International Association of Oil & Gas Producers

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EPSG Guidance Note 373-07-1

Understanding the EPSG Geodetic Parameter Dataset

EPSG GEODETIC PARAMETER DATASET

https://epsg.org

Acknowledgements

This Report was written by the Geodesy Subcommittee of the IOGP Geomatics Committee.

About

The EPSG Dataset contains definitions of coordinate reference systems (CRS) and transformations and conversions between them. This Report is part of a series providing guidance to users of the EPSG Dataset. The series provides users with concise background information, clear definitions (including mathematical formulas), examples, and discussion. This Report is intended for end users such as geodesists and data managers at energy companies that seek geodetic information in a specific project area or new working area.

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Understanding the EPSG Geodetic Parameter Dataset

Revision history

VERSION	DATE	AMENDMENTS
1	October 2004	First release, GN7 part 1. Former GN7 now released as part 2.
1.1	November 2004	Minor editorial corrections to text. Annex E SQL scripts updated.
2	April 2006	Amendment to deprecation rules. Updated references to EPSG.
2.1	February 2007	Deprecation rules updated. Policy on code uniqueness clarified. Additional information on user update utility added. Minor editorial corrections to text.
3	July 2007	Use of data conditions amended. Annex F added.
4	May 2009	Major revision to include web registry as GN7 part 3. Access- and SQL-specific discussion moved to new GN7 part 4. This document covers issues common to both registry and relational implementations.
5	November 2009	Minor amendments to clarify sections 4.4, 5.11 and 5.12.
6	November 2010	Changes to some method names in Terms of Use.
7	June 2011	Change to Deprecation rules in Appendix B.
8	August 2012	Added discussion of area polygons, corrected code range for deprecated geographic CRSs with coordinates in explicitly described degree representations
9	March 2025	Updated as part of ISO 19111:2019 revision and new Online Registry implementation (https://epsg.org/). Moved policies to IOGP Report 373-07-6.

Contents

Introduction

The EPSG Geodetic Parameter Dataset, abbreviated to the **EPSG Dataset**, is a repository of parameters required to:

- define a *coordinate reference system* (CRS) which ensures that coordinates describe position unambiguously;
- define transformations and conversions that allow coordinates to be changed from one CRS to another CRS. Transformations and conversions are collectively called *coordinate operations*.

The EPSG Dataset is maintained by the IOGP. It conforms to ISO 19111:2019 – *Referencing by coordinates*. It is distributed in three ways:

i. the EPSG Registry, in full the *EPSG Geodetic Parameter Registry*, a web-based delivery platform with a graphic user interface (GUI) and an application programming interface (API). From this repository descriptions of CRSs and transformations may be output in well-known text (WKT) conformant to ISO 19162 or as GML documents
ii. the EPSG Database, in full *the EPSG Geodetic Parameter Database*, an MS Access relational database with content derived from the online registry
iii. in a relational data model as SQL scripts which enable a user to create an Oracle, MySQL, PostgreSQL, or other relational database and populate that database with the EPSG Dataset

The terms of use of the EPSG Dataset are available here.

IOGP Reports 373-07-01 through 373-07-06 form a multi-part document for users of the EPSG Dataset

- IOGP Report 373-07-01 (EPSG Guidance Note 7-1) – *Understanding the EPSG Dataset*, (this document), sets out detailed information about the Dataset content and its maintenance.
- IOGP Report 373-07-02 (EPSG Guidance Note 7-2) – *Coordinate conversions and transformations including formulas*, provides a detailed explanation of formulas necessary for executing coordinate conversions and transformations using the coordinate operation methods supported in the EPSG Dataset. Geodetic parameters in the EPSG Dataset are consistent with these formulas.
- IOGP Report 373-07-03 (EPSG Guidance Note 7-3) – *EPSG Registry API user guide*, is primarily intended to assist computer application developers who wish to use the RESTful API of the EPSG Registry to query and retrieve entities and attributes from the Dataset.
- IOGP Report 373-07-04 (EPSG Guidance Note 7-4) – *EPSG Database and SQL Script user guide*, provides guidance for users of the EPSG Database and SQL Scripts; these may be obtained from the EPSG Registry's *Download Dataset* page.
- IOGP Report 373-07-05 (EPSG Guidance Note 7-5) – *EPSG null and copy transformations to WGS 84*, explains aspects of the policies for the inclusion in the EPSG Dataset of datum ensembles and so-called null coordinate transformations to WGS 84, including limitations in the description of WGS 84 through code EPSG:4326.
- IOGP Report 373-07-06 (EPSG Guidance Note 7-6) – *EPSG Dataset - Policies and procedures for data management*, (this document), documents strategy for populating the EPSG Dataset.

The complete texts may be found on the EPSG Registry web site under Support Documentation.

This Part 2 of the multi-part Guidance Note is primarily intended to assist computer application developers in using the coordinate operation methods supported by the EPSG Dataset. It may also be useful to other users of the data.

1. Background

Coordinates describing a position on or near the Earth's surface are referenced to a model of the earth rather than to the Earth itself. There are many models, and each model may be located with respect to the real Earth in several different ways. The consequence is that one position on the real Earth may be represented by multiple sets of coordinates, each referenced to different models. Furthermore, the direction, order, and units of the coordinate system axes are subject to variation. Hence, without a set of geodetic parameters which identify the model and its relationship to the Earth, together with the coordinate system axes, coordinates are ambiguous.

The European Petroleum Survey Group created a dataset of geodetic parameters in 1985 for internal use of its members. In 1993, the dataset was made public as reference data to the Petrotechnical Open Software Corporation data model (POSC has since changed its name to Energistics). In 2005, the European Petroleum Survey Group was disbanded and reformed as the Geomatics Committee of the International Association of Oil and Gas Producers (IOGP). Maintenance of the EPSG Dataset now resides with the IOGP Geomatics Committee's Geodesy Subcommittee. For continuity reasons, the Dataset name remains as the EPSG Geodetic Parameter Dataset, or, in short, the EPSG Dataset.

The terminology used in this Guidance Note follows that defined in ISO 19111, *Geographic information – Referencing by coordinates*. This was introduced in the late 1990s. It standardizes terms that were in use in different communities and different countries. Some terms used colloquially in the oil industry are used differently in ISO 19111 and this Guidance Note. In particular, the colloquial term "coordinate system" is "coordinate reference system" in this Guidance Note, whilst coordinate system as used in this Guidance Note has a narrower meaning (discussed in Section 2.1) than that used colloquially. The colloquial term "datum shift" is transformation in ISO 19111 and this Guidance Note. Further ISO terms and their colloquial equivalents are given in Iliffe and Lott.[1]

Purpose and intended audience

The purpose of Guidance Note 373-07 is to maximize the benefits of the EPSG Dataset and Registry for its users. This is done by providing detailed but concise background information, clear definitions (including mathematical formulas), examples and discussion. A good understanding of the ISO 19111 data model and population policies is helpful to be able to find information in the EPSG Dataset.

This Part 1 is intended for end users such as geodesists and data managers at energy companies that seek geodetic information in a specific project area or new working area. Furthermore, it may be beneficial to computer application developers who intend to create applications containing the EPSG Dataset or are working with EPSG codes and methods in software.

[1] Iliffe J and Lott R. Datums and Map Projections, 2nd Ed. Dunbeath, Whittles Publishing, 2012.

Policies and procedures described in the document support consistent maintenance of the Dataset, ensuring a high quality of reliable information.

2. Data Model Concepts

2.1. Coordinates

A high-level abstract model for spatial referencing by coordinates is shown in Figure 1.

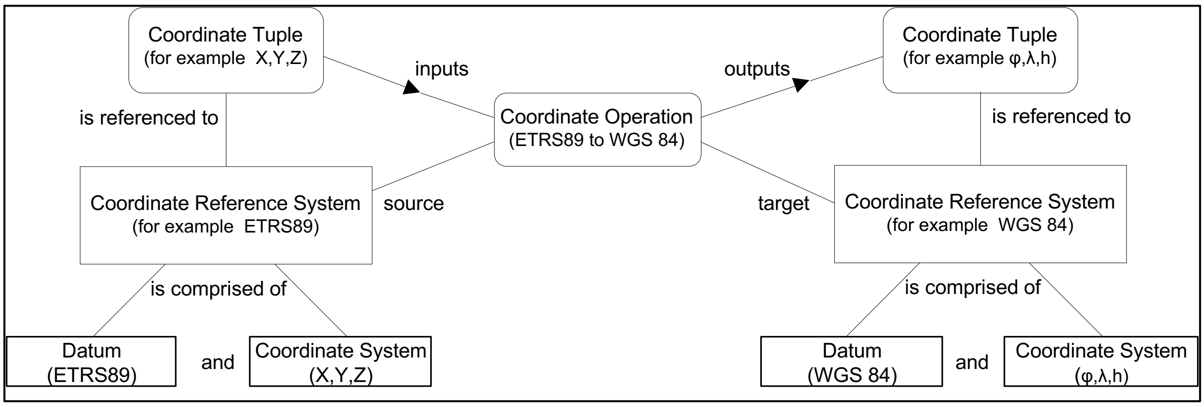

Figure 1: Referencing by coordinates.

A coordinate is one of a sequence of values describing a position. The sequence is sometimes called a coordinate tuple. Coordinates are referenced to a *coordinate reference system* (CRS). A coordinate reference system is a *coordinate system* (CS) – an abstract mathematical concept without any relationship to a physical object – that is referenced through a *datum* to the Earth or some other object such as a vessel. A *coordinate operation* may be used to change coordinate values which are referenced to one CRS to being referenced to a second CRS.

