

CFLHD ACCURACY STANDARDS BY TYPE OF SURVEY

CFLHD Class	Point Series	Type of Survey	95 % Probability Circle*
A	2000	GPS	0.066 US Survey Foot (0.020 Meter)
B	3000 5000	Primary (Terrestrial or GPS)	0.098 US Survey Foot (0.030 Meter)
C	4000	Secondary (A Lines) (Terrestrial or GPS)	0.262 US Survey Foot (0.080 Meter)
D	6000	Cadastral (Terrestrial or GPS)	0.262 US Survey Foot (0.080 Meter)
E	8000	Wing Points (Terrestrial or GPS)	0.328 US Survey Foot (0.100 Meter)

*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)
0.066 US Survey Foot (0.020 Meter)	0.098 US Survey Foot (0.030 Meter)	0.328 US Survey Foot (0.100 Meter)

Vertical Accuracy Standards

CFLHD Class	Type of Survey	Accuracy
B	Primary Control Network (Differential leveling)	0.033 US Survey Foot $\sqrt{\text{Mile}}$ (0.008m $\sqrt{\text{K}}$)
C	Secondary Control (A Lines) (Differential leveling, trigonometric leveling)	0.05 US Survey Foot $\sqrt{\text{Mile}}$ (0.015m $\sqrt{\text{K}}$)
E	Wing Points (Differential leveling, trigonometric leveling, GPS observations)	0.3 US Survey Foot (0.1 Meter)

CFLHD SURVEY SPECIFICATIONS

I Physical Standards For Survey Control Monuments:

- (a) Primary Control & Supplemental Control Monuments shall be set no more than 1,450 US survey feet (450 meters) apart and shall be inter-visible with at least two other control points. Monuments shall be set flush with natural ground or approximately 0.2 feet (.06 meter) below the existing road surface. Monuments shall be placed outside of the proposed construction limits.
- (b) Type I Monument (Class A or B), supplied by CFLHD. Monuments shall be installed on a #5 (5/8" dia.) reinforcement bar, or a substantial equivalent, a minimum of 1.22 meters (4 feet) long. Monuments shall be set firmly in the ground, as to maintain horizontal and vertical integrity thought the design and construction of the project;
- (c) Type II Monument (Class A or B), supplied by CFLHD, and 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, and shall meet the standards set forth by state statute in which the project is located.
- (e) Type IV Monument (Class C or E), may be of a temporary nature (oak hub, steel pin, etc.) that will maintain horizontal and vertical position during the current survey activity;
- (f) A 2 ½" 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. Depending on field conditions, marker posts shall be placed ± 3 feet behind the control point, perpendicular to the road alignment.

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 Traverses For Primary Control (3000/5000 Series) shall confirm with the following:

- (a) Multiple pointings: 3D 3R, rejection limit 6" from mean; positional tolerance = 0.010 US Survey Foot (e.g. $0.01' / 200' = 10''$);
- (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) Recommend maximum distance between primary control, maximum slope distance of 1,450 US survey feet (450 meters);
- (h) Traverses must be closed on a point other than the beginning point;
- (i) Length standard errors not to exceed 30 ppm.

IV Terrestrial Traverse For Secondary Mapping Control (4000 Series) shall confirm with the following:

- (a) Multiple pointings: 2D 2R, rejection limit 6" from mean; positional tolerance = 0.016 US Survey Feet (e.g. $0.016' / 200' = 17''$);
- (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 = 0.06 US Survey Feet $\sqrt{\text{Mile}}$;
- (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 (8000 Series) shall confirm with the following:

- (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 1,500 US survey feet (450 meters);
- (d) Height of instrument and target: measure and record;
- (e) Single open leg traverse, maximum slope distance of 1,500 US survey feet (450 meters);
- (f) The photogrammetrist checks the accuracy of the points.

VI Terrestrial Levels (8000 Series) shall confirm with the following:

- (a) Electronic levels;
- (b) Positional tolerance = 0.033 survey foot $\sqrt{\text{Mile}}$;
- (c) Always closed on known point (previously established elevation).

VII Cadastral Or Right-Of-Way Ties (6000 Series) shall confirm with the following:

- (a) 2005 ALTA/ACSM Standards;
- (b) Cadastral ties can be made from CFLHD Class A, B, or C 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.

VIII 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".

- (a) Calibration baselines locations can be found on the Internet at:
 - (1) <http://www.ngs.noaa.gov/CBLINES/calibration.shtml>.
- (b) The Firm shall pay the cost of calibration.
- (c) Instruments shall be adjusted to compensate for atmospheric conditions (PPM). Many CFLHD projects are at high elevations.
- (d) Barometric pressures need to be verified and PPM corrections made without adjusting the pressure to sea level.

IX Definitions:

Primary Control - Refers to reasonably permanent monumentation that is coordinated to provide the basis for all surveying and mapping operations for a particular project.

Secondary Control - Refers to monumentation that has been coordinated to serve a particular short term surveying application.

Wing Points - refer to aerial targets that are coordinated to provide control for photogrammetric

mapping.

D - Means direct reading with terrestrial instrument in the direct position.

R - Means reverse reading with the terrestrial instrument in the inverted position.

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.

Positional tolerance - Means 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.

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.

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.

Electronic levels - Means an electronic digital instrument capable of reading a bar coded level rod.

2005 ALTA/ACSM Standards - Refer to the “2005 Minimum Standard Detail Requirements for ALTA/ACSM Land Title Surveys”, established by the American Land Title Association and the American Congress on Surveying and Mapping, effective January 1, 2006.