INTERNATIONAL STANDARD

ISO
19127

First edition
2019-02

Geographic information — Geodetic register

Information géographique — Registre géodésiques

Reference number
ISO 19127:2019(E)

© ISO 2019

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso .org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

This first edition cancels and replaces ISO/TS 19127:2005, which has been technically revised.

The main changes compared to the previous edition are as follows:

— the title has changed from Geodetic codes and parameters to Geodetic register;

— the normative references are updated to reflect revisions, ISO 19115-1:2014 and ISO 19162:2015 are added and ISO 19112 removed;

— the Management of a register of geodetic codes and parameters clause is removed;

— the Management of a register of geodetic codes and parameters clause is replaced by Geodetic register management roles and responsibilities and Geodetic register management rules and procedures clauses with the latter referencing ISO 19135-1:2015 in specifying modified, unmodified and additional requirements;

— a Terms of reference of the control body for the ISO 19127 geodetic register clause is added;

— the Content of a register of geodetic codes and parameters clause is replaced by a Geodetic register content requirements clause which references ISO 19111:2007 and ISO 19135-1:2015 in specifying modified, unmodified and additional content;

— an ISO 19127 geodetic registry data export clause is added;

— Annex A (normative) is extended and updated to reflect revisions;

— Annex B (normative) is extended and updated to reflect the required elements within the geodetic register;

— Annex C (informative) is updated to reflect revisions and extended to include extents;

— Annex D (informative) Metadata and Annex E (informative) Requirements list are added.

In accordance with the ISO/IEC Directives, Part 2, 2018, *Rules for the structure and drafting of International Standards*, in International Standards the decimal sign is a comma on the line. However, the General Conference on Weights and Measures (*Conférence Générale des Poids et Mesures*) at its meeting in 2003 passed unanimously the following resolution:

"The decimal marker shall be either a point on the line or a comma on the line."

In practice, the choice between these alternatives depends on customary use in the language concerned. In the technical areas of geodesy and geographic information it is customary for the decimal point always to be used, for all languages. That practice is used throughout this document.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document specifically governs procedures for the ISO 19127 geodetic register, but may have applicability to similar national and international registers of geodetic information.

The ISO 19127 geodetic register and the ISO 19127 geodetic registry are referred to as the ISO geodetic register and ISO geodetic registry, respectively, throughout this document.

ISO 19135-1:2015 specifies procedures for the registration of items of geographic information. ISO/IEC JTC 1 defines registration as the assignment of an unambiguous name to an object in a way that makes the object available to interested parties. ISO 19135-1:2015 has changed the definition of registration to the assignment of linguistically independent identifiers, rather than names, to items of geographic information. ISO 19135-1:2015, Annex C is applicable to ISO/TC 211 registers. The ISO geodetic register is one such register.

ISO 19111:2007 describes elements necessary to define single and compound coordinate reference systems so that coordinates for positions on or near the Earth's surface can be unambiguously referenced. ISO 19111:2007 also describes elements to define coordinate operations that change coordinate values from one coordinate reference system to coordinate values based on another coordinate reference system.

This document describes how the procedures specified in the core schema within ISO 19135-1:2015 are to be applied to the ISO geodetic register of elements applicable to spatial referencing by coordinates in accordance with ISO 19111:2007. Some elements that are optional in ISO 19111:2007 become mandatory in this document to provide guidance on applicability and appropriate use.

Annex A, which is normative, provides four tests for conformance to this document.

Annex B, which is normative, provides tables that specify information for elements to be included in the ISO geodetic register.

Annex C, which is informative, provides best practices for the ISO geodetic register content.

Annex D, which is informative, provides the metadata for the ISO geodetic register.

Annex E, which is informative, provides a summary of the conformance requirements that are found in the text body of this document.

Geographic information — Geodetic register

1 Scope

This document defines the management and operations of the ISO geodetic register and identifies the data elements, in accordance with ISO 19111:2007 and the core schema within ISO 19135-1:2015, required within the geodetic register.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19111:2007, *Geographic information — Spatial referencing by coordinates*

ISO 19115-1:2014, *Geographic information — Metadata — Part 1: Fundamentals*

ISO 19135-1:2015, *Geographic information — Procedures for item registration — Part 1: Fundamentals*

ISO 19162:2015, *Geographic information — Well-known text representation of coordinate reference systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19111:2007, ISO 19135-1:2015 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
retirement
<register> declaration that a register item is no longer suitable for use in the production of new data

Note 1 to entry: The status of the retired item changes from "valid" to "retired". A retired item is kept in the register to support the interpretation of data produced before its retirement and has not been superseded by another item.

Note 2 to entry: In the geodetic register retired items are not necessarily invalid.

[SOURCE: ISO 19135-1:2015, 4.1.14, modified — Note 2 to entry has been added.]

3.2
supersession
<register> declaration that a register item has been retired and replaced by one or more new items

Note 1 to entry: The status of the replaced item changes from "valid" to "superseded".

Note 2 to entry: In the geodetic register superseded items are not necessarily invalid.

[SOURCE: ISO 19135-1:2015, 4.1.17, modified — Note 2 to entry has been added.]

4 Conformance

To conform to this document, the ISO geodetic register shall satisfy all of the conditions specified in Annex A.

5 Geodetic register management roles and responsibilities

The roles and responsibilities of the register owner, register manager, submitting organizations, control body, registry manager and register user are set out in ISO 19135-1:2015, Clause 5. This clause sets out specific requirements as follows:

NOTE   Reference to the ISO 19135-1:2015 requirement is denoted by ^{n} (i.e. [^{n}2] = Requirement 2).

— **Requirement 1 [^{n}1]:** The register owner shall set terms and conditions regarding different levels of access to the register and make the contents available to the public. In addition, the register owner shall specify the time period in which the approval process shall be completed.

— **Requirement 2 [^{n}2]:** The register owner shall appoint a register manager. The register owner may serve as the register manager for any register that it has established or it may appoint another organization to serve as the register manager.

— **Requirement 3 [^{n}3]:** The register owner shall decide whether a control body is required for the register and if so appoint the control body. The register owner may serve as the control body for any register that it has established or it may delegate that role to a subgroup within the organization or to the register manager.

— **Requirement 4 [^{n}4]:** The register owner shall specify the criteria that determine which organizations may act as submitting organizations.

— **Requirement 5 [^{n}5]:** The register owner shall clarify the process for a submitting organization to appeal decisions of the control body (if such a body is appointed). The register owner may establish a procedure for such a process. The specification of this procedure shall include appropriate time limits for the completion of the process. An alternative solution may be for a submitting organization to resubmit a new proposal with changes or a better justification.

— **Requirement 6 [^{n}6]:** The register manager shall manage a register in conformance with ISO 19135-1:2015, Clause 6.

— **Requirement 7 [^{n}7]:** Upon request, the register manager shall distribute an information package containing a description of the register and how to submit proposals for changes to the content of the register. The information package shall describe what proposed changes to the content may be considered to be substantive.

— **Requirement 8 [^{n}8]:** The register manager shall accept proposals from submitting organizations and manage the proposals as specified in ISO 19135-1:2015, 6.4. The register manager shall pass proposals to the control body for decisions as to acceptability and shall serve as the point of contact between the control body and the submitting organization for negotiations regarding changes to the proposal.

— **Requirement 9 [^{n}9]:** The register manager shall determine whether a submitting organization is qualified in accordance with the criteria established by the register owner.

— **Requirement 10 [^{n}10]:** If a control body is appointed, it shall accept proposals from the register manager and render a decision regarding each proposal within the time limits specified by the register owner.

— **Requirement 11 [^{n}11]:** The registry manager shall ensure the integrity of any register held in the registry and shall provide means for electronic access to the registry for register managers, control body members, and register users.

— **Requirement 12 [^{n}12]:** The register manager shall consider the requirements of different categories of users in selecting methods for publishing the content of a register.

— **Requirement 13:** The ISO geodetic register shall have a publicly available record of changes where historical content shall remain publicly available.

Submitting organizations for the ISO geodetic register consist of organizations and/or persons responsible for defining and maintaining geodetic parameters.

6 Geodetic register management rules and procedures

6.1 Introduction

The ISO geodetic register will be publicly available through a registry with a web-based human interface for browsing/displaying register content, provide a web service interface that ensures interoperability based on open standards, have a stable Internet domain name, be available at least 95 % of the time over one year period and have an authoritative review process.

The ISO geodetic register is a non-hierarchical register. References to principal registers and sub registers are excluded from this document.

Rules for managing a register of geographical information items, including the submission of information, are found in ISO 19135-1:2015, Clause 6.

NOTE   Reference to the ISO 19135-1:2015 requirement is denoted by ^{n} (i.e. [^{n}2] = Requirement 2).

6.2 Unmodified ISO 19135-1:2015 requirements

The unmodified ISO 19135-1:2015 requirements are as follows.

— **Requirement 14 [^{n}13]:** Every register shall have a technical document describing the item classes to be registered.

  NOTE   For the ISO geodetic register that technical document is this document.

— **Requirement 15 [^{n}14]:** Items shall be individually managed, moving through a set of well-defined states. Information about the temporal history of each item shall be maintained.

— **Requirement 16 [^{n}16]:** A clarification shall not cause any substantive semantic or technical change to a registered item.

— **Requirement 17 [^{n}17]:** Clarification shall be accomplished by updating the existing item in the register. The clarification shall be recorded with a justification of the change and the date on which the register transaction was made.

— **Requirement 18 [^{n}19]:** Retirement shall be accomplished by leaving the item in the register, having its status changed to retired, and including the date on which the register transaction was made.

— **Requirement 19 [^{n}21]:** The register manager shall review proposals received from third parties for completeness and return proposals to the submitting organization if the proposal is incomplete or if the submitting organization is not qualified, else initiate the approval process.

