ATTACHMENT 11
SIMPLIFIED DIAGRAMS OF GPS POSITIONING PROCEDURES

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

GPS Positioning Procedures

PACS Ties-

⟶ **2, >4hr Sessions PACS - CORS**
⟶ **1, >4hr Session PACS - HARN**
⟶ **1, >4hr Session PACS - BM#1**
⟶ **1, >4hr Session PACS - BM#2**

CORS

⟶ CORS < 300km PACS

BM#1

⟶ Bench Marks-
  BM's > 1km Apart
  BM's < 50km PACS

BM#2   **PACS**
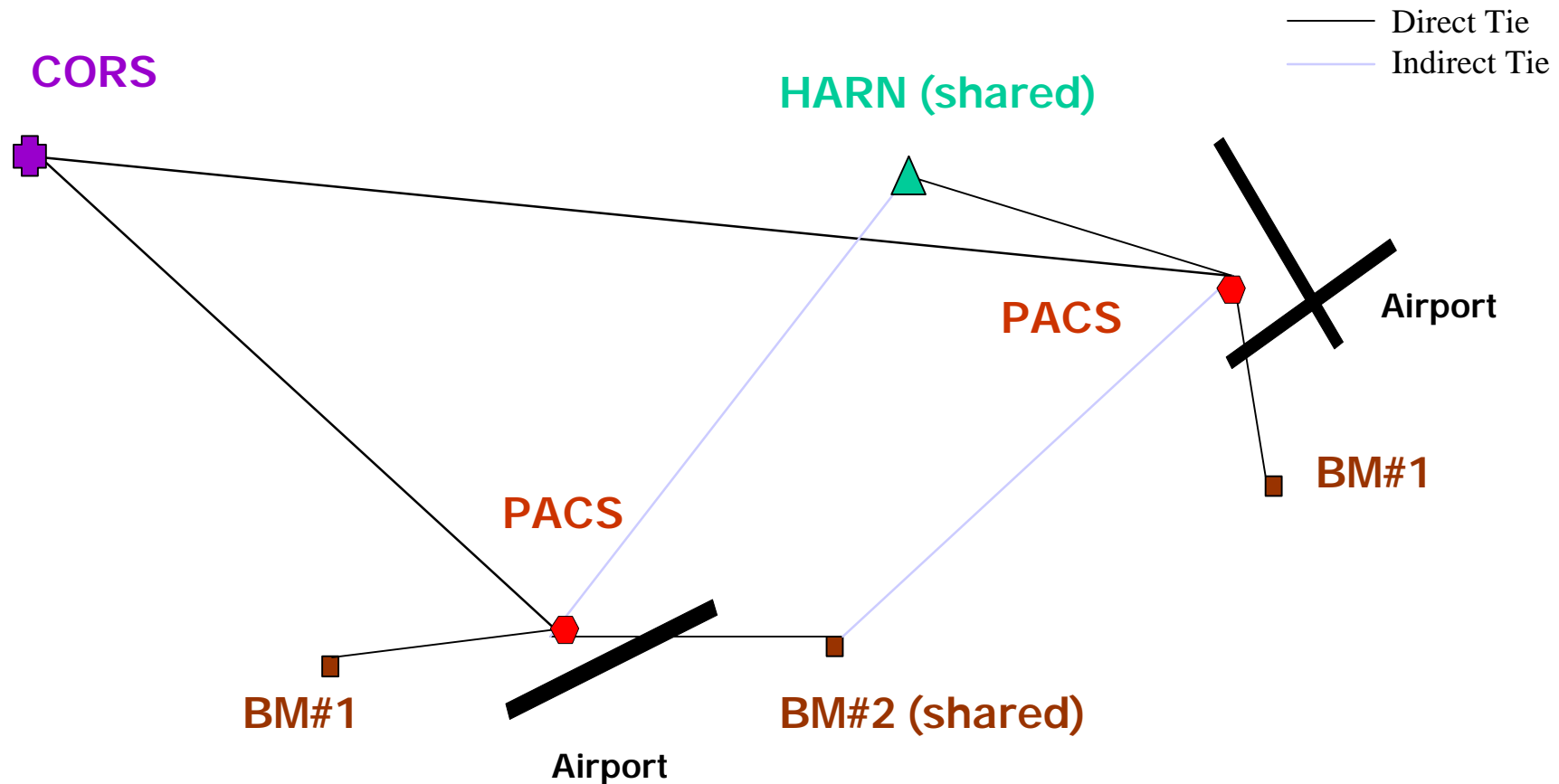
HARN

Airport

⟶ HARN > 50km CORS
   HARN < 100km PACS

Simplified Schematic, See detailed requirements in the
**General Specifications for Aeronautical Surveys,
Vol. I, Establishment of Geodetic Control on
Airports**
http://www.ngs.noaa.gov/AERO/aero.html

GPS Positioning Procedures

Shared HARN and BM ties- ➔ Must be observed simultaneously with both PACS

Direct Tie
Indirect Tie

CORS

HARN (shared)

PACS

Airport

BM#1

PACS

BM#1

BM#2 (shared)

Airport

Simplified Schematic, See detailed requirements in the
**General Specifications for Aeronautical Surveys,
Vol. I, Establishment of Geodetic Control on
Airports**
http://www.ngs.noaa.gov/AERO/aero.html