Coordinate reference systems may be classified as static or dynamic. The perspective is that of a stationary observer on the surface of the Earth observing the coordinate values over time. If the coordinate reference system is anchored to one of the Earth's tectonic plates, the observer moves with the CRS and sees no change of coordinate value with time. If the coordinate reference system is fixed to the Earth as a whole, the observer moves with the tectonic plate through the global coordinate space and coordinates in a dynamic CRS change with time. A set of coordinates referenced to a dynamic CRS requires coordinate epoch to be given. Coordinate epoch is not part of a CRS definition, although the CRS description informs whether the CRS is dynamic. Static and dynamic coordinate reference systems and coordinate epoch are described in IOGP Report 373-25 – *Geomatics Guidance Note 25 – Dynamic versus Static CRSs and Use of the ITRF*.

The EPSG Dataset stores the definitions for CRSs and coordinate operations in a relational data model. The current version of the data model was introduced from September 2020 in dataset version 10. It is shown schematically in Figure 2. Further details of the entities in this diagram are given in the following sections.

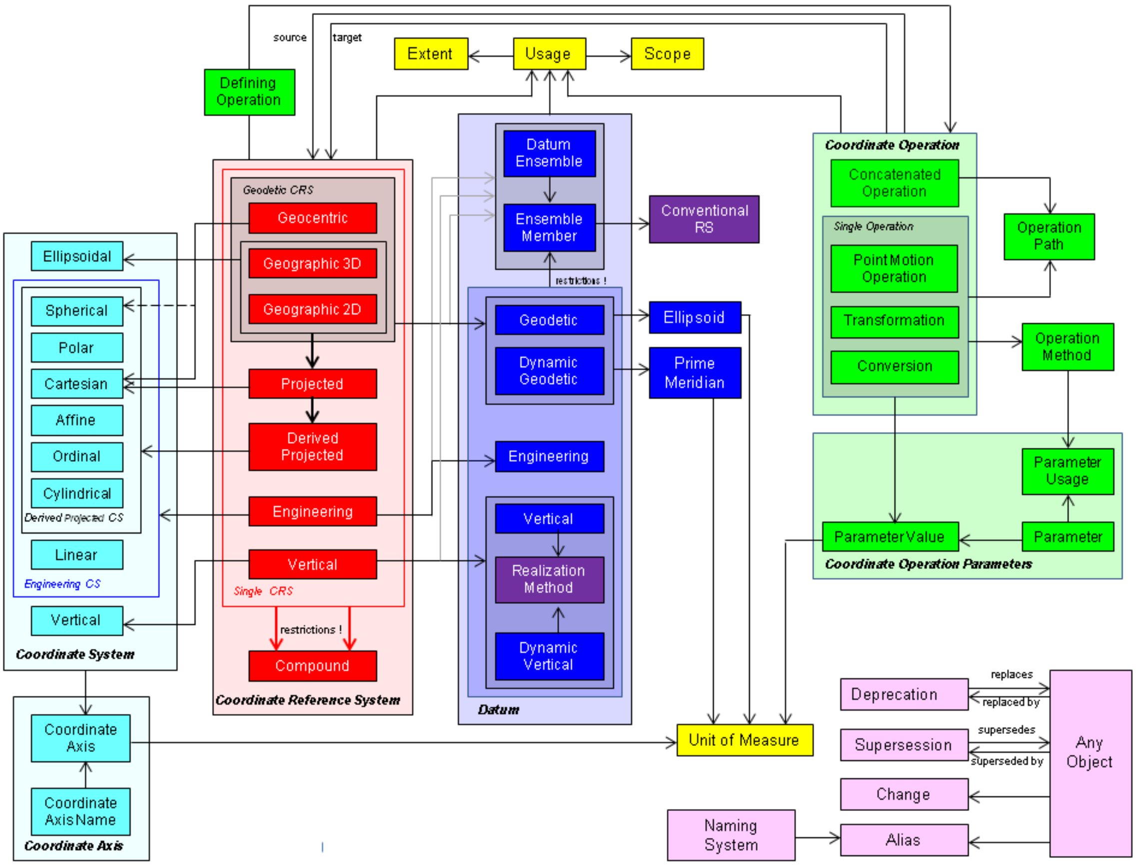

Figure 2: EPSG Dataset data model overview (v10, September 2020).

2.2. Coordinate Reference Systems

Most *coordinate reference systems* (CRSs) consist of one *coordinate system* that is related to an object through one *datum*. For the CRSs of interest to the EPSG Dataset, that object is the Earth.

A *coordinate system* (CS) is a sequence of coordinate axes with specified units of measure. A coordinate system is an abstract mathematical concept without any defined relationship to the Earth. Coordinate systems generally have not been explicitly described in geodetic literature, and they rarely have well-known names by which they are identified. The historic colloquial use of 'coordinate system' usually meant coordinate reference system.

A *datum* specifies the relationship of a coordinate system to the Earth, thus ensuring that the abstract mathematical concept can be applied to the practical problem of describing positions of features on or near the Earth's surface by means of coordinates. In modern geodesy, *'reference frame'* is sometimes used instead of *datum*.

Coordinate reference systems, coordinate systems, and datums are each classified into several subtypes. Each coordinate system type can be associated with only specific types of coordinate reference system. Similarly, each datum type can be associated with only specific types of coordinate reference system. Thus, indirectly through their association with CRS types, each coordinate system type can only be associated with specific types of datum.

2.2.1. Coordinate Reference Systems subtypes

Geodetic survey practice usually divides coordinate reference systems into a number of sub-types. The common classification criterion for sub-typing of coordinate reference systems can be described as the way in which they deal with earth curvature. This has a direct effect on the portion of the Earth's surface that can be covered by that type of CRS with an acceptable degree of error.

The following types of coordinate reference system are distinguished in the ISO 19111 data model which the EPSG Dataset follows:

a) Geographic. A coordinate reference system based on a geodetic datum and using an ellipsoidal (including spherical) model of the Earth. This provides an accurate representation of the geometry of geographic features for a large portion of the Earth's surface. Geographic coordinate reference systems can be two- or three-dimensional.

- A Geographic 2D CRS is used when positions of features are described on the surface of the ellipsoid through latitude and longitude coordinates.

- A Geographic 3D CRS is used when positions are described on, above or below the surface of the ellipsoid and includes ellipsoidal height (positive) above the ellipsoid. These ellipsoidal heights (*h*) cannot exist independently, but only as an inseparable part of a 3D coordinate tuple defined in a geographic 3D coordinate reference system. Thus, ellipsoidal heights cannot be referenced to a *vertica*l coordinate reference system.

b) Geocentric. A coordinate reference system based on a geodetic datum that deals with the Earth's curvature by taking the 3D spatial view, which obviates the need to model the curvature. The origin of a geocentric CRS is (nominally) at the centre of mass of the Earth and the centre of the ellipsoid is coincident with the CRS origin.

ISO 19111 classifies both geographic and geocentric coordinate reference systems as geodetic CRSs.

c) Projected. A coordinate reference system that is based on a geographic CRS and then uses a map projection to convert the coordinates to a plane. The distortion that is inherent to the process is carefully controlled and known. Distortion correction is commonly applied to calculated bearings and distances to produce values that are a close match to observed field values. One geographic CRS may serve as the base for many projected CRSs. One map projection may be applied independently to many geographic CRSs.

d) Derived projected. A coordinate reference system that is derived from a projected CRS through a conversion. The derived projected CRS then inherits the geodetic datum of the projected CRS, as well as the distortion characteristics of the projected CRS's map projection. Seismic bin grids typically are derived projected CRSs, where the conversion is in mathematical terms an affine transformation.

e) Engineering. A coordinate reference system that is used only in a contextually local sense. This sub-type is used to model two broad categories of local coordinate reference systems:

- Earth-fixed systems, applied to engineering activities over a local area on or near the surface of the Earth.

- Coordinates on moving platforms such as road vehicles, vessels or aircraft.

Earth-fixed Engineering CRSs are commonly based on a simple flat-earth approximation of the Earth's surface, and the effect of earth curvature on feature geometry is ignored: calculations on coordinates use simple plane arithmetic without any corrections for earth curvature. The application of such Engineering CRSs to relatively small areas and "contextually local" is in this case equivalent to "spatially local".

f) **Vertical**. A one-dimensional coordinate reference system where the axis is height or depth in the Earth's gravity field.

g) **Parametric**. A coordinate reference system that uses parameters or parametric functions for a coordinate system axis. Parametric CRSs and their components are outside the scope of the EPSG Dataset.

h) **Temporal**. A coordinate reference system where the coordinate axis is time. Temporal CRSs and their components are outside the scope of the EPSG Dataset.

i) **Compound**. In historic geodetic practice, horizontal and vertical positions were determined independently. It is established practice to combine the horizontal coordinates of a point with a height or depth from a different coordinate reference system. This has resulted in coordinate reference systems that are horizontal (2D) and vertical (1D) in nature, as opposed to truly three dimensional. The coordinate reference system to which these 2D+1D coordinates are referenced combines the separate horizontal and vertical coordinate reference systems of the horizontal and vertical coordinates. Such a system is called a compound coordinate reference system (CCRS). It consists of a non-repeating sequence of two or more single coordinate reference systems.

