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Part 10. GNSS Local and Network Accuracy; FGDC Standards; Reporting; Filing Surveys

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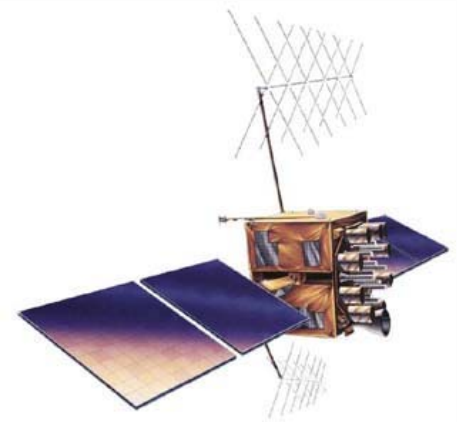
27 slides



FGDC Standards – Reporting

Federal Geographic Data Committee

- FGDC Standards – Part 1 Reporting Methodology
  - Objective, Scope
  - Accuracy Standard
    - Local and Network Accuracy Definitions

- FGDC Standards – Part 2 Standards for Geodetic Networks
  - Objective, Scope, Applicability
  - Accuracy Standards
  - Accuracy Determination
  - Accuracy Reporting

Part 1: Reporting Methodology

FGDC Geospatial Positioning Accuracy Standards (with NGS interpretations)

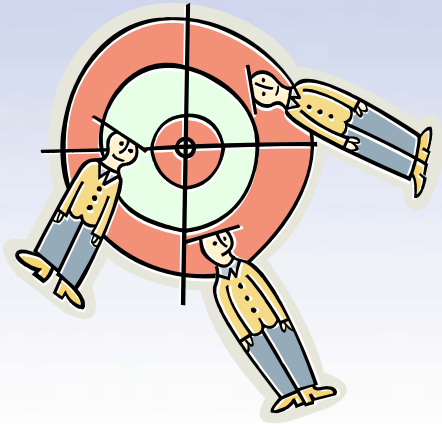
Federal Geodetic Control Subcommittee

Federal Geographic Data Committee

-FGDC-STD-007-1998

Part 1

Introduction



- Objective
  - Provides a common methodology for reporting the accuracy of horizontal and vertical coordinate values where the location is defined by a single point coordinate.
    - Examples: survey monuments, prominent landmarks, church spires, standpipes, radio towers, tall chimneys, mountain peaks, and targeted photogrammetric control points.

Objective, cont.

Part 1

- This objective provides a means to directly compare the accuracy of coordinate values obtained by one method with that obtained by another method for the same point.

  - It is increasingly important for users to know the accuracy of those coordinate values, **so <u>users can decide which values represent the best estimate of the true value for their applications.</u>**

Scope

Part 1

- Activities which collect or produce data coordinates include geodetic network and crustal motion surveys; national, regional, state and county topographic mapping; bathymetric mapping and nautical charting; engineering, construction, and facilities management mapping and drawing; cadastral and boundary surveying; etc.

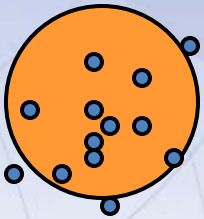
- This document was developed in separate parts to address various activities.

Additional Parts

Part 1

- Part 1: Reporting Methodology
- Part 2, Standards for Geodetic Networks
- Part 3, National Standard for Spatial Data Accuracy
- Part 4, Engineering, Construction, and Facilities Management
- Part 5, Navigation Charts and Hydrographic Surveys

Part 1



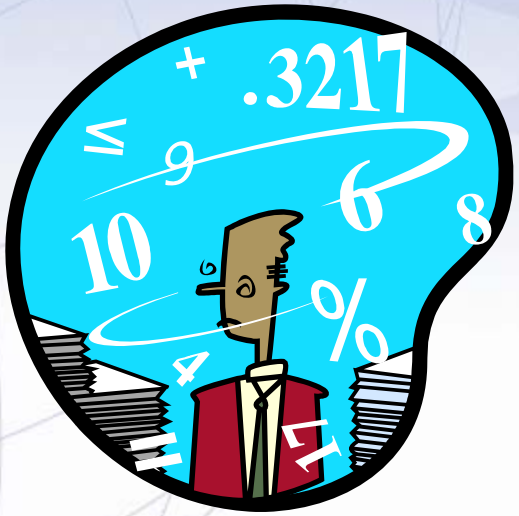
Accuracy Standard

- **Horizontal:** The reporting standard in the horizontal component is the radius of a circle of uncertainty, such that the true or theoretical location of the point falls within that circle 95% of the time.