GPS Positioning Procedures

SACS Ties-

→ **2 >1.5 hr Sessions SACS - PACS**

→ **Separate Sessions by 2.5 Hours**

PACS

24

6

SACS#1

SACS#2

Simplified Schematic, See detailed requirements in the
**General Specifications for Aeronautical Surveys,
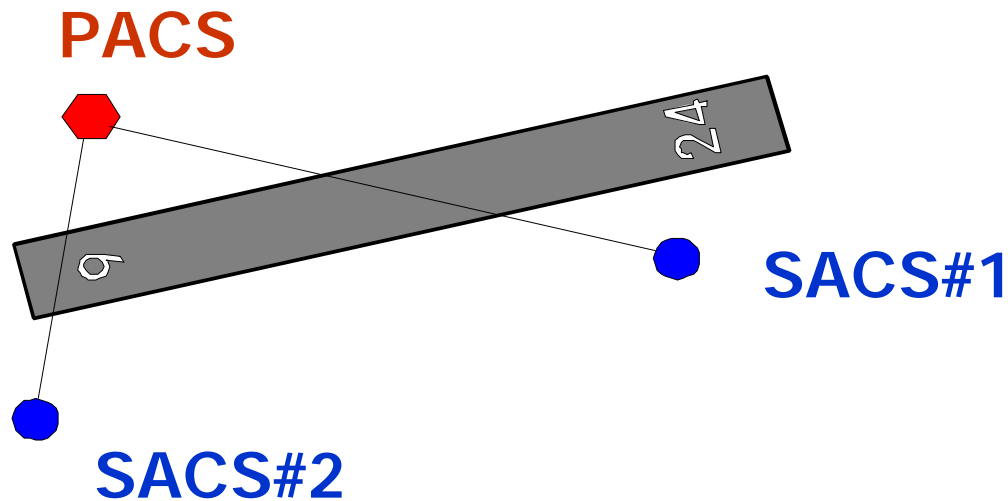Vol. I, Establishment of Geodetic Control on
Airports**
http://www.ngs.noaa.gov/AERO/aero.html
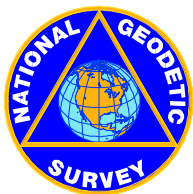
Protect the Airspace of ANA Geodetic Control Stations!

➡ GPS Survey equipment requires a 15 degree minimally obstructed view of the horizon to collect signals from GPS satellites.

15 degree horizon

➡ Keep the area surrounding the survey mark free of large reflective items such as chain-link fences, structures, and buildings.

➡ Potential sources of electrical interference such as radio repeaters and high voltage power lines should not be placed near the survey marks.
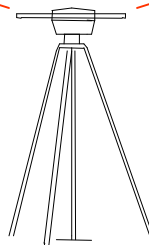
**GPS Equipment set up
over
Survey Mark**

National Oceanic and Atmospheric Administration

ATTACHMENT 12
EXAMPLE GPS OBSERVATION SCHEME

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

ANA Multi-Airport GPS Observation Scheme

Maine ANA Survey, 1998

AIRPORT(s)-Auburn-Lewiston Municipal Airport (LEW)
and Augusta State Airport (AFN)

Observation Day-   Day 1, (045)
#Receivers Used-   6
CORS Tie-   BRU1
A Order Tie-   n/a
Observers-   Contractor, Inc. (2); Subcontractor, Inc. (2)

(LEW)	(AFN)
PACS- LEW A	**PACS**- AUG AP STA C
Session 1- 8:00-13:30 (5.5hr)	Session 1- 8:00-13:30 (5.5hr)
Session 2- 14:00-19:00 (5hr)	Session 2- 14:00-19:00 (5hr)
SACS#1- LEW AP STA B	**SACS#1**- AUG AP STA B
Session 1- 8:00-10:30 (2.5hr)	Session 1- 8:00-10:30 (2.5hr)
Session 2- 14:00-16:00 (2.0hr)	Session 2- 14:00-16:00 (2.0hr)
SACS#2- ARP 1964	**SACS#2**- AUG A
Session 1- 11:00-13:30 (2.5hr)	Session 1- 11:00-13:30 (2.5hr)
Session 2- 16:30-19:00 (2.5hr)	Session 2- 16:30-19:00 (2.5hr)
BM#1- E 171	**BM#1**- G 31
8:00-13:00 (5hr)	8:00-13:00 (5hr)

<center>

BM#2- G171
14:00-19:00 (5hr)

HARN- A 196
14:00-19:00 (5hr)

</center>

Remarks:
Session duration is fixed, start and end times are approximate depending on travel times, date of survey, satellite status, weather conditions, airport logistics etc. Stations used for multiple airports are listed on the center of the page.

Detailed station information is listed in the Station Table.

ATTACHMENT 13
GPS OBSERVATION LOG & PENCIL RUBBING FORM

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

GPS STATION OBSERVATION LOG (11-Nov-1999)	Station Designation:	(FBN / CBN / PAC / SAC / BM)	Station PID:	Date (UTC):
	General Location:	Airport ID, if any:	Station Four-Character ID:	Julian Day #:

Project Name:	Project Number: GPS-	Station Serial # (SSN):	Session ID: (A / B / C / D ...)

NAD83 Latitude	NAD83 Longitude	NAD83 Ellipsoidal Height _____ meters	Agency Full Name:
o ' "	o ' "	NAVD88 Orthometric Ht. _____ meters	Operator Full Name:

Planned Start Time (UTC) _____ Planned StopTime (UTC) _____ Epoch Interval = _____ Seconds

Actual Start Time (UTC) _____ Actual Stop Time (UTC) _____ Elevation Mask = _____ Degrees

GEOID96 Geoid Height _____ meters

Phone # ( )

e-mail:

GPS Receiver:
Manufacturer & Model:

P/N:

S/N:
Firmware Version:

" CamCorder Battery, " 12V DC, " 110V AC, " Other

GPS Antenna:
Manufacturer & Model:

P/N:

S/N:
Cable Length, meters:

Vehicle is Parked _____ meters ____(direction) from antenna.

Antenna plumb before session?	(Y / N) Circle yes or no -
Antenna plumb after session?	(Y / N) If no, explain.
Antenna oriented to the North?	(Y / N) "
Weather observed at antenna ht?	(Y / N) "
Antenna ground plane used?	(Y / N) "
Antenna radome used?	(Y / N) If yes, describe
Eccentric occupation (>0.5 mm)?	(Y / N) "
Any obstructions above 10º?	(Y / N) Use visibility form
Radio interference source nearby?	(Y / N) "

Tripod or Antenna Mount: Check one:
" Fixed-Height Tripod, " Slip-Leg Tripod, " Fixed Mount

Manufacturer & Model:

P/N:

S/N:

Last Calibration date:

Tribrach: Check one:
" None, " Wild GDF 22, " Topcon, " Other (describe)

Last Calibration date:

** ANTENNA HEIGHT **
(see back of form for measurement illustration)

	Before Session Begins: measure and record both Meters AND Feet		After Session Ends: measure and record both Meters AND Feet	
A= Datum point to Top of Tripod (Tripod Height)				
B= Top of Tripod to Antenna Ref. Point (Tribrach or Spacer)				
Q= Any Other Vertical Offsets? (Explain Below)				
H= Antenna Height = A + B - Q = Datum Point to Antenna Reference Point (ARP)				

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver_____ meters

Please note and/or sketch ANY unusual conditions.
Be Very Explicit as to where and how Measured!

