

## T-0027 Rhode Island

### **NOAA Aerotriangulation Report Contents**

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# Analytical Aerotriangulation Report

T-0027, Rhode Island

February 2015

## Area Covered

The mapping area extends from Westerly north to Little Compton along the coast of Rhode Island, including Block Island. The project limits for the area are defined as 71°55' to 71°02' west longitude and 41°04' to 41°36' north latitude. Refer to Annex 1 for a diagram of the project area.

## Imagery

Number of images: 239

Number of flight lines: 9

Type of emulsion: digital RGBN

Photo scale: 1"=1800'

Date of photos: August 18, 2014

Photos taken by: Richard Crouse & Associates located in Frederick, MD

Cameras used:

- Zeiss DMC  
Forward motion compensation  
Camera Number 131  
Calibrated focal length 120.000 mm  
Calibration date 09/08/2008

Photos were taken within 25% of the Mean Range of tide around MLLW.

The photos were acceptable for analytical aerotriangulation. The forward overlap of photos along the line of flight is 60 percent, and the side lap between parallel strips is 30 percent. See Annex 2 for the flight-line diagram.

34 of the 239 photos were not used because of insufficient image detail. They cover all water or mostly water. These water photos are:

<u>Strip</u>	<u>Exposure</u>
30005	0001-0002, 0042-0060, 0068-0069
30006	0001, 0008
30007	0001, 0009-0010
30008	0001, 0013-0014
30009	0001-0002, 0013

## **Control**

54 surveyed ground points were used as horizontal and/or vertical control in the aerotriangulation. Airborne global positioning system (ABGPS) exposure stations were also used as control in the aerotriangulation. Refer to the 'Airborne Positioning and Orientation Report' for accuracy of the ABGPS exposure stations. Seven surveyed points were used to check the horizontal and vertical accuracy of the aerotriangulation. Refer to the 'Ground Survey Report' for details of the check-point survey. The control points are located at photo-identifiable positions. The check points are located at well-defined photo-identifiable positions. None of the control points or check points were paneled. Annex 6 is a listing of ground-control eastings, northings and elevations. Annex 8 is a listing ABGPS exposure station positions and times, in PATB-GPS format.

Inertial measuring unit (IMU) measurements were used to refine the ABGPS exposure stations. The IMU also provides exposure-station orientation angles for photos that are all water or have minimal land image. Refer to the 'Airborne Positioning and Orientation Report' for specifics pertaining to the airborne IMU.

## **Method**

The 12 micron digital images were left uncompressed and further processed to include overviews for softcopy aerotriangulation. The scanned-image identifiers and the aerotriangulation image-file identifiers are identical.

The softcopy analytical aerotriangulation was done using the Intergraph Image Station Automatic Triangulation (ISAT) program, version 6.1, installed on Dell Precision Workstations, running either Windows XP Professional or Windows 7 Professional with current software updates. The Dell workstations have processors and memory exceeding the software's minimum recommendations. The ISAT program includes automatic point matching (measuring) and the PhotoT least-squares-simultaneous-robust bundle-block adjustment. The point matching and bundle adjustment were done as a block of photos. The automatic point matching was done in photos along a strip and in photos of overlapping strips. The photo coordinates from point matching are used with the ABGPS exposure stations and ground-surveyed control in the robust bundle-block adjustment, which automatically detects and removes any large point-matching errors

In order to provide an accurate adjustment, the project area was adjusted in two separate blocks. The first block, Mainland, contained 202 photos and the second block, Island, contained 37 photos. The ISAT point-matching algorithm identified no photogrammetric weak areas in any of the blocks. A weak area is defined as an area with insufficient photogrammetric tie points. Points were measured manually in the weak areas, and some manual points also were measured in models with small land area. The total number of images was 239, but 34 of these are water photos that were not correlated. 54 ground-surveyed control points were measured manually. Seven ground-surveyed horizontal-

and-vertical check points were also measured manually. A-priori standard deviations for the bundle adjustments were as follows:

Mainland

ABGPS exposure-station eastings and northings: 0.3 meters

ABGPS exposure-station elevations 0.3 meters

IMU orientation angles: .05 degrees

Photo measurements: <5 micrometers

Ground-surveyed horizontal control: .3 meters

Ground-surveyed vertical control: .3 meters

Island

ABGPS exposure-station eastings and northings: 0.3 meters

ABGPS exposure-station elevations 0.3 meters

IMU orientation angles: .05 degrees

Photo measurements: <5 micrometers

Ground-surveyed horizontal control: .3 meters

Ground-surveyed vertical control: .3 meters

## **Analysis of Results**

There are no deviations from standard procedures or specifications to report. A listing of refined image-point coordinates, in micrometers, for all measured points is provided in Annex 7. The format of the file is that used for the PATB bundle-adjustment program.

