INCOSADA

Integrated Corporate Spatial and Attribute Database

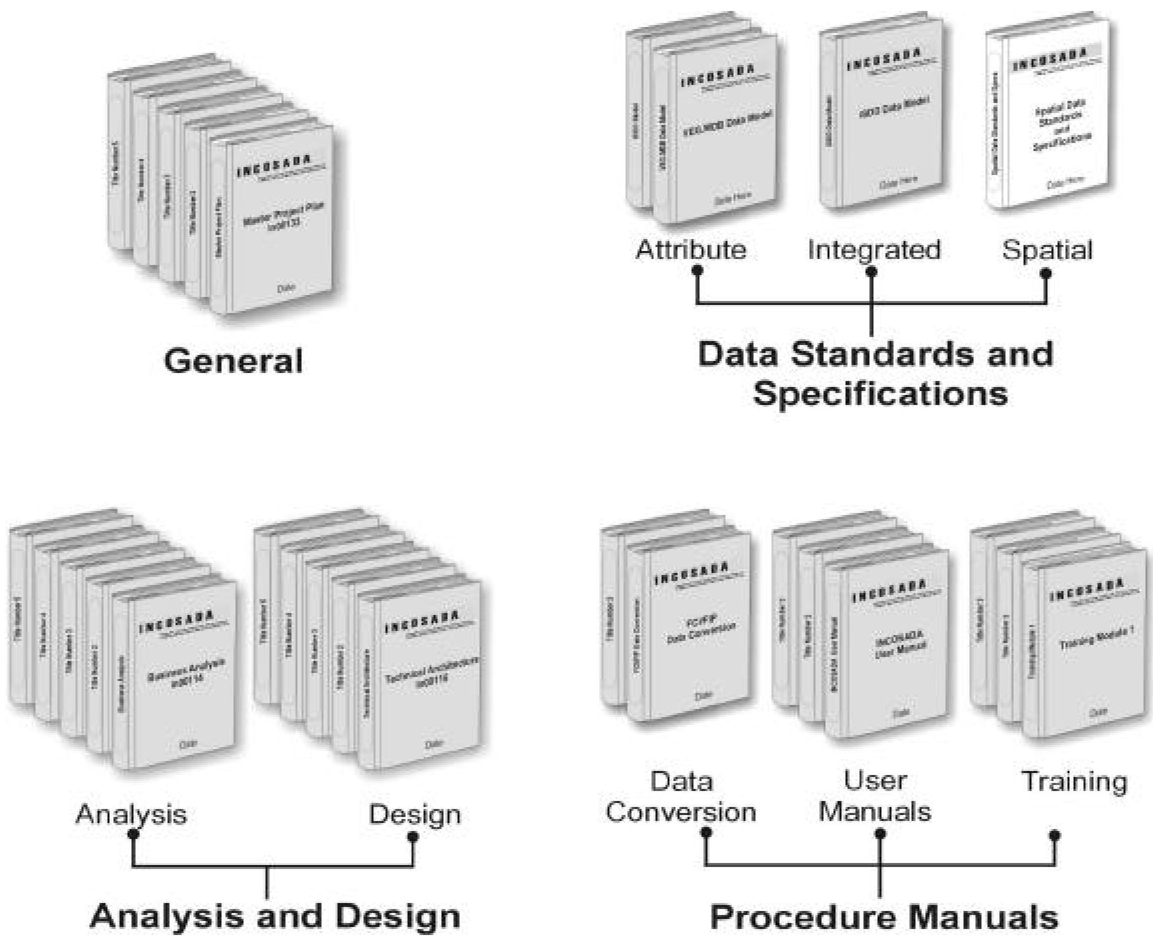
A Joint Business Alliance between B.C. Ministry of Forests and the private sector

INCOSADA Spatial Data Standards and Specifications

July 14, 2004

Forward

This manual is part of a series of documents created under the BC Ministry of Forests Integrated Corporate Spatial and Attribute Data (INCOSADA) program. The following figure shows other documents available in this series.



Current versions of these documents are available on the INCOSADA website: www.for.gov.bc.ca/isb/incosada/

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1 Introduction

1.1 Purpose

This document describes the data standards and specifications for INCOSADA spatial data. More specifically it defines standards for spatial data; geo-referencing, positional accuracy, format, attribute linkage, topology and representation. It is a part of a series of technical documents produced for Phase I of the INCOSADA project.

1.2 Target Audience

This document is intended to be used by Ministry of Forest staff who are responsible for the management of spatial and attribute data, including:

- Headquarters personnel (conversion, validation, quality assurance, audit).
- Region personnel (reporting, analysis, audit).
- District personnel (edit/update, validation, quality assurance, reporting, analysis).