Barometer:
Manufacturer & Model:
P/N:

S/N:
Last Calibration or check Date:

Psychrometer:
Manufacturer & Model:

P/N:

Weather DATA	Time (UTC)	Dry-Bulb Temp Fahrenheit Celsius	Wet-Bulb Temp Fahrenheit Celsius	Rel. % Humidity	Atm. Pressure inches Hg millibar	Weather Codes *
Before						
Middle						
After						
Average of Readings						* See back of form for codes

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Note: Entries are Required in all Unshaded areas.

Data File Name(s):

(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Julian day, s=Session ID, xxx=file dependant extension

Updated Station Description:	" Attached	" Submitted earlier
Visibility Obstruction Form:	" Attached	" Submitted earlier
Photographs of Station:	" Attached	" Submitted earlier
Pencil Rubbing of Mark:	" Attached	

LOG CHECKED BY:

ILLUSTRATION FOR ANTENNA HEIGHT MEASUREMENTS:

I. Instructions for Fixed-Height Tripods:

Measure & record the tripod length **(A)** and other offsets, if any, between the tripod and Antenna Reference Point (ARP) **(B)** and/or between the tripod and datum point **(Q)**.

$$Antenna\ Height = H = A + B - Q$$

II. Instructions for Slip-Leg Tripods:

NOTE: For Leica measuring hooks, use the instructions above.

1. Measure the Slant Height   (S)

Before and after the observation session, measure the slope distance from the mark to at least three notches on the Bottom of Ground Plane (BGP) using two independent rulers (e.g., metric and Imperial). Record measurements in the table below, and compute the average.

Measure S	Notch #_	Notch #_	Notch #_	Average
Before, cm				
Before, inch				
After, cm				
After, inch				
Note: cm= inch x (2.54)	Overall average, cm			

S = _____ cm

2. Record the Antenna Radius   (R) and the Antenna Constant   (C)

The antenna radius is the horizontal distance from the Antenna Reference Point (ARP) to the measurement notch. The antenna constant is the vertical distance from the ARP to the BGP. See your Antenna specification manual for exact measurements.

R = _____ cm

C = _____ cm

3. Compute Antenna Height   (H)

Use the following Pythagorean equation:

$$Antenna\ Height = H = ((\sqrt{S^2 - R^2}) - C) - Q$$

Record Antenna Height on the front of this form.

Detail of Mark

BGP
C
ARP
Radius
R
B_1
Antenna Height
H
Leica Measuring Hook
B_2
A_2
Slant Height
S
Fixed Height Tripod Length
A_1
See detail below
Datum Point
Point of Tripod or measuring pole
Datum Point (highest point of mark)
Q
Bottom of Dimple
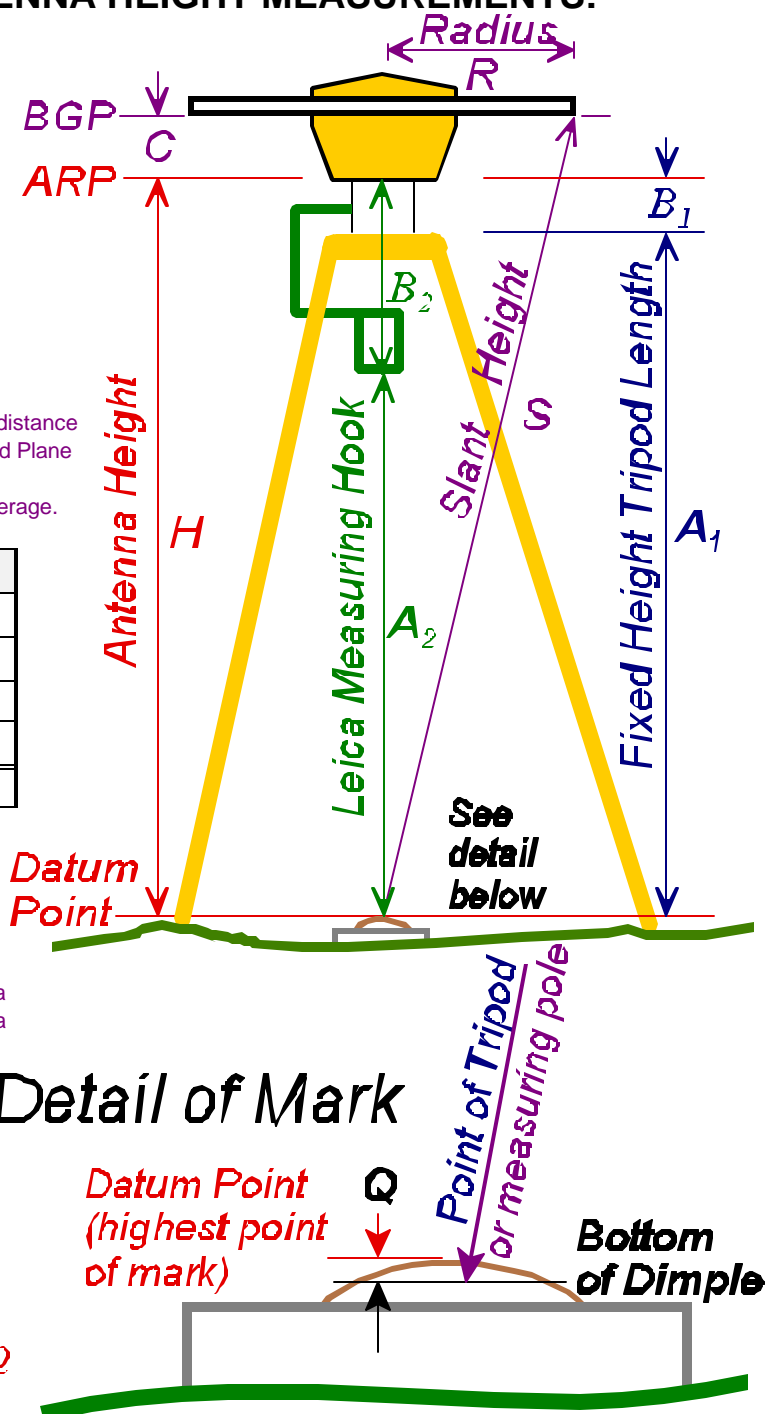
Table of Weather Codes -- for entry into Weather Data Table on front of form:

CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
0	NO PROBLEMS encountered	GOOD More than 15 miles	NORMAL 32º F to 80ºF	CLEAR Below 20%	CALM Under 5 mph (8 kph)
1	PROBLEMS encountered	FAIR 7 to 15 miles	HOT Over 80ºF (27 C)	CLOUDY 20% to 70%	MODERATE 5 to 15 mph
2	-- NOT USED --	POOR Less than 7 miles	COLD Below 32º F (0 C)	OVERCAST Over 70%	STRONG over 15mph (24kph)
Examples: Code 00000 = Code 12121 =	0 - No problems, 1 - Problems,	0 - good visibility, 2 - poor visibility,	0 - normal temperature, 1 - hot temperature,	0 - clear sky, 2 - overcast,	0 - calm wind 1 - moderate wind

Station Pencil Rubbing Form

Location / Airport Name
and ID_____ Project _____

Station Designation _____ PID_____ Date_____

Circle all applicable   Observer &

PACS SACS BM FBN CBN OTHER_____   Organization_____

Station Pencil Rubbing

Instructions: Place the blank form (or other blank paper) over the mark and rub over the entire disk with a pencil. For rod marks, rub only the designation and date stamping from the rim of the aluminum logo cap. If it is impossible to make a rubbing of the mark, or if the rubbing appears indistinct, a sketch and/or photograph may be substituted.

Remarks:

Monument Type_____

Inscribed Agency_____

Stamping_____

ATTACHMENT 14
GPS ANTENNA HEIGHT MEASURING INSTRUCTIONS

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

Attachment 14
GPS Antenna Height Measuring Instructions
(from the NGS GPS Survey Manual (draft))

Fixed height tripods are preferred over slip-leg tripods, as they reduce the potential for antenna height measurement errors. Use fixed height tripods whenever feasible.   If a slip-leg tripod is used, a low tripod setup is preferred to minimize eccentricities, though the antenna should be set high enough to avoid obstructions. Eccentric setups (antenna out of plumb from the station datum point) are to be avoided. Note any eccentricities on the observation log.

Tripod legs should be well set and sandbagged or spiked to minimize movement.

Plumbing bubbles must be shaded for at least 3 minutes before use to minimize convective currents in the bubble fluid. On tripods with rotating center poles, the bubble must be rotated and checked level throughout a 180-degree arc.

Antennas should be oriented towards true north, as closely as can be accomplished with a hand compass. Note the magnetic declination in your local area to convert from magnetic north to true north.

The proper recordation of antenna height is critical. **The Antenna Height used at NGS is the vertical distance between the station datum point and the Antenna Reference Point (ARP)**. Observers must carefully measure and check this height, and record and describe all measurements and antenna constants. Record all values to 0.0001 meters or .001 foot. All measurement computations must be checked and initialed by another person.

Fixed-height tripods simplify the measurement of antenna height (**H**) [see diagram on last page of this attachment]. The calibrated tripod height (**A**) should be checked with a quick measurement. Ensure that the antenna mates securely with the tripod head, and that any gap (**B**) between the tripod head and ARP is measured and included. The antenna height can then be computed from the equation:

$$\text{Antenna Height } H = (A + B) - Q$$

NOTE: Leica antennas use a measuring hook to determine the vertical distance between the mark and antenna. Record the measured distance from the mark to the hook as A, and the offset from the hook to the ARP as B.

Slip-leg tripods antenna height (**H**) is usually measured by slant-height (**S**), the distance of the hypotenuse from the station datum point to the bottom edge of the antenna ground plane (BGP). Measure the slant height to at least 3 points around the antenna; these measurements should all agree to within 1 millimeter. Independent measurements of the antenna height above the mark in both metric and Imperial units must be made before and

after each session. From the antenna specification sheet in your user's manual, determine the radius **(R)** of the ground plane and the offset constant **(C)** between the BGP and the ARP. The antenna height can then be computed from the following Pythagorean equation:
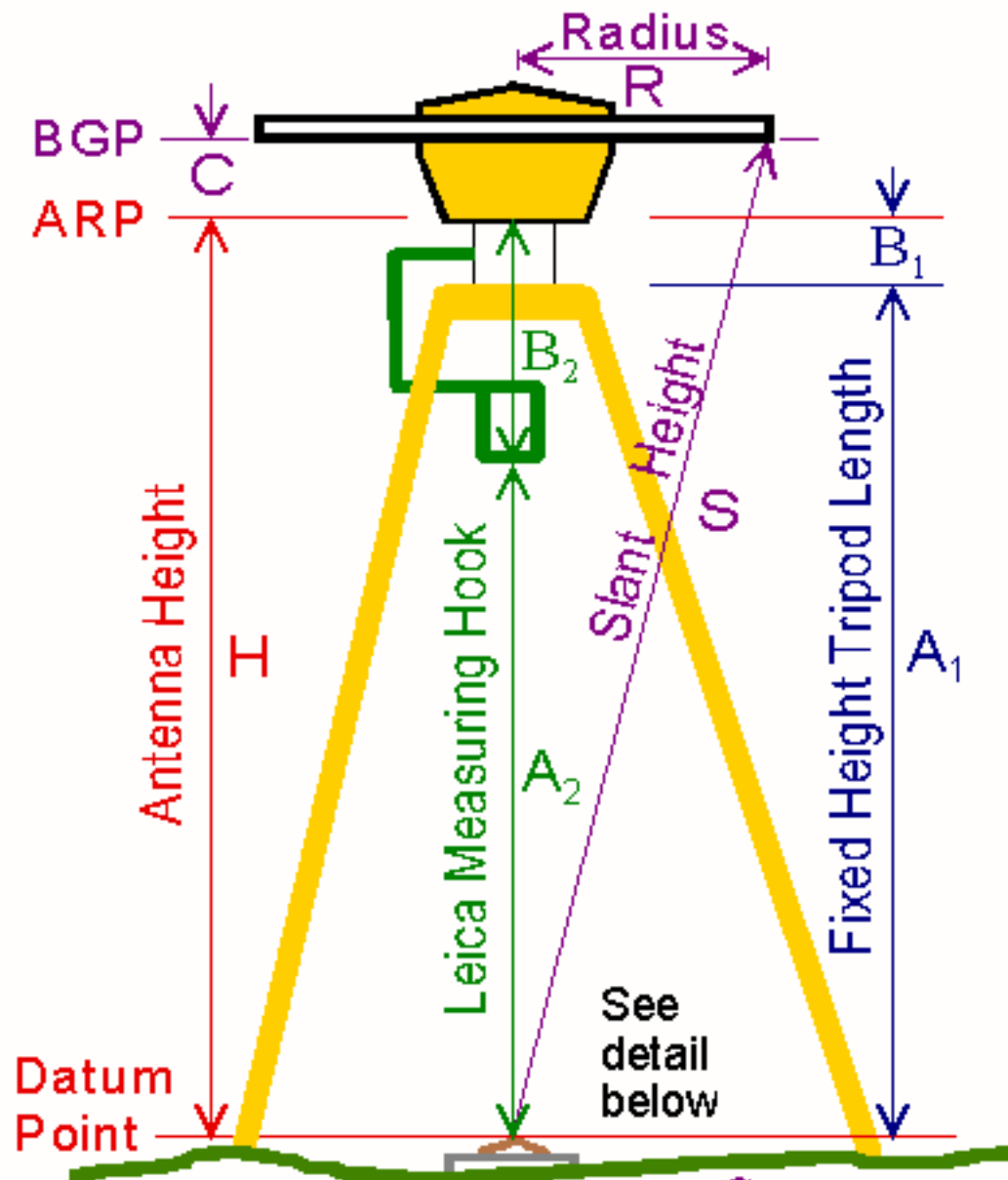
$$\text{Antenna Height } H = (\ \sqrt{S^2 - R^2}\ ) - C) - Q$$

