U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Geodetic Survey

FINAL REPORT
FAA ADVISORY CIRCULAR 150/5300-16A

State and Project Identification Number: SUFFOLK EXECUTIVE AIRPORT, VA 2009 (SFQ)

Horizontal Datum: NAD 83

Vertical Datum: NAVD 88

Geoid Model: GEOID09

Location: Suffolk, VA

Date of Field Work: March 3-4, 2009

Date of Computation: March, 2010

Office Computations

CORS:	01
BM:	02
HZ/VERT:	01
PACS established:	01
SACS established:	02
HARN:	01
Others:	00
Total:	08

	PACS	SACS
Final Free Adjustment Variance of Unit Weight	252.25	74.79
Final Free Adjustment Degrees of Freedom	3	9

Report by: Kevin S. Jordan

FINAL REPORT
SURVEY AND QUALITY CONTROL
FAA ADVISORY CIRCULAR 150/5300-16A

AIRPORT NAME: Suffolk Executive Airport
LOCATION: SUFFOLK, VA
AIRPORT IDENTIFIER: SFQ
SURVEY SPECIFICATIONS: FAA ADVISORY CIRCULAR 150/5300-16A
SUBMITTER: NATIONAL GEODETIC SURVEY

ACCURACY STANDARDS

ITEM	HORIZONTAL	VERTICAL	
		Orthometric	Ellipsoid
Primary Airport Control Station (PACS)[1]	5 cm	25 cm	15 cm
Secondary Airport Control Station (SACS)[2]	3 cm	5 cm	4 cm
Notes: [1]Accuracies are relative to the nearest NGS-sanctioned CORS [2]Accuracies are relative to the PACS and other SACS at the airport.			

PURPOSE

The purpose of the project is to establish the Primary and two Secondary Airport Control Stations (PACS, SACS) at the Suffolk Executive Airport in Suffolk, Virginia. The PACS connection to the National Spatial Reference System (NSRS) was achieved through simultaneous GPS observations with one Continuously Operating Reference Station (CORS), one Cooperative Base Network Station (CBN) and two first-order NAVD 88 bench marks. In addition, a third first-order bench mark (also B-order horizontal station) served as a supplemental tie. The SACS were connected to the NSRS through simultaneous GPS observations with the PACS.

PERSONNEL

The following National Geodetic Survey (NGS) personnel were involve in the project's operations:

Kevin Jordan ……... Coordinator, Computer, Reconnaissance, GPS Observer
George Nottage ……... GPS Observer
Donald Breidenbach …… Reconnaissance, Marksetting
Jon Carpenter ……... Reconnaissance, Marksetting

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RECONNAISSANCE/MARKSETTING

Project personnel conducted reconnaissance prior to submission of the Survey and Quality Control Plan. The project required installation of two new survey monuments. PAC station SFQ A is an NGS 3-D stainless steel rod mark and SAC station SFQ B is an NGS Vertical Control disk set in a round concrete monument. Existing NGS horizontal/vertical station J 324 RESET was selected as a SACS. Existing and new control stations used in the project appear in the Station Listing. Station descriptions and recovery notes were created for all project stations except the CORS and digitized using program WINDESC.

PROJECT PLANNING

Project personnel examined GPS surveying equipment prior to project deployment. Fixed height tripods were inspected for stability, plumb alignment, and height verification. All GPS receivers took part in a test observing session. The GPS data collected in the test session were downloaded from the receivers, translated to RINEX format, reviewed and processed. All equipment were found to be in good working order. Each receiver's internal memory was emptied prior to project observations. GPS receiver parameters were set to collect static GPS data at 15-second epoch intervals using an elevation mask of 10 degrees. Project personnel used the GPS Observation Scheme appearing in the approved Project Survey Plan.