This document is also intended to be used as an appendix to contracts issued by the Ministry of Forests for edit and update of the Ministry's corporate spatial data.

This document may also serve as a useful guide for Vendors, Contractors, T.F.L. holders (Licensees) and other agencies who wish to do business with or exchange data with the Ministry of Forests, or to understand how the Ministry of Forest manages their spatial and attribute data.

1.3 Related Documentation

This document may be supplemented by reference to the following documentation: (see document series diagram above).

- IGDS Format Publication by Intergraph Corporation, Huntsville, Alabama.
- INCOSADA Reference Manual; describing the various sub-systems and components of the INCOSADA System.
- INCOSADA User Manual; describing workflows and procedures for using the INCOSADA system.

- INCOSADA User Manuals for Attribute Capture/Edit; (e.g. VEGCAP, RTECAP, etc.).
- INCOSADA ISDD Data Model.
- INCOSADA ISDD Feature Class Report (Specifications).
- INCOSADA sub-system and component design documents (e.g. IODM, ISDDMS, VEGCAP, etc.).
- INCOSADA Implementation Training Manuals.

Please visit the INCOSADA website (www.for.gov.bc.ca/isb/incosada/) to obtain a current copy of the any of the above INCOSADA documents.

1.4 RIC Standards

This document is also part of a broader series of documents produced by the Resources Inventory Committee (**RIC**) referred to collectively as the **RIC Standards**. The **RIC Standards** are intended to ensure that B. C. Government agencies are provided with resource information which meets recognized standards for quality and consistency.

This series of RIC documents contain guidelines and specifications for resource information managed by the Government of B. C. They provide standards for data collection, storage, and presentation for both Government staff and external agencies.

This standard is provided to achieve key B. C. Government objectives for digital data by:

- providing digital spatial data that is easy to share between different agencies independent of hardware and software
- providing digital spatial data that is easy to integrate across program areas by adhering to Provincial georeferencing standards
- providing quantitative and qualitative measures of data quality and consistency to ensure data collection efforts are effective and the Province receives good value in contracted projects

The RIC Standards for Digital Data Specifications were used where possible for this document.

2 Positional and Representational Data

Spatial data sets can be either positional or representational in nature as described below.

2.1 Positional Data

Positional data sets contain spatial data that is positionally correct, complete, and topologically structured. This data is best suited for spatial data analysis or quantitative measurement, either directly or within a GIS.

All spatial features to be included in the INCOSADA positional data tiles are contained in the Integrated Spatial Data Dictionary (reference ISDD Specification Report).

All positional data **shall** be stored in **3D coordinates**. Where the "Z" coordinates of a feature are not available (2D data), the elevation shall be set to 0.0 (zero).

The positional data **shall not** contain positional offsets or topology errors introduced for cartographic purposes (i.e. cartographic symbolization, enhancement, exaggeration or generalization).

The positional data **shall** be topologically structured in accordance with spatial data capture and topology rules described later in this document.

The positional data **shall** meet the positional accuracy standards described later in this document and as further specified by the data custodians.

All spatial features contained in the positional data sets **shall** be assigned feature classes and feature component codes as per the ISDD.

Depending on feature class, spatial features may also be assigned an unique feature identifier (FID). FID's are described later in this document.

2.2 Representational Data

Representational data refers to spatial data that has been edited for cartographic presentation at a particular scale. Representational data is usually derived from positional data and not suited for quantitative measurements and analysis.

All positional offsets, partial deletions, symbolization, enhancement, exaggerations, and generalizations required to produce a cartographically correct hardcopy map are carried out on this data set.

Ideally, representational data is produced "on demand" from positional data using an automated process. Some representational features such as arrows and annotation points may be stored in the positional data files to facilitate this automated process. Where required, these features **shall** be assigned feature classes and feature component codes.

3 Geo-Referencing Standards

This section provides standards for geo-referencing of spatial data including coordinate system, file system, and positional accuracy.

3.1 Coordinate System

This section contains standards for the spatial data system of coordinates. The storage coordinate system and the operational/exchange coordinate systems are described.

3.1.1 Storage Coordinate System

Horizontal Datum

All horizontal coordinates **shall** be in metres, and referenced to the North American Datum, 1983 (NAD 83).

Vertical Datum

All vertical coordinates (elevation or Z) **shall** be in metres and referenced to mean sea level as defined by the Canadian Vertical Datum 1928.

Map Projection System

The projection system for storage of INCOSADA spatial data **shall** be the B. C. Mercator. This projection provides a seamless coordinate system for all of B. C., and has the advantage of representing geographic lines of latitude and longitude as mutually perpendicular grid lines (i.e. NTS and BCGS Mapsheets are represented by rectangles with constant X and Y coordinates along map boundaries).