— **Requirement 20 [^{n}22]:** The approval process shall be completed within the time period specified by the register owner.

— **Requirement 21 [^{n}23]:** A registry manager shall ensure that information about valid, invalidated, superseded, or retired items in the register is readily available to users.

6.3 Modified ISO 19135-1:2015 requirements

The ISO 19135-1:2015 requirements modified for this document are as follows.

— **Requirement 22 [ⁿ15]:** If an item is superseded by another item, the date the succession occurred shall be captured, along with references to and from the item that superseded it. At any given time, only one item in the series should be "valid".

   NOTE 1   The requirement that only one item in the series is "valid" is removed.

— **Requirement 23 [ⁿ20]:** If a register item is deemed to be no longer suitable for the use in the production of new data and has been superseded by a new register item, the original item shall remain in the register, have its status changed to superseded and have a reference to the item(s) that superseded it, including the date on which the register transaction was made.

   NOTE 2   The option of removing a superseded item from the register is removed.

— **Requirement 24 [ⁿ18]:** If an item in a register is found to have substantive error, it shall be left in the register, have its status changed to invalid, have a reference to the item(s) that replaced it and have the date when the register transaction was made.

   NOTE 3   The option of removing an invalidated item from the register is removed.

6.4 Additional requirements

The additional requirements are as follows.

— **Requirement 25:** The minimum level of information that the register manager shall accept from a submitting organization is complete data for a coordinate reference system that conforms to the requirements as specified in Clause 8. The register manager shall also accept data for compound coordinate reference systems, single coordinate operations and concatenated coordinate operations that conform to the requirements of ISO 19111:2007 and Clause 8.

— **Requirement 26:** The register manager shall assign individual registration identifiers for records for entities so that multiple records can point to them. Records for geodetic register entities are interdependent. When a record for an entity is modified, dependent records shall be assessed and, if required, modified.

— **Requirement 27:** The ISO geodetic register shall use open standardization (refer to C.1.) for the units of measure of ellipsoids, coordinate conversion and coordinate transformation parameters.

— **Requirement 28:** The ISO geodetic register shall conform to the ISO 6709:2008 conventions that geographic latitude is positive north of the equator and geographic longitude is positive east of Greenwich (refer to C.3.1).

— **Requirement 29:** Geographic coordinates and angles, which are natively in sexagesimal degree representation, shall be held in the ISO geodetic register as a single real number unit, termed a "sexagesimal DMS", which is a concatenation of degree, minute and second values stored as a single decimal number. A leading zero shall be used for the minute and second values less than 10 (refer to C.2).

— **Requirement 30:** The ISO geodetic register shall conform to the International Association of Geodesy's convention for a geocentric Cartesian coordinate system, with origin at the centre of the Earth, that the Z axis is along the Earth's rotation axis through the north pole, X is in the plane of the equator and through the intersection of the prime meridian with the equator, and Y is in the plane of the equator forming a right-handed coordinate system (refer to C.3.1).

— **Requirement 31:** The ISO geodetic register shall apply a closed standard (refer to C.1.) for the presentation of coordinate system coordinates as follows (refer to C.3.2):

   — geocentric Cartesian coordinates: X, Y, Z;

— geographical two-dimensional coordinates: latitude, longitude or longitude, latitude;

— geographical three-dimensional coordinates: latitude, longitude, ellipsoidal height or longitude, latitude, ellipsoidal height.

— **Requirement 32:** The ISO geodetic register shall apply an open standard (refer to C.1.) for the positive direction of axes, and the order in which the axes are presented, in a projected coordinate reference system as part of the system definition (i.e. the positive direction of axes may be in any order of north/south and east/west) (refer to C.3.1).

— **Requirement 33:** The ISO geodetic register shall implement an open standard (refer to C.1.) for coordinate system linear units. Allowing native units for coordinate system linear units will avoid the danger of corruption of values caused by the misunderstanding of conversion factors.

— **Requirement 34:** The ISO geodetic register shall apply an open standard to the two rotation conventions, which are to apply the rotations to the point's vector or to apply the rotations to the coordinate frame, with the proviso that the applied algorithm is valid for that convention (refer to C.4.1).

— **Requirement 35:** The ISO geodetic register shall name and describe coordinate operation formulae clearly and unambiguously.

— **Requirement 36:** The ISO geodetic register shall include coordinate operation formulae for each coordinate operation method, define the coordinate operation parameters that are used as variables in those formulae and have coordinate operation parameter values that are relevant to those formulae.

— **Requirement 37:** The ISO geodetic register shall describe whether a coordinate operation method may be used for the reverse operation and, when reversible, indicate whether the coordinate operation parameters are used in the reverse operation with the same or reversed sign (refer to C.4.2).

— **Requirement 38:** The ISO geodetic register shall record coordinate transformation parameter values between a local coordinate reference system and a global coordinate reference system from the local system (source) to the global system (target), subject to this direction not being indeterminate (refer to C.7.11).

— **Requirement 39:** The ISO geodetic register shall identify the unit for each parameter and include the conversion ratio required to change that unit to the ISO standard unit. Scalars shall include the conversion ratio required to change the scalar to unity (refer to C.4.4).

— **Requirement 40:** The ISO geodetic register shall record zoned map projections individually (refer to C.4.5).

— **Requirement 41:** The ISO geodetic register shall apply a closed standard by recording the semi-major axis radius (a) and the inverse of the flattening (1/f) as defining parameters for the ellipsoid. Where the inverse of the flattening (1/f) is derived from other parameters, it should be captured to a precision of not less than 10 significant digits (refer to C.5).

— **Requirement 42:** The ISO geodetic register shall apply a naming format for coordinate systems as follows (refer to C.7.3):

<CS type>. Axes:*<axes description(s)>*. Orientations:*<orientation description(s)>*. Uom: *<unit of measure description(s)>*

— **Requirement 43:** The ISO geodetic register shall apply a naming format for geodetic and vertical coordinate reference systems as follows (refer to C.7.5, C.7.6 and C.7.9):

<Geodetic *CRS [abbreviated] name> - <coordinate system axes reference>*

<Vertical *CRS [abbreviated] name> - <coordinate system axis reference >*

— **Requirement 44:** The ISO geodetic register shall apply a naming format for projected coordinate reference systems as follows (refer to C.7.8):

<Base geodetic *CRS [abbreviated] name> / <projection coordinate operation [abbreviated] name> (<unit of measure if not the metre>)*

— **Requirement 45:** The ISO geodetic register shall apply a naming format for compound coordinate reference systems as follows (refer to C.7.10):

<Horizontal CRS [abbreviated] name> (<unit of measure if not the metre>) + <Vertical CRS [abbreviated] name> (<unit of measure if not the metre>)

— **Requirement 46:** The ISO geodetic register shall apply a naming format for coordinate transformations as follows (refer to C.7.11):

<Source CRS [abbreviated] name> to <Target CRS [abbreviated] name> [<transformation version name>]

— **Requirement 47:** The ISO geodetic register shall have a unique name for each unit of measure, coordinate operation, ellipsoid, prime meridian, datum, coordinate system and coordinate reference system.

7 Terms of reference of the control body for the ISO geodetic register

The control body for the ISO geodetic register shall consist of experts nominated by ISO/TC 211. Each P-member and external liaison is permitted to nominate only one primary person and an alternate. The control body itself may also invite geodetic experts to join the control body for a specified period of time. The Chair and Co-Chair of the control body shall be nominated by the International Association of Geodesy. The membership of the control body shall be reviewed every two years or as needed (e.g. for resignations). In rendering decisions to address specific technical issues, the control body may consult with external technical advisors as required.

The control body is responsible for approving the content of the ISO geodetic register and advising the register manager of its decisions.

Control body decisions shall be made by consensus. In the event that a consensus is not possible a decision may be made if there is a two thirds (2/3) voting majority of members. A minimum of three (3) votes is required.

Summary reports of control body activities shall be submitted to TC 211 annually or as otherwise appropriate.

8 Geodetic register content requirements

8.1 Geodetic register content from ISO 19135-1:2015

The ISO geodetic register shall conform to the core register schema in ISO 19135-1:2015, Clause 7. This clause sets out specific requirements as follows.

NOTE   Reference to the ISO 19135-1:2015 requirement is denoted by [n] (i.e. [n2] = Requirement 2).

— **Requirement 48 [n24]:** The core register shall conform to the register schema as specified in UML in ISO 19135-1:2015, Clause 7.

— **Requirement 49 [n25]:** The attribute identifier that designates an item class held in a register that conforms to ISO 19135-1:2015, Clause 7, shall uniquely denote the item class within the context of the register.

— **Requirement 50 [n26]:** The attribute "*itemIdentifier*" is represented as a *CharacterString* that is used to uniquely denote that item within an item class and is intended for information processing.

Once a value has been assigned, it shall not be reused. The class/identifier union shall be unique within the register.

8.2 Geodetic register content from ISO 19111:2007

— **Requirement 51:** The ISO geodetic register shall contain coordinate reference system data and coordinate operation data that conform to ISO 19111:2007 and are international in geographic extent of application, widely used and well defined. See Tables B.1 through B.16 for requirements for entries into the geodetic register.

8.3 Geodetic register additional and modified content requirements

Additional and modified geodetic register content requirements are as follows.

— **Requirement 52:** Information on the scope of a coordinate reference system and a coordinate operation and their elements is mandatory for acceptance in the register. Some coordinate reference systems have a legal status in their valid area; this status shall be included in the scope.

— **Requirement 53:** The geographic extent description and bounding box is mandatory for acceptance in the register.

— **Requirement 54:** The geographic extent shall comprise of a north up bounding box with the southern and western extents preceding the northern and eastern extents. The southern and northern extents shall be described as decimal degrees about the equator (±90) that are positive in the northern hemisphere. The western and eastern extents shall be described as decimal degrees about the zero meridian (±180) that are positive in the eastern hemisphere (refer to C.6.2).