For spatial coordinates, a number of constraints exist for the construction of compound CRSs. Coordinate reference systems that are combined should not contain any duplicate or redundant axes. Valid combinations include:

- geographic 2D and vertical
- geographic 2D and engineering 1D (near vertical)
- projected and vertical
- projected and engineering 1D (near vertical)
- engineering (horizontal 2D) and vertical
- engineering (1D linear) and vertical
- derived projected and vertical
- derived projected and engineering 1D (near vertical)

2.2.2. Coordinate System

The coordinates of points are recorded in a coordinate system (CS). A CS is an abstract mathematical concept that is not tied to any physical or virtual object. A coordinate system is the set of coordinate system axes that spans the coordinate space. Implicit are the mathematical rules that define how coordinate values are calculated from distances, angles and other geometric elements, and vice versa. EPSG recognizes several types of coordinate system, differentiated by the geometric properties of the coordinate space spanned and the geometric properties of the axes themselves (straight or curved; perpendicular or not). Each CS type may be associated with only specific types of CRS. The following types of coordinate system are relevant for geodetic, projected, vertical, and engineering CRSs:

- Ellipsoidal. A two- or three-dimensional coordinate system in which position is specified by geodetic latitude, geodetic longitude and (in the three-dimensional case) ellipsoidal height. The ellipsoidal height direction is exactly perpendicular to the surface of the ellipsoid. An ellipsoidal CS may be associated with one or more geographic CRSs.

- Vertical. A one-dimensional coordinate system dependent on the Earth's gravity field used to record the heights (or depths) of points. The gravity field is perpendicular to the geoid and in general is not exactly perpendicular to the surface of the ellipsoid used to model the Earth. A vertical CS may be associated with one or more vertical CRSs.

- Cartesian. Coordinate system in Euclidean space which gives the position of points relative to n mutually perpendicular straight axes all having the same unit of measure. For the purposes of this document, n is two- or three-dimensional. A Cartesian coordinate system is a specialization of an affine coordinate system.

- Affine. Coordinate system in Euclidean space with straight axes that are not necessarily mutually perpendicular.

- Linear. A one-dimensional coordinate system that consists of the points that lie on the axis of a linear feature, for example a pipeline. A linear CS may be associated with one or more engineering CRSs.

- Ordinal. An n-dimensional coordinate system in which every axis uses integers. An ordinal CS may be associated with one or more engineering or derived-projected CRSs.

- Spherical. A two- or three--dimensional coordinate system with two angular coordinates and (in the 3-dimensional case) one distance measured from the origin. Not to be confused with an ellipsoidal coordinate system based on an ellipsoid 'degenerated' into a sphere. A spherical CS may be associated with one or more geodetic or engineering CRSs.

- Polar. A two-dimensional coordinate system in which position is specified by distance from the origin and the angle between the line from origin to point and a reference direction. A polar CS may be associated with one or more engineering CRSs.

- Cylindrical. A three-dimensional coordinate system consisting of a polar coordinate system extended by a straight coordinate axis perpendicular to the plane spanned by the polar coordinate system. A cylindrical CS may be associated with one or more engineering CRSs.

The vast majority of CRSs documented in the EPSG Dataset use one of the first three types of coordinate systems: Cartesian, ellipsoidal, or vertical.

2.2.3. Coordinate System axes

A coordinate system is composed of a non-repeating sequence of coordinate system axes. Each axis is completely characterized by a unique combination of axis name, axis abbreviation, axis direction and axis unit of measure.

The concept of coordinate axis requires some clarification. Consider an arbitrary *x, y, z* coordinate system. The *x*-axis may be defined as the locus of points with *y* = *z* = 0. This is easily enough understood if the *x, y, z* coordinate system is a Cartesian system and the space it describes is Euclidean. It becomes bit more difficult to understand in the case of a strongly curved space, such as the surface of an ellipsoid, its geometry described by an ellipsoidal coordinate system (2D or 3D). Applying the same definition by analogy to the curvilinear *latitude* and *longitude* coordinates the latitude axis would be the equator and the longitude axis would be the prime meridian, which is not a satisfactory definition. Bearing in mind that the order of the coordinates in a coordinate tuple should be the same as the defined order of the coordinate axes, the '*i*-th' coordinate axis of a coordinate system is defined as the locus of points for which all coordinates with sequence number not equal to '*i*', have a constant value locally (whereby *i* = 1...*n,* and *n* is the dimension of the coordinate space).

It will be evident that the addition of the word 'locally' in this definition apparently adds an element of ambiguity and this is intentional. The specified direction of the coordinate axes is often only approximate. For example, geodetic latitude is defined as the "angle from the equatorial plane to the perpendicular to the ellipsoid through a given point, northwards treated as positive". However, when used in an ellipsoidal coordinate system the geodetic latitude axis will be described as pointing 'north'. At two different points on the ellipsoid the direction 'north' will be a spatially different direction, but the concept of latitude is the same.

In a number of cases, usage of coordinate system axis names is constrained by geodetic custom, depending on the coordinate reference system type. These constraints are shown in Table 1. This constraint works in two directions; for example, the names 'geodetic latitude' and 'geodetic longitude' should be used to designate the coordinate axis names associated with a geographic coordinate reference system. Conversely, these names should not be used in any other context.

Table 1: Some naming constraints for coordinate system axis

CS	CRS	Permitted coordinate system axis names
Cartesian	geocentric	geocentric X, geocentric Y, geocentric Z
Cartesian	geographic	topocentric U, topocentric V, topocentric W
Cartesian	projected	northing or southing, easting or westing
ellipsoidal	geographic	geodetic latitude, geodetic longitude, ellipsoidal height (if 3D)
spherical	geocentric	spherical latitude, spherical longitude, geocentric radius (if 3D)
vertical	vertical	depth or gravity-related height

Engineering coordinate reference systems may make use of names specific to the local context or custom and are therefore not included as constraints in the above list.

2.2.4. Datum

A datum or reference frame implies a choice regarding the origin and orientation of the coordinate system. It is the datum that makes the coordinate reference system and its coordinates unambiguous. EPSG recognizes five types of datum: geodetic, dynamic geodetic, vertical, dynamic vertical, and engineering. In addition, EPSG recognizes the concept of a *datum* *ensemble*.

A **vertical** datum defines the relationship of a gravity-related vertical coordinate system to the Earth. An **engineering** datum defines the relationship of a coordinate system used for engineering purposes to the Earth or some other object. For both vertical and engineering types, the most important datum attribute is its name, which implies the relationship. A **geodetic** datum defines the relationship of a geographic or geocentric coordinate reference system to the Earth. In addition to the datum name (which again implies the relationship), essential attributes of a geodetic datum are the chosen model of the Earth – the **ellipsoid** – including details of its name and defining parameter values, together with the details of the zero or **prime meridian** from which longitudes are reckoned.

Geodetic and vertical datums may be classified as **static** or **dynamic**. They are static if they are not explicitly dynamic. This state is inherited by coordinate reference systems using the datum.

The concept of a **datum ensemble** is described in IOGP Report 373-07-5 – *EPSG null and copy transformations to WGS 84.* A datum ensemble is a group of closely related realizations of the same conventional reference system, modelled as subtype of datum. Its utility lies in the fact that datasets referenced to the different realizations within a datum ensemble may be merged without coordinate transformation for approximate spatial referencing purposes (where 'Approximate' is for users to define but typically is in the order of under one decimetre but may be up to two metres).

2.2.5. Ellipsoid

The Earth's surface is highly irregular and therefore difficult to compute across. Spatial computations are simplified by modelling the Earth as an oblate ellipsoid (historically colloquially called a spheroid). Two parameters are required to describe the size and shape of an oblate ellipsoid. Historically the dimensions of the semi-major and semi-minor axes were defined. More recently the semi-major axis and inverse flattening, a ratio derived from the semi-major and semi-minor axes, have been used. Other ellipsoid parameters, such as its eccentricity may be needed for coordinate conversion. These may be derived from the two defining parameters.

2.2.6. Prime Meridian

A graticule of latitude and longitude values is applied to the ellipsoid. Latitude has a natural starting point in the equator. There is no natural starting point for longitude. An arbitrarily defined starting point is adopted, known as the prime meridian. Historically, national systems usually adopted the meridian through their national astronomical observatory as the starting point for longitude. The meridian through Greenwich, England, has been accepted as the international norm for over a century, but its adoption for geodetic purposes has lagged somewhat. Longitudes based on other prime meridians, such as Paris, remain in use today. Longitude is unambiguous only when the prime meridian is defined.

2.3. Coordinate Operations

A coordinate operation changes coordinate values which are referenced to a source coordinate reference system to coordinate values which are referenced to a second (target) coordinate reference system. A coordinate operation is often popularly said to "*transform coordinate reference system A into coordinate reference system B*". Coordinate operations do not operate on coordinate reference systems, but on coordinates.

The EPSG Dataset recognizes the following types of coordinate operation:

- Conversion – a coordinate operation where both source and target coordinate reference systems are based on the same datum. The most frequently encountered conversion is a map projection. This changes coordinates between geographic and projected (i.e., grid) values, or vice-versa.
- Transformation – a coordinate operation where source and target coordinate reference systems are based on different datums.
- Point Motion Operation – a coordinate operation that changes coordinates within a coordinate reference system due to the motion of the point. The change of coordinates is from those at an initial epoch to those at another epoch. In this document the point motion is due to tectonic motion or crustal deformation.
- Concatenated operation – a series of conversions, transformations or point motion operations executed in sequence. In practice concatenated operations are a series of transformations.