- **Vertical:** The reporting standard in the vertical component is a linear uncertainty value, such that the true or theoretical location of the points falls within +/- of that linear uncertainty value 95% of the time.

- The reporting accuracy standard is defined in metric (SI) units, but may be reported in English units where the point coordinate values are reported in English units.

Method Used to Evaluate Accuracy



- **Should be described:**
  - Statistical testing
  - Least squares adjustment
  - Comparison with values of higher accuracy
  - Repeat measurements
  - Estimation of the confidence level

Coordinate Values Based on National Datum (NSRS) Part 1

Currently…

- **Horizontal: North American Datum of 1983 (NAD 83)**
- **Vertical: North American Vertical Datum of 1988 (NAVD 88)**

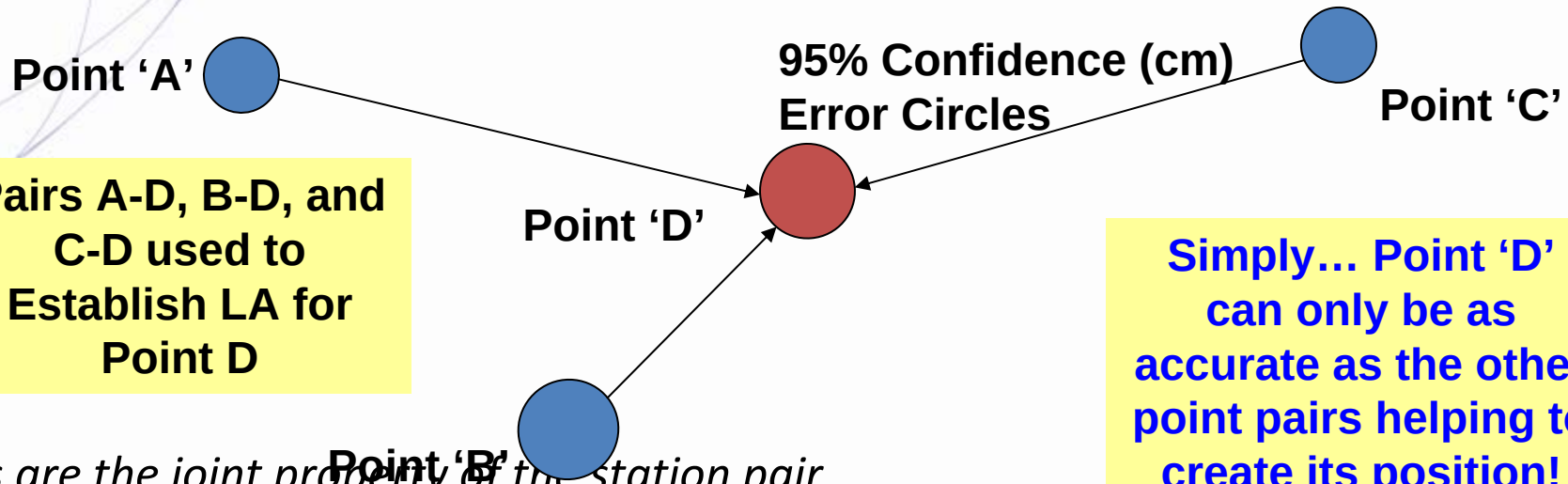
- **Legacy datum include:**
  - North American Datum of 1927 (NAD 27)
  - National Geodetic Vertical Datum of 1929 (NGVD 29)

In any case **identify** the relationship to the national datum, if local or state that the relationship to the national datum is unspecified.