STATION LIST

STATION NAME	PID	TYPE	AGENCY	H ORDER	V ORDER	STAB	SSN	CONDITION AT RECOVERY	COMMENTS
SFQ A		PACS	NGS			B	0001	NEW	SS ROD MARK
SFQ B		SACS	NGS			C	0002	NEW	VERTICAL CONTROL MARK
J 324 RESET	FX2636	SACS	NGS	3	3?	C	0003	GOOD	EXISTING BENCH MARK AND NEW SACS
PASCALE	FX4376	CBN	NGS	B		C	0004	GOOD	HARN TIE
F 468	FX2236	BM	NGS		1	B	0005	GOOD	BM TIE
G 468	FX2233	BM	NGS		1	B	0006	GOOD	BM TIE
WEATHER	DG9068	H,V	NGS	B	1	C	0007	GOOD	BM TIE (>25 KM)
DRIVER 5 CORS ARP	DI0878	CORS	USCG	CORS			9001		CORS TIE

AIRPORT SUMMARY REPORT

Airport Point of Contact: Kent Marshall, Airport Manager 757-514-4411
Airport Controlled?: No
Escort Required?: No
Radio Frequencies: CTAF:122.7
Intervisibility: The PACS and both SACS are all intervisible with each other.

GPS OBSERVATION SCHEDULE

MARCH 4, 2009
Day 063

SSN	Station Name	PID	STATION ID	Type	(UTC)	JSIN
0001	SFQ A		SFQA	PACS	1357 to 2129	468
0002	SFQ B		SFQB	SACS	1320 to 1607	628
0003	J 324 RESET	FX2636	J324	SACS	1405 to 1610	509
0004	PASCALE	FX4376	PSCL	HARN	1241 to 2210	441
0005	F 468	FX2236	F468	BM	1652 to 2108	628
0006	G 468	FX2233	G468	BM	1705 to 2113	509
0007	WEATHER	DG9068	WTHR	H,V	1646 to 2111	635

MARCH 5, 2009
Day 064

SSN	Station Name	PID	STATION ID	Type	(UTC)	JSIN
0001	SFQ A		SFQA	PACS	1344 to 2000	468
0002	SFQ B		SFQB	SACS	1351 to 1547 1627 to 1835	441 441
0003	J 324 RESET	FX2636	J324	SACS	1636 to 1848	509

INSTRUMENTATION

NGS used Trimble R8 Model 2 GNSS dual frequency receivers for performing the GPS observations on the survey detailed above. Each receiver had been updated to the latest firmware version (V3.82). SECO 2.0 meter fixed height poles were used at all stations.

JSIN	Manufacturer/Brand	Model	Serial Number
441	TRIMBLE	R8 Model 2 GNSS	4639122441
628	TRIMBLE	R8 Model 2 GNSS	4631120628
509	TRIMBLE	R8 Model 2 GNSS	4639122509
468	TRIMBLE	R8 Model 2 GNSS	4639122468
635	TRIMBLE	R8 Model 2 GNSS	4631120635

GPS OBSERVATIONS

GPS observations were conducted on March 4 and 5, 2009 (days 063 and 064). Weather conditions were generally cool and no passing weather fronts occurred. As many as five GPS receivers were operating simultaneously to complete the planned observations. All but two survey stations are located on secured facilities. This permitted unattended receiver operation, allowing two employees to complete the GPS observations. As such, with personnel setting up and monitoring multiple GPS receivers, data collection at each station site began once setup was complete. Personnel verified fixed height tripod plumb at the start, during and end of each session and completed GPS Observation logs for each station occupation. Upon completion of each day's observing sessions, personnel transferred the GPS receiver data to personal computers and a backup copy of the raw data was stored on the

NGS office server. After verifying successful data transfer, each receiver's internal memory was emptied.

CONDITIONS AFFECTING PROGRESS

During the first SACS observation of SFQ B the fixed height pole was found to be out of plumb at the end of the session. A re-observation was made to replace this session on March 5, 2009. Processing of all 3 SACS sessions proved to have repeated vectors within AC-16A standards allowing for all three to be included in the adjustment. The GPS project was processed without any problems.