✍ This projection preserves azimuths only, and is not directly suitable for quantitative measurement of area or distance. This projection is used for storage only, the user is not directly exposed to map coordinates in this projection.

The storage coordinates **must** be transformed to geographic (Latitude, Longitude) coordinates or to one of the Operational/Exchange Coordinate systems described in the next section before being used for quantitative distant and area measurement or analysis.

The B.C. Mercator map projection is a standard Mercator projection with the following parameters:

Standard Latitude	54°N
False Easting	1,000,000.000
False Northing	0.0
Meridian at False Easting	126°W

3.1.2 Operational/Exchange Coordinate Systems

Horizontal Datum

All horizontal coordinates **shall** be in metres, and referenced to the North American Datum, 1983 (NAD 83).

Vertical Datum

All vertical coordinates (elevation or Z) **shall** be in metres and referenced to mean sea level as defined by the Canadian Vertical Datum 1928.

Map Projection Systems

The projection system used for operations (edit / update) and data exchange with external agencies **shall** be either UTM or B.C. Albers.

The UTM projection system employs a series of 6º longitude zones (numbers 7 to 11 for B. C.). This projection system preserves distance and area quite well within each zone, but is not seamless across B. C.

The B. C. Albers projection provides a seamless coordinate system for all of B. C. and preserves areas. Depending on geographic location, errors in both azimuth (shape) and distance can be significant.

The data custodian will specify which of these projections will be used for their data.

> ✍ The **RIC Standards** specify that the UTM projection system **must** be used for edit and update of all resource inventory spatial features captured at map scales larger than 1:100,000.

3.2 Base Map Reference

Unless specified otherwise by the data custodian, all positional spatial data **shall** be referenced to TRIM (I or II) base maps.

3.3 Tile System

The spatial data **shall** be contained in one of the following standard INCOSADA tiles as specified by the data custodian.

- **Provincial Tile** - Spatial data is stored in a single seamless data set for the province.
- **Region Tile** - Spatial data is stored in one of 6 standard tiles defined by the MOF Forest Region Administrative Boundary as defined by Resource Tenure and Engineering Branch (Region Boundary Custodian).
- **District Tile** - Spatial data is stored in one of 41 standard tiles defined by the MOF Forest District Administrative Boundary as defined by Resource Tenure and Engineering Branch (District Boundary Custodian).
- **1:250K Map Tile** - Spatial data is stored in standard 1:250K Map tiles (1° Latitude by 2° Longitude) as defined by the National Topographic System (NTS) of map tiles.
- **1:20K Map Tile** - Spatial data is stored in standard 1:20K Map tiles (6' Latitude by 12' Longitude) as defined by the British Columbia Geographic System (BCGS) of map tiles.

3.3.1 Tile Types

INCOSADA Spatial data is stored in positional tiles. Depending on their business requirements, the data custodians may also specify that some spatial data is stored in representational or historical type tiles. **Positional** and **Representational** data have been defined previously.

Historical Data

Historical Data tiles contain spatial features that have expired (i.e. permit boundary) or no longer exist (i.e. road deactivated). This data **shall** meet all of the standards for positional spatial data as specified by the custodian. The data is stored in the historical tile for temporal analysis and reference.

3.3.2 Tile Naming Convention

Spatial data tiles **shall** be named in accordance with the following convention:

TileName_GroupNameCode_OrgUnitCode.Filetype

Where:

TileName:	Map tile name (e.g. 092b001)
GroupNameCode:	Group Name Code from ISDD (e.g. VEG)
OrgUnitCode:	Organizational Unit from the MOFCODES (e.g. DCR)
FileType:	File Type Code (POS, REP, or HIS)

Example:

092b001_VEG_DCR.POS

📖 Refer to the ***INCOSADA File System Design Document*** for additional information on naming conventions and directory structure.

3.4 Positional Accuracy

Unless specified otherwise, all positional accuracy standards for INCOSADA spatial data **shall** reflect those standards set under the North American Treaty Organization (NATO) Standard Agreement for evaluation of land maps.

The NATO positional accuracy standards use the Linear Map Accuracy Standard (**LMAS**) for vertical coordinates (Z or elevation), and the Circular Map Accuracy Standard (**CMAS**) for horizontal coordinates (XY or planimetry).