Key Definitions

Part 1

- FGDC Local Accuracy (LA) - The horizontal LA of a control point is a value that represents the uncertainty in the coordinates relative to the coordinates of other directly connected adjacent control points at the 95% confidence level. The reported accuracy is an average of the individual local accuracies between this control point and other observed control points used to establish the coordinates of the control point.



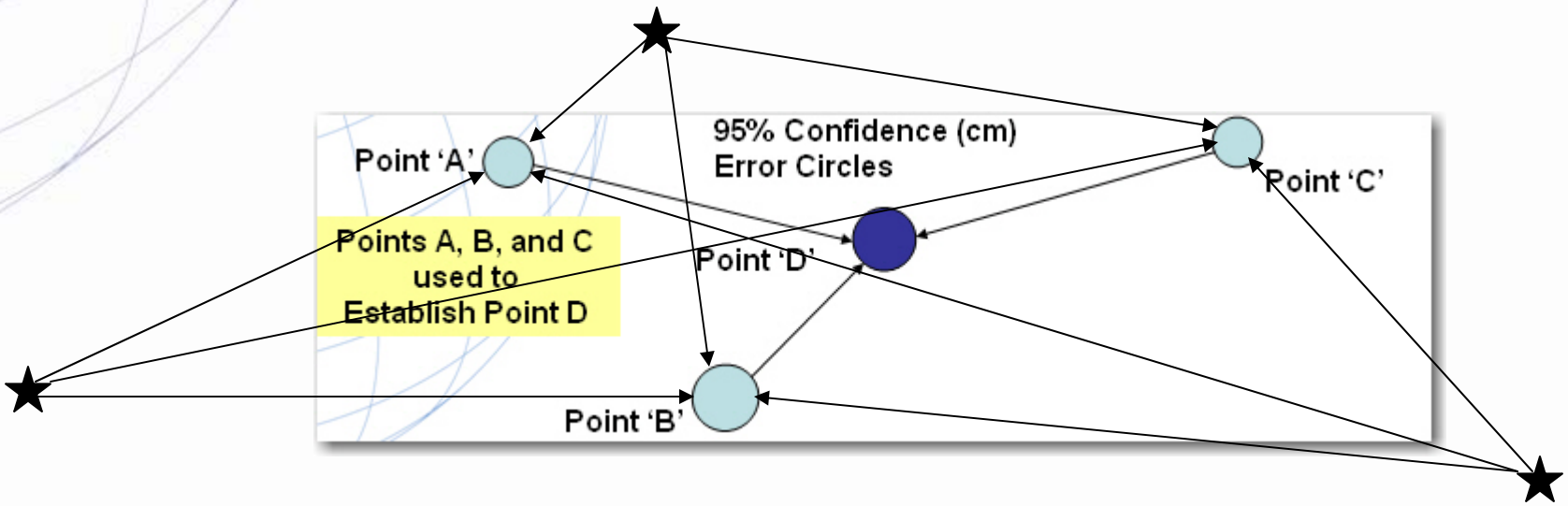
Pairs A-D, B-D, and C-D used to Establish LA for Point D

Simply… Point 'D' can only be as accurate as the other point pairs helping to create its position!

LA's are the joint property of the station pair.

NGS Local Accuracy Reporting

Horizontal LA will be reported by the NGS as a single quantity for any one given pair of points, called 'horizontal local accuracy'. It is the radius of a circle in the horizon plane (North + East) of an average 'local North, East, Up' frame centered on the difference between the reported latitudes of the two points and the reported longitudes of the two points inside of which there is a 95% chance the difference in their reported latitudes and longitudes are correct, relative to a fixed (and presumed errorless) CORS network.



LA's are the joint property of the station pairs.

NSRS CORS (Fixed & Presumed Errorless)

NGS Local Accuracy Reporting

- **NGS Local Ellipsoid Height (EH) Accuracy Reporting -** The ellipsoid height (EH) LA is a single linear value which when doubled and centered on the difference between the reported EH for the two points, represents the upper and lower bounds inside of which there is a 95% chance the difference in the reported ellipsoid heights is correct, relative to the fixed (and presumed errorless) CORS network.