2.3.1. Coordinate Operation methods

Every conversion, transformation, and point motion operation has a method – a mathematical formula applied to coordinates. The formulas are generally differentiated by name. Unfortunately, names do not always refer uniquely to a particular formula – some names can apply to different formulas which produce significantly different results. This is especially the case with map projections where the name does not differentiate between approximate formulas for a sphere and exact formulas for an ellipsoidal model of the Earth. And some map projection names, such as "Stereographic", refer to very different ellipsoidal formulas which are effectively different methods using the same name. The formulas themselves therefore are critical to the identification of conversions and transformations. For conversions and transformations included within the EPSG Dataset, their formulas are documented as attributes of their method, but these formulas are written more clearly in IOGP Report 373-07-02 *Coordinate conversions and transformation including formulas* .

2.3.2. Coordinate Operation method parameters

Each coordinate operation method requires a set of parameters, the parameter set being particular to the method. Some parameter sets or individual parameters are used by several methods.

In many coordinate operation method formulas the required parameters include ellipsoid parameters. These ellipsoid parameters are considered to be attributes of the ellipsoid and are not included in the set of parameters which are included in the definition of the coordinate operation method.

2.3.3. Coordinate Operation parameter values

Each individual conversion and transformation is defined through a specific set of values for each of the parameters used by the method. Parameter values are numbers in given units. The units may not be those required by the method formula; when this is the case they need to be converted to the required units.

The parameter values for transformations and point motion operations may be given as a gridded data set from within which the parameter values at the location of interest are interpolated. In the EPSG Dataset the parameter file names are given, but the files themselves are not included in the Dataset and need to be obtained from the information source.

2.3.4. Transformation multiplicity

From the perspective of mathematical application, conversions and transformations are identical. But they differ in the manner in which their parameter values are obtained. During application of the coordinate operation this impacts the accuracy of the output coordinates. In a conversion, the parameter values are defined. They are therefore exact. Application of the conversion introduces no loss of positional accuracy. In contrast, application of a transformation introduces some loss of accuracy in the output position. For a transformation or point motion operation the parameter values are empirically derived. Multiple transformations between any two specific CRSs or point motion operations within a specified CRS may coexist, derived for example through coordinate comparison at different locations, through different weighting strategies or through using different coordinate operation methods. These different variants or versions of the transformations and point motion operations have no common terminology within the geodetic community. Sometimes a certain version may be mandated for a particular use.

2.3.5. Coordinate Operation reversibility

There is usually a requirement to convert or transform coordinates in both forward and reverse directions, that is from being referenced to CRS 'A' to being referenced to CRS 'B' and also the reverse from being referenced to CRS 'B' to being referenced to CRS 'A'. For the reverse case, the roles of forward case source and target CRS are reversed. Whether or not the method is reversible is one of the attributes of a coordinate operation method. There are three cases:

- The formula applies to both forward and reverse cases. Some operation parameters may need to have their sign reversed when defined for the forward direction and being applied to the reverse. For example, the *Geocentric translations* method for transforming geocentric coordinates uses three parameters: X-, Y- and Z-axis translations. The transformation of coordinates from being referenced to the CRS 'AGD66' to being referenced to the CRS 'GDA94' has parameter values of –127.8m, –52.3m and +152.9m respectively. The formulas used for the forward transformation can be used unchanged for the reverse operation, but for the reverse transformation from GDA94 to AGD66 the parameter values used by the method need to have their signs reversed, i.e., are +127.8m, +52.3m and –152.9m respectively. In this example all of the parameters required their signs to be reversed. This is not always the case. For example, in the *Molodensky-Badekas 10-parameter transformation*, seven of the parameters need to be reversed whilst three parameters should not have their signs reversed. In reversible methods the requirement to reverse the sign of each parameter is one of the attributes of the parameter.

- Some coordinate operation methods are in principle not reversible but in practice are considered as such. These methods describe two formulas, one for the forward direction and a second for the reverse. Both forward and reverse formulas are considered to be part of the method. This is typically the case with map projections. For example, the *Transverse Mercator* coordinate operation method (a map projection method) includes formulas for both forward and reverse conversions. In this second case, for both forward and reverse operations the same parameters are used without sign reversal.

- Some methods are considered to be not reversible. As an example, the *similarity transformation* method is not reversible. This is because the parameters take quite different values for the forward and reverse transformations, despite the formula remaining unchanged. Another example of a non-reversible method is *Geographic 3D to GravityRelatedHeight*, because it outputs a 1D height in a 1D vertical CRS and the reverse computation from 1D to 3D is indeterminate. In many cases the EPSG Dataset documents reversible versions by using a compound CRS instead of the vertical CRS.

Note that whilst it is the method itself which is reversible, it is the treatment of the parameter values within the method's formulas that determines the reversibility and has to be considered in application implementation. Further information on coordinate operation methods and their reversibility is given in IOGP Report 373-07-02 *Coordinate conversions and transformation including formulas*.

2.3.6. Concatenated operations

A concatenated operation is a series of transformations and/or conversions executed in sequence. For a concatenated operation with *n* steps:

- The source CRS for the concatenated operation is the source CRS for step 1.
- The target CRS for step *m* is the source CRS for step *m*+1.
- The target CRS for the concatenated operation is the target CRS for step *n*.

A concatenated operation is reversible only if each of its component steps is reversible.

A concatenated operation is one of the potentially many transformation versions between the pair of initial source and final target CRSs.

3. Implicit concatenated operations created by application software

Transformation applications may need to be able to create concatenated operations that provide a route to match source CRS and target CRS with the type of coordinates upon which the method operates.

For example, if the requirement is to change latitude and longitude values (geographic 2D) referenced to a CRS using datum A into a geographic 2D CRS using datum B, and a search on the EPSG dataset reveals a suitable transformation using a method which operates in the geocentric coordinate domain (such as EPSG dataset coordinate operation method codes 9603, 9606, 9607 or 9636), the transformation application needs to implement the geocentric transformation as the central part of an implicit five-step concatenated operation using the following steps:

- geographic 3D to 2D conversion (reverse case, i.e., 2D to 3D)
- geographic/geocentric conversions (forward case, i.e., geographic 3D to geocentric)
- The geocentric transformation
- geographic/geocentric conversions (reverse case, i.e., geocentric to geographic 3D)
- geographic 3D to 2D conversion (forward case)

This implicit concatenated operation is shown in Figure 3..

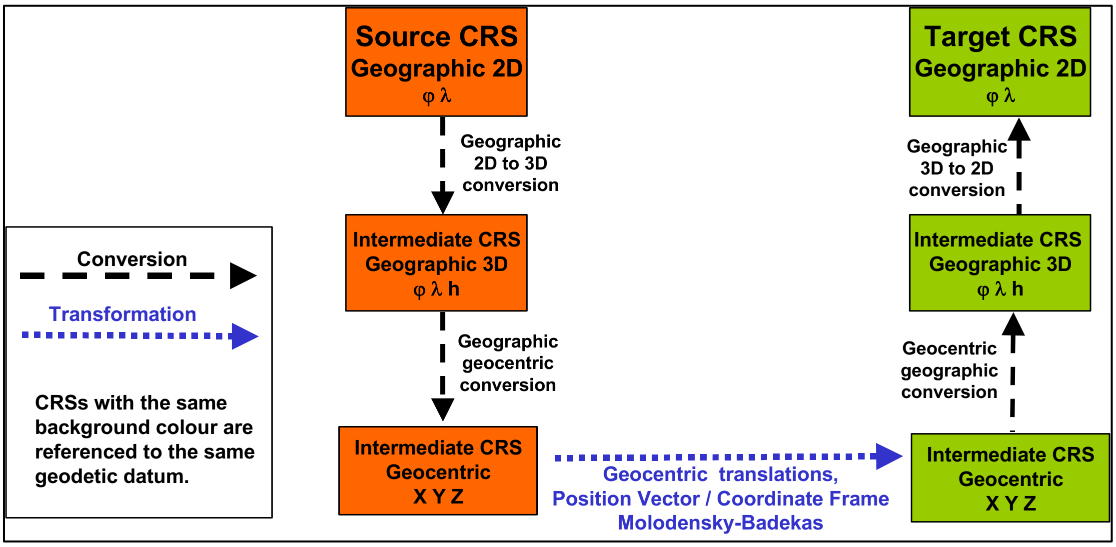

Figure 3: Implicit concatenated operations (example 1)

Alternatively, if the transformation method operated in the geographic 2D domain (NADCON, NTv2, etc.) and the source CRS was geocentric, the order would be:

1. Geographic/geocentric conversions (reverse case, i.e., geocentric to geographic 3D).
2. Geographic 3D to 2D conversion (forward case).

3. The geographic 2D to geographic 2D transformation.

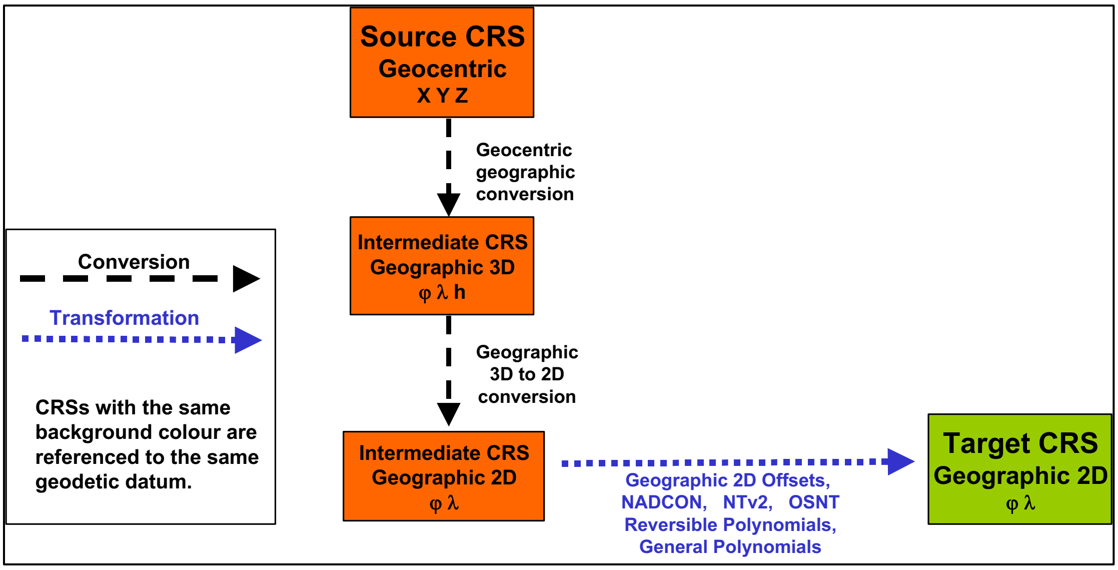

Figure 4: Implicit concatenated operations (example 2).