— **Requirement 55:** The geographic area(s) where use of the coordinate reference system is accepted shall be logically consistent with the geographic area(s) where use of the datum is accepted and, if applicable, the geographic area where use of the map projection is accepted.

— **Requirement 56:** Description of valid area(s) for a coordinate operation shall be logically consistent with the valid area(s) for the source coordinate reference system and the target coordinate reference system.

— **Requirement 57:** Information on datum type is mandatory for registration validation purposes.

— **Requirement 58:** The attributes of the submitting organization shall be accessible to register users.

9 ISO geodetic registry data export

— **Requirement 59:** The ISO geodetic registry shall export data using well-known text in accordance with ISO 19162:2015.

Annex A
(normative)

Abstract test suite

A.1 Geodetic register management roles and responsibilities

a) Test purpose: Verify that the register has a management system which addresses all requirements in this document.

b) Test method: Request information about the register from the register. Verify that required information is included.

c) Reference: Clause 5, requirements 1 to 13.

d) Test type: Capability.

A.2 Geodetic register management rules and procedures

a) Test purpose: Verify that the register is managed according to the rules specified in this document.

b) Test method: Check the procedures described in the information package distributed by the register manager.

c) Reference: Clause 6, requirements 14 to 47.

d) Test type: Capability.

A.3 Geodetic register content

a) Test purpose: Verify that the register contains the minimum specified content.

b) Test method: Inspect a sample of entries in the register to ensure that they include all elements of information required by the core register schema of ISO 19135-1:2015 and this document.

c) Reference: Clause 8, requirements 48 to 58.

d) Test type: Capability.

A.4 Publication of register contents

a) Test purpose: Verify that the contents of the register are publicly available.

b) Test method: Check the information package distributed by the registration manager. Visit the website and inspect the information made available.

c) Reference: Clause 5, requirement 12 and 13, and Clause 9, requirement 59.

d) Test type: Capability.

Annex B
(normative)

Register of geodetic codes and parameters

This Annex contains Tables B.1 through B.16, which specify information for elements to be included in the ISO geodetic register. Many of these elements are taken from ISO 19111:2007 and ISO 19135-1:2015, but this annex contains additional elements and guidance for completing those elements beyond those provided in ISO 19111:2007.

Table B.1 — Requirements for a geodetic coordinate reference system

Geodetic coordinate reference system			
Attribute name	Obligation/ Condition	Maximum occurrences	Attribute description
Geodetic CRS Description: A coordinate reference system associated with a geodetic datum.			
Derived Geodetic CRS Description: Where a conversion is incorporated the Geodetic CRS inherits its defining attributes (datum, ellipsoid and prime meridian) from the base Geodetic CRS.			
CRS name	M	1	This is the primary name for the CRS.
CRS identifier	M	1	An identifier by which this CRS is referenced.
CRS alias	O	N	Alias(es) by which this CRS is known.
CRS scope	M	1	Description of usage, or limitations of usage, for which this CRS is valid. If unknown, enter "not known".
CRS remarks	O	1	Comments on or information about this CRS, including data source information.
CRS extent	M	1	Geographic area or region or time frame in which this CRS is valid (**refer to Table B.15**).
CRS extent identifier	M	1	An identifier which references elsewhere the CRS extent source's defining information (**refer to Table B.15**).
CRS source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
CRS source citation identifier	M	N	An identifier which references elsewhere the CRS source citation's defining information (**refer to Table B.16**).
Datum type	M	1	Type of datum, which is **Geodetic Datum**.
Datum name	M	1	This is the primary name for the datum. For a **Derived Geodetic CRS** the datum is inherited from the base Geodetic CRS (**refer to Table B.5**).
Datum identifier	M	1	An identifier by which this datum is referenced. For a **Derived Geodetic CRS** the datum is inherited from the base Geodetic CRS (**refer to Table B.5**).
Coordinate system type	M	1	Type of coordinate system, which is either **Cartesian**, **Ellipsoidal** or **Spherical**.
Coordinate system name	M	1	This is the primary name for the CS (**refer to Table B.6**).
Coordinate system identifier	M	1	An identifier which references elsewhere the CS's defining information (**refer to Table B.6**).
Base CRS type	C	1	Primary name of the type of base CRS, which is **Geodetic**.
Base CRS name	C	1	This is the primary name for the CRS.
Base CRS identifier	C	1	An identifier which references elsewhere the CRS's defining information.

Table B.1 *(continued)*

Geodetic coordinate reference system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Conversion type	C	1	Primary name of the type of the coordinate operation method, which is **Conversion**.
Coordinate operation name	C	1	This is the primary name for the deriving coordinate operation, an optional entity for derived geodetic CRSs describing the deriving conversion (**refer to Table B.11**).
Coordinate operation identifier	C	1	An identifier which references elsewhere the coordinate operation's defining information (**refer to Table B.11**).
Condition: These attributes are mandatory in a **Derived Geodetic CRS**; they are not used for a **Geodetic CRS**.			

Table B.2 — Requirements for a vertical coordinate reference system

Vertical coordinate reference system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Vertical CRS Description: A 1D coordinate reference system used for recording heights or depths. Vertical CRSs make use of the direction of gravity to define the concept of height or depth, but the relationship with gravity may not be straightforward.			
Derived Vertical CRS Description: Where a conversion is incorporated the Vertical CRS inherits its defining attributes (datum) from the base Vertical CRS.			
By implication, ellipsoidal heights (h) cannot be captured in a vertical coordinate reference system. Ellipsoidal heights cannot exist independently, but only as an inseparable part of a 3D coordinate tuple defined in a geodetic 3D coordinate reference system.			
CRS name	M	1	This is the primary name for the CRS. Aliases and other identifiers may be given through the attributes alias and identifier.
CRS identifier	M	1	An identifier by which this CRS can be referenced.
CRS alias	O	N	An alias by which this CRS is known.
CRS scope	M	1	Description of usage, or limitations of usage, for which this CRS is valid. If unknown, enter "not known".
CRS remarks	O	1	Comments on or information about this CRS, including data source information.
CRS extent	M	1	Geographic area or region or time frame in which this CRS is valid (**refer to Table B.15**).
CRS extent identifier	M	1	An identifier which references elsewhere the CRS extent's defining information (**refer to Table B.15**).
CRS source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
CRS source citation identifier	M	N	An identifier which references elsewhere the CRS source citation's defining information (**refer to Table B.16**).
Datum type	M	1	Type of datum, which is **Vertical Datum**.
Datum name	M	1	This is the primary name for the datum. For a **Derived Vertical CRS** the datum is inherited from the base Vertical CRS (**refer to Table B.5**).
Datum identifier	M	1	An identifier by which this datum is referenced. For a **Derived Vertical CRS** the datum is inherited from the base Vertical CRS (**refer to Table B.5**).
Coordinate system type	M	1	Type of coordinate system, which is **Vertical**.

Table B.2 *(continued)*

Vertical coordinate reference system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate system name	M	1	This is the primary name for the CS (**refer to Table B.6**).
Coordinate system identifier	M	1	An identifier which references elsewhere the CS's defining information (**refer to Table B.6**).
Base CRS type	C	1	Primary name of the type of base CRS, which is **Vertical**.
Base CRS name	C	1	This is the primary name for the CRS.
Base CRS identifier	C	1	An identifier which references elsewhere the CRS's defining information.
Conversion type	C	1	Primary name of the type of the coordinate operation method, which is **Conversion**.
Coordinate operation name	C	1	This is the primary name for the deriving coordinate operation, an optional entity for derived vertical CRSs describing the deriving conversion (**refer to Table B.11**).
Coordinate operation identifier	C	1	An identifier which references elsewhere the coordinate operation's defining information (**refer to Table B.11**).
Condition: These attributes are mandatory in a **Derived Vertical CRS**; they are not used for a **Vertical CRS**.			

Table B.3 — Requirements for a projected coordinate reference system

Projected coordinate reference system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Projected CRS Description: A CRS which is derived from a base geodetic CRS by applying the coordinate conversion known as a map projection to ellipsoidal coordinate values.			
The Projected CRS inherits its defining attributes (datum, ellipsoid and prime meridian) from the base geodetic CRS.			
CRS name	M	1	This is the primary name for the CRS. Aliases and other identifiers may be given through the attributes alias and identifier.
CRS identifier	M	1	An identifier by which this CRS is referenced.
CRS alias	O	N	An alias by which this CRS is known.
CRS scope	M	1	Description of usage, or limitations of usage, for which this CRS is valid. If unknown, enter "not known".
CRS remarks	O	1	Comments on or information about this CRS, including data source information.
CRS extent	M	1	Geographic area or region or time frame in which this CRS is valid (**refer to Table B.15**).
CRS extent identifier	M	1	An identifier which references elsewhere the CRS extent's defining information (**refer to Table B.15**).
CRS source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
CRS source citation identifier	M	N	An identifier which references elsewhere the CRS source citation's defining information (**refer to Table B.16**).
Datum type	M	1	Type of datum, which is a **Geodetic Datum**.

Table B.3 *(continued)*

Projected coordinate reference system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Datum name	M	1	This is the primary name for the datum, which is inherited from the base Geodetic CRS (**refer to Table B.5**).
Datum identifier	M	1	An identifier by which this datum is referenced, which is inherited from the base Geodetic CRS (**refer to Table B.5**).
Coordinate system type	M	1	Type of coordinate system, which is **Cartesian**.
Coordinate system name	M	1	This is the primary name for the CS (**refer to Table B.6**).
Coordinate system identifier	M	1	An identifier which references elsewhere the CS's defining information (**refer to Table B.6**).
Base CRS type	M	1	Primary name of the type of base CRS, which is **Geodetic**.
Base CRS name	M	1	This is the primary name for the CRS (**refer to Table B.1**)
Base CRS identifier	M	1	An identifier which references elsewhere the CRS's defining information (**refer to Table B.1**).
Conversion type	M	1	Primary name of the type of the deriving coordinate operation method, which is **Conversion – Map Projection**.
Coordinate operation name	M	1	This is the primary name for the coordinate operation (**refer to Table B.11**).
Coordinate operation identifier	M	1	An identifier which references elsewhere the coordinate operation's defining information (**refer to Table B.11**).

