

**Federal Highway Administration
Central Federal Lands Highway Division
Accuracy Standards by Type of Survey**

CFLHD Class	Pt series	Type of Survey	95 % Probability Circle*
A	2000	GPS	0.020 m
B	3000 5000	Primary (Terrestrial or GPS)	0.030 m
C	4000	Secondary (A Lines) (Terrestrial or GPS)	0.080 m
D	6000	Cadastral (Terrestrial or GPS)	0.080 m
E	8000	Wing Points (Terrestrial or GPS)	0.100 m

*The semi-major axis of the error ellipse may be substituted and noted.
Exceptions to these standards must be noted in the control report.

GPS Only Standards

Local Accuracy (95 % Probability Circle)	Network Accuracy (95 % Probability)	GPS Orthometric Heights (95 % Probability Circle)
0.02 m	0.03 m	0.1 m

Vertical Accuracy Standards

CFLHD Class	Type of survey	Accuracy
A	Primary Control Network (Differential leveling)	0.008m \sqrt{K}
B	Secondary Control (A Lines) (Differential leveling, trigonometric leveling)	0.020 m
C	Wing Points (Differential leveling, trigonometric leveling, GPS observations)	0.1 m

SURVEY SPECIFICATION

I) PHYSICAL STANDARDS FOR CONTROL MONUMENTS

- A) Primary Control & Supplemental Control Monuments shall be set no more than 450 meters (1,450 feet) apart and shall be inter-visible with at least two other control points. Monuments shall be set flush with natural ground or approximately 5cm (0.2 feet) below the existing road surface. Monuments shall be placed outside of the proposed construction limits.
- B) Type I Monument (Class A, B, C or E), supplied by CFLHD. Monuments shall be installed on #5 (5/8" dia.) reinforcement bar, a minimum of 48" long, set firmly in the ground.
- C) Type II Monument (Class A, B, C or E), supplied by CFLHD, may be used in lieu FHWA CFLHD Type I Monument, when the position is located in concrete or stable rock.
- D) Type III Monument (Class D), supplied by the A/E, shall meet the standards set forth by state statute in which the project is located.
- E) A 2 1/2" x 4' brown fiberglass marker post, Carsonite Pattern No. 7092-SM or equivalent, shall be placed at each control point and be marked with decals of the control point number.

II) GPS CONTROL POINTS ESTABLISHED BY ANY METHOD (STATIC OR RTK)

- A) A minimum of two occupations is required with a significantly different constellation required for the second observations (minimum of two hours).

III) TERRESTRIAL TRAVERSE FOR PRIMARY CONTROL (3000 series)

- A) Multiple pointings: 3D 3R, rejection limit 6" from mean; positional tolerance = 3mm (e.g. 3mm/60m = 10")
- B) 10 to 12 stations between azimuth checks (GPS pairs or known azimuth),
- C) Azimuth closure = 3"/N (N = number of stations)
- D) Reciprocal zenith angles: 3D 3R, rejection limit = 10" from mean
- E) Slope distance: measure and record at each direct reading to the backsight and foresight
- F) Height of instrument and target: measure and record
- G) Positional tolerance = 0.04m /K (K = distance in kilometers)
- H) Recommend maximum distance between primary control, maximum slope distance of 450 meters
- I) Traverses must be closed on a point other than the beginning point.
- J) Length standard errors not to exceed 30 ppm.

IV) TERRESTRIAL TRAVERSE FOR SECONDARY MAPPING CONTROL (4000 Series)

- A) Multiple pointings: 2D 2R, rejection limit 6" from mean; positional tolerance = 5mm
- B) 20 stations maximum between primary control checks
- C) Reciprocal zeniths: 1D 1R, rejection limit = 10" from mean
- D) Slope distance: measure and record at each direct reading to the backsight and foresight
- E) Height of instrument and target: measure and record
- F) Positional tolerance = $0.05/K$ (K = distance in kilometers)
- G) Traverse must be closed on a point other than the beginning point.
- H) Length standard errors not to exceed 30 ppm

V) TERRESTRIAL TRAVERSE FOR WING POINTS

- A) Multiple pointings: 1D 1R, rejection limit 6" from the mean
- B) Reciprocal zeniths: 1D 1R, rejection limit = 10" from mean
- C) Slope distance: measure and record at each direct reading to the backsight and foresight, maximum slope distance of 450 meters.
- D) Height of instrument and target: measure and record
- E) Single open leg traverse, maximum slope distance of 450 meters
- F) The photogrammetrist checks the accuracy of the points.

VI) TERRESTRIAL LEVELS

- A) Electronic levels
- B) Positional tolerance = $0.008m / K$
- C) Always closed on known point (previously established elevation)

VII) CADASTRAL OR RIGHT-OF-WAY TIES

- A) ALTA Standards (Rural surveys adopted 1997)
- B) Cadastral ties can be made from A, B, or C class points.
- C) RTK methods can be utilized for cadastral ties.
 - 1) Two sessions at least ten minutes long, at least two hours apart, using a bipod or tripod.

Instruments shall be calibrated before and after the project at a NGS/NOAA-approved calibration course using the methods specified by NGS in a publication titled "Use of a Calibration Base Lines". Calibration baselines locations can be found on the Internet at: http://www.ngs.noaa.gov/PUBS_LIB/TMNOSNGS10.pdf. The Firm shall pay the cost of calibration.

Instruments shall be adjusted to compensate for atmospheric conditions (PPM). Many CFLHD projects are at high elevations. Barometric pressures need to be verified and PPM corrections made without adjusting the pressure to sea level.

VIII) Notes on Specifications

- A) “Primary Control”, refers to reasonably permanent monumentation that is coordinated to provide the basis for all surveying and mapping operations for a particular project.
- B) “Secondary Control”, refers to monumentation that has been coordinated to serve a particular short term surveying application.
- C) “Wing Points”, refer to aerial targets that are coordinated to provide control for photogrammetric mapping.
- D) “D”, means direct reading with terrestrial instrument in the direct position.
- E) “R”, means reverse reading with the terrestrial instrument in the inverted position.
- F) “Multiple pointings”, means the number of times a reading is taken with the instrument cross hairs centered on a target centered on a remote point.
- G) “Positional tolerance”, with respect to angular observations means a trigonometric computation of the linear uncertainty based on the product of the sine (or the tangent) of the angular discrepancy and the length of the measured line.
- H) “Azimuth check” means comparing a computed azimuth based on field observations to a reliable known azimuth derived independently from equal or higher standard and specifications than the current survey.
- I) “Traverse must be closed”, means that coordinate calculations can be made for each point and sufficient redundancy is provided for valid statistical analysis. A known point is one for which coordinates have been calculated by independent means from field observations of equal or higher standards and specifications. A terrestrial traverse is not closed under this definition unless an angular closure can be computed from the field data.
- J) “Electronic levels” means an electronic digital instrument capable of reading a bar coded level rod.
- K) “ALTA” standards refer to the standards and specifications established by the American Land Title Association and the American Congress on Surveying and Mapping adopted in 1997.
- L) “Rural surveys” refer to the positional tolerance chart and the maximum angle, distance and closure requirements for Survey Measurements Which Control Land Boundaries chart contained within the document. No other requirements contained with the ALTA standards document are applicable.