DEVIATIONS FROM APPROVED SURVEY PLAN

In the approved plan the CORS tie selected was VA GLOUCESTER PT CORS ARP (DJ5202). Prior to processing and adjustment, DRIVER 5 CORS ARP (DI0878) was selected as it was the closest CORS in proximity to the PACS.

DATA PROCESSING

Prior to beginning data processing, the latest version of NGS software were downloaded from the NGS web site. All original data were backed up on the local NGS server and a copy of the data was used for processing. The raw data were translated from the Trimble proprietary format to RINEX version 2.11 format using Trimble program ConvertToRinex version 1.0.1.29. The raw data files were not identified by station ID. File RCVR_RAW_RINEX_LIST.pdf contains the list of input raw files and output RINEX files for all station occupations. GPS Observation logs were checked for completeness and accuracy. The GPS vector processing was accomplished using PAGE-NT software version 2008.10.16. Precise ephemerides determined by the International GNSS Service (IGS), referenced to IGS05 Epoch 2000.0 were used in all data reductions. Vector processing sessions followed recommendation of the AC-16A with vectors reduced as follows: CORS-PACS, PACS-HARN tie and BM ties, and PACS-SACS. Final solution type and tropospheric settings followed AC-16A specifications. Once solutions were complete, post-fit residual plots and solution files were examined for acceptance. The mean ITRF coordinates for the PACS were determined in the CORS-PACS solutions and held fixed in solutions where vectors emanate from the PACS. After completing the PAGE-NT processing, the GFILES for the PACS and SACS networks were created using PAGE-NT program SINEX2G.

VECTOR PROCESSING SCHEME								
REF (type)	REM (type)	OBS TIME	SPAN	SOL TYPE	RMS	TROPO REF	TROPO REM	SESS
DRV5(CORS)	SFQA(PACS)	1615-2129	5:14	I-F	0.0133	OFF	ON	063A
DRV5(CORS)	SFQA(PACS)	1344-2000	6:16	I-F	0.0124	OFF	ON	064A
SFQA(PACS)	PSCL(CBN)	1357-2129	7:32	I-F	0.0173	OFF	ON	063B
SFQA(PACS)	F468(BM)	1652-2108	4:16	I-F	0.0173	OFF	ON	063B
SFQA(PACS)	G468(BM)	1705-2113	4:08	I-F	0.0173	OFF	ON	063B
SFQA(PACS)	WTHR(BM,BO)	1646-2111	4:25	I-F	0.0146	OFF	ON	063D
SFQA(PACS)	J324(SACS)	1405-1610	2:05	L1	0.0044	OFF	OFF	063C
SFQA(PACS)	SFQB(SACS)	1357-1607	2:10	L1	0.0044	OFF	OFF	063C

SFQA(PACS)	SFQB(SACS)	1350-1547	1:57	L1	0.0041	OFF	OFF	064B
SFQA(PACS)	J324(SACS)	1636-1848	2:12	L1	0.0047	OFF	OFF	064C
SFQA(PACS)	SFQB(SACS)	1627-1835	2:08	L1	0.0047	OFF	OFF	064C

The project BFILES were created using NGS program CR8BB. The BFILES and GFILES were validated using NGS programs COMPGB and OBSCHK. The BFILES were validated using NGS program CHKOBS. The description files and final BFILES were validated using NGS program OBSDES.

ADJUSTMENTS

The project's PACS and SACS adjustments were accomplished using NGS program ADJUST. Coordinate and height constraints used in the PACS adjustments are the published values appearing on the NGS data sheets for control stations used in the project. Coordinates and heights determined for control stations in the PACS free horizontal and free vertical adjustments were compared to the published NGS values. All were found to meet tolerances set forth in the AC-16A and were held fixed in the constrained adjustments. The final coordinates and heights determined for PACS SFQ A in the PACS adjustments were used as constraints in the SACS adjustments. The SACS, SFQ B and J 324 RESET, were positioned relative to the PACS.

