GIS DATA STANDARDS

GIS Data Standards

Columbus Regional Airport Authority
Columbus, Ohio

June 2012

WOOLPERT

DESIGN | GEOSPATIAL | INFRASTRUCTURE

GIS Data Standards

CAD & GIS Standards Update

Columbus Regional Airport Authority
Columbus, Ohio

June 2012

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TRADEMARKS

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PREFACE: CHANGE CONTROL & REVISION HISTORY

All changes to these *GIS Data Standards* will be documented below and incorporated into this document as the Standards may be adjusted over time. This document will be redistributed as appropriate each time a revision is adopted.

If the current GIS Data Standards requires modification to accommodate a new project, new feature or data not currently defined, consultants, designers and Columbus Regional Airport Authority (CRAA) staff may request modifications to the GIS Data Standards (features, attributes, enumerations, etc.). The procedures and change control form below define the general framework to request and document all change requests and approved changes.

CHANGE CONTROL

As requests to modify the GIS Data Standards arise, a change control form shall be completed and signed by the CRAA Planning and Construction Administration Department for a change to be approved.

Using a defined process to consider all requests and a standard request form will ensure that all change requests are thoroughly evaluated through a consistent procedure. This formal modification request process will also allow CRAA to accumulate information on both adopted and rejected changes to aid long-term maintenance of the GIS Data Standards.

Adopted changes shall be appended to this document in both electronic and hardcopy form, to record the document change history. Rejected change requests shall also be archived to accumulate a complete history of requested changes in order to help evaluate future requests, and help ensure consistent reasoning for rejecting or approving future changes.

Change Control Processes and Responsibilities

GIS Technician Responsibilities

1. Receive requests for Standards Modification, complete and then print the Change Control Form and provide to the GIS Supervisor for review along with any supporting information.

2. If after review, the change request is approved, the GIS Technician will insert the approved Change Control Form in the Appendix D – Approved Change Control Forms to this electronic document for future reference.

3. Revise appropriate sections in this GIS Data Standard as a result of the approved change request, and document that changes have occurred in the affected sections in the revision history table.

4. Archive any rejected change requests.

GIS Supervisor Responsibilities

1. Review the hardcopy Change Control Form.

2. Evaluate the request and document the reasons for approval or rejection.

3. Oversee the updating of the GIS Data Standards

1. INTRODUCTION

1.1. PURPOSE

All GIS-oriented spatial data created for the Columbus Regional Airport Authority (CRAA) must be developed and submitted according to the specifications documented in this standard. This includes data prepared internally by CRAA employees and data prepared by outside consultants.

Each submitted GIS dataset becomes part of the permanent archive and also serves as a source for updating information within the CRAA's enterprise Geographic Information System (GIS) and, thus, part of the foundation for future work at CRAA facilities. The availability of standardized data products and drawing files for use on future projects enhances the value of the original data creation effort. Standardization allows drawing files and individual data layers to be integrated with other data components, ensuring consistency in planning and design at CRAA facilities.

Additionally, the FAA needs standard airport geospatial data so that it can share important information with airports and internally within the FAA. The data standards described in this document are intended to support those needs.

1.2. SCOPE

This standard encompasses all aspects of GIS spatial data for the CRAA's GIS.

1.3. INTENDED AUDIENCE

This document is intended to be used by people who maintain or create GIS data for the CRAA's GIS. All airport staff and outside consultants should understand the requirements of this standard and follow its specifications for submitting spatial data to the CRAA.

1.4. REFERENCES TO PARTIES

The primary receiving party and owner of the GIS, its content and the standards is referred to as the Columbus Regional Airport Authority. CRAA is the short name for Columbus Regional Airport Authority.

The party providing the GIS database information is referenced as the Data Provider. This is generally going to be a party external to the CRAA whose submittals are controlled by contract. This standard and its related documents are meant to be part of the contract addendum.

The primary contact between the CRAA and the Data Provider is the CRAA Project Manager. Waivers to the required portions of these standards must be authorized by the CRAA GIS Supervisor. Non-required standards elements shall be determined by the CRAA Project Manager.

1.5. Related Documents

This document is intended to be coupled with the geodatabase design itself, which is published in a document titled *"CRAA GIS Geodatabase Design Report"*, (hereinafter referred to as the Geodatabase Design). Any outside organization required to deliver GIS Data must contact the CRAA's assigned Project Manager to obtain the latest version of the Geodatabase Design prior to beginning data development.

All GIS data must be developed to be consistent with the **Data Creation Rules** described in these standards in Appendix 1.

In addition to this GIS Data Standards document, CRAA has developed a set of standards that define the requirements for spatial data creation at CRAA. These "companion" standards are comprised of the following documents:

- GIS Data Standards (this document)
- CAD Data Standards
- Coordinate System Standards
- Aerial Photography Standards

Together, these standards document the concepts, policies, and data creation practices necessary for the CRAA to incorporate data into the GIS Program. These documents are designed to develop the GIS for the CRAA so that spatial data relevant to the CRAA can be developed from multiple sources.

It is the responsibility of the Data Provider to obtain the latest set of GIS Standards referenced in this document. The Data Provider is encouraged to contact the CRAA Project Manager to facilitate obtaining these documents.

1.6. Request for Waiver

Situations may arise where data should be created for the CRAA GIS that would not be consistent with this standard. If such a situation were to arise, the party creating the data must request a waiver to this standard. Using the Change Control form in Section 1.1, the request must define the specific section of the standard for which the waiver is requested, the reason for the waiver, the resulting impacts on the use of the data in the GIS, and any alternative approaches that should be considered. The request will also include a detailed description of the business need for the waiver request and why adherence to this standard will prevent satisfaction of the business need.

The CRAA GIS Supervisor or Project Manager must approve any waiver request before such data can be submitted.

CRAA GIS Change Control / Waiver Request Form		
Date Submitted		
Proposed By: Name, Title, Company		
Contact Phone No. & Email		
Project Name		
Requested Revision or Waiver Request and Applicable Section No. :		
Impact on Budget if not approved:		
Impact on Schedule if not approved:		
Signing this document confirms that both the Proposer and GIS Supervisor have agreed on the changed standards as described in this form.		
Proposer:		
	Signature	**Date**
CRAA GIS Supervisor		
	Signature	**Date**
Final Resolution: Approved as requested or as modified and listed here, or rejected		

1.7. Revision History

As changes to the GIS Data Standards are indicated and accepted, this document will be updated accordingly. The following revision history will log when these revisions occur, why and refer to the approved change control forms appended to these standards in Appendix D – Approved Change Control Forms.

Table 1: Revision History

Name	Date	Reason for Change	Change Control Form

2. SPATIAL DATA STANDARDS

2.1. GIS DATA STANDARDS LINEAGE

The CRAA GIS Data Standards were created by incorporating elements of the following documents:

- **Federal Aviation Administration Advisory Circular 150/5300-18B** (General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards). These standards focus on exterior (outside the building) features and generally lack interior features.

- **ESRI Building Interior Space Model (BISDM 2.0/3.0)**; http://www.esri.com/industries/facilities-management/community/bisdm.html

- **CRAA GIS SDSFIE Standards – 2004**

- **CRAA CAD Standards - 2011**

2.2. GIS SOFTWARE FORMAT

CRAA has standardized on a SQL database and Autodesk MapGuide suite of products as the enterprise GIS software platform.

However, GIS data using ESRI format and now Autodesk GIS-oriented data are both widespread and may be used for GIS data deliveries to CRAA. Therefore, GIS standards are therefore appropriate to address GIS data that may be delivered in either Autodesk .DWG format or ESRI GIS format (ArcGIS 9 or later compatibility).

2.3. GIS DATA FORMAT

2.3.1. CRAA GIS

GIS data shall be stored in a format compliant with the Open Geospatial Consortium (OGC) defined types, or as modified for MS SQL Types.

2.3.2. Delivery of Spatial Data to CRAA

Spatial data shall be delivered to the CRAA in a manner readily converted to the Department GIS format. The database may be exported into an XML Workspace format using ESRI ArcCatalog/ArcEditor, or by creating a file-based geodatabase in ArcCatalog/ArcEditor. Microsoft Access databases are not recommended because of potential incompatibilities in the manner in which data is stored in the Access database format versus the CRAA SQL database.

Shapefile (.SHP format) is also permitted if not delivering data in a geodatabase or .DWG file with object data. All data deliverables must be accompanied by metadata, which meets the metadata standards defined in this document.

2.4. GIS Database Components

The detailed geodatabase design that all data must adhere to is found in the "*CRAA GIS Geodatabase Design Report*." The following sections introduce and explain the fundamental terms needed to understand the geodatabase design.

2.4.1. Feature Classes

Feature classes are the fundamental "layers" of GIS data. Feature class data is needed to build advanced geometric network or topology – geometric relationships between features and different Feature Classes. Feature classes store a group of similar feature types with a shared geographic extent, spatial reference, and common attribute table, etc. FAA Advisory Circular 150/5300-18B defines many GIS data feature classes useful for airports.

2.4.2. Geometric Networks

Geometric networks are used to model linear networks of line and point features and allow for tracing of flow direction and other network-specific GIS analysis. Only line and point feature classes can participate in a geometric network. All lines within a geometric network shall be created as edges as defined in the geodatabase. In addition, all lines within a gravity or pressure system must be digitized in the proper flow direction. The initial design of the CRAA GIS Database does not include the use of geometric networks; however, they may be deployed in the future for some feature classes (e.g. utilities).

2.4.3. Attributes

An attribute is descriptive information for a particular feature within a feature class (or object class). All attributes designated as "required" in the database must have a value assigned for the feature. Non-mandatory attributes will be assigned values on a case by case basis depending on the needs of the particular project, and with approval of CRAA staff.

2.4.3.1. Attribute Data Types

The attribute data types and their constraints are defined below.

- **Small/Short and Long Integer:** Both short and long integers can store only real numbers. Fractions or numbers to the right of the decimal place cannot be stored with this data type.

- **Single/Float and Double:** Floats and doubles are both binary number types that store the positive or negative nature of the number, a series of significant digits, and a coded value to define the placement of a decimal point. This is referred to as the exponent value.

- **Text/String:** A text field represents a series of alphanumeric symbols. This can include street names, attribute properties, or other textual descriptions that can be a mixture of letters and numbers as needed.

- **Date:** The date data type can store dates, times, or dates and times. The default format in which the information is presented is *mm/dd/yyyy hh:mm:ss* and a specification of AM or PM. When users enter date fields in the table, the field values shall be converted to this format.

- **BLOB (binary large object) or CLOB (coded large object):** Data stored in the geodatabase as a long sequence of binary numbers. Items such as images, multimedia, or bits of code can be stored in this type of field. Delivery of BLOB or CLOB data to CRAA must be approved in advance as data may instead be preferred in its native format.