Table B.4 — Requirements for a compound coordinate reference system

Compound coordinate reference system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Compound CRS Description: A coordinate reference system describing the position of points through two or more independent single coordinate reference systems.			
NOTE: Two coordinate reference systems are independent of each other if coordinate values in one cannot be converted or transformed into coordinate values in the other.			
Compound CRS name	M	1	This is the primary name for the CRS. Aliases and other identifiers may be given through the attributes alias and identifier.
Compound CRS identifier	M	1	An identifier by which this CRS is referenced.
Compound CRS alias	O	N	An alias by which this CRS is known.
Compound CRS scope	M	1	Description of usage, or limitations of usage, for which this CRS is valid. If unknown, enter "not known".
Compound CRS remarks	O	1	Comments on or information about this CRS, including data source information.
Compound CRS extent	M	1	Geographic area or region or time frame in which this CRS is valid (**refer to Table B.15**).
Compound CRS extent identifier	M	1	An identifier which references elsewhere the CRS extent's defining information (**refer to Table B.15**).

Table B.4 *(continued)*

Compound coordinate reference system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Compound CRS source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Compound CRS source citation identifier	M	N	An identifier which references elsewhere the CRS source citation's defining information (**refer to Table B.16**).
Horizontal CRS type	M	1	Primary name of the type of horizontal CRS, which is **Geodetic** or **Projected**.
Horizontal CRS name	M	1	This is the primary name for the CRS (**refer to Tables B.1 or B.3**).
Horizontal CRS identifier	M	1	An identifier which references elsewhere the CRS's defining information (**refer to Tables B.1 or B.3**).
Vertical CRS type	M	1	Primary name of the type of vertical CRS, which is **Vertical**.
Vertical CRS name	M	1	This is the primary name for the CRS (**refer to Table B.2**).
Vertical CRS identifier	M	1	An identifier which references elsewhere the CRS's defining information (**refer to Table B.2**).

Table B.5 — Requirements for a datum

Datum			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Geodetic Datum Description: A geodetic datum defines the location and precise orientation in three-dimensional space of a defined ellipsoid (or sphere) that approximates the shape of the Earth, or of a Cartesian coordinate system centred in this ellipsoid (or sphere).			
Vertical Datum Description: A textual description and/or a set of parameters identifying a particular reference level surface used as a zero-height or zero-depth surface, including its position with respect to the Earth.			
Datum name	M	1	This is the primary name for the datum. Aliases and other identifiers may be given through the attributes alias and identifier.
Datum identifier	M	1	An identifier by which this datum is referenced.
Datum alias	O	N	An alias by which this datum is known.
Datum scope	M	1	Description of usage, or limitations of usage, for which this datum is valid. If unknown, enter "not known".
Datum remarks	O	1	Comments on or information about this datum, including data source information.
Datum extent	M	1	Geographic area or region or time frame in which this datum is valid. (**refer to Table B.15**).
Datum extent identifier	M	1	An identifier which references elsewhere the datum extent's defining information (**refer to Table B.15**).
Datum source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Datum source citation identifier	M	N	An identifier which references elsewhere the datum source citation's defining information (**refer to Table B.16**).
Datum anchor	O	1	The datum definition – a description, possibly including coordinates of an identified point or points, of the relationship used to anchor the coordinate system to the Earth.

Table B.5 *(continued)*

Datum			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Datum publication date	O	1	The date that the datum was released to the public. The date may be precise or merely a year if not well defined.
Datum realization epoch	O	1	This is the epoch applying to the defining coordinates.
Ellipsoid name	C	1	This is the primary name for the ellipsoid (**refer to Table B.8**).
Ellipsoid identifier	C	1	An identifier which references elsewhere the ellipsoid's defining information (**refer to Table B.8**).
Condition: These attributes are mandatory in a **Geodetic Datum**; they not used in a **Vertical Datum**.			
Prime meridian name	C	1	This is the primary name for the prime meridian (**refer to Table B.9**).
Prime meridian identifier	C	1	An identifier which references elsewhere the prime meridian's defining information (**refer to Table B.9**).
Condition: These attributes are mandatory in a **Geodetic Datum**; they are not used in a **Vertical Datum**.			

Table B.6 — Requirements for a coordinate system

Coordinate system			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate System Description: A non-repeating sequence of coordinate system axes. The dimension of the coordinate space, the names, the units of measure, the directions and sequence of the axes all shall be part of a coordinate system definition. The number of axes shall be equal to the dimension of the space of which it describes the geometry. Geodetic CRSs have an ellipsoidal 2D or 3D coordinate system, Cartesian 3D coordinate system or Spherical 3D coordinate system. Projected CRSs have a Cartesian 2D coordinate system. Vertical CRSs have a Vertical 1D coordinate system.			
CS name	M	1	This is the primary name for the CS. Aliases and other identifiers may be given through the attributes alias and identifier.
CS identifier	M	1	An identifier by which this CS is referenced.
CS alias	O	N	An alias by which this CS is known.
CS type	M	1	Primary name of the type of CS, which is **Cartesian**, **Ellipsoidal**, **Vertical** or **Spherical**.
CS remarks	O	1	Comments on or information about this CS, including data source information.
CS source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
CS source citation identifier	M	N	An identifier which references elsewhere the CS source citation's defining information (**refer to Table B.16**).
CS axis name	M	N	This is the primary name for the CS axis.
CS axis identifier	M	N	An identifier by which this CS axis is referenced.
NOTE These attributes are repeated for each of the ordered set of dimensions of the coordinate system. The order is significant as it determines the order of the axes and coordinates.			

Table B.7 — Requirements for a coordinate system axis

\<Coordinate system axis\>			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate System Axis Description: A coordinate system shall be composed of a non-repeating sequence of coordinate system axes. Each of its axes shall be completely characterized by a unique combination of axis name, axis abbreviation, axis direction and axis unit. Aliases for these attributes may be used.			
CS axis name	M	1	Repeat in order of convention for that coordinate system.
CS axis identifier	M	1	An identifier by which this CS axis is referenced.
CS axis alias	O	N	An alias by which this CS axis is known.
CS axis remarks	O	1	Comments on or information about this CS axis, including data source information.
CS axis abbreviation	M	1	The abbreviation used for this coordinate system axis; this abbreviation is also used to identify the coordinates in the coordinate tuple. Examples are X and Y.
CS axis direction	M	1	Direction of this CS axis (or in the case of Cartesian projected coordinates, the direction of this CS axis locally). Examples: north or south, east or west, up or down. Within any set of CS axes, only one of each pair of terms can be used. For Earth-fixed CRSs, this direction is often approximate and intended to provide a human interpretable meaning to the axis. When a geodetic datum is used, the precise directions of the axes may therefore vary slightly from this approximate direction.
CS Axis Direction Description: The direction of positive increase in the coordinate value for a coordinate system axis.			
north	C	1	Axis positive direction is north. In a geodetic or projected CRS, north is defined through the geodetic datum. In an engineering CRS, north may be defined with respect to an engineering object rather than a geographical direction.
east	C	1	Axis positive direction is $\pi/2$ radians clockwise from north.
south	C	1	Axis positive direction is π radians clockwise from north.
west	C	1	Axis positive direction is $3\pi/2$ radians clockwise from north.
up	C	1	Axis positive direction is opposite to the direction of the gravity vector.
down	C	1	Axis positive direction is in the direction of the gravity vector.
Geocentric X	C	1	Axis positive direction is in the equatorial plane from the centre of the modelled Earth towards the intersection of the equator with the prime meridian.
Geocentric Y	C	1	Axis positive direction is in the equatorial plane from the centre of the modelled Earth towards the intersection of the equator and the meridian $\pi/2$ radians eastwards from the prime meridian.
Geocentric Z	C	1	Axis positive direction is from the centre of the modelled Earth parallel to its rotation axis and towards its north pole.
Condition: For each axis one and only one of the listed direction attributes shall be supplied.			
CS axis unit of measure name	M	1	This is the primary name for the UoM (**refer to Table B.10**).
CS axis unit of measure identifier	M	1	An identifier which references elsewhere the UoM's defining information (**refer to Table B.10**).
CS axis minimum value	O	1	The minimum value normally allowed for this axis, in the unit for the axis.

Table B.7 *(continued)*

Coordinate system axis			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
CS axis maximum value	O	1	The maximum value normally allowed for this axis, in the unit for the axis.
CS axis range meaning	C	1	Meaning of axis value range specified by minimumValue and maximumValue. This element shall be omitted when both minimumValue and maximumValue are omitted. It may be included when minimumValue and/or maximumValue are included.
Condition: If this element is omitted when minimumValue or maximumValue are included, the meaning is unspecified.			
CS axis source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
CS axis source citation identifier	M	N	An identifier which references elsewhere the CS axis source citation's defining information (**refer to Table B.16**).