3.4.1 Vertical Positional Accuracy

- Ninety percent (90%) of all observed vertical coordinates (elevations) **shall** be accurate to within (ZZZ.ZZ) metres of their true elevation. This corresponds to a **LMAS** of 1.64 X sigma(Z) = 90% probability, where sigma(Z) is the Standard Error in elevation.
- Ninety percent (90%) of all derived vertical coordinates (elevations) **shall** be accurate to within 2 X (ZZZ.ZZ) metres of their true elevation. This corresponds to a **LMAS** of 1.64 X sigma(Z) = 90% probability, where sigma(Z) is the Standard Error in elevation.
- True elevation is defined as the coordinates which would be obtained from observations using higher order ground surveys methods.
- The above Vertical Positional Accuracy standards are for ground not sufficiently obscured by vegetation or other features to cause significant error in observation.

The data custodian will specify the value for (ZZZ.ZZ) in the above standards, for each feature class.

3.4.2 Horizontal Positional Accuracy

- Ninety percent (90%) of all observed horizontal coordinates (of well defined planimetric features) **shall** be accurate to within (XXX.XX) metres of their true position. This corresponds to a **CMAS** of 2.14 X sigma(XY) = 90% probability, where sigma(XY) is the Circular Standard Error in position.
- True position is defined as the coordinates which would be obtained from observations using higher order ground surveys methods.
- The above Horizontal Positional Accuracy standards are for well defined features or ground not sufficiently obscured by vegetation or other features to cause significant error in observation.

The data custodian will specify the value for (XXX.XX) in the above standards, for each feature class.

4 Positional Data Standards

All positional spatial data **shall** adhere to the following standards:

4.1 INCOSADA IGDS Format

All spatial data shall be stored in INCOSADA IGDS format. A detailed description of the IGDS format is available from Intergraph Corporation, Huntsville, Alabama, USA. The INCOSADA IGDS format is a sub-set of the standard IGDS format as published by Intergraph Corporation. The following sections contain detailed descriptions of the INCOSADA IGDS format.

4.1.1 Default Settings

The INCOSADA IGDS tiles **shall** have the following default settings:

Global Origin

Coordinate	Mercator	UTM	Albers
X=	-2,147,483.648	-4,000.000	-2,147,483.648
Y=	3,500,000.000	5,296,000.000	-2,147,483.648
Z=	-2,147,483.648	-2,147,483.648	-2,147,483.648

Working Units for All Projections:

Master units = metres

Sub-units per Master Unit = 1000

Units of Resolution per Sub-unit = 1

MOF Standard Cell Library

The Ministry's standard cell library (project.cel in the INCOSADA project directory) **shall** be used for all point features that are to represented by a symbol. This will be provided by the Ministry.

MOF Standard Colour Table

The Ministry's standard colour table (color.tbl in the INCOSADA project directory) **shall** be used. This will be provided by the Ministry.

4.1.2 Spatial Feature Types for Positional Data

Each INCOSADA map feature class can be categorized by Spatial Feature Type, based on its' physical characteristics, and how it is to be represented spatially. The basic Feature Types are; Text, Point, Line and Polygon. For INCOSADA, these basic Types have been expanded to include the Feature Types shown in the following table:

Feature Type	IGDS Type	IGDS Class	Components	Comments
Text	17	P	Text	Used for Cartographic Text
Point 1	2 / 7 7	P P	Point Annotation Point	Business Key point with Annotation Point
Point 2	2 / 7 7	P P	Point Annotation Point	Business Key point with optional Annotation Point
Point 3	2 / 7	P	Point	Business Key point with no Annotation Point
Point 4	3	P	Point	DEM point
Point 5	2	P	Point	Point with Symbol and no Annotation Point
Linear 1	4 7	P P	Line Annotation Point	Line with mandatory Annotation Point
Linear 2	4 7	P P	Line Annotation Point	Line with optional Annotation Point
Linear 3	4	P/C	Line	Line with no Annotation Point
Linear 4	4	P/C	Line	Line at Neatline with no Annotation Point
Non-Continuous Polygon	4 7 7	P C P	Line Centroid Annotation Point	Non-continous polygon boundary, centroid and Annotation Point
Continuous Polygon	4 7 7	P C P	Line Centroid Annotation Point	Continous polygon boundary, centroid and Annotation Point.

In addition to the INCOSADA Feature Types, the above table shows the IGDS element type code and class, the spatial components making up each feature type, and comments. A brief description of each of these columns follows.

Feature Type

The type of spatial feature (e.g. text, point, line, continuous polygon, non-continuous polygon, etc.).

IGDS Type

The element type number as defined in the IGDS standard. **Only graphic element types 2, 3, 4, 7, and 17 are permitted for the INCOSADA IGDS format.**

Graphic element type 16 (Arcs) are permitted for representational features stored in the positional file (e.g. arrow-in for map labels etc.).

IGDS Class

The element class as defined in the IGDS standard. Permitted values are Primary (P) or Construction (C).