- **Global Identifier (also referred to as a GlobalID or GUID (Globally Unique Identifier):** Data types store registry-style strings that uniquely identify a feature or table row within a geodatabase and across geodatabases. Developers can use them in relationships or in any application requiring globally unique identifiers. GlobalID fields are 38 bytes (36 characters).

- **Raster:** Unlike a hyperlink that only links a feature's field to an image; a raster field type can actually store the raster data within or alongside the geodatabase. For example, a photograph of the commercial property can be added as an attribute of a parcel feature or a scanned drawing of property features. Only one raster type field may be used on each feature class or table. A different table with a relating field must be used to associate more than one raster dataset with each feature. In addition, only appropriate raster imagery should be added as an attribute to a feature class. All valid raster formats are available, but it is highly recommended that only small pictures (less than 25K bytes) be used for this field.

2.4.4. Subtypes

A subtype is an attribute that can be used to distinguish features within an object or feature based on the subtype value. Each unique subtype allows the other attributes within the object or feature class to have their own default values, associated domains, and validation rules. All subtypes must be populated for each feature. CRAA has chosen to avoid subtypes to simplify data maintenance and display.

2.4.5. Domains

GIS data can be constrained to the limited values contained within defined GIS domains.

If changes to a domain are required to accurately input GIS attribute data, the changes must be requested through the CRAA GIS change control process.

There are two types of domains—**coded value domains** and **range domains.** Below is a description of the uses and constraints for each domain type.

2.4.5.1. Coded Value Domains

Coded value domains are used for both numeric (double/single/integer/small integer) and string fields. They often are presented to users as a dropdown list of predetermined allowable values in the GIS editing environment. An important concept with coded value domains is the distinction between the code and description for each item in the domain. The code is the actual value that shall be stored in the geodatabase. The description is the value displayed in the dropdown list. This allows for more efficient storage of information in the geodatabase by using the smallest data type and precision/scale/length possible.

Table 2 shows an example of a coded value domain.

Table 2: Coded Value Domain Example	
Code	Description
2	2 inch
4	4 inch
6	6 inch
8	8 inch
10	10 inch

2.4.5.2. Range Domains

Range domains are used for numeric fields (double/single/integer/small integer) and specify the minimum and maximum values for information within that field. Fields with associated range domains are edited like any other normal non-domain associated field. However, when features are validated, the entered values are compared within the database to the allowable range domain to ensure that the entered value falls within the minimum and maximum values.

Table 3 shows an example of a range domain.

Table 3: Range Domain Example	
Minimum Value	Maximum Value
0	50

2.4.6. Relationship Classes

For a non-attributed relationship, an origin primary key field is defined within the origin feature and linked to an origin foreign key in the destination feature. For an attributed relationship, which is required for a many-to-many relationship but is otherwise optional, an addition table, *a relationship class table*, is used to manage the data relationships between the origin and destination tables. An origin primary key field is defined within the origin feature table and linked to an origin foreign key in the relationship class table. Likewise, a destination origin primary key field is defined within the destination feature and linked to a destination foreign key in the relationship class.

2.4.6.1. Simple Relationships

Simple relationships are normal relationships linking two objects that exist independent of one another. A simple relationship can have a one-to-one, one-to-many, or many-to-many feature relationships and are non-attributed or attributed. Additionally, one feature can participate in multiple simple relationships.

2.4.6.2. Composite Relationships

A composite relationship is a relationship where the existence of one of the features is dependent on the existence of the other. That is, a feature, row, or table is not only related to another, but creating, editing, and deleting one feature in the relationship will affect the other object in the relationship. For example, in a composite relationship between a utility pole and an electrical transformer, if the pole is deleted, so is the transformer. Composite relationships only have a one-to-one relationship. CRAA has chosen to avoid Composite Relationships to simplify data maintenance.

2.4.6.3. Relationship Creation Rules

The ObjectID should never be used when creating user-defined relationships since the ObjectID is not a static number. If using an attributed relationship class, the primary keys fields used to build the relationships should be programmatically generated.

2.4.7. Annotation and Labeling

2.4.7.1. Labeling

Labels are the preferred method for adding text information in a map as label values are typically linked to the feature as an attribute or object data.

While FeatureLinked annotation (described below) can be linked to some GIS features, standard annotation labeling is just a graphic label placed in the map with no connection to a feature – making migration of the information from any graphical (unlinked) annotation more difficult. Annotation feature classes should only be used if labeling is not adequate to produce cartographically-pleasing maps for display or plotting.

2.4.7.2. Annotation Feature Class

An annotation feature class is used to define and display spatially-referenced text and symbol features. Annotation feature classes are typically used to maintain a static location of the annotation when:

- The complexity of placement exists with the subsequent need to adjust one or more display properties of an individual piece of annotation in order to place it in a desired location of choice.
- The annotation is used in multiple maps using the same placement location.

2.4.7.2.1. Standard versus Feature Linked Annotation

Standard annotation should only be used for annotation that is not associated to any information tracked within attributes of the geodatabase feature classes. Otherwise, feature-linked annotation should be used to generate the annotation.

Within annotation feature classes, one or more annotation classes can exist that determine how a subset of annotation in the feature class displays. For standard annotation feature classes, the annotation class properties include what default symbology is applied when creating new annotation and the visible scale range. For feature-linked annotation feature classes, the annotation class properties also include how the annotation text strings shall be defined. These properties define which features in the linked feature class shall be annotated by the annotation class, and how to place the new annotation.

2.4.8. Topology

Topology is used to define the spatial relationship between features in one or more feature classes through a set of predefined rules. Table 4: Topology Rules lists different types of topology rules that may be used in GIS. (Note: feature classes may subject to one or more topology rules.).