PACS First Free Adjustment

The NGSIDB position and ellipsoid height of station DRIVER 5 CORS ARP were constrained in this adjustment.

Degree of Freedom	=	3
Variance of sum	=	756.7
Std. Dev. Of Unit Weight	=	15.882
Variance of Unit Weight	=	252.25

PACS Horizontal Adjustment

The NGSIDB positions and ellipsoid heights of stations DRIVER 5 CORS ARP, PASCALE (B-order CBN station) and WEATHER (B-order Horizontal Control) were constrained in this adjustment. The updated BFILE from the first free adjustment was used as input.

Degree of freedom	=	9
Variance of Sum	=	8359.6
Std. Dev. Of Unit Weight	=	30.477
Variance of Unit Weight	=	928.85

PACS Final Free Adjustment with Accuracies

For the final free adjustment, the updated BFILE from the horizontal adjustment was used as input for the final adjustment and length relative accuracies were computed. The NGSIDB position and ellipsoid height of station DRIVER 5 CORS ARP were constrained in this adjustment. Files containing the ellipsoid height accuracies and the length relative accuracies determined in this adjustment were output by execution of programs ELLACC and BBACCUR2 respectively. Internal

and external length relative accuracies for three baselines exceeded 1: 1,000,000. The relative accuracies for two baselines are less than 1: 1,000,000. The two baselines are less than 7 km in length and connect the PACS to two bench marks that were each observed in a single session.

Degree of freedom	=	3
Variance of Sum	=	756.7
Std. Dev. Of Unit Weight	=	15.882
Variance of Unit Weight	=	252.25

PACS Free Vertical Adjustment

Prior to this adjustment, geoid heights were computed using GEOID09 program INTG using the output BFILE from the horizontal adjustment as input. The INTG output file was then used as input for this adjustment. For this adjustment, the NGSIDB position of DRIVER 5 CORS ARP and the orthometric height of station F 468, an existent first-order vertical station were constrained.

Degree of freedom	=	3
Variance of Sum	=	756.7
Std. Dev. Of Unit Weight	=	15.882
Variance of Unit Weight	=	252.25

PACS Vertical Adjustment

For this adjustment, the NGSIDB position of DRIVER 5 CORS ARP and the orthometric heights of stations F 468, G 468 and WEATHER, existent first-order vertical stations were constrained.

Degree of freedom	=	5
Variance of Sum	=	803.8
Std. Dev. Of Unit Weight	=	12.679
Variance of Unit Weight	=	160.77

Program ELEVUP was used to create the final BFILE by combining the orthometric heights output by the constrained vertical adjustment with the horizontal positions output by the constrained horizontal adjustment. The final BFILE and GFILE, named FNL.BBK and FNL.GFL respectively, reside in the \SFQ\PACS\ADJUST subdirectory.

The position, ellipsoid height and orthometric height for the PACS were extracted from the final BFILE and used as constraints for the SACS adjustments. Since the SACS adjustments for the Suffolk Airport contain no fixed control other than the PACS, only the minimally constrained horizontal adjustment, free vertical adjustment, and final free adjustment with accuracies are necessary.

SACS First Free Adjustment

The position and ellipsoid height of station SFQ A were constrained in this adjustment.

Degree of Freedom	=	9
Variance of sum	=	673.1

Std. Dev. Of Unit Weight = 8.648
Variance of Unit Weight = 74.79

SACS Final Free Adjustment with Accuracies

For the final free adjustment, the updated BFILE from the horizontal adjustment was used as input for the final adjustment and length relative accuracies were computed. The position and ellipsoid height of station SFQ A were constrained in this adjustment. Files containing the ellipsoid height accuracies and the length relative accuracies determined in this adjustment were output by execution of programs ELLACC and BBACCUR2 respectively. Length relative accuracies exceeded the required standards (1: 100,000)

Degree of Freedom = 9
Variance of sum = 673.1
Std. Dev. Of Unit Weight = 8.648
Variance of Unit Weight = 74.79

SACS Vertical Adjustment

Prior to this adjustment, geoid heights were computed using GEOID09 program INTG using the output BFILE from the horizontal adjustment as input. The INTG output file was then used as input for this adjustment. The position and orthometric height of station SFQ A were constrained.