The exact order of steps of an implicit concatenated operation is dependent upon (a) the CRS domain in which the transformation method operates and (b) the type of CRS for the source and target CRSs. The concept of implicit concatenated operations can be extended as shown in Figure 5.

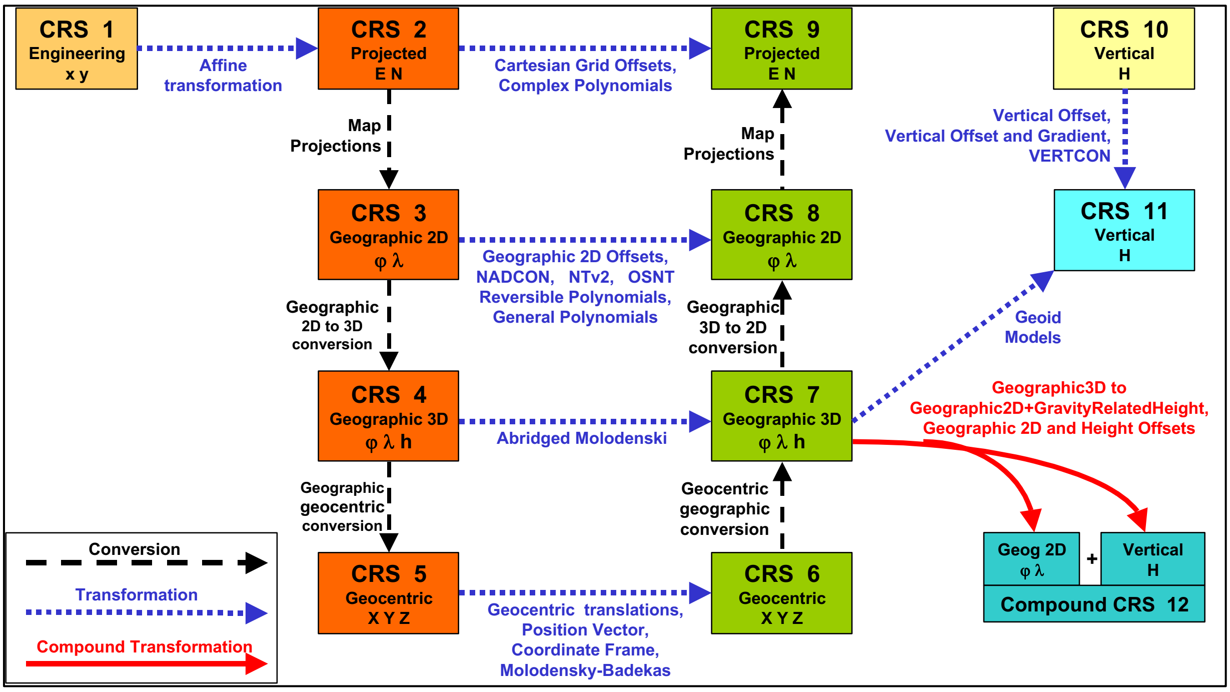

Figure 5: General concept of implicit concatenated operations.

The implicit concatenated operation technique embedded within transformation application design should not be confused with concatenated operations within the EPSG dataset.

Further discussion of implicit concatenated operation techniques using the hub concept are given in Guidance Note 373-07, Part 5.

4. EPSG Data Population

4.1. Dataset maintenance

The EPSG Geodetic Parameter Dataset is managed by the IOGP Geodesy Subcommittee. Members of the subcommittee are domain experts (e.g., geodesists from IOGP member operating companies, survey companies, software developers) and actively contribute to the work of the subcommittee. The subcommittee's nominal meeting schedule is monthly except for August and December.

4.2. Dataset content limitations

The data model is capable of describing coordinate reference systems and coordinate operations. The EPSG Dataset contains several thousand records. Typically, these definitions are sourced from scientific bodies and government authorities. However, the Dataset does not describe every system or operation known to mankind. The emphasis is on systems used for national mapping and similar systems used across multiple organisations. There is minimal coverage of systems used for small-scale "atlas" mapping as these systems tend to be designed for one particular map. North American legal survey systems (which cannot technically be described in the data model) are excluded.

In general, supporting data for component parts of coordinate reference systems (such as ellipsoids, map projections or units) are included within the Dataset only when they are utilized by a CRS or a coordinate operation.

4.3. How to make a request to add or change data

Suggestions for improvements or additions to dataset content are accepted from any interested party. They should be made by electronic submission of the "Change Request": see https://epsg.org/dataset-change-requests.html.

Change requests should clearly state what is being proposed. If the change is to existing dataset content then the entity type and code for the entity in question must be stated, preferably along with its name. For proposed new entries the website includes a link to download a template showing the information required. This minimum information may be included directly in the change request message or may be given indirectly by providing the URL for a publicly available website which contains the information.

Changes that are accepted are first made in an unpublished part of the Registry where they are put through a quality control check. Correspondents may be asked to comment on draft entries. The review process is described in IOGP Report 373-07-6 – *Policies and procedures for EPSG Dataset data management*.

4.4. Data release cycle

The Dataset is updated on an as-needed basis. Publishing updated versions of the Dataset is a compromise between making new information available as soon as possible and consolidating changes into batches issued on a regular but infrequent basis. Historically, new versions of the Dataset have been released approximately twice per year. Increasingly data will be released on completion of its quality check.

Up to and including version 6.18, the canonical version of the EPSG Dataset was an Access database. From version 7.1 (May 2009), the Online Registry became the canonical version of the EPSG Dataset.

4.5. Dataset archive

IOGP undertakes to make available an archive of all full releases of the Dataset from v6.1 onwards (February 2002).

The archive is available to Registry registered users who have logged in via https://epsg.org/archives.html.

The archive consists of:

- MS Access databases from v6.1 (February 2002), in the version of Access used for that dataset publication (Access 97 for dataset versions 6.x, Access 2000 for dataset versions 7.x).
- SQL script files from v6.4 (October 2003).

4.6. Metadata

For each primary entity within the dataset, records include information on the data and its provenance:

- Remarks. Text giving miscellaneous information about the data, including (if applicable) cross-reference to superseding records.
- Information source. This is a brief textual description of the source from which IOGP Geodesy Subcommittee has obtained the information. It may include an internet URL current at the time of record population.
- Data source. This is the organization, body or person who populated this record; for the EPSG Dataset it is always "EPSG".
- Change ID. This is a text field listing code or codes referencing a Change record in which any minor changes to the record are recorded. Not populated when records are first introduced to the dataset.

- **Revision date**. The date on which the record was created or, if minor changes to the record have been made, the date of the latest changes. The record revision date is not altered on deprecation.

The above metadata applies to all primary entity types. In addition, metadata for the Dataset as a whole is given in Appendix A and B.

4.7. Deprecated data (data validity)

Effective from the release of database version 6.1 in July 2001, a policy of never deleting records from the EPSG Dataset has been adopted. Any records found to be in error are corrected. Minor corrections are made through amendment to the record. Significant errors are dealt with through "deprecation". ISO 19135 uses the term 'invalidation'. The deprecation policy applied to the Dataset is described in IOGP Report 373-07-6.

All primary data records include a deprecation indicator. A record containing significantly erroneous data will have its deprecation indicator set to 'true' and a corrected record added as a replacement. Valid records have a deprecation indicator set to 'false'.

Records that have been deprecated in general should not be used – they contain significant error and are retained in the dataset only for purposes of replicating historical use of the records.

Deprecated records have a 'trail' which documents the date and reason for deprecation and if there are replacement records gives links to these records.

4.8. Superseded data (lifecycle information)

Lifecycle information is available in the Dataset and can be seen by generating a Detailed Report of an entity. The policy for marking a record as superseded is given in IOGP Report 373-07-6.

ISO 19135-1:2015, *Geographic information — Procedures for item registration — Part 1: Fundamentals*, defines superseded as "status that indicates the *register item* has been replaced by one or more register items". In ISO 19135 this is a change of status of a valid item.

The concept of supersession is very difficult to apply in the context of coordinate reference systems and transformations. This is because adoption of new systems or transformations is context dependent. The phasing-out of older systems and phasing-in of newer systems can be complex, varying by application, legal regime or user preference, and may take place over decades. As a consequence, in the EPSG Dataset superseded items remain valid, but are additionally indicated as being superseded. Superseded items have a 'trail' which documents the date and reason for supersession, and gives links to replacement items.

4.9. Data applicability

The appropriate usage of the principal geodetic data - datum, coordinate reference system, and coordinate operation entities only - is described through Usage(s): scope or purpose of use, and the spatial and sometimes temporal extent of its applicability.