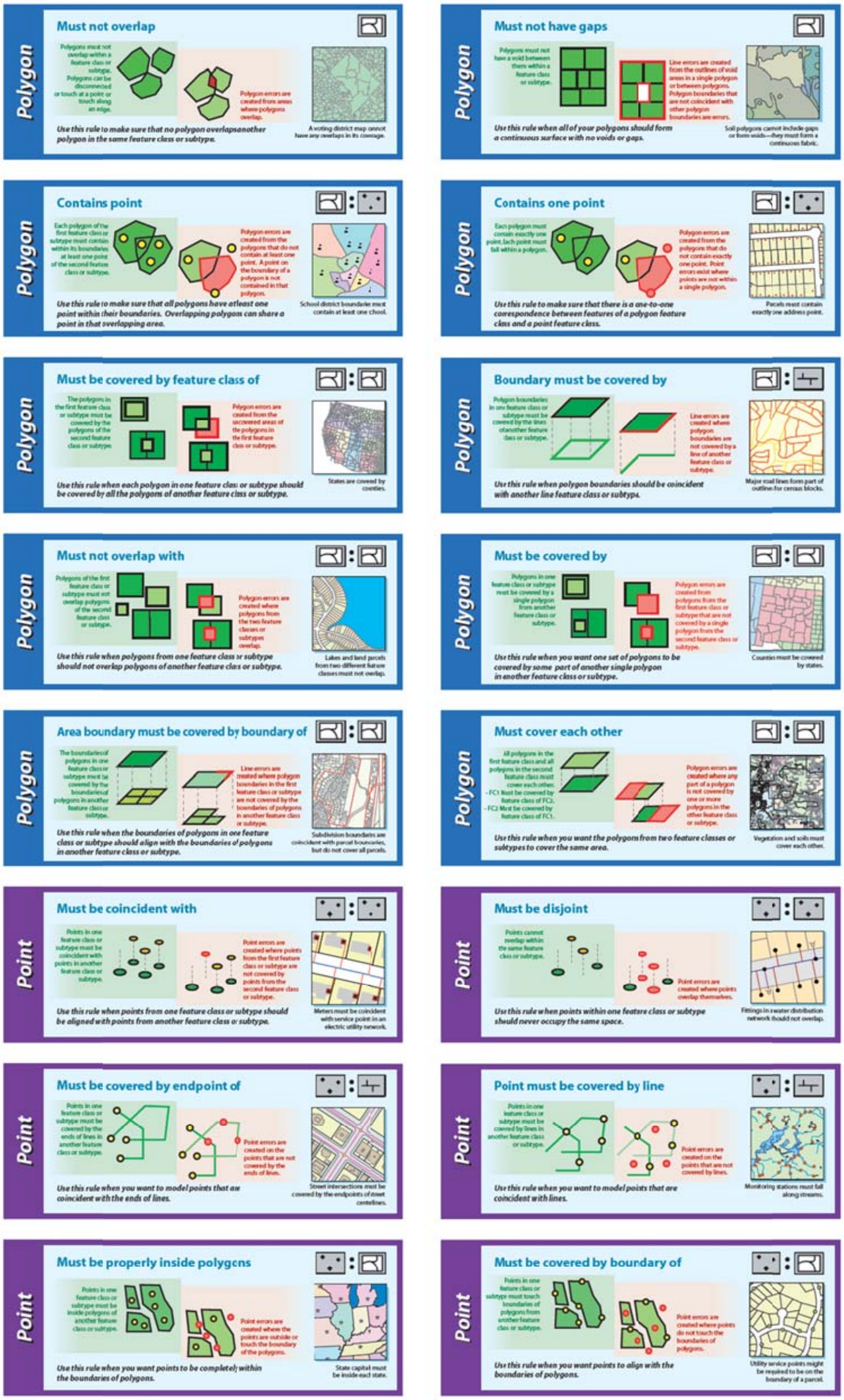
Table 4: Topology Rules

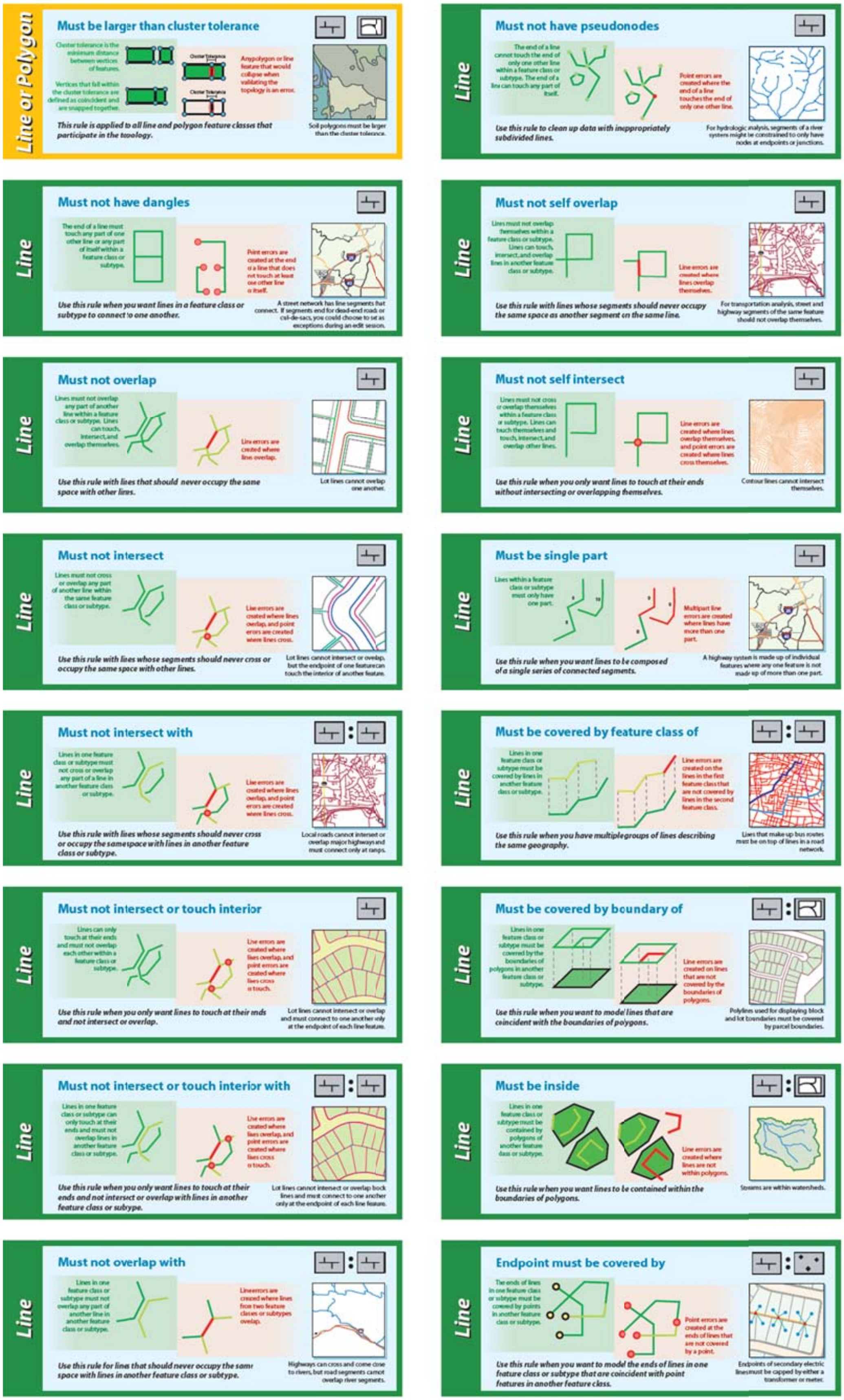
Rule Name	Rule Description for Appropriate Geometry Type
Polygon Rule	**Rule Description**
Must Not Overlap	The interior of polygons in the feature class must not overlap. The polygons can share edges or vertices. This rule is used when an area cannot belong to two or more polygons. It is useful for modeling administrative boundaries, such as lease lines codes or airspace surfaces, and mutually exclusive area classifications, such as land cover or landform type within the same feature class.
Must Not Have Gaps	No voids can within a single polygon or between adjacent polygons. All polygons must form a continuous surface. An error will always exist on the perimeter of the surface. You can either ignore this error or mark it as an exception. Use this rule on data that must completely cover an area. For example, polygons illustrating individual concrete panels in the runway cannot include gaps or form voids—they must cover an entire area.
Must Not Overlap With	The interior of polygons in one feature class must not overlap with the interior of polygons in another feature class. Polygons of the two feature classes can share edges or vertices or be completely disjointed. This rule is used when an area cannot belong to two separate feature classes. It is useful for combining two mutually exclusive systems of area classification, such as pavement and landscaping type, where areas defined within the pavement class cannot also be defined in the landscaping type class and vice versa.
Must Be Covered By Feature Class Of	A polygon in one feature class must share all of its area with polygons in another feature class. An area in the first feature class that is not covered by polygons from the other feature class is an error. This rule is used when an area of one type, such as an airport property, should be completely covered by areas of another type, such as airport land use type (revenue, non-revenue).
Must Cover Each Other	Polygons of one feature class must share all of their area with the polygons of another feature class. Polygons may share edges or vertices. Any area defined in either feature class that is not shared with the other feature class is an error. This rule is used when two systems of classification are used for the same geographic area, and any given point defined in one system must also be defined in the other. One such case occurs with nested hierarchical datasets, such as small watersheds and large drainage basins. The rule can also be applied to non-hierarchically related polygon feature classes, such as soil type and slope class.
Must Be Covered By	Polygons of one feature class must be contained within polygons of another feature class. Polygons may share edges or vertices. Any area defined in the contained feature class must be covered by an area in the covering feature class. This rule is used when area features of a given type must be located within features of another type. This rule is useful when modeling areas that are subsets of a larger surrounding area, such as taxiways within aircraft movement areas.
Boundary Must Be Covered By	Boundaries of polygon features must be covered by lines in another feature class. This rule is used when area features need to have line features that mark the boundaries of the areas. This is usually when the areas have one set of attributes and their boundaries have other attributes. For example, parcels might be stored in the geodatabase along with their boundaries. Each parcel might be defined by one or more line features that store information about their length or the date surveyed, and every parcel should exactly match its boundaries.
Area Boundary Must Be Covered By Boundary Of	Boundaries of polygon features in one feature class are covered by boundaries of polygon features in another feature class. This is useful when polygon features in one feature class, such as subdivisions, are composed of multiple polygons in another class, such as parcels, and the shared boundaries must be aligned.
Contains Point	Each polygon in one feature class contains at least one point from another feature class. Points must be within the polygon, not on the boundary. This is useful when every polygon should have at least one associated point, such as when parcels must have an address point.

Line Rule	Rule Description
Must Not Overlap	Lines must not overlap with lines in the same feature class. This rule is used where line segments should not be duplicated; for example, in a stream feature class. Lines can cross or intersect but cannot share segments.
Must Not Intersect	Line features from the same feature class must not cross or overlap each other. Lines can share endpoints. This rule is used for contour lines that should never cross each other or in cases where the intersection of lines should only occur at endpoints, such as street segments and intersections.
Must Not Have Dangles	A line feature must touch lines from the same feature class at both endpoints. An endpoint that is not connected to another line is called a dangle. This rule is used when line features must form closed loops, such as when they are defining the boundaries of polygon features. It may also be used in cases where lines typically connect to other lines, as with streets. In this case, exceptions can be used where the rule is occasionally violated, as with cul-de-sac or dead end street segments.
Must Not Have Pseudonodes	A line must connect to at least two other lines at each endpoint. Lines that connect to one other line (or to themselves) are said to have pseudonodes. This rule is used where line features must form closed loops, such as when they define the boundaries of polygons or when line features logically must connect to two other line features at each end, as with segments in a roadway network, with exceptions being marked for the originating ends of first-order roadways.
Must Not Intersect Or Touch Interior	A line in one feature class must only touch other lines of the same feature class at endpoints. Any line segment in which features overlap or any intersection not at an endpoint is an error. This rule is useful where lines must only be connected at endpoints, such as in the case of lot lines, which must split (only connect to the endpoints of) back lot lines and which cannot overlap each other.
Must Not Overlap With	A line from one feature class not overlap with line features in another feature class. This rule is used when line features cannot share the same space. For example, roads must not overlap with railroads or depression subtypes of contour lines cannot overlap with other contour lines.
Must Be Covered By Feature Class Of	Lines from one feature class must be covered by the lines in another feature class. This is useful for modeling logically different but spatially coincident lines, such as routes and streets. A bus route feature class must not depart from the streets defined in the street feature class.
Must Be Covered By Boundary Of	Lines must be covered by the boundaries of area features. This is useful for modeling lines, such as lot lines, that must coincide with the edge of polygon features, such as lots.
Endpoint Must Be Covered By	Endpoints of line features must be covered by point features in another feature class. This is useful for modeling cases where a fitting must connect two pipes, or a street intersection must be found at the junction of two streets.
Must Not Self Overlap	Line features must not overlap themselves. They can cross or touch each other, but must not have coincident segments. This rule is useful for features such as streets, where segments might touch in a loop, but where the same street should not follow the same course twice.
Must Not Self Intersect	Line features must not cross or overlap themselves. This rule is useful for lines, such as contour lines, that cannot cross themselves.
Must Be Single Part	Lines must not have any breaks. This rule is useful where line features, such as highways, may not have multiple unconnected parts.
Point Rule	**Rule Description**
Must Be Covered By Boundary Of	Points must fall on the boundaries of area features. This is useful when the point features help support the boundary system, such as boundary markers, which must be found on the edges of certain areas.
Must Be Properly Inside Polygons	Points must fall within area features. This is useful when the point features are related to polygons, such as wells and well pads or address points and parcels.
Must Be Covered By Endpoint Of	Points in one feature class must be covered by the endpoints of lines in another feature class. This rule is similar to the line rule, "Endpoint Must Be Covered By," except that, in cases where the rule is violated, it is the point feature that is marked as an error, rather than the line. Boundary corner markers might be constrained to be covered by the endpoints of boundary lines.
Must Be Covered By Line	Points in one feature class are covered by lines in another feature class. It does not constrain the covering portion of the line to be an endpoint. This rule is useful for points that fall along a set of lines, such as taxiway signs along taxiways.

Figure 1 - ArcGIS Geodatabase Topology Rules

; Source ESRI ArGIS Resource Center:
http://help.arcgis.com/en/arcgisdesktop/10.0/help/001t/001t000000sp000000.htm





Line or Polygon
Must be larger than cluster tolerance
This rule is applied to all line and polygon feature classes that participate in the topology.
Line
Must not have pseudonodes
Use this rule to clean up data with inappropriately subdivided lines.
Must not have dangles
Use this rule when you want lines in a feature class or subtype to connect to one another.
Must not self overlap
Use this rule with lines whose segments should never occupy the same space as another segment on the same line.
Must not overlap
Use this rule with lines that should never occupy the same space with other lines.
Must not self intersect
Use this rule when you only want lines to touch at their ends without intersecting or overlapping themselves.
Must not intersect
Use this rule with lines whose segments should never cross or occupy the same space with other lines.
Must be single part
Use this rule when you want lines to be composed of a single series of connected segments.
Must not intersect with
Use this rule with lines whose segments should never cross or occupy the same space with lines in another feature class or subtype.
Must be covered by feature class of
Use this rule when you have multiple groups of lines describing the same geography.
Must not intersect or touch interior
Use this rule when you only want lines to touch at their ends and not intersect or overlap.
Must be covered by boundary of
Use this rule when you want to model lines that are coincident with the boundaries of polygons.
Must not intersect or touch interior with
Use this rule when you only want lines to touch at their ends and not intersect or overlap with lines in another feature class or subtype.
Must be inside
Use this rule when you want lines to be contained within the boundaries of polygons.
Must not overlap with
Use this rule for lines that should never occupy the same space with lines in another feature class or subtype.
Endpoint must be covered by
Use this rule when you want to model the ends of lines in one feature class or subtype that are coincident with point features in another feature class.