Components

This defines the component parts that make up each feature type. Permitted values are Text, Point, Annotation point, Line, and Centroid.

4.1.3 ISDD Component Rule Code

The ISDD component rule code is used to define the INCOSADA data models for each of the feature types. The component rule code governs how INCOSADA linkages are assigned during data capture, and is used during quality assurance to ensure the correct Feature Linkages are present for all component parts of a feature class. The component rule codes are defined in the following table:

Feature Type	Component Rule Code	Component Name	IGDS Class	IGDS Type	FID Assignment
Text	T	Text	P/C	17	No FID or Annotation
Point 1	G G	Point Annotation	P P	2 / 7 7	Same FID as Annotation Same FID as Point
Point 2	H H	Point Annotation	P P	2 / 7 7	Unique FID Optional (point FID)
Point 3	I	Point	P	2 / 7	Unique FID no Annotation
Point 4	Z	Point	P	3	No FID or Annotation
Point 5	S	Point	P	2	No FID or Annotation
Linear 1	D D	Line Annotation	P P	4 7	Same FID as Annotation Same FID as Line
Linear 2	E E	Line Annotation	P P	4 7	Unique FID Optional (Line FID)
Linear 3	F	Line	P/C	4	Unique FID no Annotation
Linear 4	N	Line	P/C	4	No FID or Annotation
Linear 5	J J J	Line B-Key Point Annotation	P C P	4 7 7	Same FID all components Same FID all components Optional (Line FID)
Non-Continuous Polygons	C C C	Boundaries Centroid Annotation	P C P	4 7 7	Same FID all components Same FID all components Same FID all components
Continuous Polygons	A B B	Boundaries Centroid Annotation	P C P	4 7 7	Unique or NULL FID Same FID as Annotation Same FID all components

4.1.4 Point Features

Point features are features too small to be represented as lines or polygons. These features are represented by a single X, Y, Z location and are defined as features which do not have any spatial area or length. If there is associated non-spatial information for a point, it is stored as a centroid.

Point features in a positional data file **must** be represented by one of the following IGDS element types:

IGDS Type	IGDS CLASS	NAME	DESCRIPTION
2	P	Cell	Used for point features that require a symbol
7	C	Text Node	Used for polygon centroids (point in polygon), Business Key point, or point features with associated attributes. One only centroid / Business Key point per unique incidence of feature.
7	P	Text Node	Used as annotation points. Same FID as feature it is associated with (point, line or polygon). Can be many annotation points per unique incidence of feature.
3	P	Zero Length Line	Used exclusively for DEM points. No FID assigned. No associated annotation point or attributes.

4.1.5 Linear Features

Linear features in a positional data file **must** be represented by the IGDS element type shown in the following table:

IGDS Type	IGDS CLASS	NAME	DESCRIPTION
4	P	Line	Used for linear features.
7	C	Text Node	Used for Business Key point to store FID linkage to associated attributes (optional). One only Business Key point per unique incidence of feature.
7	P	Text Node	Used for linear annotation points (optional). Same FID as feature it is associated with (Business Key point). Can be many annotation points per unique incidence of feature.

Network/Routes

Networks and routes may be maintained in the IGDS spatial data file. The Forest Road Management System (FRMS) roads model will be used. The route number (FRMS business key) will be associated with each element of the route using the INCOSADA FID and sequence number stored in an IGDS User Linkage. The sequence number is used to maintained the order of the elements for “chainage” computation purposes, from the point of commencement.

This model provides for a single definition of routes within a network which will be maintained by the custodian to ensure their integrity.

4.1.6 Polygon Features

Two types of polygon features are supported in INCOSADA, continuous polygons and non-continuous polygons.

Continuous Polygon Features

The Continuous Polygon Feature model is used to store polygonal features that are continuous in nature and can not overlap one another. For the continuous polygon model, all areas are defined (i.e. no holes in coverage). Examples of continuous polygon features are vegetative coverage, biogeoclimatic coverage, etc. Gaps in these coverages are still assigned a polygon number, and the associated attribution is used to define the “gap” in the coverage area (e.g. lake, not classified, ocean, no typing available etc.).

For the continuous polygon model, the boundaries between polygons are stored as a single line (or line elements). This reduces file size and facilitates ease of editing within a CAD environment. The continuous polygons are defined implicitly by a centroid located within each polygon area (point in polygon). The feature class is used to associate the centroid, annotation points and linear boundary components of these polygons. Each polygon centroid is assigned a unique FID (stored in the User Linkage - see below) that links the polygon to its’ associated attributes.

