ATTACHMENT 20

Bench Mark Ties

Guidelines for Third-order leveling ties from GPS stations to nearby bench marks

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

Introduction

The purpose of these guidelines is to provide the information necessary to transfer an elevation from an existing NAVD 88 benchmark that cannot be used for GPS observations to a nearby GPS station. The two stations must be "close by" which is defined here as no more than four "set-ups" of the level instrument.

Single Mark Level Tie (3rd Order)

An assumed elevation for the bench mark can be used in the leveling since the principal concern is with the **difference of elevation** between the bench mark and the GPS station. It should be noted that the published elevation of the GPS station would only be published to the nearest centimeter. This is because the absolute elevation of the bench mark cannot be verified without incorporating other bench marks into the survey as a check. Many projects do not provide the resources required for this multiple mark check, but it is still imperative that the GPS station have the best precision allowable.

Record rod readings to millimeters or hundredths of feet. The model, type of instrument, and serial number of instrument and rods (e.g., fiberglass, aluminum, single piece, etc.) as well as rod scale units (e.g., meters, feet, or bar code) shall be entered on the "Observations of Bench Mark Ties" form where indicated.

Observing Sequence for Conventional Level

1. Remove equipment from travel cases, attach level instrument to tripod, and let equipment acclimate to local conditions. Perform instrument check per manufacturer's instructions. Set up the instrument about halfway between the stations, but no more than 70 m (230 ft) away from either point or from one of the points and a turning pin in the case of multiple setup requirements. Backsight distance to foresight distance imbalance shall be less than 5 meters. Accumulated backsight to foresight distance imbalance shall be less than 10 meters in the case of multiple setups

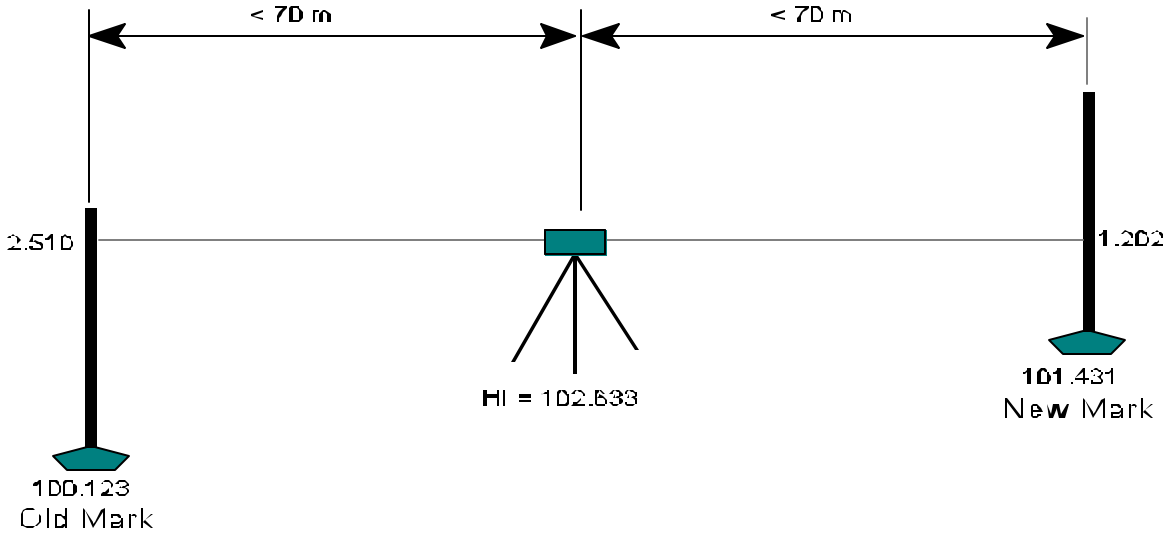

Figure 2. Direct old mark to new mark level tie. **Note:** Backsight-foresight distance imbalance should be less than 5 meters.

2. Plumb the level rod on the highest point of the old mark. Let's call the old mark M 123. Record the designation of the point and its published elevation noting the reference vertical datum and units of measure.