2.4.9. Symbology

Symbology for GIS data being submitted to CRAA in either hard copy or electronic format must be created according to the symbol dataset used by CRAA GIS. If delivering any GIS data with symbology, the data creator must contact the CRAA GIS Supervisor to obtain the latest version of the symbol dataset prior to beginning data development. This standardization is intended to ensure that similar GIS feature data received from multiple Data Providers look similar.

2.5. COORDINATE SYSTEM

2.5.1. Introduction

This section defines the coordinate system and coordinate system metadata standards that will be used for geographic data developed for CRAA.

2.5.2. Purpose

Coordinates are the numeric representation of the location of spatial features on the Earth's surface. Each set of coordinates is defined by their coordinate system. A coordinate system is a set of rules that define the parameters for the coordinates contained within. To ensure data accuracy, all coordinates for features must be calculated utilizing the same rules (coordinate system) to ensure not only overall data accuracy of each located feature, but accuracy in relation to other coordinate systems and features within the same coordinate system.

This section provides general information about coordinates, different coordinate systems, and map projections. More importantly this document specifies the coordinate system and coordinate system metadata standards that are to be used for all spatial data developed for CRAA.

2.5.3. Map Projection and Coordinate Systems

2.5.3.1. Understanding Map Projections

Coordinate systems can be grouped in two major categories: Geographic Coordinate Systems (GCS) and Projected Coordinate Systems (PCS).

2.5.3.1.1. Geographic Coordinate Systems

In Geographic Coordinate Systems, locations on Earth are defined using a three-dimensional spherical surface. This surface is defined by a **datum**. A datum provides reference for measuring in GCS by defining various parameters: the origin of the coordinate system (i.e. the location of the center of the spheroid - using an approximation of the Earth's size and shape), orientation of latitude and longitude lines, and prime meridian. Coordinates for a point in GCS are typically given using latitude and longitude. These represent angular measurements from the Earth's "center" to the point on Earth's surface. For example:

- Latitude: 46.24°
- Longitude: 16.21°

Although geographic coordinates can represent locations on the Earth's surface based on a spherical coordinate system, GCS are not suitable for representing geographic data on a flat surface, such as a map or computer screen.

Because of the Earth's shape as a sphere and the curvature of its surface in two directions, measuring distances or areas in GCS is inaccurate. For example one degree of longitude at the equator is approximately 69 miles, whereas the same one degree of longitude measured at 60° latitude amounts to only 35 miles This is due to the surface of the Earth "narrowing" as measurements are taken approaching the poles (examples calculated using Clarke's 1866 spheroid).

To be able to correctly represent the Earth's curved surface on a "flat" (planar) surface it is necessary to project points from the Earth's surface to this plane. Map projections and projected coordinate systems are used to accomplish this task.

2.5.3.1.2. Projected Coordinate Systems

Projected coordinate systems are used in conjunction with a specific map projection. Each projected coordinate system depends, among other factors, on the map projection that is being used to project points from the Earth's surface to a plane.

Classification of map projections is based on two factors: according to their geometric properties (correct representation of selected geometric characteristic) and according to method of construction (projection surface and positioning and orientation of that surface).

Geometric properties classification:

- **Equivalent or equal area projection** – projections that maintain constant areal scale over the entire surface of the map

- **Equidistant projection -** projections that maintain distances between certain points on the map (it is not possible to preserve distances for the entire projected map area)

- **Azimuthal or zenithal projection -** projections that maintain angular relationships between certain points on the map (it is not possible to preserve angular relationships for the entire map area)

- **Conformal projection** – projections that preserve scale around a specific point. In other words angles around that point are shown correctly which in turn preserves shapes (it is not possible to preserve shapes of larger areas so this are usually distorted)

- **Compromise projection** – "compound" projections that attempt to maintain more than one of the above described properties.

- **Other geometric properties** – do not fall in any of above categories

Method of construction classification:

- Projection from the spherical GCS to different projection surface

    - **Planar projection** – Earth's surface is projected to a plane.

    - **Cylindrical projection -** Earth's surface is projected to the surface of a cylinder.

    - **Conic projection -** Earth's surface is projected to the surface of a cone.

- One or more points of contact with projection surface
    - Tangent at one point; example – the North Pole. Usually in use with planar projections.
    - Tangent to the globe along certain a parallel or meridian; example – the Equator. Usually in use with cylindrical or conic projections.
    - Tangent to the globe along ***one or more*** parallels or meridians. Usually in use with conic or cylindrical projections.
- The angle of the projection surface
    - **Normal/Polar orientation -** For cylindrical and conic projection – the tangent is along the parallel; for planar projections, the tangent is one of the poles.
    - **Transverse/Equatorial orientation -** For cylindrical and conic projection, the tangent is along a meridian; for planar projections, the tangent is on a point along the Equator.
    - **Oblique orientation -** For cylindrical and conic projection tangent is along great circle line that cannot be defined as parallel or meridian, for planar projections tangent is on any point on Earth's surface that is not one of the poles or a point on the Equator.

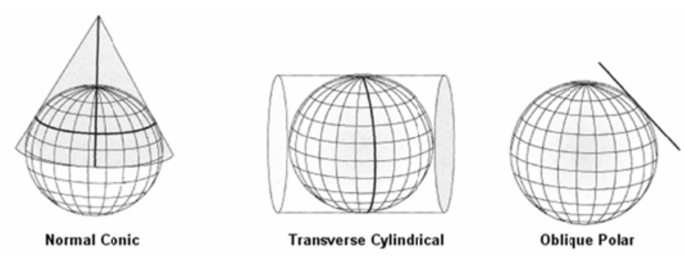


Figure 2 – Map Projection Examples

Once map projection geometric properties and construction methods are defined it is necessary to define coordinate system specifications (coordinate system center, x and y, axis and scale - units of measurement and orientation). One example of a common projected coordinate system (and the one in use at CRAA) is the State Plane Coordinate System.

2.5.3.2. Overview of the State Plane Coordinate System

All spatial data developed for CRAA will be in the State Plane Coordinate System. This section provides an overview of the State Plane Coordinate System.

The State Plane Coordinate System is also known as SPCS, SPC, State Plane, and State. It was originally designed by the U.S. Coast and Geodetic Survey in the 1930s to provide a basis for large scale mapping in the United States.

The State Plane Coordinate System (SPCS) divides the United States and its territories into more than 120 sections called **Zones**. Each state is covered by one or more zones. A Conformal Projection (Section 2.5.3.1.2 above) is used to define geometric properties and depending on the individual shape of each state, different projection surfaces (method of construction) are used.

For states that are longer east-west, such as Tennessee, a Lambert Conformal Conic projection is used. For states that are longer north-south, a Transverse Mercator (Cylindrical) projection is used. One exception to this rule is the state of Alaska which is projected using an Oblique Mercator projection to accommodate the angle of the Alaskan panhandle.

When State Plane was originally introduced it was based on a network of geodetic control points known as North American Datum of 1927 (NAD 1927 or NAD 27). The advances in technology have increased the capabilities for measurement accuracy and that, together with the need for compatibility with global positioning satellite systems, made it necessary to update datum specifications. The new redefined and updated datum is called North American Datum of 1983 or **NAD 83**, and the State Plane Projections based on NAD 83 are called SPCS 83. Some changes have been also made in the number and size of certain zones. Detailed information about all zones can be found from the National Geodetic Survey (NGS) website at http://www.ngs.noaa.gov.

2.5.3.2.1. Unit of measure

The standard unit of measure for SPCS 83 is the meter. Most states, however, support both meters and feet. In this case the feet-to-meter conversion is legalized and documented. See Section 2.5.4.1 below for the unit of measure required for CRAA GIS data.

2.5.3.3. Vertical Measurements

NAD83 specifies the horizontal datum of the SPCS (x and y coordinates). To be able to represent points in space an additional coordinate is required (z coordinate). This vertical coordinate (point height) is defined by another datum called the vertical datum. A vertical datum is a reference surface (the approximation of Earth's globe - geoid) to which heights are referred. The original U.S. vertical datum was National Geodetic Vertical Datum of 1929 (NGVD 29). This datum was updated during the surveying process started in 1977. The new North American Datum of 1988 (**NAVD 88**) was adjusted and released to the public in 1991.

2.5.3.3.1. Unit of measure

The standard unit of measure for NAVD 88 is the meter. Most states, however, support both meters and feet. In this case the feet-to-meter conversion is legalized and documented. See Section 2.5.4.1 below for the vertical unit of measure required for CRAA GIS data.

2.5.4. Specifications

2.5.4.1. Coordinate System Definition

All spatial data developed for CRAA will be developed in Ohio State Plane Coordinate System – Northern Zone using NAVD 88 for vertical measurements, NAD 83 HARN for horizontal measurements, and US Survey feet as the units of measurements. Table 5 below lists the details regarding these specifications.

Table 5: CRAA Coordinate System Specifications	
Ohio State Plane Coordinate System – South Zone	
Projection	NAD_1983_HARN_StatePlane_Ohio_South_FIPS_3402
False Easting	600000.000000
False Northing	0.000000
Central Meridian	-82.500000
Scale Factor	None
Latitude of Origin	38.000000
Angular Unit	Degree , 0.0174532925199433295
Linear Unit	*U.S. Survey Foot*
Datum	D_North_American_1983_HARN
Spheroid	GRS_1980, 6378137, 298.257222101
Grid/Ground Projection	Grid Projection only
Vertical Measurements	
Vertical Datum	NAVD 88
Vertical Unit	*U.S. Survey Foot*

2.6. METADATA STANDARD

2.6.1. Purpose

This section defines the metadata standards that will be used for GIS data developed for CRAA. All GIS-oriented spatial data created for CRAA must include metadata that is developed and submitted according to the specifications documented in this standard. This includes data prepared internally by airport staff and data prepared by outside data providers (designers, contractors and consultants).

This section also provides general information about what metadata is and current industry standards. More importantly, this section defines metadata standards and its elements (both required and optional) that will be used for all geospatial data developed for CRAA.

2.6.2. Scope

The term "Metadata" is a term that can be described as "data about data." It is typically represented as an XML (eXtensible Markup Language) document that answers "who, what, when, where, why, and how" questions about data and its creation. Every metadata file has multiple sections including:

- **General description section –** summary or abstract, data purpose, source, status, etc.
- **Spatial section -** describing the coordinate system and the data's spatial characteristics
- **Attributes section -** describing attributes included in the dataset

2.6.3. Introduction

The word metadata consists of two words—the Greek word *meta*, which means going above and beyond and the English word *data*. There are various descriptions of metadata — **metadata is**:

- data used to describe other data
- information about particular data, or
- a term that describes the data.