Continuous polygon features in a positional data file must be represented by the IGDS element types shown in the following table:

IGDS Type	IGDS CLASS	NAME	DESCRIPTION
4	P	Line	Used for the boundaries of the polygons.
7	C	Text Node	Used for polygon centroids (point in polygon) to store FID linkage to associated attributes. One only centroid per polygon feature.
7	P	Text Node	Used as annotation points. Same FID as Centroid (point in polygon). Can be many annotation points per polygon feature. Does not need to be inside the polygon it is associated with.

Neatlines and Continuous Polygon Features

Continuous Polygon features that are stored in BCGS or NTS Map tiles **shall** be "closed" along map tile neatlines using a "feature at neatline" boundary component with a component rule code of "N".

Where a continuous polygon feature does not "join" a similar polygonal features in the adjoining map sheet (i.e. data does not tie spatially), it **shall** be closed along the map tile neatline using the normal feature boundary component (i.e. with the same component number as the feature boundaries within the map sheet), and **not** the "feature at neatline" boundary component.

Non-Continuous Polygon Features

The Non-Continuous Polygon Feature model is used to store polygonal features that are discontinuous in nature and may or may not overlap one another. Non-continuous polygon features can be thought of as spatial objects consisting of an associated set of polygon boundary lines, centroid (point in polygon), and annotation point components.

Although not stored as a single object in the IGDS file (in fact individual component elements will most likely be dispersed though out the IGDS file), these components are explicitly associated by the assignment of the same unique FID value to each component making up the non-continuous polygon or object.

For adjoining non-continuous polygons the boundaries between polygons are stored twice, once for each polygon or object.

A single polygon feature can be represented by two or more spatial objects (i.e. disjointed spatially). In this case each spatial object must be associated with the same FID and Business Keys. The FID sequence number will be used to uniquely define these spatially disjointed objects.

Examples of non-continuous polygon features are tenure permit areas and silviculture activity treatment units (ATUs).

Non-Continuous polygon features in a positional data file must be represented by the IGDS element types shown in the following table:

IGDS Type	IGDS CLASS	NAME	DESCRIPTION
4	P	Line	Used for the boundaries of the polygons. Same FID linkage used for the Centroid is stored in each line element.
7	C	Text Node	Used for polygon centroids (point in polygon) to store FID linkage to associated attributes. One only centroid per spatially disjointed objects. There may be two or more spatially disjointed objects per non-continuous polygon feature.
7	P	Text Node	Used as annotation points. Same FID as Centroid (point in polygon). Can be many annotation points per polygon feature. Does not need to be inside the polygon it is associated with.

4.1.7 Attribute Linkages

All elements in an IGDS file will have a MSLink attribute linkage, which links the element with its feature class definition in the Integrated Spatial Data Dictionary (ISDD) database. This is the Feature Class Linkage.

Some of the elements in an IGDS file will have a second attribute linkage (User Linkage), which links the element to its associated attributes. This is the Feature IDentifier (FID) linkage.

Feature Class Linkage

The IGDS MSLink (entity number 1) is used to link spatial data features to their appropriate feature class definition as contained in the ISDD. To facilitate capture and edit / update in a CAD, this linkage is made at the feature component level and not the feature class level (refer to ISDD data model). Each feature component is assigned a unique feature component MSLink number. Where available, the feature components have also been assigned a Canadian Council on Surveying and Mapping (CCSM) feature code in the ISDD. The feature component number linkage is a one too many relationship (e.g. all definite river features in the province will have the same feature class and feature component number).

The feature component number is stored in the MSLink key field. The exact data format layout for this linkage is given in the following C code (for Intel x86 and compatible architectures). Detailed technical specifications on the format of the MSLink linkage is contained in the IGDS format specifications available from Intergraph Corporation.

```
typedef struct {
unsigned short words          :8;    // words to follow: MUST = 7
unsigned short class          :4;    // MUST = 0
unsigned short user           :1;    // user linkage; MUST = 0
unsigned short modified       :1;    // boolean; MUST = 0
unsigned short remote         :1;    // boolean; MUST = 0
unsigned short info           :1;    // boolean; MUST = 0
unsigned short primary_id;    // dBase database type indicator MUST = 0x1971
unsigned short secondary_id;// ALWAYS 0x0f81
unsigned short entity;        // MUST = 1
unsigned long  FeatureCodeNum; // Feature Code Number
short      pad[2];      // filler
} FeatureCodeLinkage;
```

Feature Identifier (FID) Linkage

Any spatial data which has associated descriptive attribute information is linked to the attribute tables with a unique Feature IDentifier (FID). FIDs are defined as 32 character strings generated by calling the MicroSoft NT Universally Unique Identifier (UUID) function. FIDs are stored as **User Linkages** in the IGDS spatial data files. The corresponding FID is stored in the Feature Link Table (FLT) used to associate the features to their associated attributes using the feature business keys. The characters which comprise a FID have no special significance or meaning of any kind and FIDs are transparent to users.