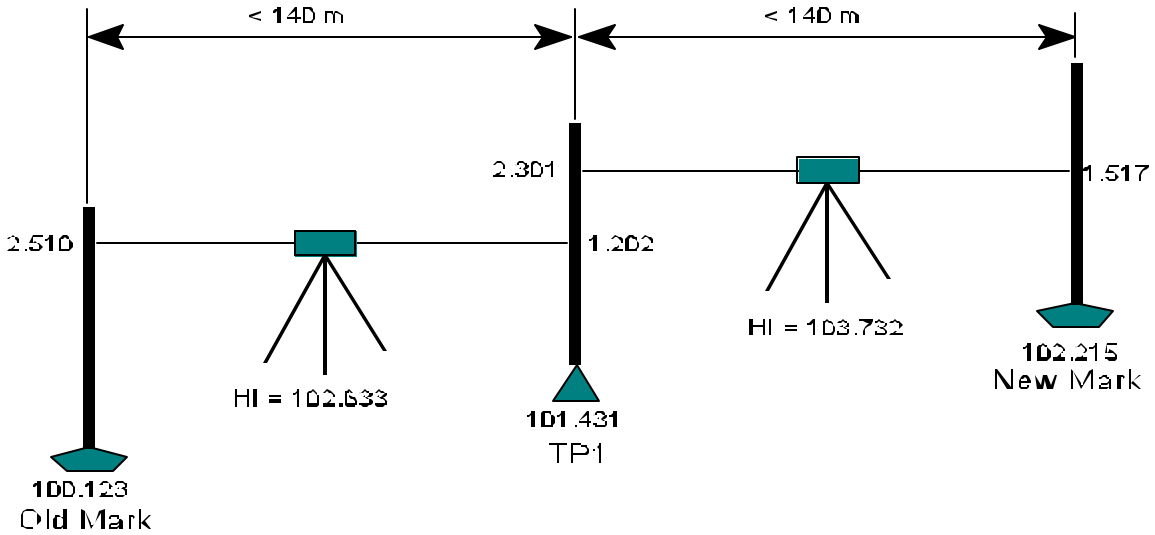

Figure 3. Old mark to new mark level tie for distances over 140 m. **Note:** Accumulated backsight-foresight setup imbalance should be less than 10 m.

3. Backsight Reading: Observe the intercept of the middle reticule of the rod scale as backsight reading. Record the rod reading to the nearest millimeter (or hundredths of a foot) as indicated above. Record the stadia reading to determine distance from the point to the instrument.

4. Compute height of instrument, HI, which is the sum of the backsight and the published elevation.

5. Plumb the rod on the highest point of the new bench mark. Record the designation of the new mark, e.g., M 123 RESET, or TP1 (for turning point 1 in the case of multiple setups).

6. Foresight Reading: Observe the intercept of the middle reticule of the rod scale as foresight reading. Record the stadia reading to determine distance from the point to the instrument.

7. Compute the elevation of the new point, new bench mark, or turning point, which is the difference of the HI minus the foresight.

8. Reset and re-level the instrument. Level backward from the new point to the old, in the same manner as steps 2 through 7.

Note: The elevation computed for the old point as a result of the backward leveling may differ by no more than $+/-12\sqrt{D}$ mm (where D is the shortest length of section in kilometers one-way) from the published elevation.

9. To compute the elevation difference from the old mark to the new, subtract the mean of the two elevations for the old mark from the elevation for the new mark.

Observing Sequence for Digital Level

These observing procedures are intended for use with digital levels.

1. Remove equipment from travel cases, attach level instrument to tripod, and let equipment acclimate to local conditions. Perform instrument check and adjustment as outlined in the digital level manual.

2. Set up the instrument about halfway between the stations. Limit sight lengths to no more than 70 m (230 ft) from either point or from one of the points and a turning pin in the case of multiple setup requirements, e.g., distance between points is greater than 140 meters. Backsight distance to foresight distance imbalance shall be less than 5 meters. Accumulated backsight to foresight distance imbalance shall be less than 10 meters in the case of multiple setups.

Level up the instrument using the three foot screws while observing the bulls-eye bubble. Turn on instrument and select the backsight/foresight level program. Confirm that you want to start then enter the starting elevation for the old mark. Set and confirm instrument parameters, e.g., meaning 3 measurements, display maximum decimal places, record readings to onboard module, and observing configuration, such as rod type, and metric units.