Table B.8 — Requirements for an ellipsoid

Ellipsoid			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Ellipsoid Description: An ellipsoid is a geometric figure that can be used to describe the approximate shape of the Earth. In mathematical terms, it is a surface formed by the rotation of an ellipse about its minor axis.			
Ellipsoid name	M	1	This is the primary name for the ellipsoid. Aliases and other identifiers may be given through the attributes alias and identifier.
Ellipsoid identifier	M	1	An identifier by which this ellipsoid can be referenced.
Ellipsoid alias	O	N	An alias by which this ellipsoid is known.
Ellipsoid remarks	O	1	Comments on or information about this ellipsoid, including data source information.
Ellipsoid source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Ellipsoid source citation identifier	M	N	An identifier which references elsewhere the ellipsoid source citation's defining information (**refer to Table B.16**).
Length of semi-major axis	M	1	Length of the semi-major axis of the ellipsoid.
Second Defining Parameter Description: Definition of the second parameter that defines the shape of an ellipsoid. An ellipsoid requires two defining parameters: a semi major axis and inverse flattening or a semi-major axis and a semi-minor axis. When the reference body is a sphere rather than an ellipsoid, only a single defining parameter is required, namely the radius of the sphere; in that case, the semi-major axis "degenerates" into the radius of the sphere.			
Inverse flattening	C	1	Inverse flattening value of the ellipsoid.
Length of semi-minor axis	C	1	Length of the semi-minor axis of the ellipsoid.
"Ellipsoid = Sphere" indicator	C	1	The ellipsoid is degenerate and is actually a sphere. The sphere is completely defined by the semi-major axis, which is the radius of the sphere. This attribute has the value "true" if the figure is a sphere.
Condition: One and only one of these three elements shall be supplied.			
Ellipsoid unit of measure name	M	1	This is the primary name for the UoM (**refer to Table B.10**).
Ellipsoid unit of measure identifier	M	1	An identifier which references elsewhere the UoM's defining information (**refer to Table B.10**).

Table B.9 — Requirements for a prime meridian

Prime meridian			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Prime Meridian Description: A prime meridian defines the origin from which longitude values are determined. NOTE The default value for prime meridian name is "Greenwich". When the default applies, the value for the greenwichLongitude shall be 0 (degrees).			
Prime meridian name	M	1	This is the primary name for the prime meridian. Aliases and other identifiers may be given through the attributes alias and identifier.
Prime meridian identifier	M	1	An identifier which references elsewhere the prime meridian's defining information; alternatively an identifier by which this Prime Meridian can be referenced.
Prime meridian alias	O	N	An alias by which this prime meridian is known.
Prime meridian remarks	O	1	Comments on or information about this prime meridian, including data source information.
Prime meridian Greenwich longitude	M	1	Longitude of the prime meridian measured from the Greenwich meridian, positive eastward. Default value: 0 degrees. NOTE If the value of the prime meridian name is "Greenwich" then the value of greenwichLongitude shall be 0 degrees.
Prime meridian unit of measure name	M	1	This is the primary name for the UoM (**refer to Table B.10**.)
Prime meridian unit of measure identifier	M	1	An identifier which references elsewhere the UoM's defining information (**refer to Table B.10**).
Prime meridian source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Prime meridian source citation identifier	M	N	An identifier which references elsewhere the prime meridian source citation's defining information (**refer to Table B.16**).

Table B.10 — Requirements for a unit of measure

Unit of measure			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Unit of Measure Description: Definition of a unit of measure. If not an SI standard unit, the unit is defined by the ratio B/C relative to an SI standard unit of the same type (e.g. metre if unit is linear).			
Unit of measure name	M	1	This is the primary name for the unit of measure. Aliases and other identifiers may be given through the attributes alias and identifier.
Unit of measure identifier	M	1	An identifier which references elsewhere the unit of measure's defining information; alternatively an identifier by which this unit of measure can be referenced.
Unit of measure alias	O	N	An alias by which this unit of measure is known.
Unit of measure remarks	O	1	Comments on or information about this unit of measure, including data source information.
Unit of measure Standard Target unit of measure name	M	1	This is the primary name for the Standard Target unit of measure.
Unit of measure Standard Target unit of measure identifier	M	1	An identifier which references elsewhere the Standard Target unit of measure's defining information.

17

Table B.10 *(continued)*

Attribute name	Obligation/ Condition	Maximum occurrences	Attribute description
Unit of measure			
Unit of measure numerator (factor B)	O	1	The numerator factor used to define this unit of measure.
Unit of measure denominator (factor C)	O	1	The denominator factor used to define this unit of measure.
Unit of measure type	M	1	Type of the unit of measure, which is angle, length, scale, time or velocity.
Unit of measure symbol	O	1	The unit of measure symbol.
Unit of measure source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Unit of measure source citation identifier	M	N	An identifier which references elsewhere the unit of measure source citation's defining information (**refer to Table B.16**).

Table B.11 — Requirements for a coordinate operation

Attribute name	Obligation/ Condition	Maximum occurrences	Attribute description
Coordinate operation			
Coordinate Operation Description: A coordinate operation that is either a conversion, where the output coordinates are referenced to the same datum as are the input coordinates, or a transformation, where the output coordinates are referenced to a second datum/CRS. The parameter values describing coordinate conversions are defined rather than empirically derived. Coordinate transformations are empirically derived, requiring a quality attribute.			
Coordinate operation name	M	1	This is the primary name for the coordinate operation. Aliases and other identifiers may be given through the attributes alias and identifier.
Coordinate operation identifier	M	1	An identifier by which this coordinate operation is referenced.
Coordinate operation alias	O	N	An alias by which this coordinate operation is known.
Coordinate operation scope	M	1	Description of usage, or limitations of usage, for which this coordinate operation is valid. If unknown, enter "not known".
Coordinate operation remarks	O	1	Comments on or information about this coordinate operation, including data source information.
Source CRS name	C	1	This is the primary name for the CRS (**refer to Tables B.1, B.2 or B.3**).
Source CRS identifier	C	1	An identifier which references elsewhere the CRS's defining information (**refer to Tables B.1, B.2 or B.3**).
Target CRS name	C	1	This is the primary name for the CRS (**refer to Tables B.1, B.2 or B.3**).
Target CRS identifier	C	1	An identifier which references elsewhere the CRS's defining information (**refer to Tables B.1, B.2 or B.3**).
Condition: These attributes are **mandatory** in a coordinate **transformation.** These attributes are **not used** in a coordinate **conversion** (i.e. a **Derived CRS** or a **Projected CRS**).			
Coordinate operation extent	M	1	Geographic extent of area or region or time frame in which this coordinate operation is valid (**refer to Table B.15**).

Table B.11 *(continued)*

Coordinate operation			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate operation extent identifier	M	1	An identifier which references elsewhere the coordinate operation extent's defining information (**refer to Tables B.15**).
Coordinate operation source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Coordinate operation source citation identifier	M	N	An identifier which references elsewhere the coordinate operation source citation's defining information (**refer to Table B.16**).
Coordinate operation version	C	1	Version of the coordinate transformation (i.e. instantiation due to the stochastic nature of the parameters).
Coordinate operation accuracy	C	1	Estimate(s) of the impact of this coordinate operation on point accuracy. Gives position error estimates for target coordinates of this coordinate operation, assuming no errors in source coordinates.
Condition: These attributes are **mandatory** in a coordinate **transformation.** These attributes are **not used** in a coordinate **conversion** (i.e. a **Derived CRS** or a **Projected CRS**).			
Coordinate operation method name	M	1	This is the primary name for the coordinate operation method (**refer to Table B.12**).
Coordinate operation method identifier	M	1	An identifier by which this coordinate operation method is referenced (**refer to Table B.12**).
Coordinate operation source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Coordinate operation source citation identifier	M	N	An identifier which references elsewhere the coordinate operation source citation's defining information (**refer to Table B.16**).

Table B.12 — Requirements for a coordinate operation method

Coordinate operation method			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate Operation Method Description: The method (algorithm or procedure) used to perform the coordinate operation.			
Coordinate operation method name	M	1	This is the primary name for the coordinate operation method. Aliases and other identifiers may be given through the attributes alias and identifier.
Coordinate operation method identifier	M	1	An identifier by which this coordinate operation method is referenced.
Coordinate operation method alias	O	N	An alias by which this coordinate operation method is known.
Coordinate operation method remarks	O	1	Comments on or information about this coordinate operation method, including data source information.
Coordinate operation method source citation	M	N	Source citation information – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Coordinate operation method source citation identifier	M	N	An identifier which references elsewhere the coordinate operation method source citation's defining information (**refer to Table B.16**).
Coordinate operation parameter name	M	1	Repeat for the number of parameters referred to in the formula (**refer to Table B.13**).

Table B.12 *(continued)*

Coordinate operation method			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate operation parameter identifier	M	1	An identifier by which this coordinate operation parameter is referenced (**refer to Table B.13**).
Coordinate operation method formula reference	M	1	Formula(s) or procedure used by this coordinate operation method. This may be a reference to a publication. Note that the operation method may not be analytic, in which case this attribute references or contains the procedure, not an analytic formula.
Coordinate Operation Method Formula Description: Specification of the coordinate operation method formula.			
Coordinate operation method formula	C	1	Formula(s) or procedure used by this operation method.
Coordinate operation method formula identifier	C	1	An identifier by which this coordinate operation method formula is referenced.
Coordinate operation method formula citation	C	1	Reference to a publication giving the formula(s) or procedure used by the coordinate operation method – ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Coordinate operation method formula citation identifier	C	1	An identifier which references elsewhere the coordinate operation method formula citation's defining information (**refer to Table B.16**).
Condition: The **formula** or the **formula citation** attributes shall be supplied.			
Dimension of source CRS	O	1	Number of dimensions in the source CRS of this coordinate operation method.
Dimension of target CRS	O	1	Number of dimensions in the target CRS of this coordinate operation method.