The information and description contained in the metadata helps users to evaluate the data and determine for what and how it can be used.

Geospatial datasets metadata in most cases describes purpose, source, and status of the data; spatial data characteristics such as map projection; and attribute information description which may include a definition of what particular attributes describe.

2.6.4. Geospatial Metadata Standards

Without metadata, it is difficult and sometimes impossible to assess the usability of particular geospatial datasets. Questions such as: when was this data created and by whom, is this data current, what is the map projection, or what are the units of measurements, can all be answered by reading an associated metadata document.

2.6.4.1. When to Gather and Provide Metadata

Metadata must always be delivered with GIS data. If there is no metadata, the investment in geospatial datasets is not protected.

- What if the original data creator leaves the organization?
- What if there is a need to use the data for other purposes? What is its original intent?
- How will potential geospatial data users asses the quality or usability of the data?

Metadata will provide the necessary information to answer these questions. Knowing the actual source and quality of geospatial data is essential in preventing expensive “data disasters.” The answer on all posed questions is in the metadata document that will, if correctly created, be the main source for all that valuable information.

2.6.4.2. When to Maintain Metadata

For metadata to be effective and truly valuable, it has to be updated whenever the dataset is updated. If metadata is created during the initial geospatial data creation and then never updated while the data has changed, the metadata’s value will dissipate. If metadata is not regularly maintained, it will ultimately become unusable, or even worse, become deceiving.

2.6.4.3. What Standard to Use

Several issues must be addressed when deciding what metadata standard to use for a particular dataset. Some of these issues might include the following:

- Data types—text, numeric, date, and so on.
- Is the standard too complex (too many things to report) or too simple (not enough essential information for a specific dataset)?
- Is standard easy to read/follow—the content of the metadata document has to be more important than the actual standard.
- The final product, the metadata document, is easily understandable for users that are not necessarily familiar with the standard.
- Are there existing standards the organization is already using?
- What is the intended audience for the metadata, both within and outside of the organization?

CRAA has established a minimum standard for GIS metadata, which must be submitted along with GIS data or GIS-oriented CAD data. See Table 6 below.

2.6.4.4. GIS Tools and Storage

The CRAA GIS is based on the Autodesk Suite of GIS products. The creation of metadata by Data Providers may be automated by the software used; either ESRI for GIS data or AutoCAD for GIS-oriented CAD data.

2.6.5. Minimum Metadata Element Requirements

The following table lists metadata elements typically required for geospatial data developed for GIS. **The metadata required for submittal to CRAA for GIS data and GIS-oriented CAD data is highlighted.**

Table 6: Metadata Element Specifications

Element Description [Required is Highlighted]	Metadata Element
Keywords	• Identification o Keywords Theme • Keyword • Thesaurus (If the keyword(s) are derived from a formal thesaurus add thesaurus name otherwise add None.)
Abstract: Description/Purpose	• Identification o General Description • Abstract • Purpose
Creation History: Method, Source	• Data Quality o Source Information General • Source Contribution
Update Frequency	• Identification o Status Update Frequency

Data Creator – Firm & individual	• Identification o Citation General • Originator
Time period for which the data is relevant	• Identification o Time Period Currentness reference Calendar Date
Status of the data	• Identification o Status o Progress
Constraints on accessing the data	• Identification o General
Security Classification & Use Constraints	• Access Constraints o Use Constraints
Who completed the metadata document	• Metadata reference o General
Publication date and time	• Identification o Citation
Spatial Reference General Information	• Spatial Reference o General (all)
Horizontal Coordinate System	• Spatial Reference o Horizontal Coordinate System (all)

2.6.6. Metadata Standard - FGDC

The CRAA Metadata profile listed above is designed to comply with Federal Geospatial Data Center FGDC-STD-001-1998, with some modifications. The FGDC metadata standard is universally accepted as "the" metadata standard for the US Government, many regional and local governments, GIS standards committees and GIS software providers.

2.6.7. Metadata Acceptance Testing Procedures

All geospatial datasets created for CRAA will be evaluated for metadata compliance:

- Every geospatial dataset must have associated metadata information, including "draft" in-progress data being submitted at in-development milestones (30% , 60%, 90% complete).
- All required metadata elements must be completed (information has to be present for every required metadata element, no empty values allowed).
- Metadata Acceptance Testing Steps will consist of the following:

1. The first step will be to check if every feature dataset has an associated metadata document.
2. When the first requirement is met, then it is necessary to ensure that the existing metadata document complies with the metadata standard.
3. Finally the check will be run on every metadata document to verify that information for all required metadata elements is completed.

3. DATA DELIVERY AND ACCEPTANCE

3.1. DELIVERY FORMATS AND MEDIA

All data shall be submitted in a stable electronic media format. The media format shall be of an acceptable type to the CRAA (FTP upload, CD, DVD or external hard drive). External thumb drives or SD memory cards are not acceptable media format. If the delivery is larger than available space on a single storage device, an alternative delivery approach shall be pre-approved by the CRAA.

3.2. DELIVERY PROCEDURES

This section applies to all data that will be created by external organizations for inclusion into the GIS.

3.2.1. Data Security

All GIS data shall be created exclusively for use and ownership by the CRAA, and no copies of the data will be provided to any other parties.

[Author's Note: SSI = Security Sensitive Information, governed by Title 49 of the Code of Federal Regulations (CFR), parts 15 and 1520]

All parties who receive electronic or hard copy drawings pertaining to CRAA properties must comply with the following CRAA Regulation:

§ 1520.13 Marking SSI.

(a) Marking of paper records. In the case of paper records containing SSI, a covered person must mark the record by placing the protective marking conspicuously on the top, and the distribution limitation statement on the bottom, of

> (1) The outside of any front and back cover, including a binder cover or folder, if the document has a front and back cover;
>
> (2) Any title page; and
>
> (3) Each page of the document.

(b) Protective marking. The protective marking is: SENSITIVE SECURITY INFORMATION/OHIO INFRASTRUCTURE RECORD.

(c) Distribution limitation statement. The distribution limitation statement is:

> WARNING: This record contains Sensitive Security Information that is controlled under 49 CFR parts 15 and 1520. No part of this record may be disclosed to persons without a "need to know", as defined in 49 CFR parts 15 and 1520, except with the written permission of the Administrator of the Transportation Security Administration or the Secretary of Transportation. Unauthorized release may result in civil penalty or other action. For U.S. government agencies, public disclosure is governed by 5 U.S.C. 552 and 49 CFR parts 15 and 1520……INFRASTRUCTURE RECORD Section 149.433(A)(2), ORC

(d) Other types of records. In the case of non-paper records that contain SSI, including motion picture films, videotape recordings, audio recording, and electronic and magnetic records, a covered person must clearly and conspicuously mark the records with the protective marking and the distribution limitation statement such that the viewer or listener is reasonably likely to see or hear them when obtaining access to the contents of the record.

3.2.1.1. Before Delivery

The Data Provider will acknowledge their understanding of the requirements of the GIS Data Standards and their commitment to them in a formal letter to the city within 30 days of the initiation of any project that will deliver GIS data.

The Data Provider must develop a Quality Control plan that meets the requirements of this standard and submit it in a formal letter to the city within 60 days of the initiation of any project that will deliver GIS data. The plan must be approved by the CRAA Project Manager prior to any data being developed.

The Data Provider shall document and enforce a process that ensures the security of the data before delivery, at the security level the data established in the contract.

3.2.1.2. At Delivery

The Data Provider shall provide for transport of the data in a secure manner from their office to the CRAA GIS. Chain-of-custody documentation (including transmittal) shall be established by the organization for each spatial data delivery.

As part of each data delivery, the Data Provider must remit a document certifying that the data to be delivered to CRAA was reviewed by the vendor and it was found to be in compliance with the standards. The document will contain an inventory of the data and will document any deviations from the standard that were detected. All such deviations shall be examined by CRAA who will then make a determination whether the dataset submitted is acceptable or not.

Unapproved deviations from the standard may be subject to rejection of the entire submittal.

3.2.1.3. After Loading/Post-Use

Delivered GIS data media shall be stored in an appropriate secure location by CRAA.

3.3. Data Development Quality Control and Quality Assurance

3.3.1. Quality Assurance Requirements

The quality assurance requirements for GIS data are as follows:

3.3.1.1. Quality Control Testing

As defined in this document and the contract scope, 100% of the GIS data must pass the quality control testing. A quality control report must be included with each submittal that documents the quality control testing that was performed, the results that were reported, and any corrective action that was taken. If any waivers to the standard were granted, those waivers must also be included with the submittal.

3.3.1.2. Spatial Data

Standards defining the accuracy of spatial data have been developed by the U.S. Geological Survey, and can be found at http://erg.usgs.gov/isb/pubs/factsheets/fs17199.html. This standard will be applied to all data developed according to this document, except that no less than 95% of the spatial data will be placed within the defined national map accuracy standards based on the nominal accuracy of the product map, or as defined in the contract scope.

This requirement will be evaluated by visual spot checks versus original source documents. The data creator will perform a spot check using a statistically significant sample size based on random selection methodology that will compute a confidence interval that the accuracy is within the parameters of the requirements. This test will be fully documented with a memo stating that the procedures were undertaken and that the actual results obtained are within the constraints.

3.3.1.3. Attribute Data

No less than 95% of the attribute data for each feature will be accurate.

This requirement will be evaluated by programmatic checks and/or spot checks versus original source documents. The data creator will perform a spot check using a statistically significant sample size based on random selection methodology that will compute a confidence interval that the accuracy is within the parameters of the requirements. This test will be fully documented with a memo stating that the procedures were undertaken and that the actual results obtained are within the constraints.

3.3.2. Quality Control Requirements

All data to be entered into the CRAA GIS will be subjected to a rigorous quality control process to ensure that it is compliant with this standard. The submitter will perform an electronic, pre-submission quality control check of each spatial data deliverable. A report documenting the results of the quality control process shall be submitted with each spatial deliverable to the CRAA.

3.4. Acceptance Testing Procedures

Acceptance of a spatial data delivery to the CRAA GIS shall be evaluated against the criteria in this document.

The CRAA shall run a quality control application that programmatically checks and reports the compliance with the Spatial Standards of the deliverable. The CRAA may reject submittals that exceed the quality thresholds. The quality control checks will include but not be limited to:

- Attribute domain conformance
- Attribute integrity
- Topologic integrity
- Spatial accuracy

3.4.1. Attribute Domain Conformance

All attributes will be evaluated against the domains defined for each feature class and attribute. Any values that fail these criteria will be flagged. If the Data Provider believes that the domain values should be modified, this information must be submitted to the CRAA for review at least 60 days prior to submission of the data.