3. Plumb the level rod on the highest point of the old mark, e.g., domed top of disk M 123. Record the designation of the point and its published elevation, noting the reference vertical datum and units of measure.

4. Backsight Reading: Point using the vertical crosshair of the level instrument on the middle of the rod over the old mark and use the focusing knob to bring the image of the rod into sharp focus Depress the measure button and record the rod reading. Note distance from rod to instrument. It should be less than 70 meters.

5. Plumb the rod on the highest point of the new bench mark. Record the designation of the new mark, e.g., M 123 RESET, or TP1 (for turning point 1 in the case of multiple setups).

6. Foresight Reading: Point and focus the level instrument on the rod over the new mark. Depress the measure button and record the rod reading. Note distance from rod to instrument. It should be less than 70 meters. Note imbalance between backsight and foresight distances. This difference shall be less than 5 meters.

7. The elevation of the new bench mark or turning point is computed as the sum of the backsight reading and the published elevation minus the foresight reading.

8. Reset and re-level the instrument. Level backward from the new point to the old, in the same manner as steps 2 through 6. Use the elevation determined from the forward leveling as the starting elevation for the backward leveling. The elevation computed for the old point as a result of the backward leveling may differ by no more than +/- $12\sqrt{D}$ (where D is the shortest length of section in kilometers one-way) from the published elevation.

9. To compute the elevation difference from the old mark to the new, subtract the mean of the two elevations for the old mark from the elevation for the new mark. The elevation for the new bench mark will be this computed difference, mean of both forward and backward leveling, plus the published elevation of the old bench mark.

Data Submission

The following **shall be supplied** by the submitting office:

1. Completed “Observations for Bench Mark Ties” form . (See attached form.)

2. Digital Levels: Paper as well as digital copy of leveling observations.

Observations for Bench Mark Ties

Original Mark Stamping: ____________________ PID (if known): ____________________ Elevation: ____________________ (ft / m) Datum: NGVD 29 or NAVD 88 (circle one)	Replacement Mark Stamping: ____________________ Date of Leveling: ____________________ Computed Elevation: ____________________ (ft / m) (from below)

State: County: Latitude: N Longitude: W Datum:

Leveling Equipment:	Manufacturer	Model Number	Serial Number
Level Instrument:			
Rod # 1:			
Rod # 2 (optional):			
Rod Scale Units:			

Point	Backsight	H.I.	Foresight	Elevation	Length (ft/m)	Remarks
Forward Running: Old to New						
Backward Running: New to Old						

Agency / Firm: ____ Signed: ________________________________

Address: ____ Telephone: ( ) ____________________

City / State / Zip: E-mail:

ATTACHMENT 21
GLOSSARY

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

GLOSSARY

(For an additional glossary of terms, see FAA No. 405, Fourth Edition.)

ANA - Area Navigation Approach

ASAP - As Soon As Possible

AZ MK - Azimuth Mark: A marked point established in connection with a triangulation (or traverse) station to provide a starting azimuth for dependent surveys. Note, some azimuth marks also were positioned and some have an underground disk. The azimuth mark is usually a pre-stamped survey disk, generally 1/4 to 2 miles from the horizontal station. The next consecutive azimuth mark number was used if an earlier number was destroyed. See ATTACHMENT 1.

BM - Bench Mark

CD-ROM - Compact Disc - Read Only Memory

CBN - Cooperative Base Network (NGS)

CTCORS - Central Temporary Continuously Operating Reference Station. A permanently monumented control station established near the center of a 300 km (radius) survey area (as defined elsewhere in this document) and which functions as a temporary Continuously Operating Reference Station (CORS).

CORS - Continuously Operating Reference Station, See FAA No. 405, Fourth Edition, Glossary.

DISK - A thin metal plate about 9 cm in diameter, with a stem attached to the center of the bottom. The plate is slightly convex (in vertical), usually round (in horizontal) and contains the mark for which survey information is known, or to be determined. The plate usually also contains a designation, year, and the name of the agency setting the plate. It is usually made of bronze, brass, or aluminum and may be set in a drill hole or embedded in concrete.