Annex 7A is a point-statistics listing from the PhotoT bundle-adjustment program. This listing contains the least-squares residuals, in micrometers, for all image points in the adjustment. These columns are titled 'Vx' and 'Vy'. The column titled 'Vxy' is the straight-line residual error computed using Vx and Vy. The summary of image-points statistics is as follows:

Mainland

Number of image points in adjustment: 6094

Mean of Vx image residuals: 0.000320 micrometers

Mean of Vy image residuals: 0.001829 micrometers

RMS of Vx residuals = 2.0 micrometers

RMS of Vy residuals = 1.5 micrometers

Island

Number of image points in adjustment: 711

Mean of Vx image residuals: -0.005384 micrometers

Mean of Vy image residuals: -0.006339 micrometers

RMS of Vx residuals = 2.2 micrometers

RMS of Vy residuals = 1.3 micrometers

The summary of statistics for seven check points is as follows:

<u>Point ID</u>	<u>Residuals (VX,VY,VZ) meters</u>		
AT_0375A	0.094	-0.086	-0.096
AT_0379	-0.081	-0.073	0.209
115-11	0.144	0.02	0.42
AT_0385A	0.114	-0.102	-0.31
AT_0401A	0.058	0.009	-0.307
AT_0410A	-0.109	0.038	-0.008
AT_0430A	0.245	0.223	-0.015

The X Y Z RMS of the 54 control point residuals are 0.104, 0.105, 0.108 meters. Annex 6A is a listing of check-point and control ground residuals per block in meters, from the PhotoT adjustment. Annex 10A includes the statistics from the PhotoT adjustment.

The following is a summary of statistics for adjustment exposure-station residuals:

#### Mainland

The ABGPS exposure stations for 177 photos were included in the adjustment.

RMSVX = 0.132 meters, RMSVY = 0.108, RMSVZ = 0.146  
RMSomega = 0.004 degrees, RMSphi = 0.009, RMSkappa = 0.007

#### Island

The ABGPS exposure stations for 28 photos were included in the adjustment.

RMSVX = 0.088 meters, RMSVY = 0.067, RMSVZ = 0.118  
RMSomega = 0.009 degrees, RMSphi = 0.007, RMSkappa = 0.004

Annex 8A is a listing of exposure-station residuals from the PhotoT adjustment. Position residuals are in meters. Orientation residuals are in degrees.

Annex 3A is a listing of standard deviations for all image points in the adjustment. Annex 3 shows the steps used to compute the 95% Circular Error probability using the RMS of the standard deviations in Annex 3A. The 95% Circular Error computed in Annex 3 for Mainland is 0.32 meters, and for Island it is 0.21 meters.

### **Project Data Base**

Project identifier: T-0027, Rhode Island

Camera calibration: see 'Imagery' on page 1

Annex 1: Project-area diagram, including flight-line diagram

Annex 2: Flight-line diagram included in Annex 1

Annex 3: Computation of 95% Circular Error accuracy for all points in aerotriangulation

Annex 3A: Listing of standard deviations for all image points in aerotriangulation

Annex 5: See survey report for ground-control diagram

Annex 6: Listing of ground-surveyed check points and vertical-control points

Annex 6A: Ground residuals of check and vertical-control points in adjustment  
Annex 7: Listing of refined photo coordinates for all image points  
Annex 7A: Listing of image-point residuals from adjustment  
Annex 8: Listing of ABGPS exposure stations and times, antenna-to-lens offset  
Annex 8A: Listing of ABGPS and IMU residuals from adjustment  
Annex 9: IMU orientation angles and associated standard deviations  
Annex 10: Exterior-orientation file from aerotriangulation, in ALBANY opm-file format  
Annex 10A: Aerotriangulation log file  
Annex 11: Contains interior-orientation report for each photo  
Annex 12: Listing of coordinates and elevations for all image points in aerotriangulation  
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Horizontal datum: NAD83/11  
Coordinate system: UTM, zone 19, meters  
Vertical Datum: NAVD88, orthometric elevations