Local Accuracy Interpretations

- LA's are not point values specific to the individual marks...
  - Rather they are the joint property of both marks (endpoints of a baseline).
- LA expresses the (correlated) relationship between the two marks forming the baseline.
- Unconnected points in the network are called 'uncorrelated' and considered to not have a LA (but could be calculated).

Part 1

Network Accuracy

- **FGDC Network Accuracy** (NA) – The network accuracy of a control point is a value that represents the uncertainty in the coordinates of the control point with respect to the geodetic datum at the 95% confidence level.
  - For NSRS network accuracy classification, the datum is considered to be expressed by the geodetic values at the CORS supported by NGS.
  - **By this definition, the local and network accuracy values at CORS sites are considered to be infinitesimal, i.e., to approach zero.**

NGS Network Accuracy (interpretation)

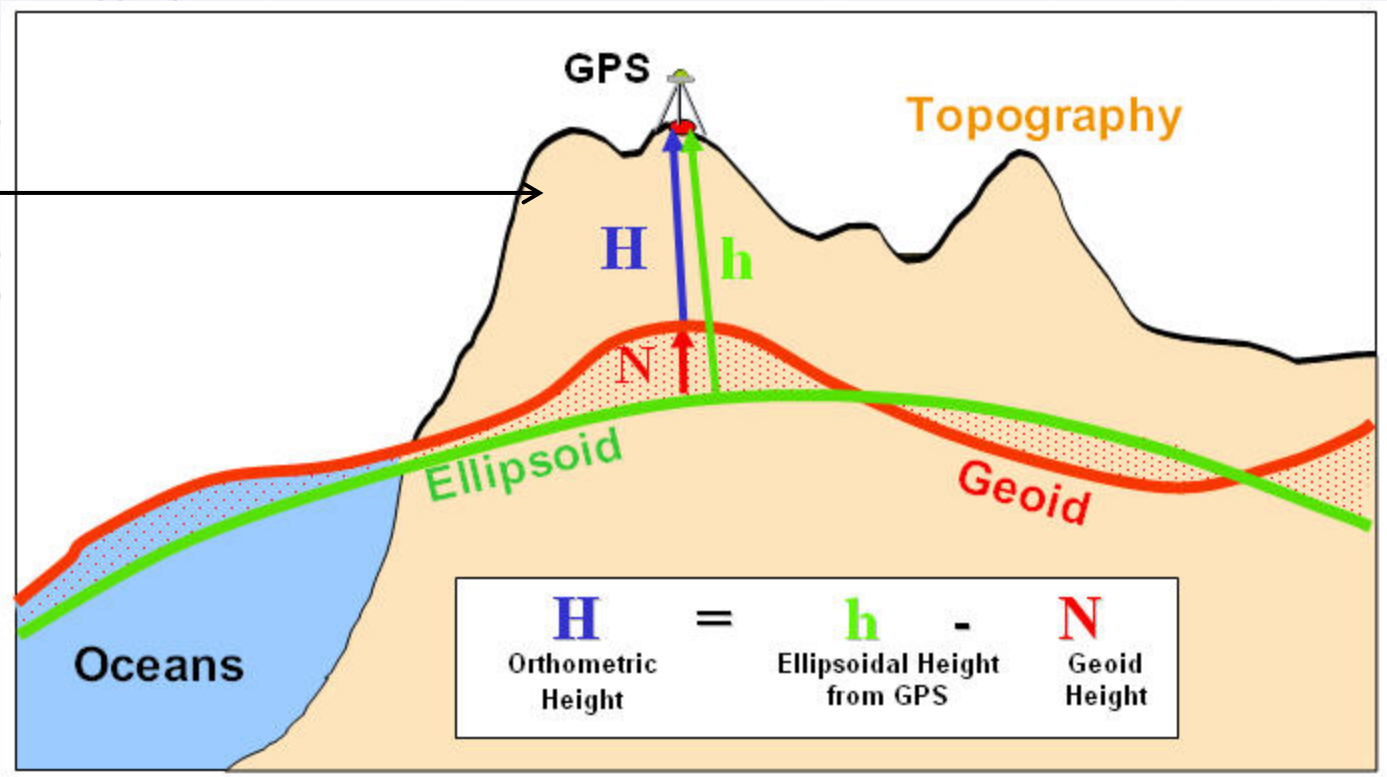
NGS Network Accuracy (NA) – Horizontal NA will be reported by the NGS as a single quantity for any one given pair of points, called 'horizontal network accuracy'. It is the radius of a circle in the horizon plane (North + East) of an average 'local North, East, Up' frame centered on the reported latitude and longitude of a point, inside of which there is a 95% chance the reported latitude and longitude are correct, relative to a fixed (and presumed errorless) CORS network.