DOD - Department of Defense

FAA - Federal Aviation Administration

FBN - Federal Base Network (NGS)

FGCC - Federal Geodetic Control Committee (Changed to FGCS in October 1990)

FGCS - Federal Geodetic Control Subcommittee

GPS - Global Positioning System

HARN - High Accuracy Reference Network

ITRF - International Terrestrial Reference Frame

MARK - (1) A dot, the intersection of a pair of crossed lines, or any other physical point corresponding to a point in a survey; (2) The object, such as a disk, on which the mark (1) is placed; (3) The entire monument, consisting of the mark (1), the object on which it occurs (2) and the structure to which the object is fastened.

MONUMENT - A structure that marks the location of a point determined by surveying. In the case of a disk in concrete, the monument would be the entire structure. Mark, monument, and station can mean the same thing.

NAD 27 - North American Datum of 1927

NAD 83 - North American Datum of 1983

NAVD 88 - North American Vertical Datum of 1988

NGS - National Geodetic Survey, NOAA. Disks inscribed with this name have been set from 1970 to the present.

NGVD 29 - National Geodetic Vertical Datum of 1929

NOAA - National Oceanic and Atmospheric Administration. No survey disks have been set with this name.

NOS - National Ocean Survey, NOAA. Disks inscribed with this NOS name were set from about 1970 to December,

1982.

NOS - National Ocean Service. Disks inscribed with this NOS name were set from about 1983 to the present.

NSRS - National Spatial Reference System

PACS - Primary Airport Control Station

RM - Reference Mark: A survey mark of permanent character close to a survey station, to which it is related by an accurately measured distance and azimuth. For a triangulation station, reference marks are pre-stamped survey disks, usually within 30 meters (one tape length) of the triangulation station. Standard procedure was to set two reference marks, numbered clockwise from north, with the next consecutive reference number used if an earlier number was destroyed. See ATTACHMENT 1.

SACS - Secondary Airport Control Station

STATION - A physical location or site at which, from which, or to which survey observations have been made. See also mark and monument.

USACE - U.S. Army Corps of Engineers (Blue Book abbreviation is USE)

USCG - U.S. Coast Guard

USC&GS - U.S. Coast and Geodetic Survey. Disks inscribed with USC&GS were set from about 1900 to 1970. Over 10 different pre-stampings were used. (Bluebook abbreviation is CGS)

USE - U.S. Army Corps of Engineers or U.S. Engineers Department (old acronym; present Blue Book abbreviation)

WAAS - Wide Area Augmentation System (FAA)

WGS 84 - World Geodetic System 1984

National Agency abbreviations are listed in Bluebook, Appendix

c.

ATTACHMENT 22
SAMPLE TRANMITTAL LETTER

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

LETTER TRANSMITTING DATA

REFERENCE NO.

DATA AS LISTED BELOW WERE FORWARDED TO YOU BY *(Check):*

☐ ORDINARY MAIL ☐ AIR MAIL

☐ REGISTERED MAIL ☐ EXPRESS

☐ GBL *(Give number)* _____

TO:

DATE FORWARDED

NUMBER OF PACKAGES

NOTE: A separate transmittal letter is to be used for each type of data, as tidal data, seismology, geomagnetism, etc. State the number of packages and include an executed copy of the transmittal letter in each package. In addition the original and one copy of the letter should be sent under separate cover. The copy will be returned as a receipt. This form should not be used for correspondence or transmitting accounting documents.

FROM: *(Signature)*

RECEIVED THE ABOVE
(Name, Title, Date)

Return receipted copy to:

ATTACHMENT 23
SAMPLE PROJECT STATUS REPORT

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

ATTACHMENT 23

EMAIL STATUS REPORT FORMAT - The Contractor shall submit project status reports via email to the NGS POC every Monday by 2:00 PM Eastern Time, from the date of a Task Order award until the work is complete and accepted by NGS. These reports shall break the work into phases in order to help track the progress, a suggested format follows (but the percent complete and date are required):

Contractor Name:
Date:

Project Designation	RMN (% Complete / Date)		
Reconnaissance	100% / 1 Dec 03		
Survey Plan	100% / 12 Dec 03		
Mark Setting	90% / 1 Feb 04		
Observations			
Vector Processing			
Adjustment Processing			
Final Project Report			
Quality Control			
Overall Completeness			

Note: Include dates phases were completed and anticipated completion dates for phases underway. Flag entries that have been changed from the previous week. Include comments/unusual circumstances/approved modifications from General Specifications.