Table B.13 — Requirements for a coordinate operation parameter

Coordinate operation parameter			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate Operation Parameter Description: The definition of a parameter used by a coordinate operation method. Most parameter values are numeric, but other types of parameter values are possible.			
Coordinate operation parameter name	M	1	Repeat for the number of parameters referred to in the formula.
Coordinate operation parameter identifier	M	1	An identifier by which this coordinate operation parameter is referenced.
Coordinate operation parameter alias	O	N	An alias by which this coordinate operation parameter is known.
Coordinate operation parameter remarks	O	1	Comments on or information about this coordinate operation parameter, including data source information.
Coordinate operation parameter minimum occurrences	O	1	The minimum number of times that values for this parameter group or parameter is required. If this attribute is omitted, the minimum number is one.
Coordinate Operation Parameter Value Description: A parameter value, ordered sequence of values, or reference to a file of parameter values.			
Coordinate operation parameter numeric value	C	1	Numeric value of the coordinate operation parameter with its associated unit.
Coordinate operation parameter string value	C	1	String value of a coordinate operation parameter. A string value does not have an associated unit.

Table B.13 (continued)

Coordinate operation parameter			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Operation parameter integer value	C	1	Positive integer value of a coordinate operation parameter, usually used for a count. An integer value does not have an associated unit.
Coordinate operation parameter Boolean value	C	1	Boolean value of a coordinate operation parameter. A Boolean value does not have an associated unit.
Coordinate operation parameter value list	C	1	Ordered collection, i.e. sequence, of two or more numeric values of a coordinate operation parameter list, where each value has the same associated unit.
Coordinate operation parameter integer value list	C	1	Ordered collection, i.e. sequence, of two or more integer values of a coordinate operation parameter list, usually used for counts. These integer values do not have an associated unit.
Coordinate operation parameter file reference	C	1	Reference to a file or a part of a file containing one or more parameter values. When referencing a part of a file, that file shall contain multiple identified parts, such as an XML encoded document. Furthermore, the referenced file or part of a file can reference another part of the same or different files, as allowed in XML documents.
Coordinate operation parameter file reference citation	C	1	Citation for a reference to a file or a part of a file containing one or more parameter values. When referencing a part of a file, that file shall contain multiple identified parts, such as an XML encoded document. Furthermore, the referenced file or part of a file can reference another part of the same or different files, as allowed in XML documents.
Condition: Only one of the listed parameter value attributes shall be supplied.			

Some countries, including the United States, Canada, the United Kingdom, France, Japan and New Zealand, provide a datum transformation program that looks up and interpolates a table of local transformation parameters given at grid points. In such a case, the total number of parameters can be so large that the listing of parameters using the format of Table B.13 becomes unrealistic. For example, a parameter file of TKY2JGD (ver.2.0.5) used for a datum transformation from Tokyo Datum to JGD2000 in Japan, contains latitude and longitude differences at 392,183 grid points. A grid lookup table for the TKY2JGD coordinate transformation is presented in C.9.

Therefore, for transformation methods using a grid lookup table, the description of parameter names and values can be omitted by denoting "Grid lookup table – too many parameters to be listed below." in the entry of the coordinate operation method remarks. In the entry of coordinate operation method number of parameters, the total number of parameters in the grid lookup table should be described.

NOTE   Examples of transformation methods that use a grid lookup table: NADCON (United States), TKY2JGD (Japan), NTv2 (Canada, Australia, New Zealand), gr3df97a (France) and OSTN02 (United Kingdom).

Table B.14 — Requirements for a concatenated operation

Concatenated operation			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Concatenated Operation Description: An ordered sequence of two or more single coordinate operations. The sequence of coordinate operations is constrained by the requirement that the source coordinate reference system of step (n + 1) shall be the same as the target coordinate reference system of step (n). The source coordinate reference system of the first step and the target coordinate reference system of the last step are the source and target coordinate reference system associated with the concatenated coordinate operation. Instead of a forward coordinate operation, an inverse operation may be used for one or more of the coordinate operation steps mentioned above, if the inverse coordinate operation is uniquely defined by the forward coordinate operation method.			
Concatenated operation name	M	1	This is the primary name for the concatenated operation. Aliases and other identifiers may be given through the attributes alias and identifier.
Concatenated operation identifier	M	1	An identifier by which this concatenated operation is referenced.
Concatenated operation alias	O	N	An alias by which this concatenated operation is known.
Concatenated operation scope	M	1	Description of usage, or limitations of usage, for which this concatenated operation is valid. If unknown, enter "not known".
Concatenated operation remarks	O	1	Comments on or information about this concatenated operation, including data source information.
Concatenated operation extent	M	1	Geographic extent of area or region or time frame in which this concatenated operation is valid (**refer to Table B.15**).
Concatenated operation extent identifier	M	1	An identifier which references elsewhere the concatenated operation extent's defining information (**refer to Table B.15**).
Concatenated operation source citation	M	N	Source citation information - ISO 19115-1:2014, B.3.2.1 (**refer to Table B.16**).
Concatenated operation source citation identifier	M	N	An identifier which references elsewhere the concatenated operation source citation's defining information (**refer to Table B.16**).
Concatenated operation version	M	1	Version of the concatenated operation.
Concatenated operation accuracy	M	1	Estimate(s) of the impact of this concatenated operation on point accuracy. Gives position error estimates for target coordinates of this concatenated operation, assuming no errors in source coordinates.
Source CRS name	M	1	This is the primary name for the CRS (**refer to Tables B.1**, **B.2** or **B.3**).
Source CRS identifier	M	1	An identifier which references elsewhere the CRS's defining information (**refer to Tables B.1**, **B.2** or **B.3**).
Target CRS name	M	1	This is the primary name for the CRS (**refer to Tables B.1**, **B.2** or **B.3**).
Target CRS identifier	M	1	An identifier which references elsewhere the CRS's defining information (**refer to Tables B.1**, **B.2** or **B.3**).
Concatenated Coordinate Operations Description: An ordered sequence of two or more single coordinate operations,			

Table B.14 *(continued)*

Concatenated operation			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Coordinate operation type	M	N	Primary names of the type of coordinate operations, which are an ordered sequence of two or more single coordinate operations, being **Conversions and/or Transformations (1..N)** (**refer to Table B.11**).
Coordinate operation name	M	N	These are the primary names for the coordinate operations, which are an ordered sequence of two or more single coordinate operations, being **Conversions and/ or Transformations (1..N)** (**refer to Table B.11**).
Coordinate operation identifier	M	N	Identifier which references elsewhere the coordinate operation defining information (**refer to Table B.11**).

Table B.15 — Requirements for an extent

Extent			
Attribute name	**Obligation/ Condition**	**Maximum occurrences**	**Attribute description**
Extent Description: Textual description, geographic extent and temporal extent. The geographic extent is defined by a bounding box indicated from bottom left (southern-western extent) to top right (northern-eastern extent).			
Extent description	M	1	Area or region or timeframe in which the item is valid.
Bounding box southern latitude	M	1	Latitude of bottom left (south-western extent) of bounding box being a value of ±90, northern hemisphere positive.
Bounding box western longitude	M	1	Longitude of bottom left (south-western extent) of bounding box being a value of ±180, eastern hemisphere positive.
Bounding box northern latitude	M	1	Latitude of top right (north-eastern extent) of bounding box being a value of ±90, northern hemisphere positive.
Bounding box eastern longitude	M	1	Longitude of top right (north-eastern extent) of bounding box being a value of ±180, eastern hemisphere positive.
Bounding polygon	O	1	Polygon containing area(s) or region(s). A polygon may contain many rings. For areas crossing the 180° meridian longitudes must not contain a discontinuity (refer to C.6.3).
Temporal extent start date	O	N	Start date for time frame in which the item is valid.
Temporal extent finish date	O	N	Finish date for time frame in which the item is valid.

Table B.16 — Requirements for a source citation

Attribute name	Obligation/ Condition	Maximum occurrences	Attribute description	Data type	Domain
Source citation
Source Citation Description: Source citation information. (ISO 19115-1:2014, B.3.2.1)
Source citation Title	M	1	The name by which the cited resource is known.	CharacterString	Free text
Source citation AlternateTitle	O	N	Short name or other language name by which the cited information is known.	CharacterString	Free text
Source citation author	M	1	Name and position information for an individual or organisation that is responsible for the resource.	Class	ISO 19115-1:2014, (B.3.2.2)
Source citation publisher	O	1	Name and position information for an individual or organisation that is responsible for the resource.	Class	ISO 19115-1:2014, (B.3.2.2)
Source citation publication date	C	1	Date of the publication (required if revision date is not provided).	Class	ISO 19115-1:2014, (B.4.2)
Source citation revision date	C	1	Date of the revision (required if publication date is not provided).	Class	ISO 19115-1:2014, (B.4.2)
Source citation edition	O	1	Version of the cited resource.	CharacterString	Free text
Source citation edition date	O	1	Date of the edition.	Class	ISO 19115-1:2014, (B.3.2.6)
Source citation name of series/journal/periodical	O	1	Name of the series/journal/periodical, or aggregate resource, of which the resource is a part.	CharacterString	Free text
Source citation issue	O	1	Information identifying the issue of the series.	CharacterString	Free text
Source citation page	O	1	Details on which pages of the publication the article was published.	CharacterString	Free text
Source citation other details	O	1	Other information required to complete the citation that is not recorded elsewhere.	CharacterString	Free text
Source citation online resource	O	1	Information about on-line sources from which the resource, specification, or community profile name and extended metadata elements can be obtained.	Class	ISO 19115-1:2014, (B.3.2.7)

Annex C
(informative)

Best practices for the ISO geodetic register content

C.1 Introduction

Standardization may be considered from two perspectives:

a) in an open way, where various conventions in actual use are all permitted and the standard requires that each be unambiguously described, however, the local convention is captured;

b) in a closed way, when a particular convention is mandated.

Advantages and disadvantages are:

a) open standardization allows data to be recorded as used, without the need for conversion to a closed standard;

b) closed standardization has the advantage of using a single defined format that enhances data interchange.