Compare Metric and Imperial measurements using the following equations:

Meters = Feet × (0.3048) Example: 1.286 Meters = 4.219 Feet
Feet = Meters ÷ (0.3048) Example: 5.345 Feet = 1.629 Meters

Note that the 3-dimensional datum point of a standard survey disk is located at or above the dimple in the disk's center, on a level with the highest point of the disk, where the foot of a level rod would rest. If the point of the fixed-height pole or slant-height measuring rod is recessed significantly below this level to reach the bottom of the dimple (1 millimeter or more), make a careful measurement of the vertical separation**(Q)** and note this on the observation log.

Radius
R

BGP

C

ARP

B_1

B_2

Antenna Height

H

Leica Measuring Hook

Slant Height

S

A_2

Fixed Height Tripod Length

A_1

Datum Point

See detail below

Detail of Mark

Point of Tripod or measuring pole

Q

Datum Point (highest point of mark)

Bottom of Dimple

ATTACHMENT 15
INFORMATION, DATA, AND SOFTWARE AVAILABLE
ON THE WORLD WIDE WEB

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

ATTACHMENT 15
World Wide Web Sites

NGS Aeronautical Survey Program Web Site can be accessed at:
http://www.ngs.noaa.gov/AERO/aero.html

NGS Home Page can be accessed at: http://www.ngs.noaa.gov
There NGS presents a wealth of information on its data products, software programs,
and user services, as well as links to other helpful sites on the Web.

CORS and IGS Ephemeris Data can be accessed at: http://www.ngs.noaa.gov/CORS/
Information on the National CORS system and access to CORS and Precise Ephemeris data
downloads are available on the NGS web site. Use the "User Friendly CORS" utility to
download customized RINEX data sets and IGS ephemeris. The latest coordinate files and
other metadata for each CORS site is also available. The "Data Availability" feature can be
used to determine if a CORS site is missing data for a particular time period.

USCG Navigation Center GPS Web Site can be accessed at: http://www.navcen.uscg.gov/
This site provides information on the status of the GPS constellation and provides NANU
message postings and notices for outages at WAAS and DGPS sites.

GPS ANTENNA CALIBRATION Site: http://www.ngs.noaa.gov/ANTCAL/
Provides information on which antennas have been calibrated.

PAGE-NT - PAGE-NT is a menu-driven suite of programs used to process GPS data and
is suitable for projects requiring the highest accuracy. A User's Manual, the software, and
sample data set can be downloaded from the NGS anonymous ftp server:

ftp ftp.ngs.noaa.gov
login: anonymous
passwd: your complete email address

Once logged on, go to the /pub/pnt6 directory and download all the files using binary
transfer mode. The input1 and results1 directory contain the sample data sets.
Follow the setup instructions in the PAGE-NT User's Manual.

ADJUST - The ADJUST and ADJUST UTILITIES software package can be downloaded from
the NGS home page (http://www.ngs.noaa.gov) by accessing the "PC Software" link. Check
the web page for the latest version of each program. The software performs a least squares
adjustment on horizontal, vertical angle, and/or GPS observations. The program comprises six

data checking programs in addition to the adjustment software. This software package has numerous options, such as choice of ellipsoid, and includes sample input data. Also available is the source code.

ADJUST UTILITIES - Suite of programs that are used in conjunction with PC program ADJUST. This group of programs includes:

BBACCUR provides a formatted listing of the external and internal accuracies which have been computed by program ADJUST-- sorted in numerical ascending order of external accuracy. Output from program ADJUST, run with accuracies, is used as input.

CLUSTER is used to identify geodetic stations which are common to two data sets with respect to name or a given position tolerance.

ELEVUP creates a bfile which combines the bfile output from the constrained horizontal adjustment with the bfile output from the constrained vertical adjustment. This new bfile contains *80* records with adjusted positions from the horizontal and *86* records with the ellipsoidal heights from the horizontal adjustment and the orthometric heights and geoid heights from the vertical adjustment.

ELLACC computes ellipsoidal height order and class for a project. Output from program ADJUST, run with accuracies, is used as input.

MAKE86 adds *86* records to the bfile. If the existing *80* records contain orthometric heights, these are added to the new *86* records.

MODGEE scales the standard errors assigned to the observations in the gfile. Input is a gfile and the scaling factor.