- Scope: brief text describing the entity's usage and applicability.
- Extent. This corresponds to the ISO 19115 Extent metadata description. An extent consists of:
    - Name: A short cryptic text field used only to list area of use records in a compact manner for selection purposes. This element is not an ISO 19115 attribute.
    - Description: A text field describing the applicable geographical extent, for example "New Zealand – North Island", possibly augmented by temporal and/or vertical extent.
    - Geographic bounding box: Approximate WGS 84 latitude and longitude limits for the applicable geographic extent of an item.
      For bounding boxes straddling the 180º meridian, the "west" longitude will have a higher absolute value than the "east" longitude.
      Can be used for approximate searches and selection, but the nature of bounding boxes means that as well as the area over which a geodetic entity is used also much spurious territory is included. A much better representation of area is given by the extent polygon.
    - Extent polygon: The polygons have been prepared referenced to WGS 84 for use at a nominal map scale of about 1:15,000,000. The international and administrative area boundary data included has been taken from several publicly available sources.
    - Country code: Only populated for Extents which are complete single countries.
    - Vertical extent: height or depth restrictions on item applicability. Rarely populated.
    - Temporal extent: start and/or end dates for item applicability. Rarely populated.

For details see IOGP Report 373-07-6.

Note: IOGP is not an authority on the location of political boundaries.

5. Hints for searching the registry

This section provides information relevant for searching the Registry through the web interface, and to understand reports generated by this interface. It may also be useful for people utilizing the RESTful API or the MS Access database. Further information specific to the Registry API is given in 373-07-3 EPSG Registry API User Guide. IOGP Report 373-07-04 has details for the MS Access Database and SQL implementations.

Additional help may be found in the online user guide for the Registry, available on the Registry website under https://epsg.org/template/IOGP/downloads/user_manual.pdf.

5.1. Searching for Coordinate Reference Systems

The EPSG Dataset's focus is on the complete description of Coordinate Reference Systems (CRSs). The values of parameters of CRS components such as ellipsoids and map projections are given, along with the units for those values as described by the information source. In addition, the Coordinate System (CS) elements are given – the dimension, axes names, abbreviation, direction, order and units – necessary to make coordinates unique. Figure 6 shows schematically the main components of geodetic, vertical and engineering CRSs. It is necessary to resolve the lower-level entities to find this information.

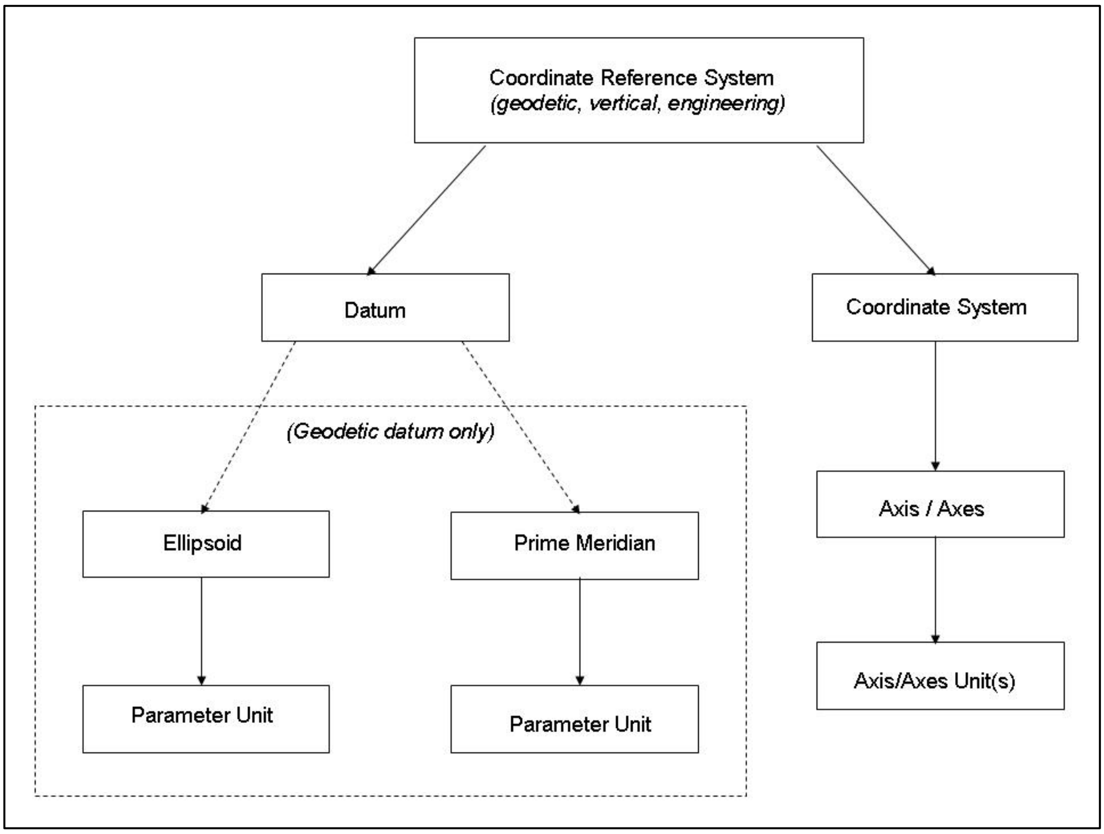

Figure 6 - Geodetic, Vertical and Engineering CRS description.

Projected CRSs inherit their geodetic datum (and its attributes including prime meridian and ellipsoid) from their base geographic CRS. Projected CRSs are associated with their own coordinate system and the coordinate system for the base CRS should be ignored. Projected CRSs also have a reference to their map projection. Figure 7 shows schematically the main components of projected CRSs. Again, these lower-level components need to be resolved.

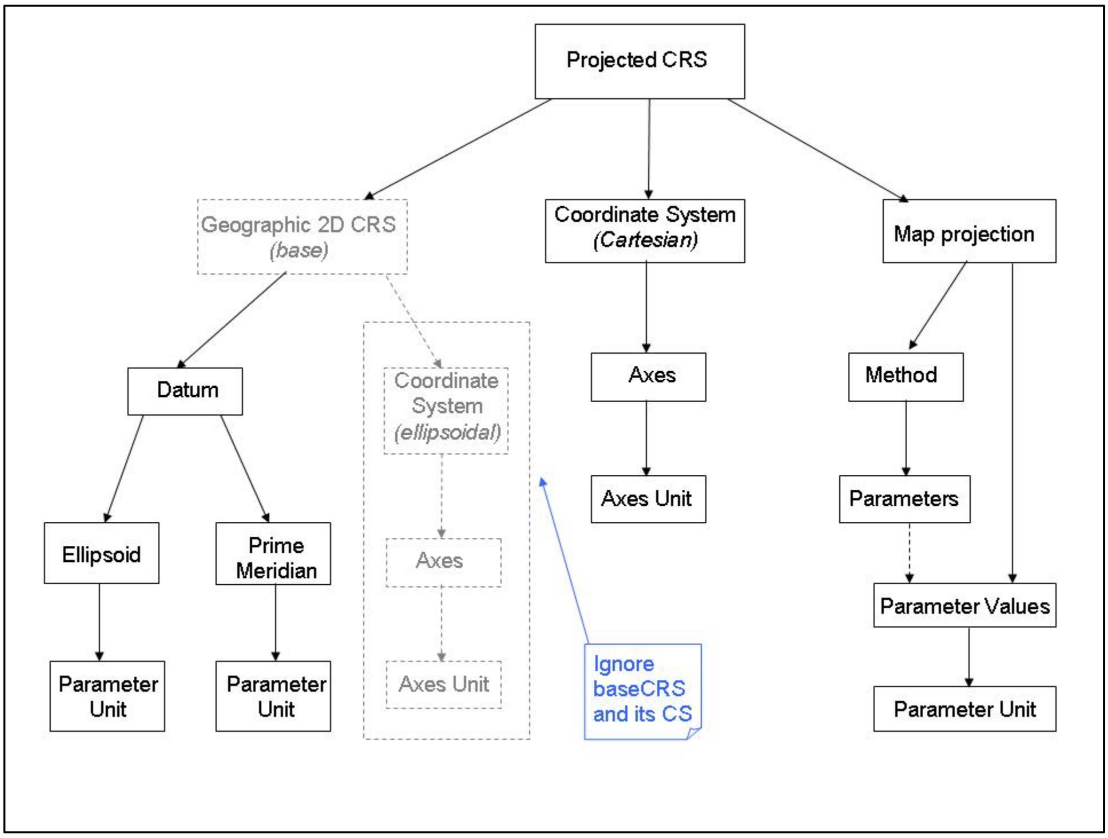

Figure 7: Projected CRS description.

The components may not all be in consistent linear or angle units. This needs to be checked for and, if necessary, the parameter values need to be converted into a consistent unit.

Most map projection methods include parameters referencing "Longitude": for example, "Longitude of [natural/false] origin". These parameters are incompletely specified within the projection because a longitude is meaningless without its reference prime meridian. Within the EPSG Dataset the prime meridian for a projected CRS is inherited from its base geographic CRS. The value for "Longitude of [natural/false] origin" is implicitly referenced to the prime meridian forming part of this base geographic CRS definition.

5.2. Searching for Coordinate Operation definitions

5.2.1. Geocentric transformation methods

The EPSG dataset supports multiple transformation methods between geocentric coordinate reference systems with three, seven, eight, then and fifteen parameters. With the exception of the three-parameter method, each of these mathematical geocentric based transformations has two different versions with specific conventions for the rotation parameters. Care is required to ensure that the method and its parameter values are consistent with the method supported in applications.