A closed standard reduces the cost of data interchange, particularly if it is introduced in an emerging environment. However, in a mature environment where many conventions have already been adopted, an open standard is more likely to meet with early acceptance.

The key information contained in a geodetic register are the values of ellipsoids, coordinate conversion and coordinate transformation parameters. Many independent coordinate operation methods have been and are in use globally.

This Annex describes commonly encountered conventions and recommends those to be used.

C.2 The representation of degrees

ISO 80000-3:2006 describes the document for angle units, such as the radian. Geographic coordinates (latitude and longitude) are usually expressed in whole circle measure [degrees, 1/360th circle, but note that degrees are not the only whole circle units used in geographic applications; a 1/400th circle (grad or gon) is also found]. For geographic information processing, the adoption of the radian as the standard for geographic coordinate system units is inconvenient, requiring the application of π (pi) to convert from whole circle measure to and from radian measure, with no standard for the precision to which it should be taken. The retention of geographic values in whole circle measure is recommended.

Geographic coordinates (latitude and longitude) are usually expressed as degrees, minutes and seconds with a hemisphere suffix abbreviation (N, S, E or W). This is a natural result of geographic position being correlated with time (given in hours, minutes and seconds). Degrees, minutes, seconds and hemisphere suffixes are inconvenient for data processing, requiring description through four separate fields. The conversion of minutes and seconds to decimal degrees can result in rounding problems. For the registry of geodetic codes and parameters, there are advantages in retaining original degree-minute-second values ("sexagesimal degrees"). ISO 6709:2008 codifies a concatenation in the form DDMMSS.ss ("sexagesimal DMS.s")." However almost all practical implementations use DD.MMSSss ("sexagesimal DMS"), which includes the ISO geodetic registry. For example, the sexagesimal DMS value 12°34'56.78"W is stored as –12.345678, which is in "sexagesimal DMS" form (refer to requirement 29).

C.3   Coordinate systems

C.3.1   Coordinate system axis direction

ISO 6709:2008 for geographic coordinates incorporates a convention where positive latitude is north of the equator and positive longitude is east of Greenwich (refer to requirement 28). Other conventions have been used.

The positive direction of a geocentric Cartesian coordinate system with an origin at the centre of the Earth is defined by the International Association of Geodesy. Z is along the Earth's rotation axis through the North Pole, X is in the plane of the equator and through the intersection of the prime meridian with the equator, and Y is in the plane of the equator forming a right-handed coordinate system (that is, through the intersection of longitude 90° east with the equator) (refer to requirement 30).

The positive direction of axes in a projected coordinate reference system is part of the system definition (refer to requirement 32). Although north and east predominate, south and west or north and west are found. To avoid confusion and the need to convert values, an open standard is desirable.

C.3.2   Coordinate system axis order and axis abbreviation

The coordinate system axis order is the order in which n-dimensional coordinates are quoted. Several conventions are found.

For projected coordinate reference systems there is a bias in English-speaking countries to present the abscissa (easting) first and the ordinate (northing) second. However, in much of central and eastern Europe and northern Asia, the normal practice is to present the ordinate (northing) first and the abscissa (easting) second. These practices may have followed the local adoption of abbreviations for the axes: in English-speaking countries the abscissa (easting) is often given the abbreviation X and the ordinate (northing) the abbreviation Y, whereas in central Europe the ordinate (northing) is given the abbreviation X and the abscissa (easting) the abbreviation Y. In a list of coordinates, in both cases the X coordinates precede the Y coordinates. An open standard requires that the adopted convention be reflected. In certain communities, such as NATO, a de facto closed standard is in use.

For other types of coordinate systems a closed standard is more applicable. Geocentric Cartesian coordinates shall always be presented in the order X, Y, Z. Geodetic or geographical coordinates in the geodetic and navigation communities shall be presented in the order latitude, longitude, ellipsoidal height or longitude, latitude, ellipsoidal height (refer to requirement 31). Despite ISO 6709:2008 codifying this, some English-language computer applications associate longitude with the projected X direction and present it before latitude, potentially confusing the navigator.

C.3.3   Coordinate system units

The units for projected coordinate reference systems will be implicitly defined through the units in which grid origin coordinates (false easting and false northing) are given. The ISO standard for linear units, as those given in ISO 80000-3:2006, is the metre. Historically, projected coordinate reference systems have used a variety of linear units. The non-metric systems have a complex array of conversion factors to metres, and rarely use the foot-metre conversion given in ISO 80000-3:2006. Some metric systems use metres of different length to the SI metre.

C.4   Coordinate operations

C.4.1   Coordinate operation methods

Coordinate operation parameter values are only meaningful when properly related to a coordinate operation method formula. Unfortunately, coordinate operation formula names are not sufficient identification of the formula. For instance, the map projection name "oblique stereographic" is found in many mathematical cartography references. Even those which distinguish between spherical and ellipsoidal formulas are not internationally consistent in their treatment of the ellipsoidal method.

This is because mapping of the ellipsoid requires assumptions to be made about the relationship of the map plane to the ellipsoid surface. Different approaches have made differing assumptions. A commonly cited U.S. reference for the oblique stereographic map projection calculates intermediate parameters conformal latitude and longitude at the projection origin only, whereas in Europe they are calculated at every point. Both approaches are valid, however, they are different. Applying U.S. formulae in Europe will give results that may differ by up to 100 m from those calculated using European formulae. Effectively, these are two different ellipsoidal map projection methods sharing the same name.

Coordinate transformation names may also be ambiguous. For example, a three-dimensional similarity transform of geocentric coordinates is often employed for medium accuracy geodetic datum transformations. This may sometimes be called the Bursa-Wolf method. However, there has been and is significant usage of two opposing conventions for the rotation parameters.

a) Rotations to be applied to the point's vector. The sign convention is such that a positive rotation about an axis is defined as a clockwise rotation of the position vector when viewed from the origin of the Cartesian coordinate system in the positive direction of that axis; e.g. a positive rotation about the Z-axis only from source system to target system will result in a larger longitude value for the point in the target system.

b) Rotations to be applied to the coordinate frame. The sign convention is such that a positive rotation of the frame about an axis is defined as a clockwise rotation of the coordinate frame when viewed from the origin of the Cartesian coordinate system in the positive direction of that axis, that is a positive rotation about the Z-axis only from source coordinate system to target coordinate system will result in a smaller longitude value for the point in the target coordinate system.

The rotation parameter values will have been derived using one of these two conventions. They may be validly applied only in algorithms using that convention. Application of the values in algorithms using the opposite convention will give erroneous results. This document uses both conventions with the proviso that the applied algorithm is valid for that convention (refer to requirement 34).

C.4.2   Coordinate operation reversibility

Many coordinate operation methods can be applied to the reverse operation. Some, for example map projections, require differing forward and reverse formulas but use the same coordinate operation parameters with unchanged coordinate operation parameter values. Some coordinate operation method formulas can be used for both forward and reverse transformations using the same parameters but with the sign of some or all of the parameter values being reversed. The generality is that coordinate operation parameter values are valid with a specific formula for a specific coordinate operation direction.

The ISO geodetic registry of geodetic codes and parameters should indicate whether coordinate operation methods may be used for the reverse operation. Formulas should clearly indicate the forward and (if applicable) reverse directions. Where coordinate operation methods are reversible the registry should indicate whether coordinate operation parameters are used in the reverse operation with the same or reversed sign.

The above provisions allow for coordinate operation parameter values to be stored only once for both forward and reverse operations, except where the method is not reversible (refer to requirement 37).

C.4.3   Coordinate transformation direction

The ISO geodetic register may include coordinate transformations between local coordinate reference systems and global coordinate reference systems. The direction for which the parameter values are valid is indicated by the identification of the source and target systems. Recommended practice is to make the local system the source and the global system the target.

C.4.4   Coordinate operation parameter value units

A wide range of linear and angular units are in use in coordinate reference systems and geodetic transformations. Conversion to the ISO 80000-3:2006 standard (metre and radian) is not trivial, either

due to complexities associated with linear conversion ratios or due to uncertainty in the precision of π (pi). An open standard allowing coordinate operation parameter units to be recorded in their native values is required.

For coordinate operation parameter values expressed in degrees (for example, coordinates of a map projection origin) the geodetic register should store values as "sexagesimal degrees" (see C.2).

The ISO geodetic register should identify the unit for each parameter and include the conversion ratio required to change that unit to the ISO standard unit (metre and radian for linear and angle units, respectively). Scalars should include the conversion ratio required to change the scalar to unity (refer to requirement 39).

C.4.5   Zoned map projections

There are many instances where a map projection has been applied on a zoned basis, with a subset of the parameter values being unchanged throughout all zones. Whilst human beings can interpret words describing the common elements, machine readability of free text is much more complex.

The ISO geodetic register should present each set of coordinate reference system information in a machine-readable form. Zoned map projections can be accommodated either by recording each zone individually, or by documenting a coordinate operation method whose formulas and defined parameters account for the zoning. Recording individual zones is the recommended approach (refer to requirement 40).

C.5   Ellipsoid parameters

Ellipsoids have a number of parameters, only two of which are necessary to define the size and shape of the ellipsoid. Some of these parameters such as eccentricity (e) are frequently encountered as variables within coordinate operation formulas. However, such parameters are usually derived and require more significant digits than users' document. The two parameters documented for many ellipsoids have been semi-major axis radius (a) and semi-minor axis radius (b). ISO 19111:2007 requires that ellipsoids be defined through the two parameters which are the semi-major axis radius (a) and either the inverse of the flattening (1/f) or the semi-minor axis (b). From these parameters other required parameters may be derived. The ISO geodetic register should use the semi-major axis radius (a) and the inverse of the flattening (1/f) as defining parameters for the ellipsoid. Where the inverse of the flattening (1/f) is derived from other parameters, it should be captured to a precision of not less than 10 significant digits (refer to requirement 41).