3.4.2. Attribute Integrity

All attributes will be evaluated against the GIS Data Creation Rules using an automated checking process. Any values that fail these criteria will be flagged. If the Data Provider believes that the data creation rules should be modified, this information must be submitted to the CRAA for review at least 60 days prior to submitting the data.

3.4.3. Topologic Integrity

All topology will be evaluated against the GIS Data Creation Rules using an automated checking process. Any values that fail these criteria will be flagged. If the Data Provider believes that the data creation rules should be modified, this information must be submitted to the CRAA for review at least 60 days prior to submitting the data.

3.4.4. Spatial Accuracy

Spatial accuracy will be evaluated through a visual inspection procedure. The visual inspection will be performed by comparing the GIS features with the scanned images (where available), with the digital orthophotos, and with the source documents. In addition CRAA may choose to survey certain features for comparisons to the database submittal. Any anomalies uncovered during the inspection will be identified.

3.4.5. Quality Control Report

All data items that have been flagged from the quality control processes will be documented in a quality control report. If the dataset fails the quality control criteria, the dataset will be returned to the submitter for rework. The updated data will be resubmitted for acceptance until it passes the quality control testing.

3.4.6. Accepted Data

Once the data has passed the quality control process, it will be loaded into the CRAA's GIS system. CRAA will then formally accept the data

APPENDIX A – CRAA GIS DATA CREATION RULES

GIS data and GIS-oriented CAD data intended to be loaded into the CRAA GIS database must be consistent with the **CRAA GIS Data Creation Rules** defined herein.

FIELD DATA COLLECTION

Field data collection is one method to create data required for new GIS data or maintenance of existing GIS data. Consultants, contractors and others may conduct fieldwork on behalf of CRAA to develop CRAA GIS data. The following steps are to be performed by contractors or CRAA staff (collectively referred to as "GIS Technician) when developing GIS data from field observations.

1. CRAA Planning and Engineering staff will coordinate all geospatial data collection conducted by the airport. Priorities for conducting fieldwork will be based on construction activity being tracked and data discrepancies requiring correction.

2. Whether the data collection is to be performed outside or inside of buildings will dictate what processes and equipment the GIS Technician should use.

3. Depending on the type of data to be collected, the accuracies required and accessibility of the features being recorded, the GIS Technician will chose from a variety of data collection devices. For exterior work, redlining on hardcopy or electronic maps, survey grade Real Time Kinematic (RTK) Global Positioning System (GPS) units may be selected. For interior data collection, redlining on hardcopy or electronic maps or electronic measuring devices (such as a Leica Disto laser measuring device) may be selected.

4. Regardless of where the data is to be collected or the type of data collection method/device the GIS Technician plans to use, the first step is to download or print existing information from the GIS database.

5. If hardcopy or electronic maps are used for exterior data collection, then redline annotations should be made to record observations in the field.

6. If hardcopy redlines are used for exterior data collection, then these should be transposed into an electronic format by the GIS Technician once they have returned from the field.

7. Points along with any associated attributes and metadata should be recorded in the field.

8. Points captured using GPS may need to be post-processed once back in the office to obtain the accuracies desired.

9. If hardcopy or electronic maps are used for interior data collection, then redline annotations should be made to record observations in the field.

10. If hardcopy redlines are used for interior data collection, then these should be transposed into an electronic format by the GIS Technician once they have returned from the field.

11. Interior measurements may be taken using measuring tape or electronic devices.

12. The final step, regardless of how field data is collected, is to convert the information into a format that can be used within the enterprise GIS to support geometry and attribute data maintenance.

13. Data collected in the field should be checked by reviewing error statistics from GPS equipment, randomly checked against another source of equal or higher accuracy, compared with high resolution orthophotos and other means.

Electronic Data Creation

These steps below describe how new data that is collected should be assessed and prioritized for incorporation into the GIS database. These assessment procedures evaluate the quality of the new data in comparison with the current data in the GIS. Quality is assessed based on the accuracy, correctness, comprehensiveness and other factors. Where the new data is determined to be of higher quality than data currently in the GIS, this assessment will help prioritize the efforts required to cleanup, convert and load it into the GIS.

1. The first step in data assessment is to review any metadata that may have been provided with the source data. If no formal metadata (e.g. metadata saved within a personal Geodatabase or as an XML component of a Shapefile) is provided, information including transmittal letters, CD labels, 'readme' files on the media and other supporting documentation should be reviewed. If this information is still insufficient, then the person who provided the data should be contacted for further details.

2. The metadata should be checked for temporal accuracy (i.e. how current it is). If the data is determined to be newer than data in the GIS Query Database then it may be of use.

3. The data should be checked for positional accuracy (i.e. how close it is to the feature's true position). If the data is determined to be more accurate than data in the GIS Query Database then it may be of use.

4. The data should be examined to determine the physical extent of the data to ensure that it is relevant to CRAA.

5. If the metadata indicated that the data may be relevant based on its temporal and positional accuracies and its extent, then the data should be examined.

6. The positional accuracy should be checked to ensure that the data is more accurate than what is already in the GIS. This time, the data should be checked against a source of known higher accuracy such as existing survey control data, planimetric features derived from orthophotos or data specifically collected in the field to test the positional accuracy.

7. The data should also be examined to ensure that it is complete based on the defined data extent.

8. The GIS Technician should summarize the results of the assessment of the data set and convey them to the GIS Supervisor.

Data Created During Design & Construction

All projects whether carried out by CRAA through Capital improvements, tenant improvement or maintenance activities will be tracked by the Planning and Engineering Department.

Preliminary design processes will collect available data and add, modify and remove features to reflect a new design concept. At the end of the preliminary design phase, when design is considered 30%, 60% and 90% complete, this new data will be checked to ensure it conforms to the CRAA GIS/CAD Standards.

At the end of the final design phase, when design is considered 100% complete, this new data will be checked to ensure it conforms to the CRAA GIS/CAD Standards and meets criteria for loading into the CRAA GIS Database if desired.

During construction, redlines will be made on 100% design drawings to indicate changes made during the course of construction. Fieldwork may also be conducted to capture data while features are exposed by construction, such as new utility structures that will be covered by earth. Whether through redlines or through fieldwork prompted by construction, construction activity is an important source of new data that will drive geometry and/or attribute changes to the GIS Database.

Following construction, but before a facility is commissioned for use, an inspection and certification process shall be carried out, which can yield additional redlines on design drawings and possibly additional fieldwork.

Data Created from Aerial Photography

The periodic update of orthophotos and resulting planimetric features is another process that creates geospatial information for CRAA. This process is another important source of new data that will drive geometry and/or attribute changes to the GIS Database. In the future, other remote sensing means such as Light Detection and Ranging (LIDAR) and satellite imagery may follow a similar data creation process.

CRAA shall periodically obtain new orthoimagery and derive updated planimetric features through the planimetric development process using 3D stereo image compilation. GIS features should not be digitized directly from orthophotos as the 3D stereo imagery has a greater spatial accuracy. Mixing features compiled from stereo imagery with hand-digitized features from orthoimagery will degrade the spatial accuracy of the CRAA GIS features.

Geometry Maintenance

This section describes procedures should be followed to update geometric data features. This section also describes procedures that may be necessary to cleanup CAD, GIS and other geospatial data before it can be converted into the GIS. Steps for correcting undershoots/overshoots, closing polygons, finding and resolving slivers, and methods for correcting topology are identified. Details on how to perform steps for using the software that will be used to carry out these procedures are addressed in the user manuals of the specific software tools. These procedures are to be carried out by the GIS Technician or contractor staff at their direction.

1. The data creation process will produce data from a variety of sources. Data will be produced by external sources such as Consultants and Contractors, CRAA, other governmental agencies, third-party data vendors and others. The GIS Supervisor will be responsible for collecting and distributing this data to those who need it. The periodic update of orthophotos and resulting planimetrics carried out by CRAA is an important source of wholesale feature data updates. “GIS Technicians” will also record a variety of data in the field. Finally, others divisions may report discrepancies between existing data and current conditions in the field. Sometimes these discrepancies may prompt further fieldwork to investigate and resolve any discrepancies between the GIS data and the actual field conditions.

2. Regardless of the source of the data to be used for data maintenance, the first step of the GIS data maintainer is to determine if this data must comply with the GIS data standards. In most cases, data will be coming from CRAA staff or consultants and must comply with the standards. In cases where

data is coming from third-party vendors, the City or other sources, compliance with CRAA GIS Standards may not be required.

3. If compliance is required, the GIS Technician should validate that the data received complies with Standards.

4. The next step is for the GIS Technician to determine what type of data has been received.

5. CAD data will need to be converted into a format compatible for loading in the enterprise GIS.

6. Survey data may also need to be converted into a format that can be edited and prepared for loading. Many formats such as Comma Separated Value (CSV) coordinates and Coordinate Geometry (COGO) files can be read directly by GIS. Other formats such as LandXML may require conversion.

With all incoming data in a format that can be edited in the CRAA GIS, the GIS Technician should determine if the new data is expressed in ground- or grid-based coordinates. Although CRAA CAD and GIS standards require CAD and GIS data in grid-based coordinates, some data may be submitted by sources that do not have to adhere to these standards and may be in ground-based coordinates. In many cases, metadata will be provided that will indicate which coordinate system was used. In other cases, features in the incoming data may have to be compared with the same features in a known coordinate system.

1. If the incoming data has been determined to be in ground-based coordinates, the ground>grid scale factor must be applied using the appropriate coordinate transformation functions.

2. The GIS Technician then loads the data into a location where a working copy should be created for evaluation, leaving the original undisturbed. Software data management tools may also facilitate creation of an “edit” version of the data.

3. The GIS Technician can then begin the process of reviewing the incoming data to determine what changes need to be made to the GIS database.

4. In many cases, the new data will contain new features that do not exist in the GIS database and must therefore be added.

5. The GIS Technician may find that new features, created by others, have to be cleaned before being added to the database. Following are the typical types of issues that will need to be cleaned from new data sets:

    - Polygons may not be closed. In these cases, polygons should be closed by snapping two existing vertices together or by adding a new line segment that closes the gap. If the polygon isn't closed, it won't be represented as a polygon and will need to be closed for loading into the GIS database.

    - Polylines may need to be manipulated so that each polyline or line segment connects to adjacent nodes (typically shown as point features).

    - Polygons which fall below a logical size limit may have been created as an anomaly in the data creation process and may need to be removed.

    - Vertices of polygons and lines should be sufficient to achieve the desired accuracy. Additional vertices that do not provide clarity to the data could be removed using various software tools (e.g. in ArcMap, use the Generalize Tool).

