, etc. Multimedia issues to be investigated include user requirements and implementations, attribute datatypes, multimedia standards etc., prior to its inclusion into future versions of FACC.

5.5.5 Mapping to Other Standards

A major consideration when creating features and attributes in FACC is the need to harmonize new codes with their equivalents in other standards. It is frequently desirable to share or combine data from sources which conform to different standards. There are also instances where FACC should look to other authoritative standards as a source for definitions. For example, the S-57 Object Catalogue, which is controlled by the International Hydrographic Organization (IHO), is widely recognized as the authoritative source for hydrographic object definitions. It is therefore necessary, and beneficial, to develop and maintain mappings (or crosswalks) between the encodings used in different standards. Such mappings serve to improve interoperability through easier sharing, conversion, re-use of data, and by permitting the identification of potential inconsistencies between standards.

For example, a study of hydrographic features was completed in 1996, comparing the codes and definitions in FACC to the IHO S-32 Hydrographic Dictionary and S-57 IHO Transfer Standard for Digital Hydrographic Data. While there are similarities in many of the definitions, many were also significantly different. Furthermore, there were many instances of a single feature in one standard representing several individually encoded features in the other, creating problematic "one-to-many" mappings. A further issue was identified in respect to the use of metadata objects and attributes in S-57 which have no equivalent in FACC. FACC instead uses feature tables containing the appropriate attribution for the same purpose. The following informative table is an example of the results of the 1996 study:

Table 5-3 Example of Hydrographic Definitions

FACC Code	FACC Sub-Category	FACC Name	FACC Description	S-32 Feature Description	S-57 Feature Description
BA010	BA-Hydrography-Coastal Hydrography	Coastline/Shoreline	The line where a land mass is in contact with a body of water.	858 coastline. See SHORELINE//4695 shoreline. The line where SHORE and water meet. Although the terminology of COASTS and SHORES is rather confused, shoreline and coastline are generally used synonymous.	COALNE-The line where shore and water meet. Although the terminology of coasts and shores is rather confused, shoreline and coastline are generally used as synonyms. (IHO Dictionary, S-32, 5th Edition, 858,4695) Distinction: canal bank; lake shore; river bank; shoreline construction