The basic definition of FIDs is as follows:

- FIDs are unique and do not contain any information.
- FIDs exist as pairs stored in the spatial data and the Feature Link Table.
- Every spatial object that is linked to an associated attribute database has its own unique FID.
- FIDs are not repeated or copied in either the spatial data or the Feature Link Table.
- FIDs can be replaced with another FID at any time, provided the spatial data and the Feature Link Table are both updated.
- Business Keys can be duplicated in the spatial data and the Feature Link Table with different FIDs for each feature instance.

The exact data format layout for this linkage is given in the following C code (for Intel x86 and compatible architectures).

```
typedef  struct {
unsigned short words          :8;     // words to follow;     Must = 19
unsigned short class          :4;     // reserved;            Must =  0
unsigned short user           :1;     // user bit on;         Must =  1
unsigned short modified       :1;     // unused;              Must =  0
unsigned short remote         :1;     // unused;              Must =  0
unsigned short info           :1;     // unused;              Must =  0
unsigned short UserID;        // = 0x7e7e
unsigned char fid[32];  // 128-bit Feature ID (in ASCII hex, uppercase)
unsigned int    sequenceNum;  // sequence number for networks, etc
} INCOSADA_FID;
```

Notes

- The FID number is a 32-digit uppercase ASCII hex string. (e.g. 7452B930D20711D09D920000C91A9CB1). It is NOT null-terminated.
- The sequenceNum field is used to order the elements comprising a single feature into a linear sequence. For instance, this field will be used by the future INCOSADA network standard to allow network edges to be comprised of multiple elements. This field is also used to uniquely define spatially disjoined objects making up a non-continuous polygon (i.e. each component of the spatially disjoined object is assigned the same unique sequenceNum value). This INCOSADA specification is not yet implemented).

Universal Unique Identifier

The Microsoft Universally Unique Identifier function is used to generate UUIDs on each PC desktop workstation. This function is available with NT 4 and later operating system. It uses a combination of CPU date and time plus information about certain system hardware components to generate a 32 digit uppercase ASCII hex string (e.g. 7452B930D20711D09D920000C91A9CB1) that is guaranteed to be unique. This UUID is used as a unique Feature Identifier (FID) for INCOSADA.

4.1.8 Storing Business Keys in IGDS

As discussed above, the FID and Feature Link Table (MDB) is used to link spatial features contained in an IGDS file with their associated attributes contained in a database. This linkage is facilitated by a one to one association of the feature Business Keys with the FIDs which are both contained in the Feature Link Table.

To guard against the possible loss of this implicate linkage through file corruption or loss, some redundancy was built into the INCOSADA system. The feature attribute Business Keys are also stored as text strings with the Centroid points (Text Nodes). This built in redundancy also facilitates the edit and update of the spatial data tiles by contractors, outside the INCOSADA environment (i.e. the contractor does not have to deal with FID generation and the FLT table, since this can be regenerated by Ministry staff during QA).

The Business Keys are stored as construction text (right justified, no spaces, font XX, font size XX) on the Centroid Text Nodes. Where there is more than one Business Key field, the subsequent keys are stored on additional lines of text. The Feature Link Table can be generated at any time from the spatial tile using the INCOSADA FIDGEN application.

4.1.9 Tile Metadata in IGDS

Metadata in this section refers to the information that is stored at the tile level with the positional spatial data. The INCOSADA tile level metadata includes the following information:

- Tile Name
- Version Number
- Last Update Date
- Last User ID
- Last Agency to update

- CRC check sum value for the spatial and associated attribute files
- Map Projection
- Map Datum
- Tile Range Rectangle Coordinates (Mercator)

The Tile Metadata it is stored in the IGDS design tile with the following definition:

- It is a IGDS Type 66 element on Level 20.
- It is the fourth element in the tile after the minimal IGDS header elements (Types 9, 8, 10). All design tiles created within the INCOSADA environment will contain this element.
- It has the locked bit set, so that the MicroStation “DEL 66” command will not delete this element.
- It has a check sum number (CRC) based on the contents of the file AFTER the metadata element less (FileSize % 512) bytes. Some processes pad the design file to an even multiple of 512 bytes.
- It has an element size of 1536 bytes (wtf = 766).

This information is defined during initial tile creation and subsequently managed by the INCOSADA system software. Specific operations such as NAD shift or coordinate re-projection uses this metadata to ensure the integrity of the operation (e.g. MapProj-3D will not permit a re-projection to UTM, if the tile is already in UTM). The INCOSADA application METAVIEW can be used to view the tile metadata from within the INCOSADA environment.