In some cases, incoming data may be modifications to existing features. Depending on the nature of the change required, the GIS Technician may decide to archive the existing feature, adjust the existing feature or bring the modified feature in as a new feature, the latter of which would only be used when the existing data is substantially older than the new data or when the feature's geometry has changed significantly enough that it is easier to bring the modified feature in as new and delete the feature that it is replacing. Alternatively, the GIS Technician may simply make edits to the geometry of the existing feature. The GIS database is designed so that most features have a “status” attribute that will permit archival of demolished facilities easier to accomplish by changing the status of the “status” attribute.

New and modified features may also require topology to be adjusted. Following are the typical types of topology issues that will need to be corrected. Diagrams of such topological relationships can be found in FAA Advisory Circular AC5300-18:

- Polygons may overlap each other. In some cases, overlaps are not allowed (e.g. runway element). In these cases, polygon edges should be adjusted to remove the overlap and vertices of features should be snapped to corresponding vertices of adjacent features.

- Polygons may have slivers of unaccounted space between them. In these cases, polygon edges should be adjusted to remove the gap and vertices of features should be snapped to corresponding vertices of adjacent features.

- Line overshoots may need to be trimmed so that line segments end at a node, endpoint or point of intersection as appropriate.

- Line undershoots may need to be extended so that line segments end at a node, endpoint or point of intersection as appropriate.

- Vertices of features should be snapped to corresponding vertices of adjacent features.

New or modified feature may also require attributes to be edited. New or modified features will also require metadata to be entered.

GIS Technicians may need to perform action to remove a feature from the GIS database. No significant features should permanently be deleted. Depending on the database design, features can remain as is with a status attribute change, or moved to an archive of removed features.

The GIS Technician should conduct Quality Control (QC) of their work throughout the geometry maintenance process, especially when removing parts of features and inserting new parts – remember to join the parts into a “whole” feature. This QC should include reviewing their work for polygons that aren’t closed, overlapping polygons, slivers between polygons, improperly placed vertices, overshoots and undershoots. These can be checked by zooming and panning to areas of the map that have been edited and visually checking for issues.

Once the GIS Technician has added new features, modified changed features and/or archived/ removed features, they should perform Quality Assurance (QA) on the data by 1 – checking the features against other layers or related layers, and 2 - having an independent review by another qualified GIS technician or GIS Supervisor. If the data does not pass QA then the GIS Technician must clean and adjust topology as necessary.

After geometry (and attribute) editing and passing QA, the data can be updated to the GIS “production” environment as appropriate.

CAD Data Preparation & Conversion

Preparing CAD data that is compliant with the CRAA CAD Standards is not only a requirement of CAD data submitted to or prepared by CRAA, but it is an important prerequisite to updating GIS data where CAD data is the original source. The procedure and specifications for preparing compliant CAD data are described in the CAD Data Standards. Existing CAD data sources or CAD data that is not prepared by CRAA staff or consultants will not conform to the CRAA CAD data standards. In these cases, CAD data may need to be manipulated by the GIS Technician before it can be used for GIS data maintenance.

CAD Preparation & Conversion Steps

1. Where applicable, check for Compliance with the CRAA CAD Data Standards.

2. Each CAD .DWG or .DGN file should be checked to ensure that it can be opened in the correct version of Autodesk AutoCAD (or Bentley's MicroStation), respectively.

3. The model space of each CAD drawing should be checked to ensure that it is in the proper geographic coordinate space. This can be accomplished by checking the drawing coordinates of at least two points shown in the CAD drawing against the true known coordinates for those points. Control stations, for which high accuracy coordinates are known, are recommended for this purpose.

4. The GIS Technician should randomly check a representative sample of layers which will be used for GIS feature creation, modification or archival to ensure that the proper geometry and type of features are on each layer.

5. Depending on the type of data and the number of similar CAD files to import, the GIS Technician may decide to use FME or other software tools to convert the CAD data into a GIS file format before bringing it into GIS format. FME should be considered in the following cases:

    - CAD files to be converted contain a large number of layers for which there are many CAD layers that are to be combined into a single GIS layer with an attribute (typically a type code) that distinguishes between them. FME's workbench can be used to read the layers in the CAD file and they can be graphically matched with the corresponding layer(s) of the GIS database. The separation of features on different CAD layers can be used to set an attribute in the GIS file.

    - Multiple CAD files are submitted with the same layers but for different geographic areas. An example of this is when sections of a building are split into separate files with match lines to align the data. FME Workbench can be used to create a translation file which the GIS Technician can save and reuse for each CAD file of the same structure.

    - CAD files that are submitted as part of a long term project where future submittals are likely to require the same layer manipulation. FME Workbench can be used to create a translation file which the GIS Technician can save and reuse for future CAD files of the same structure.

6. The GIS technician should then bring the data from the CAD file or from the file(s) created by FME into GIS for manipulation and editing.

7. The Geometry Maintenance Procedure should now be carried out with the CAD data.

Attribute Data Maintenance

This procedure describes methods for the entry, cleanup, conversion and loading of alphanumeric data that is in some cases maintained separately from the corresponding geometry in a data set. This procedure covers text that is manually entered and text that is loaded from electronic files. It does not include procedures for transferring data from other systems.

Attribute Data Maintenance Steps

1. The data creation process will produce attributes that are usually entered by GIS Technicians or external data providers and then collected by the GIS Supervisor.

2. Attributes will also be produced through field data collection activities. This field data collection will be coordinated by the GIS Supervisor.

3. The first step in the attribute maintenance process is for the GIS Technician to determine the format of the attribute data to be entered into the GIS. Viable attribute formats can include hardcopy data, spreadsheets (e.g. Microsoft Excel), personal databases (e.g. Microsoft Access), and comma delimited text files.

4. Attribute data provided in a hardcopy format will need to be manually entered into the attribute table for the appropriate feature class within GIS. In some cases where a large number of attributes are to be entered, the GIS Technician may decide to enter the data into another format such as a Microsoft Excel spreadsheet, which can allow long lists of data to be more easily copied and checked, then joined to the appropriate feature table.

5. Attribute data provided in tabular electronic format such as a Microsoft Excel spreadsheet, Microsoft Access database, or CSV ASCII file can often be linked with features in a spatial data set. In order for this to work, the feature class and the external tabular data to be joined need to share a common unique identifier. This can be achieved by exporting attributes data including such an identifier from the feature class first and then using this exported file for subsequent data entry. When the external data is joined to the feature class, the joined attributes are not saved into the feature class directly, but they can be copied into the desired attribute fields.

6. In some cases, attributes may be provided in GIS or CAD files in a manner that can be converted to the appropriate attributes in the GIS database. Tools such as FME Workbench and others can help in such conversion. For example, GIS files may contain fields that need to be concatenated or edited before being compliant with the GIS Spatial Data Standards Specification. With CAD data, attributes can be attached to blocks or as object data. In some cases, tools such as FME can be used to convert these attributes into a format that can be read by the GIS.

7. After attributes are entered, metadata should be adjusted as necessary to reflect the changed entries. Metadata changes may include the source of the revisions, the date the edits were made and any notes regarding cleanup or conversions steps that may have been used to alter the data.

8. Quality Assurance should be completed on all modified datasets once the modifications are completed by the GIS Technician.

9. After all modifications have passed QA, the GIS Technician should post the new data to the production database.

GIS Data QC, QA and Validation Procedures

This section will describe the quality control (QC), quality assurance (QA) and validation procedures that are to be applied to data that is to be loaded into the GIS. These procedures include those that CRAA personnel responsible for data maintenance should use as data is being maintained. Consultant and contractors that develop data for the GIS should also be encouraged to use these procedures. The procedures in this section also include steps that the GIS Data Section should use to check contractor data submittals against the data standards and specifications before it is loaded into the GIS. Finally, the process for carrying out annual audits to check data in the GIS is described.

Quality Control Procedures

The procedures that data maintainers should use to establish quality as they develop and maintain data are described in this section. These procedures are mainly defined for CRAA staff responsible for data maintenance, but consultants and contractors should be encouraged to use them as well. Consultants and contractors cannot be mandated to use these procedures as they may have procedures they have designed that are specific to their business process.

1. As geometric data is created, it should be checked for spatial accuracy. This is especially the case if data is being created based on source data that is converted from another coordinate system such as ground coordinates. Data can be checked for accuracy by comparing it with a source of similar data that is known to be of higher quality. Two sources that can provide such information, depending on the expected quality of the data being checked, are the planimetric data provided as a result of the orthophoto development process or fieldwork to collect high-accuracy coordinates.

2. As features are created, edited or archived, the GIS Technician should check to ensure that all pertinent features are properly handled. There are several ways this can be done depending on the data. A query to indicate the number of features edited can be executed and compared with the number of features in the source data set. A visual review of the physical extent of the area being edited can be conducted. Edited features can be overlaid on top of aerial photography or features from the database to ensure all expected features have been edited. In some cases, field verification of the data may be warranted.

3. All features created or edited should be checked for conformance to the appropriate geometric rules. While these will vary between various feature classes, the following general rules apply to all based on their geometry type.

    - Polygons may not be closed. In these cases, polygons should be closed by snapping two existing vertices together or by adding a new line segment that closes the gap.
    - Polylines may need to be dissolved so that each polyline or line segment connects to adjacent nodes (typically shown as point features).
    - Polygons which fall below a logical size limit may have been created as an anomaly in the data creation process and may need to be removed.
    - Line segments and polylines may need to be merged so that each polyline or line segment connects to adjacent nodes (typically shown as point features).
    - Vertices of polygons and lines should be sufficient to achieve the desired accuracy. Additional vertices that do not provide clarity to the data should be removed.

4. All features created or edited should be checked for conformance to the appropriate topology rules. While some rules are specific to individual feature classes, the following rules apply to all.

- Polygons may overlap each other in cases where overlaps are not allowed (e.g. lease lines). In these cases, polygon edges should be adjusted to remove the overlap.

- Polygons may have slivers of unaccounted space between them. In these cases, polygon edges should be adjusted to close the gap.

- Line overshoots may need to be trimmed so that line segments end at a node, endpoint or point of intersection as appropriate.

- Line undershoots may need to be extended so that line segments end at a node, endpoint or point of intersection as appropriate.

- Vertices of features should be snapped to corresponding vertices of adjacent features.

5. As attributes are entered, they should be checked for correctness against the source data and conformity with the format and rules relevant to each attribute. For example, all numbers should be checked to include only numeric values, positive values should be positive, dates should be valid dates, etc. Software validation routines will check for many of these issues, but manual quality control should also be performed. One method of doing this is to sort attributes in a table and examine the results for outliers.

6. Metadata should also be checked in much the same manner as attributes are checked. The GIS Technician should also proofread all narrative and explanatory text in the metadata to ensure that it is logical and that it does not contain grammatical or typographical errors.