QQRECORD adds qq records to the Afile (used by program ADJUST) to compute accuracies for all observed lines. Either the gfile (for GPS projects) or the bfile (for classical terrestrial projects) can be used as input.

Data Sheet Utilities -

DSDATA is the Digital Data Sheet extraction program. Extracts individual or groups of data from a DSDATA file. Includes options to extract by Station Identifier, Station Name, Area, and more.

Other Software Programs - Below is a select listing of other software that is currently accessible through the Web. For the full and most recent list of NGS programs, visit the NGS PC Software web page. On-line interactive versions of some of these programs are available in the NGS PC Software Website at: http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml

COMPGB tests the consistency and compatibility of the Blue Book B file (GPS project and station occupation data) and G file (GPS vector data transfer file).

CR8BB reformats GPS project information to fit the requirements of the National Geodetic Survey data base. The file created, which is called the B-file, contains project information, station information, and survey measurements. The CR8BB software functions independently of the type of GPS receivers used in a project.

CR8SER extracts data from a GPS Blue Book G file to create a station serial number file (serfil) for GPS observations.

WDDPROC organizes control point descriptions in accordance with the National Geodetic Survey's description file (D-FILE) format.

DSWIN is Windows-based software for data sheet viewing and extraction. It displays a list of county names as found on your CD-ROM. Click on a county and a list of stations appears. Click on a station from the list and a data sheet appears. You may save the data sheet to a file or print it. The search feature allows for filtering the station list by: Point Radius, Min/Max Box, Station Name, or PID. You can also filter by type of control, such as first-order bench marks only.

GEOID03 Computes geoid height values for the conterminous United States, Alaska, Puerto Rico, Virgin Islands, and Hawaii. Suitable for conversion of NAD 83 GPS ellipsoidal heights into NAVD 88 orthometric heights.

HTDP is a horizontal time-dependent positioning software program which allows users to predict horizontal displacements and/or velocities at locations throughout the United States. This software also enables users to update geodetic coordinates and/or observations from one date to another.

INVERSE3D is the three dimensional version of program INVERSE, and is the tool for computing not just the geodetic azimuth and ellipsoidal distance, but also the mark-to-mark distance, the ellipsoid height difference, the dx, dy, dz (differential X, Y, Z used to express GPS vectors), and the dn, de, du (differential north, east, up using the FROM station as the origin of the neu coordinate system). The program requires geodetic coordinates as input, expressed as either: 1) latitude and longitude in degrees, minutes, and seconds or decimal degrees along with the ellipsoid heights for both stations, or 2) rectangular coordinates (X, Y, Z in the Conventional Terrestrial Reference System) for each station. The program works exclusively on the GRS80 ellipsoid and the units are meters. Both types of coordinates may be used in the same computation. The program reads input geodetic positions as positive north and positive west.

LOOP determines the loop misclosures of GPS base lines using the delta x, delta y, delta z vector components computed from a group of observing sessions.

ATTACHMENT 16
OUTLINE FOR PROCESSING AIRPORT GEODETIC CONTROL
SURVEYS WITH PAGE-NT

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

Outline for Processing
Airport Geodetic Control Surveys
with PAGE-NT

1. Place Raw data files (zip format o.k.) in the following directory:

   `:\ProjectName\RawData\DOY\`   Project Name is two-letter state ID, plus ANA

   DOY = Day of Year of Observation Files

2. Place RINEX data files, TEQC summary file, and precise orbit files (.SP3 format) in the following directory:

   `:\ProjectName\RinexData\DOY\`

3. Ensure the latest sitecors.bin, siteigs.bin and ant_info.* files are in the `:\pnt*\` directory.

4. Create a SERFIL and place into the directory: `:\ProjectName\serfil\`
   Create a GFILE directory: `:\ProjectName\gfile\`

5. Establish a session processing outline based on the procedures in section 9.6, vol. A, of the General Specifications for Aeronautical Surveys. Create a directory for each processing session:

   `:\ProjectName\DOY\DOYS\`   S = Processing session letter

6. Process each session following the procedures in the PAGE-NT documentation.
   - Use the latest ITRF coordinates for the Antenna Reference Point (ARP) [or monument of applicable] of each CORS station.
   - Ensure the proper antenna height (monument to ARP) and model number is input in the station information menus.
   - OMIT the PACS station from the triple difference solution for the PACS to UNKNOWN sessions and ensure you enter the proper (derived mean) coordinates for the PACS into the station information menu.
   - Use the default meteorological values.
   - Put in the proper session letter for the session (Merge RINEX Files screen).
   - Turn off Tropospheric Unknowns for stations if required (Baseline Processing Options screen: Off = Fix = Not Highlighted; On = Solve = Highlighted in Blue [default]).

7. To run a L1 solution, first run a L3 solution. If the results are satisfactory, rename the output file "combined.sum" to "combinedL3.sum". Return to the Baseline Processing Options screen and select "L1" for the frequency of solution. Save the change before exiting the menu. Select check box 6 (only) under the RUN menu to run another combined solution. Rename the output "combined.sum" file "combinedL1.sum".

8. Review the combined.sum, float.rms, and fixed.rms files for each session. View plots and other files as necessary to analyze the processing session.

9. Create a GFILE for each session by running SINEX2G under the Utilities menu. Ensure the gfile.inp file is correct before each run. Save the individual GFILE for each session by naming it DOYSgf and saving it in the gfile directory or processing directory for the session. Run

SINEX2G again, appending the session GFILE to the project GFILE by editing thegfile.inp file to save the file in the `:\ProjectName\gfile\` directory with the name "gfile".