Most transformations that operate between geographic 2D, geographic 3D and geocentric CRS types are given in the EPSG Dataset with geographic 2D CRSs as their source and target CRS. The reason is historic – see the policy on the population of coordinate operations in IOGP Report 373-07-6 for more information. Consequently, if an application is presented with a CRS for which the type is geocentric or geographic 3D, a search of the EPSG Dataset coordinate operation table on source- or target-CRS code will return no transformations. The application should first determine the CRS code for the related geographic 2D CRS, and then use the code for this CRS in the search for transformations. This relationship is stored using the Base CRS code in the Coordinate Reference System where generally the Geographic 2D system will have a parent code of the Geographic 3D, and the Geographic 3D system will have a parent code of the Geocentric.

5.2.2. Transformation and conversion parameters

If parameter values are defined by the data information source in sexagesimal degrees they are stored in the Dataset in sexagesimal DMS, a packed real number representing the sexagesimal degree value. For display at the human interface the sexagesimal DMS value is decoded into the original degree, minute and second fields.

Some methods use a gridded data file or files. The actual files are not included in the EPSG Dataset. The Dataset does, however, include a reference to the data file name(s) in the field PARAM_VALUE_FILE_REF. Information about where the file may be obtained from is given within the coordinate operation's INFORMATION_SOURCE field.

5.2.3. Coordinate Operation reversibility

See Section 2.3.5 for general remarks on transformation and conversion reversibility.

Within the EPSG Dataset, each coordinate operation method has a flag to indicate whether the method itself is reversible, that is the parameters for the forward operation can be used for the reverse operation. If the method is reversible, the entry in the coordinate operation method table's REVERSE_OP field will be 'yes' (or 'true' or '1'). When a method is reversible, each parameter used by that method has a flag to indicate whether the parameter value needs to have its sign reversed for the reverse transformation. When the method itself is not reversible the reversibility of parameter values is not indicated.

These reversibility flags allow coordinate operation data for reversible operations to be stored only once in the dataset. For example, using the Australian example cited in Section 2.3.5 (EPSG dataset coordinate operation code 1278), the dataset stores the transformation giving the source CRS as AGD66, the target CRS as GDA94, the method as geocentric translations, and the values for the three parameters used by that method as –127.8m, –52.3m and +152.9m respectively. There is sufficient information here for applications to use this data to transform coordinates from AGD66 to GDA94 or from GDA94 to AGD66.

When seeking to transform data from CRS 'A' to CRS 'B' one therefore should not be searching on coordinate operation name but should examine coordinate operation's SOURCE_CRS_CODE and TARGET_CRS_CODE fields for match using the code of each CRS as both source and target. If a match is found the coordinate operation method's REVERSE_OP field should be examined to determine whether the dataset contains the information needed to perform a reversible operation.

Non-reversible methods

When a coordinate operation is not reversible, two coordinate operations may be in the dataset for reciprocal 'forward' and 'reverse' directions. For example, a transformation published by the national mapping agency of The Netherlands from the "Amersfoort / RD New" projected CRS to the "ED50 / UTM zone 31N" projected CRS uses the complex polynomial of degree 4 method (EPSG dataset coordinate operation code 1044), which is not reversible. This is complemented by a similar transformation using the same method but with different parameter values (EPSG Dataset coordinate operation method 1045). In coordinate operation 1044, the source CRS is "Amersfoort / RD New" (CRS code 28992) and the target CRS is "ED50 / UTM zone 31N" (CRS code 23031). In coordinate operation 1045, the source CRS is code 23031, and the target CRS is code 28992. These reciprocal operations are cross-referenced in the remarks field of each coordinate operation. Reciprocal transformations have the following characteristics: they use the same method, the source and target CRSs are transposed, and they have identical transformation versions. Note that not all transformations using non-reversible methods will have a reciprocal.

Concatenated operation reversibility

A concatenated operation is a sequence of single operations, i.e., transformations and/or conversions. If any of the steps use a reversible transformation or conversion, that transformation or conversion is stored only once in the EPSG dataset. Its source and target CRSs in the dataset may be defined using the opposite of that required in the concatenated operation step, in which case the reverse transformation or conversion needs to be applied.

A concatenated operation is only reversible when all of its component steps are themselves reversible.

5.2.4. Multiplicity of transformations between specific source and target CRSs

In the EPSG dataset, the multiplicity of transformations and/or concatenated operations between two specific CRSs is represented in two ways:

- transformation *variants* of each pair of source and target CRSs are numbered sequentially as they are loaded to the dataset; these sequentially-allocated numbers are artefacts of the EPSG dataset management, have no prior meaning to users, and given as integers.
- each variant is also allocated a textual *version* which cryptically indicates the transformation derivation or information source and its area of applicability

This multiplicity in transformations between given pairs of CRSs causes difficulties for transformation users. There is a need to select the appropriate variant. This is a non-trivial task. Several criteria may be used in the assessment, including:

- extent of the transformation – is it consistent with the area for the coordinate data to be transformed?

- scope – is the purpose for which the transformation was derived consistent with the proposed usage?
- supersession – has the data been replaced or superseded?
- accuracy – is it sufficient for the purpose?
- method – is it supported by the software application?

In general, appropriate selection will require matching the purpose, area of applicability and accuracy of the transformation against similar user criteria.

Take, for example, a hypothetical situation in the northern North Sea straddling the UK-Norway international boundary, in which data for oil exploration has been derived in ED50 geographic CRS terms in three general ways:

1. Positioned using GPS and transformed from WGS 84 to ED50 using the transformation officially recognized by Norwegian regulatory authorities.
2. Positioned using GPS and transformed from WGS 84 to ED50 using the de facto standard transformation for UK offshore oil industry purposes.
3. Older data predating satellite navigation systems and positioned directly in ED50 by radionavigation.

Users or their organizations may adopt different strategies for addressing the problem of merging these datasets.

- User 1 may wish to work in ED50 coordinates honouring them as they have been produced. He or she will merge the three ED50 datasets without applying any further transformation.
- User 2 may wish to adopt the official Norwegian transformation. He would accept the coordinates for datasets a and c but take the view that the ED50 coordinates of dataset b could be "improved" by returning the coordinates to their original WGS 84 form by applying in reverse the WGS 84 to ED50 transformation variant initially applied to the data, and then applying to these WGS 84 coordinates the official Norwegian transformation.
- User 3 may have a strategy to do all of her work in the WGS 84 CRS. She will take ED50 datasets (a) and (b) and to each apply in reverse the transformation variant initially applied. For dataset (c) she may decide to arbitrarily prefer one ED50 to WGS 84 transformation variant, or alternatively apply the variant used for (a) and (b) depending upon whether the data falls on Norwegian or UK side of the international boundary.
- Meanwhile, user 4 has adopted a strategy of working in the ETRS89 CRS recommended for pan-European applications. For him, it is ETRS89, not WGS 84, which is the "standard" CRS. He will have to decide whether, for his particular purposes, the sub-metre difference between WGS 84 and ETRS89 is significant.

Application design should be capable of accommodating any of these example user strategies and not forcing one strategy on all.

5.2.4.1 Coordinate Operation accuracy

The coordinate operation accuracy information may be used for ranking transformations applicable to an area of interest. It needs to be treated with caution. Although described as accuracy, in reality the value may be a measure of the internal precision of the transformation derivation. Whilst accuracy for transformations from a single information source may be safely ranked, "accuracy" from different information sources may not be consistent.

See IOGP Report 373-07-6 for details on the EPSG policy for the population of transformation accuracy.

5.3. Searching for deprecated (invalid) data

As described in Section 4.7, the EPSG Dataset includes records which are invalid (deprecated). In general, searches for data should exclude invalid records, and this is what the GeoRepository web interface and API do by default.

At times, spatial data may be associated with a deprecated CRS or CT. In such cases it is useful to search for deprecated data. Users that have registered and logged in to the system can search for deprecated data by checking the box for "Include Deprecated".

Search results for invalid entities are indicated in the web interface by appending "[DEPRECATED]", e.g.,

AGD66 / AMG zone 48 [DEPRECATED] (code 20248).

Summary reports indicate deprecation by a "Deprecations" trail. Detailed reports additionally include a lifecycle status.

5.4. Searching by code

A code is unique across the top-level entities CRS and CT. To ensure that a single entity is returned use the keyword filter "[code]" in the web interface (and API), e.g.,

[code]=2083

Otherwise, a search for "2083" might return the entity with code "20831", or entities which have the word "2083" in one of the tables (for example, if this substring is contained in the extent description).

5.5. Searching by name

The strategy for the population of names is described in IOGP Report 373-07-6. Alternative names may be stored as an alias. A name may have many aliases and an alias may be associated with several names.

A user may not know whether the name of an object as he/she knows it is stored in the dataset as name or alias. Therefore, a search on 'name' should not only be on the name of the object, but also on its aliases. The Registry web interface performs this extended search automatically. Aliases are included in detailed reports but omitted from summary reports.

Furthermore, it may be confusing to end users whether an entity contains a space between a name and a year, and whether two digits are used for years or four digits (e.g., "NAD27" vs. "WGS 84" vs. "SIRGAS 2000" vs. "ITRF2020"). Therefore, the web interface automatically searches both variations when it detects a string ending on 2 digits. For example, a text search in the online Registry for "SIRGAS2000" returns the same result as a search for "SIRGAS 2000", even though only the latter name is stored in the Dataset.