- **NGS Network Ellipsoid Height (EH) Accuracy** is a single linear value which when doubled and centered on the difference between the reported EH for the two points, represents the upper and lower bounds inside of which there is a 95% chance the difference in the reported ellipsoid heights is correct, relative to the fixed (and presumed errorless) CORS network.

Orthometric Height

Part 1

- The distance measured along the plumb line between the geoid and a point on the Earth's surface, taken positive upward from the geoid



Part 2

FGDC Geospatial Positioning Accuracy Standards

Part 2: Standards for Geodetic Networks

Federal Geodetic Control Subcommittee

Federal Geographic Data Committee

-FGDC-STD-007-1998

Additional Parts

Part 2

- **Part 2, Standards for Geodetic Networks**
- **Part 3, National Standard for Spatial Data Accuracy**
- **Part 4, Engineering, Construction, and Facilities Management**
- **Part 5, Navigation Charts and Hydrographic Surveys**

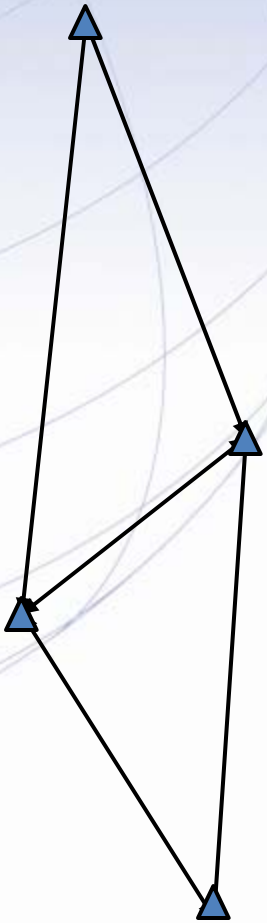
Introduction

Part 2

- **Objective**
  - Provides a common methodology for determining and reporting the accuracy of horizontal and vertical coordinate values for geodetic control points such as brass caps and rod marks.
  - It provides a means to directly compare the accuracy of coordinate values obtained by one method (such as classic line of site traverse) with the accuracy of coordinate values obtained by another method (GPS), for the same point.

Scope

Part 2



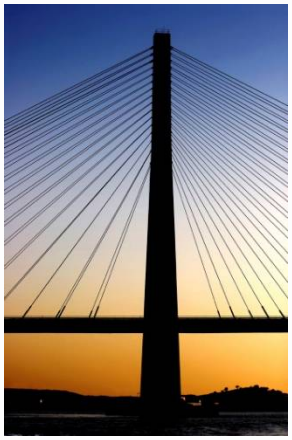
- Geodetic control surveys are usually performed to establish a basic control network, from which supplemental surveying and mapping work is performed.
- **Geodetic network surveys are distinguished by the use of redundant, interconnected, permanently monumented control points that comprise the framework of the NSRS, or are often incorporated into the NSRS.**
  - These surveys must be performed to far more rigorous accuracy and QA standards than control surveys for engineering, construction or topographic mapping.

Applicability

Part 2

- Geodetic network surveys are often employed when large geopolitical area (county or larger) mapping control is required, and where seamless connection with adjacent political areas is critical.

- Accurate network control may also be required for controlling interstate transportation corridors (highways, railroads, bridges, pipelines etc.)