10. Submit a hard copy of the processing scheme and a spreadsheet showing the positions and X,Y,Z value differences between sessions for each station. If requested by NGS, also submit hard copies of the following files (for each session) with the processing report.
    * combined.sum, combinedL3.sum, combinedL1.sum
    * float.rms
    * fixed.rms

11. Edit the "#/File Types To Delete During Clean Up" section of the default.txt file to delete only the following files, then run "Clean Up Output Directory" from the Run menu. Submit all of the remaining data in the `:\ProjectName\` directory and subdirectories on CD-ROM or other pre-approved medium to NGS with the project report.
    Files to be DELETED:
    * *.00
    * *.dat
    * *.scn
    * *.prn
    * *.out
    * *.pom
    * *.new
    * eclipse
    * sum-*.flt
    * sum-*.fix
    * *.sp3
    * *.99o
    * *.99n

12. Place copies of the following files that were used during vector processing in the `:\ProjectName\` directory for submittal:
    * ant_info.*
    * sitecors.bin
    * siteigs.bin
    * default.txt (template)
    * gfile.inp   (template)

ATTACHMENT 17
NGS PROCEDURAL OUTLINE FOR ADJUSTING GPS DATA FOR AIRPORT
GEODETIC CONTROL SURVEYS

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

ATTACHMENT 17

**NGS Procedural Outline for Adjusting GPS Data
For Airport Geodetic Control Surveys**

This outline should be used to supplement the guidance in Section 9.7, vol. A, of the General Guidance and Specifications for Aeronautical Surveys.

These procedures apply to both the PACS and SACS portions of the project. The only difference is that the Gfile is scaled for the SACS adjustments (run MODGEE after the first free adjustment) and the only control will normally be the PACS determined in the PACS adjustments. Consult NGS if either SACS is used for the BM or HARN tie in the PACS adjustments for guidance on procedures for the SACS adjustments.

1. Complete PAGE-NT processing:
      -Ensure all fixed coordinates used in processing were correct.
      -Ensure up offset values for each station are equal to the monument to Antenna Reference
       Point (ARP).
      -Ensure all PFR plots are acceptable.
      -Ensure RMS values in COMBINED.SUM files are acceptable.
      -Ensure all redundant vectors and multiple occupied station results check within 3cm/5cm
       of each other.
            -show comparisons using a spreadsheet.

2. Create input files:
      -Use the combined Gfile created in PAGE-NT
         -Ensure all vectors are included in the file.
         -Ensure there are no duplicate or misspelled station ID's; or mismatched serial
          numbers.
         -Check B record, column 52-53 for proper coordinate system code (contact NGS)
      -Make an Afile using program CRAFILE or by editing a previous Afile.
         Recommended II and MM records-
           II159999999
           MM3NYnewbb
      -Make a Bfile using program CR8BB, The Bfile serial numbers must match the SERFIL,
       Gfile, and Dfile. Designations in the Bfile and Dfile must match.
         Tips for using CR8BB for windows-
         -Use tab key to move to each data entry window
         -Input text using upper case letters
         -Create *86* records

3. Format and check Bfile:
      -Manually edit Bfile into proper format:
         -Insert GPS Survey Method Code >4= into *12* record column 76
      -Run checking program COMPGB; do not continue adjustment unless all errors are
       corrected

-Run Bfile format checking programs-NEWCHKOBS and OBSCHK (ignore errors relating
to missing codes at this time).

Substitute CTCORS for CORS below if applicable

4. Run a Free Adjustment (ADJUSTMENT 1):
       Afile- Constrain the NAD 83 position and ellipsoid height (EHT) of the CORS station.
           -For multiple airports, use the CORS station that is centrally located in the project
            area, or which was the reference station for most of the CORS to PACS vectors.
           -Save copies of each Afile used- Name AAFILE.1" etc.
       Bfile- Use clean Bfile from step 3 as input.
       Output- Name output file ADJOUT.1
           -Rename output Bfile BBOUT.1
           -Analyze results, review residuals on vector components (all less than 3-5cm?)
           -If more than one CORS was used, check the agreement between the computed and
            published positions of other CORS stations used in the project.
           -Check the agreement between the computed and published positions of the HARN
            and any other published stations used in the project.

5. Run a Constrained Adjustment (ADJUSTMENT 2):
       Afile- Constrain NAD83 position and EHT of all HARN and CORS stations used
       Bfile- Use BBOUT.1 again as input
       Output- Name ADJOUT.2;
           rename output Bfile BBOUT.2; review results

6. Run a Free Adjustment with Accuracies (ADJUSTMENT 3):
       Afile- Run program QQRECORD to add QQ records to AFILE.1 (output AFILE.3)
       Bfile- Use BBOUT.2
       Output- ADJOUT.3
           -Run program BBACCUR to obtain a listing of the length relative accuracies
             -Output-BBACC.OUT; review results
           -Run program ELLACC to obtain a listing of EHT accuracies
             -Output-ELLACC.OUT; review results
             -Manually edit the mode EHT order and class code into columns 54-55 of
             each *86* record of BBOUT.2

**The following two adjustments are performed to obtain orthometric heights to be inserted into
the output Bfile from ADJUSTMENT 2**

7. Run the latest version of NGS GEOID software to insert geoid heights into the Bfile:
       Input- BBOUT.2
       Output- GEOID.OUT

8. Run a Free Vertical Adjustment (ADJUSTMENT 4):
       Afile- Constrain the NAD83 horizontal position of one CORS station and the NAVD88
           orthometric height of the best@ (center of project, high quality) benchmark

Bfile- Use GEOID.OUT for input
Output- Name ADJOUT.4; rename output Bfile BBOUT.45
-Review orthometric heights with published NGS values (agree w/in 15cm?)
-Use spreadsheet or table to show the comparison results.

9. Run a Constrained Vertical Adjustment (ADJUSTMENT 5):
Afile- Same as ADJUSTMENT 4, except constrain additional orthometric heights of
benchmarks that worked well in the Free Vertical Adjustment
Bfile- Use GEOID.OUT for input
Output- Name ADJOUT.5; rename output Bfile BBOUT.5; review results and rerun using
different constraints in the Afile if necessary.

10. Run program ELEVUP to transfer orthometric heights from ADJUSTMENT 5 to the final
Bfile:
Input vertcal Deck- BBOUT.5
Input horizontal Deck- BBOUT.2
-Name the final Bfile FNL.BBK
-double check values in *80* and *86* records against ADJOUT. 2 and ADJOUT.5
-rename GFILE to FNL.GFL

11. Run checking programs on the final Bfile and correct errors
No error messages are allowed except those relating to the zero antenna height of the
CORS; contact NGS for assistance in correcting errors identified by one of the programs.
-COMPGB
-NEWCHKOB
-OBSCHK
-OBSDES (matches Bfile with description file)
-CHKDES (checks description file for format errors)

12. Write the final project report and submit the following digital files (and paper copy if
requested by NGS) in a :\ProjectName\Adjust\ directory (If applicable, create an
%%%%\Adjust\ subdirectory for each grouping of airports adjusted together, where
%%%% is a unique ID created for the adjustment group):
-ADJUST Files:
FNL.BBK
FNL.GFL
AFILE.*
ADJOUT.*
BBIN.* (1st Bluebook)
BBOUT.*
BBACC.OUT
ELLACC.OUT
GEOID.OUT
SERFILE
-Output Files From Checking Programs
COMPGB.OUT

NEWCHKOB.OUT
OBSCHK.OUT
OBSDES.OUT (Checks description files vs Bfile)
CHKDES.OUT (Checks description files)

-Place a copy of the final Bfile, Gfile, and Dfile in a :\ProjectName\FinalFiles\ directory.