Degree of Freedom = 9
Variance of sum = 673.1
Std. Dev. Of Unit Weight = 8.648
Variance of Unit Weight = 74.79

Program ELEVUP was used to create the final BFILE by combining the orthometric heights output by the vertical adjustment with the horizontal positions output by the horizontal adjustment. The final BFILE and GFILE, named FNL.BBK and FNL.GFL respectively, reside in the \SFQ\SACS\ADJUST subdirectory.

SOFTWARE & VERSION LISTING

TRIMBLE - CONVERT TO RINEX Ver. 1.0.1.29
PAGE-NT Ver. 2008.10.16
INVERS3D Ver 2.0
CR8BB Ver. 6.0
ADJUST Ver. 5.6
QQRECORD Ver. 1.9
BBACCUR2 Ver. 1.6
INTG Ver. 2.22
ELLACC Ver. 2.7
ELEVUP
CHKOBS Ver. 2.6
OBSCHK Ver. 3.11
COMPGB Ver. 1.8

WINDESC Ver. 4.15.35
OBSDES Ver. 2.5
Microsoft Office Excel 2007

PROJECT ANALYSIS

Analysis of the processing and adjustment results indicate the accuracy standards for the PACS and SACS surveys were met. Stations F 468, G 468, PASCALE and WEATHER were each observed in single 4-hour observation sessions and are classified as first-order horizontal stations for this project.

File COORDINATE COMPARISON.pdf contains analysis of the PAGE-NT output ITRF00 coordinates for repeated vectors. It also contains comparisons of the adjusted NAD 83 coordinates, ellipsoid heights and NAVD 88 heights of the control stations with the published NGS values. Program INVERS3D output files PASCALE.INV and WEATHER.INV contain results of inverses computed between the adjusted NAD 83 coordinates and ellipsoid heights of control stations and the published NGS values.