To explicitly search only names and aliases, the filter syntax "[name]=" may be used, For example, a text search for:

[name]=PSAD56

Also returns the transformation "La Canoa to WGS 84 (18)", because it has an alias "PSAD56 to WGS 84 (18)".

5.6. Searching by type

The Online Registry web interface text search facilitates searching for a specific type using the "[type]=" filter. For example:

[type]=proj

finds all projected CRSs.

5.7. Searching by geographic extent

Searching by extent description

Searches on extent description need to consider the uncertainties of text string content and the application used. An extent description text string might contain multiple country names or sub-area text within the description. A search for the country name alone will not return the record. For example, an exact string match search for "Sudan" would not find an extent description containing "Ethiopia and Sudan", or one described as "Sudan east of 30 deg East". To ensure success in these circumstances the argument should be surrounded with wildcards (e.g., "*Sudan*"). These strategies may return unwanted records, however. For example, a search using "*Oman*" will return data not only for Oman but also for Romania. The Online Registry web and API interfaces automatically includes the wildcards around the text string, returning all occurrences.

Searching by polygon vs. bounding box

The Online Registry web interface enables an interactive map search, i.e., returns entities for which their extent polygon intersects with the location drawn on a map.

The registry interface visualizes the bounding polygon and geographic bounding box against a zoomable world map background. See example below.

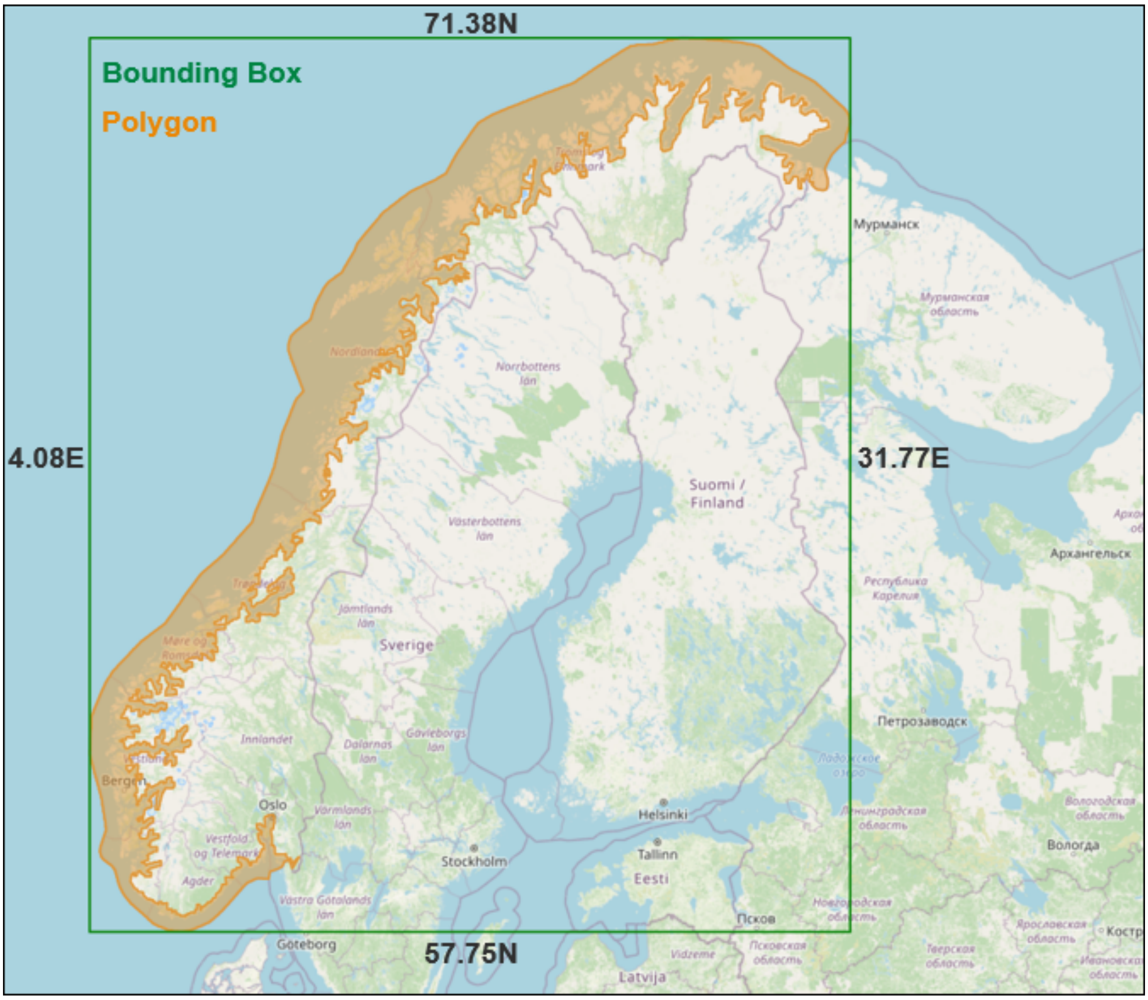

Figure 8: Example geographic bounding box and polygon shown on map interface in EPSG registry.

For irregular and obliquely orientated geographic extents, the polygon (shown in orange in Figure 8) gives a more refined description than does the bounding box (shown in green), which includes significant territory outside of the actual geographic extent.

Using the EPSG polygons greatly reduces the risk of inappropriate CRS or coordinate transformation selection in mapping applications. It also minimizes the risk of applying the geodetic data to inappropriate areas.

Appendix A. Metadata for the EPSG Dataset

The metadata in this section follows the provisions of ISO 19115, *Geographic information – Metadata*.

Register	
Title	EPSG Geodetic Parameter Dataset
Alternate title	EPSG Dataset
Date	2009-05-21
Edition	See latest entry in Version History
Abstract	This dataset holds codes and parameter values for coordinate reference system (CRS) definitions. The CRSs held in the dataset are typically those defined by national mapping organisations to be used for national mapping and spatial data infrastructures as well as additional items of especial interest to the energy industry. The CRSs described are local, national, regional or global in extent; local, national and regional systems may be from any part of the Earth. Several thousand systems are described. The dataset includes all components of these CRSs, for example datum, ellipsoid, prime meridian, map projection and coordinate system, as specified in ISO 19111. The dataset also includes definitions for coordinate transformations between CRSs. Metadata include remarks, scope, extent polygons, and change records.
Purpose	Coordinates are ambiguous unless their reference system is defined. If coordinates are associated with a registry CRS entry, they then may be interpreted unambiguously. The inclusion of map projections and transformations facilitates the merging of spatially referenced datasets by allowing all to be referenced to a common CRS.

Distribution	The EPSG Dataset is made available through following methods: • The EPSG Registry, a web-based delivery platform. • an MS Access database; • SQL scripts which enable a user to create an Oracle, MySQL, PostgreSQL or other relational database and populate that database with the EPSG Dataset; • A zip file containing individual WKT files for all CRSs, Transformations, Point Motion Operations and Concatenated Operations, including their components, following ISO 19162. • Extent polygons in Shapefile format and as GML documents. The Registry and the Access database include a user interface for querying and browsing the dataset, as well as reporting capabilities. The Registry also supports a service-level interface (RESTful API). Up to and including version 6.18, the canonical version of the EPSG Dataset was the Access database. From version 7.1 (May 2009) the Registry is the canonical version of the EPSG Dataset. The Dataset is supported by IOGP Report 373-07, a series of documents describing how to get the most from the Dataset and giving mathematical formulas for coordinate conversion and transformation methods supported in the Dataset. All are distributed at no charge via https://epsg.org/
Registry content	coordinate reference systems, coordinate transformations
URI	https://epsg.org/
Extent	Global systems and local, national and regional systems from any part of the world.
Keywords	EPSG, coordinate, reference system, code, datum, ellipsoid, map projection, geodetic, parameter, registry, spatial referencing, spheroid, transformation
Constraints	See Terms of Use via URI
Update frequency	On an as-needed basis, approximately ten times per year.
Language	English
Contact information:	
Organisation name	International Association of Oil and Gas Producers (IOGP)
Contact position	Chairman, Geodesy Subcommittee
Role code	007
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Contact URI	https://www.iogp.org/

Appendix B. Metadata for the EPSG Registry

The metadata in this section follows the provisions of ISO 19115:2015, *Geographic information – Procedures for item registration*.

Register	
Name	EPSG Geodetic Parameter Registry
Content summary	Codes and parameter values for coordinate reference system (CRS) definitions. The CRSs held in the dataset are typically those defined by national mapping organisations to be used for national mapping and spatial data infrastructures as well as additional items of especial interest to the energy industry. The CRSs described are local, national, regional or global in extent; local, national and regional systems may be from any part of the world. Several thousand systems are described. The Registry includes all components of these CRSs, for example datum, ellipsoid, prime meridian, map projection and coordinate system. The dataset also includes definitions for coordinate transformations between CRSs. Metadata include remarks, scope, extent polygons, and change records.
Item class name	coordinate reference system
Item class technical standard	ISO 19111:2019
Item class name	coordinate transformation
Item class technical standard	ISO 19111:2019
URI	https://epsg.org/
Operating language name	English
Operating language code	eng
Operating language country code	GBR

Register Owner	
Name	International Association of Oil and Gas Producers (IOGP)
Contact position	Chairman, Geodesy Subcommittee
Role name	Owner
Role code	003
Contact address delivery point	Level 14 City Tower, 40 Basinghall Street
Contact address city	London
Contact address postal code	EC2V 5DE
Contact address country	United Kingdom
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Registry Manager	
Name	IOGP Geodesy Subcommittee
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