ATTACHMENT 18
EXAMPLE COORDINATE COMPARISON SPREADSHEET

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

Tennessee ANA Survey 1999
Vector Processing Results

Paris Henry County Airport (HZD) - Day 244

CORS - mem2

PACS - HZD A	Observed ITRF Coordinates			SOLN	RMS	KM
	X	Y	Z			
244A	138517.6508	-5157909.9332	3736955.8065	L3X	0.0146	172
244B	138517.6602	-5157909.9284	3736955.8076	L3PFX	0.0170	
difference	-0.0094	-0.0048	-0.0011			
MEAN	138517.6555	-5157909.9308	3736955.8071			

SACS1 - FAA HZD A

244F	138244.3948	-5158611.2409	3735995.7541	L1X	0.0057	1
244G	138244.3946	-5158611.2392	3735995.7494	L1X	0.0073	
difference	0.0002	-0.0017	0.0047			

SACS2 - HZD C

244F	138364.7295	-5158170.6200	3736597.6080	L1X	0.0057	0.5
244G	138364.7285	-5158170.6243	3736597.6115	L1X	0.0073	
difference	0.0010	0.0043	-0.0035			

HARN - GPS 15	Adjusted vs. Published NAD 83					
	X	Y	Z			
244C obs. (NAD83)	145521.9648	-5141684.5452	3758877.3789	L3X	0.0113	28
published. (NAD83)	145521.9690	-5141684.5610	3758877.3980			
difference	-0.0042	0.0158	-0.0191			

BM1 - F 181	NAD 83 EHT (m)	NAVD 88 (m)				
244D obs.	144.223	172.572		L3X	0.0116	22
published	N/A	172.628				
difference		-0.0560				

BM2 - Y 161	NAD 83 EHT (m)	NAVD 88 (m)				
244E obs.	94.516	122.698		L3X	0.0129	39
published	N/A	122.739				
difference		-0.0410				

Comments: 12 minute gap in CORS data from 1318-1330
GPS 15 also observed in session 242A -see sheet2 for vector comparison

ITRF Coordinate Comparison for Multiple Occupied Stations
HARN and Bench Marks

ITRF vector comparison for GPS 15-

HARN - GPS 15	Observed ITRF Coordinates			SOLN	RMS	KM
	X	**Y**	**Z**	**SOLN**	**RMS**	**KM**
244C	145521.3912	-5141683.0467	3758877.2319	L3X	0.0113	28
242A	145521.3883	-5141683.0334	3758877.2145	L3PFX	0.0152	191
Difference	0.0029	-0.0133	0.0174			

ITRF vector comparison for GPS 32-

HARN - GPS 32	Observed ITRF Coordinates			SOLN	RMS	KM
	X	**Y**	**Z**	**SOLN**	**RMS**	**KM**
254C	90432.9992	-5169962.2991	3721755.0682	L1X	0.0099	13
265C	90432.9988	-5169962.3238	3721755.0829	L3X	0.0099	50
266C	90433.0042	-5169962.3131	3721755.0756	L1X	0.0085	17
Max Difference	0.0054	-0.0247	0.0147			

ITRF vector comparison for ...-

ATTACHMENT 19
PROJECT SUBMISSION CHECKLIST

TO
GENERAL GUIDANCE AND SPECIFICATIONS FOR
AERONAUTICAL SURVEYS VOLUME A

FEDERAL AVIATION ADMINISTRATION
AIRPORT SURVEYS

ATTACHMENT 19
PROJECT SUBMISSION CHECKLIST - GPS PROJECTS

Project Title: _____

Accession Number: _____

Submitting Agency: _____

Observing Agency: _____

Receiver Type: _____

PACKAGE CONTENTS

Project Report and Attachments	**Required For**
( ) Project Report	All Projects
( ) Approved Reconnaissance and Project Sketch	All Projects
( ) Project Instructions or Contract Specifications	All Projects
( ) Final Station List	All Projects
( ) Station Visibility Diagrams	All Projects
( ) Final Observing Schedule	All Projects
( ) Observation Logs	All Projects
( ) Equipment Failure Logs	NGS Projects
( ) Loop Misclosures	Optional
( ) Free Adjustment with Analysis	All Projects
( ) Free Adjustment with Accuracies	All Projects
( ) Constrained Horizontal Adjustment	All Projects
( ) Constrained Vertical Adjustment (NAVD 88 Heights)	All Projects
( ) Meteorological Instrument Comparison Logs	If Specified
( ) Photographs of Views from Stations	If Specified
( ) Photographs or Rubbings of Station Marks	All Projects
( ) COMPGB Output (Validation program-B/G file)	All Projects
( ) OBSDES Output (Validation program-D-file)	All Projects
( ) OBSCHK Output (Validation program-D-file)	All Projects
( ) CHKDESC Output (Validation program-D-file)	All Projects
( ) ELLACC Output	All Projects
( ) BBACCUR Output	All Projects

Digitized Data Files ( ) Diskettes ( ) Other:_____

( ) Raw Phase Data (R-files)	All Projects
( ) Base Line Vectors (G-file)	All Projects
( ) Project and Station Occupation Data (Final B-file)	All Projects
( ) Descriptions or Recovery Notes (D-file)	All Projects
( ) Terrestrial Horizontal Observations (T-file)	If Applicable
( ) Differential Leveling Observations (L-file)	If Applicable

Comments - Enter on the reverse side of this form.

	Org Code	**Name**	**Date**
Received by:	_____		
Reviewed by:	_____		
Reviewed by:	_____		