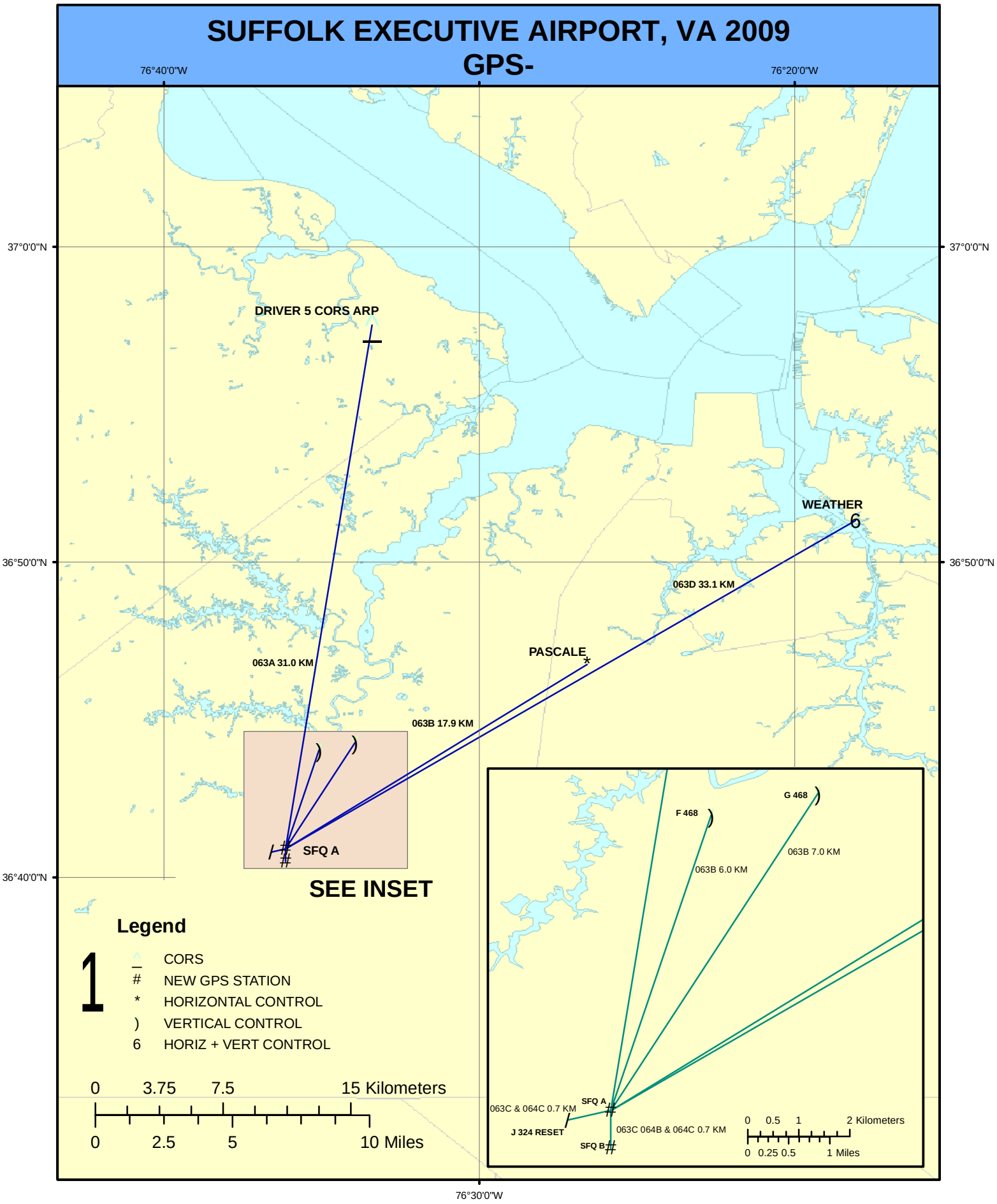
QUALITY CONTROL

Field forms were checked for accuracy and completeness. Manual data computer entries were checked. Final project data are submitted in the NGS Bluebook format or in the appropriate format specified in the AC-16A. The checks of file formats of deliverable BFILES, GFILES and DFILES were achieved through comprehensive review of the files and by utilizing NGS bluebook file checking programs CHKOBS, COMPGB, OBSCHK and OBSDES. All checking program output files were examined and contain only allowable error messages (ARP HEIGHT IS ZERO, NO RECOVERY NOTE FOR CORS). The Windesc checking programs Windesc Check and Spell Check were run on the description files prior to export and the .ERR files were examined for error messages and warnings. Only allowable warnings appeared in the final files. Programs DISCREP and NEIGHBOR were run through the Windesc software. The error messages generated by program DISCREP were caused by differences in the submitted data and the NGSIDB. The new information in the DFILE will be used to update the NGSIDB. All reports and deliverable data were reviewed for accuracy and completeness.

DATABASE NOTES

The station name of J 324 RESET (PID FX2636) is carried as J 324 RESET 1983 in the NGSIDB. The ‘Year Mark Set’ should be dropped from the designation, per NGS Bluebook Annex D, Guidelines for Geodetic Control Point Designations.

COMMENTS

The original GPS Observation logs were scanned into file GPS OBSERVATION LOGS.pdf that resides in the \SFQ\REPORTS\Final Reports subdirectory. The original Station Location Sketch and Visibility Diagram forms and Survey Station Description and Recovery forms were scanned into file SURVEY AND QUALITY CONTROL PLAN.pdf that resides in the \SFQ\REPORTS\Survey and Quality Control Plan subdirectory. The original logs and forms are retained by the submitting organization.

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