C.6   Extent

C.6.1   General

The Reference System class is defined in ISO 19115 and ISO 19111:2007 references this definition. The Reference System has two attributes, which are:

— a name, which is mandatory;

— a domain of validity, being the extent, which is optional.

The domain of validity of a geodetic entity (coordinate reference system, datum, coordinate conversion or coordinate transformation) has the following components:

— a geographic element, which may be:

— a bounding polygon;

— a geographic bounding box;

— a geographic identifier;

— a vertical element, with minimum and maximum depths referenced to a vertical CRS;

— a temporal element, with start and finish dates;

— a text description (which may cover any or all of the three elements).

All of these components are optional, but at least one shall be given.

The elements relevant to CRS are bounding polygon, geographic bounding box and the text description. Bounding polygon and geographic bounding box use coordinates and there are constraints on the values.

C.6.2   Bounding box

A bounding box is an arc-rectangle bounded by parallels and meridians. Four attributes are defined (west-most longitude, east-most longitude, south-most latitude and north-most latitude). Latitudes shall be in the range −90° to +90° and longitudes shall be in the range −180° to +180°. The longitude definition is ambiguous as it describes a full cycle and it is not possible to differentiate between a bounding box that crosses the 180° meridian from another that does not.

This longitude ambiguity may be removed by assuming that the box is "north up" and interpreting the west-most longitude and east-most longitude as left-most longitude and right-most longitude. The bounding box that does not cross the 180° meridian (the general case) will have a western (left) longitude value that is less than the eastern (right) longitude value. The bounding box crossing the 180° meridian will have a western (leftmost) longitude value that is greater than the eastern (right-most) meridian. An example would be a bounding box for the New Zealand continental shelf, which will span from approximately 160°E across the 180° meridian to 171°W, or +160° to −171° (refer to requirement 55).

C.6.3   Bounding polygon

A bounding polygon cannot be restricted to longitudes in the range −180° to +180°. ISO 19107 requires that the longitudes contain no discontinuity. A polygon for the New Zealand continental shelf with +160° on its western (left) side and −171° on its eastern (right) side would be invalid. To remedy this 360° should be added to the longitude of vertices east of the 180° meridian, or subtracted from the longitude of vertices west of the 180° meridian. Here the longitude range should be either from −200° to −171° or from 160° to 189°. Best practice is to choose that range which is mostly within the range −180° to +180°, in this case it is 160° to 189°.

C.6.4   Temporal extent

A temporal extent provides the start and end dates (and times) for which a geodetic entity is valid. Dates and times should accord with ISO 8601:2004.

C.7   Element naming

C.7.1   General

For human understanding, there shall be a name associated with the code.

C.7.2   Names and abbreviations

An ideal naming convention would honour locally-accepted names and also ensure that all names are unique. Given the historic practice associated with geodetic parameters, these two aims are mutually exclusive.

C.7.3 Coordinate systems

Coordinate systems do not have well-known names. They should be allocated a name which is descriptive, for example (refer to requirement 42):

Cartesian 2D CS. Axes: easting, northing (E,N). Orientations: east, north. UoM: m.

Ellipsoidal 2D CS. Axes: latitude, longitude. Orientations: east, north. UoM: deg.

C.7.4 Datums

Datums are allocated a name, usually in English, which corresponds to the local naming of the reference frame and realization date. This may be the name of the fundamental point, network adjustment, etc.

C.7.5 Geographic coordinate reference systems

Geographic coordinate reference systems (GeogCRS) are allocated the name of the related geodetic datum abbreviation (if it exists), or the geodetic datum full name, appended by a reference identifying the applicable coordinate system axes, for example (refer to requirement 43):

NAD83 (CSRS) v6 – LatLon

NAD83 (CSRS) v6 – LonLat

NAD83 (CSRS) v6 – LatLonEHt

NAD83 (CSRS) v6 – LonLatEHt

This is NAD83 (CSRS) version 6 with the applicable two-dimensional and three-dimensional coordinate system axes references that make up the CRS name.

NOTE   The ellipsoidal height (EHt) is an inseparable part of a three-dimensional GeogCRS.

In choosing the geogCRS name, consideration should be given to its use as part of a projected coordinate reference system name (see C.7.8).

Following the provisions of ISO 19111:2007, a change in any part of a coordinate reference system, including units, causes the CRS to be changed. However, latitude and longitude in degrees are an exception. When the latitude and longitude unit is degree, any one of the representations described in C.2 is implied. The registry will record the geogCRS axis unit as degree. The two recognized display formats will not be tabulated as duplicate CRSs.

C.7.6 Geocentric Cartesian coordinate reference systems

Geocentric Cartesian coordinate reference systems are allocated the name of the related geodetic datum abbreviation (if it exists), or the geodetic datum's full name, appended by the reference identifying the coordinate system axes, for example (refer to requirement 43):

NAD83 (CSRS) v6 – XYZ

This is NAD83 (CSRS) version 6 with the three-dimensional Cartesian coordinate system axes reference that make up the CRS name.

C.7.7 Map projections

Map projections are allocated a name which corresponds to the local naming convention. A country prefix or suffix may be added when local naming might result in ambiguity in a global database.

For a Transverse Mercator projection which takes UTM parameter values other than central meridian, the name comprises TM, space, longitude of natural origin value, space, two characters to indicate hemisphere quadrant. For example:

TM 56 SW a projection with origin at 0°N, 56° W, scale factor of 0,999 6, false easting of 500 000 m and false northing of 10 000 000 m.

C.7.8 Projected coordinate reference systems

Projected coordinate reference systems (ProjCRS) are allocated a name comprising the GeogCRS abbreviation (if it exists) or name, space/space, projection abbreviation (if it exists) or name, for example (refer to requirement 44):

ED50 / UTM zone 30N

Most projected coordinate reference systems have defined axis units. Changes of units to an arbitrary user preference will not be tabulated in the ISO geodetic registry. External registries may record such systems using a different code and name. Occasionally, a projected coordinate reference system will be officially used in different units. In these instances, the abbreviation for the units for the secondary usage will be included in the name, for example:

NAD83 / Virginia North   *CRS uses metres*

NAD83 / Virginia North (ftUS)   *CRS uses U.S. survey feet*

NAD83 / Arizona East (ft)   *CRS uses international feet*

C.7.9 Vertical coordinate reference systems

Vertical coordinate reference systems (VertCRS) are allocated the name of the related vertical datum abbreviation (if it exists) or of the vertical datum name, appended by the reference identifying the coordinate system axes, for example (refer to requirement 43):

FictHD – OHt, FictHD – DHt, FictHD – NHt, FictHD – NOHt, FictHD - GPU

These represent fictitious height datums that have a one-dimensional coordinate system axis reference for orthometric heights (OHt), dynamic heights (DHt), normal heights (NHt), normal orthometric heights (NOHt) and geopotential units/numbers (GPU) that make up the CRS name.

NOTE   These heights are, generally, related to the direction of gravity. It is possible that this relationship is not straightforward.

C.7.10 Compound coordinate reference systems

Compound coordinate reference systems are allocated a name comprising the GeogCRS or ProjCRS abbreviation (if one exists) or name, space+space, VertCRS abbreviation (if one exists) or name, for example (refer to requirement 45):

NAD83 + NAVD88

NAD83 / UTM zone 15N + NAVD88

C.7.11 Coordinate transformations

Coordinate transformations are allocated a name comprising source CRS abbreviation (if one exists) or name, space, "to", space, target CRS abbreviation (if one exists) or name, space, (transformation version), for example (refer requirement 46):

ED50 to ETRS89 (NMA-Nor N65 1997)

The transformation version describes the data source, area of applicability and/or date of the transformation.

Where transformations are reversible, and a source or target CRS is a realization of the ITRS (e.g. ETRS89), then the transformation should be entered in the direction from local to ITRF, i.e. ED50 to ETRS89, and not ETRS89 to ED50 (refer to requirement 38).

C.8 Transformation version

The geogCRS name, and for projected CRSs the geogCRS element of the projCRS name, should be modified to the GeogCRS abbreviation (if it exists) or name, space*space, transformation version. For example:

GeogCRS name: *ED50 * IGN-Fra*

ProjCRS name: *ED50 * NMA-Nor N62 2001 / UTM zone 32N*

The ISO geodetic registry should separately document coordinate reference systems and transformations between CRSs. It therefore will not use this naming convention. However, to standardize naming across applications that use the aforementioned practice, transformations should be allocated a transformation version. Transformation versions should be constrained to be unique within any particular pair of source and target CRSs. The version comprises a cryptic indication of the information source for the transformation (usually the organization's initials), - (hyphen), the ISO three-character country code, and if the transformation is not applicable to a complete country, a cryptic indication of its area or scope. For example:

IGN-Fra   a transformation for all France from the Institut Géographique National (IGN).

IGN-Fra NW   a transformation for northwest France from the IGN.

To facilitate this, the registry should include a cryptic transformation version for each coordinate transformation.

C.9 Grid lookup table

An example of a coordinate transformation using a grid lookup table is given in Table C.1.

Table C.1 — Coordinate transformation using a grid lookup table

Element name	Entry	Comment
Coordinate operation identifier	TKY2JGD	
Coordinate operation valid area	Japan	
Coordinate operation scope	Coordinate transformation for surveying and mapping on lands	
Source coordinate reference system identifier	TD/(B, L)	Tokyo Datum
Target coordinate reference system identifier	JGD2000/(B, L)	Japanese Geodetic Datum 2000
Coordinate operation version	TKY2JGD ver.2.0.5	
Coordinate operation method name	Longitude and latitude differences	
Coordinate operation method name alias	Grid lookup table transformation	