Quality Assurance & Validation Procedures

The procedures to be performed before CRAA staff submit data are described in this section. (Consultants and contractors cannot be mandated to use these procedures as they may have procedures they have designed that are specific to their business process.)

Procedures for validating data before it is loaded into the GIS are included in this section. This covers random sampling procedures recommended by the American National Standards Institute (ANSI). This section also describes methods for the entry, cleanup, conversion and loading of alphanumeric data that is, in some cases, maintained separately from the corresponding geometry in a data set. These procedures cover text that is manually entered, and text that is loaded from electronic files. It does not include procedure for transferring data from other systems.

Data may be received by the GIS Supervisor from sources outside of CRAA, other Departments, or from within the Planning and Engineering Section.

1. The GIS Supervisor will assign a GIS technician or a qualified consultant to validate the data. A qualified GIS Technician who was not directly involved in the data creation process should be assigned to preserve the independent nature of the checking.

2. The first step for the GIS Technician assigned to validate the data should be to check for the presence of metadata. Metadata is a fundamental requirement of all data sets submitted or used by CRAA. A lack of required metadata is grounds to fail the data set, discontinue further validation steps, and return the data to the provider for revisions.

3. After examining the metadata and determining that the required metadata fields have been properly populated, the GIS Technician should perform an overview of the data. The specific steps taken will

vary depending on the type of data being examined. If significant errors are found during this overview, then the data being examined should be returned to the data submitter without further checking.

4. A statistically valid random sample of items submitted in the data set (e.g. features, attributes, image tiles, etc.) should be taken. ANSI testing procedures should be used to determine the valid number of samples to be taken. Subsequent tests will be performed on these samples.

5. The positional accuracy of the sampled items should be tested against a source of known higher accuracy. Geometric data can be checked for accuracy by comparing it with a source of similar data that is known to be of higher quality. Three sources that can provide such information, depending on the expected quality of the data being checked, are the orthophotos and planimetric data derived from the orthophotos, and high-accuracy coordinates collected in the field.

6. The topological relationships between each of the sampled features and those in the same feature class, and those in other feature classes, should be evaluated against any topological rules established for that data.

7. Next the correctness of any attributes associated with the sampled items should be confirmed against the original source of the data as indicated in the metadata.

8. The GIS Technician should record results as Pass, Fail or Question for each sample.

9. After reviewing all samples, unresolved questions should be addressed by reviewing the items with the GIS Supervisor or the data provider. Care should be taken to evaluate the data submitted against the specifications for that data without any bias introduced by the data provider.

10. The number of tested samples that failed to meet the required specifications should be counted. If this total number of failures exceeds the allowed number of failures for that quality level based on ANSI/ASQC Z1.4-2003, the Coordinator will determine if the data set passed validation or not.

11. The GIS Supervisor will communicate the results of the testing to the data provider. If corrections are required then it is up to the data provider to make the changes, perform quality control and quality assurance procedures, and then resubmit the data for validation (now at a lower threshold of failures).

Data Audit Procedures

After new data sets are introduced, the airport configuration is updated or a significant period of time passes, periodic audits should be performed to check data in the GIS against actual conditions in the field, including geometry and attributes that may have changed. A periodic orthophotography update is also an audit in that it can be used to compare current conditions with existing data that will then be brought up-to-date.

Operations and maintenance personnel are constantly in the field making observations and should report any discrepancies that they observe between current conditions in the field and the map data which they are using. While less formal, these ongoing observations are an important way of keeping up with the dynamic nature of airport infrastructure changes. Other divisions that use GIS feature classes may wish to establish more formal observations (such as the annual FAA airfield inspection, or informal audit procedures such as during the daily Part 139 inspections discrepancy reporting and follow up.

Regardless of the data being checked or the frequency of the audit, these data audits are a form of field data gathering and should be carried out as described earlier. In summary:

- Current data should be downloaded or printed from the GIS Database
- Field observations should be made comparing current conditions with the data
- Redlines should take note of any discrepancies (in some cases, measurements or coordinates will be taken), and
- The data recorded in the field should be converted into GIS upon return.
- Finally, the GIS Technician responsible for the data should modify geometry and/or attributes, as appropriate.

APPENDIX B – REQUIREMENT REFERENCE / DATA CHECKLIST

CHAPTER / SECTION	*REQUIREMENT*
	CAD STANDARDS
Error! Reference source not found.	Submitted data complies with CRAA CAD Standard.
Error! Reference source not found.	CRAA CAD Support Package obtained.
Error! Reference source not found.	Raster scanned drawings provided in the proper format and at various data submittal stages.
Error! Reference source not found.	Project Data Specifications Form submittal to CRAA required at start of project – within 30 days of Notice to Proceed date. Specifies what software versions and electronic data deliverable formats are planned. See Appendix __ for this form.
Error! Reference source not found.	Layer names follow the CRAA naming convention either by using existing CRAA defined layers or a waiver has been requested and granted to add a new layer name to the CRAA standard.
Error! Reference source not found.	Electronic CAD Model Files follow the CAD Standard for annotation layers, status indicators and Externally Referenced (Xref) files.
Error! Reference source not found.	Only CRAA supplied or approved Blocks are used.
Error! Reference source not found.	CRAA Linetype styles are used unless at the discretion of the designer other linetypes defined in the CAD Standard are used.
Error! Reference source not found.	Electronic CAD files are provided in a file structure with the hierarchy matching that defined in the CAD Standard or as otherwise approved in advance by CRAA for a project with special data needs.
Error! Reference source not found.	All electronic CAD and GIS-Oriented CAD data provided to CRAA will comply with Spatial Data requirements for both Civil (outside of the building) and Building data (terminal only).
Error! Reference source not found.	All electronic CAD and GIS-Oriented CAD data provided to CRAA has been checked for compliance with the CAD and GIS Data Standards and meets all required standards. Specifications include: fonts, blocks, plotting using CRAA pen table, Xref files, proper raster scans, etc.
Error! Reference source not found.	Electronic data for both CAD Plan data and CAD GIS-Oriented/GIS Data is submitted to CRAA at the proper stages.

Error! Reference source not found.	Final "As-Built" Data is submitted in 3D form and meets all applicable requirements for GIS-Oriented CAD Data. **Also see GIS Data Standards.**
Error! Reference source not found.	CAD Drawing Files (Model Files and Sheet Files) are properly names and organized and all Xref files are appropriately named and organized following the CRAA CAD Standard for file naming.
Error! Reference source not found.	Detail and Schedule sheets are prepared following National CAD Standard guidance. CRAA does not define specifications for Details or Schedule Sheets in the CRAA CAD Standards.
Error! Reference source not found.	All presentation graphics follow the guidelines defined in the CRAA or following the standards, the designer has modified how the data appears for plotting purposes as appropriate.
Error! Reference source not found.	Text Styles for annotation are Verdana only. Border template file fonts are set using Arial and should not be changed.
Error! Reference source not found.	The Standard CRAA .CTB Pen Table shall be used to control the plan plotting styles.
Error! Reference source not found.	Only standard sheet sizes and CRAA Border template files shall be used. See CAD Support Package for these template files.
GIS DATA STANDARDS (Applicable to GIS Data/GIS-Oriented CAD Data)	
2.3	GIS Data shall be properly formatted for delivery to CRAA.
2.4	For GIS Data submitted in GIS Database, all data must meet the requirements set forth in this Section.
2.5	For GIS Data submitted to CRAA, all data must meet the Coordinate System requirements set forth in this Section.
2.6	For GIS Data submitted to CRAA, all data must meet the Metadata requirements set forth in this Section.
3	For GIS Data submitted to CRAA, all data must meet the Data Delivery and Acceptance specifications and procedures set forth in this Section.

Appendix C – CAD/GIS Related Terms

	Definition
ArcGIS	A collection of Geographic Information System software product lines produced by ESRI, composed of ArcInfo, ArcEditor, and ArcView.
ArcGIS Server	A GIS web Map Server, produced by ESRI, which facilitates sharing of GIS data across the Internet or within an Intranet.
ArcMap	The central application in ArcGIS Desktop for all map-based tasks including cartography, map analysis, and editing.
ArcSDE	An application server that facilitates storing and managing spatial data (raster, vector, and survey) in a database management system. Makes this data available to many applications.
Attribute data	Descriptive data of a system feature, such as manufacturer, size, or material.
AutoCAD	A suite of CAD software products for 2- and 3-dimensional design and drafting developed and sold by Autodesk.
Data model	The logical data structure developed during the database design process. It is a description of the structural properties that define all entities represented in a database and all the relationships that exist among them.
Enterprise GIS system	A GIS that integrates geographic data across multiple departments or divisions and serves the entire organization. Provides access to other information systems in the organization by using a map or application as the integrator of the organization's information.
ESRI	Environmental Systems Research, Inc., of Redlands, California. Producer of ArcGIS family of products.
External reference	Xref – files such as border sheets or images that are shown in an AutoCAD file by externally referencing the data rather than having the data resides in the current drawing file.
Geodatabase	A database for spatial and tabular geographic data.
GIS	Geographic Information System. A system that integrates tabular system data with a spatial representation.
Metadata	Detailed information about the dataset—how it was created and by whom. Accuracy and completeness descriptions.
MicroStation	A CAD drafting software by Bentley Microsystems. Not currently used by CRAA.
National CAD Standard	(NCS) Version 5 is currently the CRAA adopted version. NCS is collaboration between the American Institute of Architects and National Institute of Building Sciences to create a unified approach to CAD software design.
Object data	A method by which some versions of AutoCAD (Map/Civil 3D) store attribute data about AutoCAD entities. Not all versions of AutoCAD use Object Data.
Orthophotograph	An aerial photograph that shows images of ground features in their true map positions.
Planimetric data	A map that represents the horizontal position of features such as boundaries, fences, streets, and structures.
Raster data	A raster data structure is usually a rectangular, square-based "gridding" of a 2D plane into cells. Some raster datasets contain elevation data but most are "flat". Raster data typically isn't scalable.
Shapefile	The Esri shapefile is a popular geospatial vector data format for use in GIS software. Shapefile store geometric information as points, lines or polygons and potentially some attribute information about each in a tabular format.
Spatial data	Information about the location, shape, and relationships among geographic features, usually stored as coordinates and topology.
SQL Server	A relational database management system (RDBMS) produced by Microsoft.
Tabular data	Non-spatial descriptive data of system features often captured in spreadsheets, databases, or hardcopy sources.
Vector data	Vector data consists of geometric features such as points, lines, curves, and shapes or polygon(s), which are all based on mathematical expressions, to represent more complex geometric shapes. Vector data is scalable.

APPENDIX D – APPROVED CHANGE CONTROL FORMS