Accuracy Standards

Part 2

Testing Methodology and Reporting Requirements →

Note that these accuracy standards replace the standards found in FGCC 1984 and FGCC 1988.

When control points in a survey are classified they have been verified as being consistent with all other points in the network, not merely those within that particular survey.

It is not observation closures within a survey which are used to classify control points, but the ability of that survey to duplicate already established control values. This comparison takes into account models of crustal motion, refraction, and other systematic effects.

Table 2.1 -- Accuracy Standards
Horizontal, Ellipsoid Height, and Orthometric Height

Accuracy Classification	95-Percent Confidence Less Than or Equal to:
1-Millimeter	0.001 meters
2-Millimeter	0.002 "
5-Millimeter	0.005 "
1-Centimeter	0.010 "
2-Centimeter	0.020 "
5-Centimeter	0.050 "
1-Decimeter	0.100 "
2-Decimeter	0.200 "
5-Decimeter	0.500 "
1-Meter	1.000 "
2-Meter	2.000 "
5-Meter	5.000 "
10-Meter	10.000 "

Accuracy Determination

Part 2

- **Classification procedure ---- <u>4 steps</u>**
  - 1. The survey measurements, field records, sketches, and other documents are examined with the specifications for the intended accuracy…
  - 2. Results of a minimally constrained, least squares adjustment of the survey measurements are examined to ensure correct weighting of the observations and freedom from blunders.
  - 3. Local and network accuracy measures computed by random error propagation determine the provisional accuracy. In contrast to a constrained adjustment where coordinates are obtained by holding fixed the datum values for the existing network control, accuracy measures are computed by weighting datum values in accordance with the network accuracies of the existing network control.
  - 4. The survey accuracy is checked by comparing minimally constrained adjustment results against established control. The result must meet a 95% confidence level.

Accuracy Determination

Part 2

- It is not necessary to directly connect to a CORS to compute the network accuracy of a control point. However, it is necessary that the survey be properly connected to existing NSRS control points with established network accuracy values.

- By supporting both local accuracy and network accuracy, the diverse requirements of NSRS users can be met. Local accuracy is best adapted to check relations between nearby control points. For example, a surveyor checking closure between two NSRS points is mostly interested in a local accuracy measure. On the other hand, someone constructing a Geographic or Land Information System (GIS/LIS) will often need some type of positional tolerance associated with a set of coordinates. Network accuracy measures how well coordinates approach an ideal, error-free datum.

- Thus, for control points in the NSRS, both local accuracy and network accuracy will be reported for each geodetic component (horizontal control, ellipsoidal height, and orthometric height).

Accuracy Reporting

Part 2

- When providing geodetic point coordinate data, a statement should be provided that the data meets a particular accuracy standard for both the *local accuracy and the network accuracy*.
  - ***For example, "this geodetic control data meet the 2-centimeter local accuracy standard for the horizontal coordinate values and the 5-centimeter local accuracy standard for the vertical coordinate values (heights) at the 95-percent confidence level."***
  - ***A similar statement should be provided for these same data reporting the network accuracy.***
- **It is preferred that accuracy value(s) be reported in metric units; however, feet shall be used when the dataset coordinates are in feet (i.e., State Plane Coordinates in feet). The number of significant digits for the accuracy value(s) shall be consistent with the number of significant digits for the dataset point coordinates.**
- **For most geodetic control network applications, centimeters should be used for reporting local accuracy and network accuracy values.**

Questions

Part 2

- **Geospatial Positioning Accuracy Standards**
- **Part 1: Reporting Methodology, FGDC-STD-007.1-1998**
- **Part 2: Standards for Geodetic Networks, FGDC-STD-007.2-1998**
- **Part 3: National Standard for Spatial Data Accuracy, FGDC-STD-007.3-1998**
- **Part 4: Architecture, Engineering, Construction, and Facilities Management, FGDC-STD-007.4-2002**
- **Part 5: Standards for Nautical Charting Hydrographic Surveys, FGDC-STD-007.5-2005**

http://www.fgdc.gov/standards/standards_publications/index_html