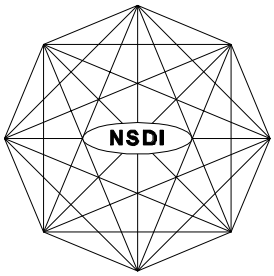

National Spatial Data Infrastructure

Draft Geospatial Positioning Accuracy Standards
Part 2: Standards for Geodetic Networks

Federal Geodetic Control Subcommittee
Federal Geographic Data Committee

December 1996

Federal Geographic Data Committee
Department of Agriculture • Department of Commerce • Department of Defense • Department of Energy
Department of Housing and Urban Development • Department of the Interior • Department of State
Department of Transportation • Environmental Protection Agency
Federal Emergency Management Agency • Library of Congress
National Aeronautics and Space Administration • National Archives and Records Administration
Tennessee Valley Authority

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2 GEODETIC NETWORKS

2.1 Purpose

Geodetic control surveys are usually performed to establish a basic control network (framework) from which supplemental surveying and mapping work, covered in other parts of this document, is performed. Geodetic network surveys are distinguished by use of redundant, interconnected, permanently monumented control points that comprise the framework for the National Spatial Reference System (NSRS) or are often incorporated into the NSRS.

These surveys must be performed to far more rigorous accuracy and quality assurance standards than those for control surveys for general engineering, construction, topographic mapping, or cadastral purposes. Geodetic network surveys included in NSRS must be performed to meet automated data recording, submittal, project review, and least squares adjustment requirements established by the National Geodetic Survey (NGS).

2.2 Applicability

Geodetic network surveys are often employed when large geopolitical area (e.g., county-level or larger) mapping control is required, and where seamless connection with adjacent political areas is critical. Precise network control may also be required for controlling interstate transportation corridors (highways, pipelines, railroads, etc.); long-span bridge construction alignment; geophysical studies; structural deformation monitoring of dams, buildings, and similar facilities.

2.3 Maintenance

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Geodetic Survey, maintains accuracy standards for geodetic networks for the Federal Geodetic Control Subcommittee, Federal Geographic Data Committee. Address questions concerning accuracy standards for geodetic networks to: Director, National Geodetic Survey, NOAA, N/NGS, 1315 East-West Highway, Silver Spring, Maryland 20910.

2.4 Standards Development Procedures

Draft accuracy standards for geodetic networks were developed by the Methodology Work Group of the Federal Geodetic Control Subcommittee (FGCS), Federal Geographic Data Committee. The draft accuracy standards were released for public review through the FGCS and evolved into the final form presented in Table 2.1 of this publication.

2.5 Accuracy Standards

Note that the following accuracy standards supersede and replace the accuracy standards found in FGCC 1984 and FGCC 1988 (Part 2 BIBLIOGRAPHIC REFERENCES).

The classification standard for geodetic networks is based on accuracy. Accuracies are categorized separately according to Table 2.1 for horizontal, ellipsoid height, and orthometric height.

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 "

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 any other systematic effects known to influence survey measurements.

2.6 National Spatial Reference System

The classification standard for NSRS is based on Table 2.1.

The procedure leading to classification involves four steps:

l. The survey measurements, field records, sketches, and other documentation are examined to verify compliance with the specifications for the intended accuracy of the survey. This examination may lead to a modification of 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 of 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 percent confidence level. This comparison takes into account the network accuracy of the existing control, as well as systematic effects such as crustal motion or datum distortion. If the comparison fails, then both the survey and network measurements must be scrutinized to determine the source of the problem.

Definition: The *local accuracy* of a control point is a value expressed in centimeters that represents the uncertainty in the coordinates of the control point relative to the coordinates of other directly connected, adjacent control points at the 95-percent confidence level. The reported local accuracy is an approximate average of the individual local accuracy values between this control point and other observed control points used to establish the coordinates of the control point.

Definition: The *network accuracy* of a control point is a value expressed in centimeters that represents the uncertainty in the coordinates of the control point with respect to the geodetic datum at the 95-percent confidence level. For NSRS network accuracy classification, the datum is considered to be best expressed by the geodetic values at the Continuously Operating Reference Stations (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.

Users with specialized applications that require more exacting accuracy estimates at the CORS sites should contact NGS. 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).

In addition, NGS will publish individual local accuracy values along measured lines. The local accuracy, dLij, between points i and j that have not been directly connected by measurements is computed by:

$$dLij = (dNi2 + dNj2)1/2$$

where

dNi = network accuracy for point i
dNj = network accuracy for point j.

Studies have found that this formula will generally give satisfactory approximations to rigorously computed local accuracies.

NORMATIVE REFERENCES

Federal Geographic Data Committee, 1996, Part 1, Introduction and Reporting Methodology, Geospatial Positioning Accuracy Standards *(draft)*: Washington, D.C., Federal Geographic Data Committee, 7 p.

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