4.1.10 Red Line Spatial Data Format

The term “Red Line” refers to spatial and attribute data that is to be exchanged with non-INCOSADA sites such as Contractors, Licensees or other government agencies. Red Line spatial data is in the INCOSDADA IGDS format, with the exception that the INCOSADA FID assignments (in the IGDS User Linkage Field) are not mandatory. Instead, the linkage between spatial and attribute data is done by carrying the feature attribute Business Keys as text with the Feature Centroid point (Text Node). Refer to the above section on storing Business Keys in IGDS format.

This eliminates the requirement to carry out interactive edit / update outside the INCOSADA environment (FIDs, Business Key servers etc.), and facilitate easier data translation to and from other spatial data formats.

The FIDs and Feature Link Table will be generated as part of the QA acceptance process carried out by Ministry staff, when these Red Line data sets have been submitted for integration with the Ministry's corporate data (e.g. from update / re-inventory contractors or licensees).

4.2 Topology and Data Capture Rules

The spatial data shall be captured and topologically structured in accordance with the following rules.

4.2.1 Connectivity and Network Rule

All lines of like and unlike features which intersect or close on themselves, **shall** do so at numerically exact (3D) coordinate junction points or nodes. These nodes divide continuous features into discrete elements which begin and end at node locations.

All lines of like and unlike features which intersect horizontally but not vertically (e.g. a bridge feature crossing a road feature), **shall** do so at numerically exact horizontal coordinates (X,Y), but **shall not** connect vertically (Z).

4.2.2 Continuity Rule

Map features **shall** not be "broken" (i.e. gap in line) or discontinuous when crossing other map features.

4.2.3 Direction of Flow Rule

Hydrographic features with a gradient (i.e. rivers and streams), **shall** be captured in a downstream direction.

4.2.4 Right Hand Rule

Unless specified otherwise by the data custodian, all non-continuous polygon features **shall** be captured so that the area being bounded (inside polygon) is on the "right hand" side relative to the direction of the spatial data.

> ✍ The Right Hand Rule is superseded by the Downstream Rule for double-sided hydrographic features (i.e. double-sided rivers).
>
> ✍ The Right Hand Rule does **not** apply to the continuous polygon features model since the boundaries are stored as single lines (or line elements) and are shared by the two adjoining polygon features.

4.2.5 Pseudo Node Rule

Pseudo nodes or 2 way nodes (i.e. nodes with two end points only) **shall** be minimized. Some Pseudo nodes are necessary for data stored in IGDS format due to the maximum vertices per element limitation (i.e. 101 vertices).

4.2.6 Self Intersection Rule

Lines (arcs) **shall not** intersect (i.e. touch or cross) themselves, other than at their end points.

4.2.7 Polygon Integrity Rule

Polygonal features (continuous or non-continuous) **shall not** contain undershoots or overshoots (i.e. boundary line end points not connected to other end points).

4.2.8 Point in Polygon Rule

All polygonal features (continuous or non-continuous) **shall** contain one (and only one) inside point (centroid) component, which **shall** contain the FID attribute linkage.

4.2.9 Level Feature Rule

The "Z" value for coordinates of Polygonal Hydrographic features (e.g. Lakes, swamps, marshes, reservoirs, etc.) and Hypsographic features (e.g. index contours, intermediate contours, etc.), **shall** be the same (within the vertical accuracy standards) throughout the feature (i.e. these features should be flat).

4.2.10 Seamless Spatial Database Rule

Linear and polygonal features crossing adjoining positional map tiles, shall connect (be edge tied) at numerically exact (3D) coordinate junction points or nodes.

4.3 Specifications in ISDD

4.3.1 IGDS Graphic Attributes

The IGDS graphic attributes (i.e. level, colour, line code, etc.) for all positional features is contained in the Integrated Spatial Data Dictionary (ISDD).

4.3.2 Quality Control Parameters

The Quality Control processing parameters and tolerances for all positional features is contained in the ISDD.

4.3.3 Other Specifications

The ISDD also contains specifications for Custodian, Steward, Storage tile, and Business Keys for all positional features.

5 Representational Data Standards

Ideally, representational data will be produced "on demand" from the positional data using automated processes with INCOSADA. The Representational Data will not be stored and maintained, and it will be deleted after the cartographic product(s) are produced. Some representational features may be stored in the positional data tile (e.g. arrow heads, annotation points, etc.) to facilitate the automatic generation of representational data and products.

5.1 Representational Specifications in ISDD

Multiple IGDS graphic attributes (i.e. level, colour, line code, etc.) for each positional feature can be defined and stored in the ISDD. The INCOSADA representational processes and tools permit this information to be accessed and used to generate custodian and custom representational products.