NOAA FORM 76-35A

U.S. DEPARTMENT of COMMERCE
NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

Horizontal and Vertical Control Report

Type of Survey: *Multibeam and Sidescan Sonar*

Project No. *OPR-D302-KR-07*

Time Frame: *6 July 2007 – 18 November 2007*

LOCALITY

State: *Delaware – Maryland*

General Locality: *Atlantic Ocean*

2007

CHIEF of PARTY

Jason M. Infantino

Science Applications International Corporation

LIBRARY & ARCHIVES

DATE: _____

NOAA FORM 77-28 (11-72)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY NO.

H11647
H11648
H11649
H11650

HYDROGRAPHIC TITLE SHEET

INSTRUCTIONS - The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

FIELD NO. **C, D, E, F**

State: Delaware - Maryland

General Locality: Atlantic Ocean

Locality: *East of Cape Henlopen (H11647); East of Indian River Inlet (H11648); East of Fenwick Island (H11649); 7 NM East of Fenwick Island (H11650)*

Scale: 1:20,000 Date of Survey: 6 July 2007 – 18 November 2007

Instructions Dated: 22 February 2007 Project No. OPR-D302-KR-07

Vessel: *M/V Atlantic Surveyor*, D582365

Chief of Party: Gary R. Davis, Paul L. Donaldson, Jason M. Infantino & Tom Waddington

Surveyed by: *Brian Biggert, Alex Bernier, Gary Davis, Paul Donaldson, Chuck Holloway, Jason Infantino, Mike Kelly, Jeff Koch, Colette LeBeau, Rick Nadeau, Chris Pinero, Evan Robertson, Alex Schneider, Jeremy Shambaugh, Deb Smith, and Tom Waddington.*

Soundings taken by **echosounder**, hand lead, pole: MULTIBEAM RESON SEABAT 8101

Graphic record scaled by: _____

Graphic record checked by: _____

Protracted by: _____ Automated plot by: _____

Verification by: _____

Soundings in fathoms, feet, **meters** at MLW, **MLLW**

REMARKS: **Contract:** DG-133C-05-CQ-1088
Contractor: Science Applications International Corp., 221 Third Street; Newport, RI 02840 USA
Subcontractors: Williamson & Associates, 1124 NW 53rd Street, Seattle WA 98107; Rotator Staffing Services, PO Box 366, 557 Cranbury Rd, E. Brunswick NJ 08816
Times: All times are recorded in UTC
UTM Zone: Zone 18
Purpose: To provide NOAA with modern, accurate hydrographic survey data with which to update the nautical charts of the assigned area: Sheet C (H11647), Sheet D (H11648), Sheet E (H11649), Sheet F (H11650) in the Mid-Atlantic Corridor, Coast of Delaware and Maryland.

NOAA FORM 77-28 SUPERSEDES FORM C&GS-537. ☆ U.S. GOVERNMENT PRINTING OFFICE: 1976—665-661/1222 REGION NO. 6

Science Applications International Corporation (SAIC) warrants only that the survey data acquired by SAIC and delivered to NOAA under Contract DG-133C-05-CQ-1088 reflects the state of the sea floor in existence on the day and at the time the survey was conducted.

Table of Contents

List of Tables

List of Figures

A. VERTICAL CONTROL

For H11647, H11648, H11649, and H11650, the NOAA tide station 8534720 Atlantic City, NJ was the source of final verified water level heights for the Mid-Atlantic Corridor, Coast of Delaware and Maryland surveys. All preliminary and verified tides obtained for the 2007 survey season were downloaded from the National Oceanic and Atmospheric Administration (NOAA) Tides and Currents website (http://tidesandcurrents.noaa.gov/). All tide data are annotated with Coordinated Universal Time (UTC).

Final water level files for each tide zone were created from downloaded verified tide data using the **SABER Create Water Level Files** tool. Water level files contained water level heights that were algebraically subtracted from depths to correct the sounding for tides and water levels. These water level files were applied to the multibeam data using the **SABER Apply Tides** program.

When it was necessary to apply updated tide correctors such as verified water levels to the GSF files, the program removed the previous tide corrector and applied the new corrector. Each time a processing routine was run on the GSF multibeam data file, a history record was appended to the end of the GSF file. For quality assurance, the **Check Tides** program was run on all GSF files to confirm that the appropriate water level corrector had been applied to the GSF file.

After confirmation that verified water levels were applied to all multibeam data, grids were created and analyzed using various color change intervals. The color intervals provided a means to check for significant, unnatural changes in depth across zone boundaries due to water level correction errors, unusual currents, storm surges, etc.

In addition, cross line analysis using the **SABER Analyze Crossings** software was used to identify possible depth discrepancies resulting from the applied water level corrector. Discrepancies were further analyzed to determine if they were the result of incorrect zoning parameters or weather (wind) conditions between the tide station and the survey area. The NOAA provided preliminary zone boundaries and zoning parameters are presented in Table A-1.

Table A-1. Preliminary Tide Zone Parameters

Zone	Time Corrector (minutes)	Range Ratio	Reference Station
DB1	0	1.00	8557380
DB1A	-12	1.00	8557380
SA26	0	0.92	8534720
SA26A	0	0.87	8534720
SA27	+6	0.88	8534720
SA27A	+6	0.92	8534720
SA28	+6	0.97	8534720
SA35	+18	0.97	8534720
SA36	+18	0.93	8534720
SA37	+30	0.98	8534720
SA38	-36	1.00	8557380
SA44	-24	1.00	8557380

A.1.1 Final Tide Note

H11648, H11649, and H11650 surveys were entirely within preliminary water level zones for Atlantic City, NJ, 8534720 (SA26, SA26A, SA27, SA27A, and SA36). Analysis of the multibeam data from all three surveys in **MVE** and in depth grids revealed minimal depth jumps across the junction of the zones. A spreadsheet analysis of the correctors for each zone (summarized in Table A-2) also confirmed the adequacy of zoning correctors based on Atlantic City, NJ (8534720). For this analysis, observed verified water levels from 06 July 2007 through 18 November 2007, were entered into the spreadsheet. Correctors were computed at 6 minute intervals for each zone. Differences were computed zone-to-zone. As a result, the NOAA preliminary zone boundaries and zoning parameters for Atlantic City (8534720) were accepted as final and applied to all multibeam data for H11648, H11649, and H11650.

Table A-2. Comparison of Water Level Correctors with Zoning Parameters for Station 8534720

Zones	SA36 – SA27A	SA26 – SA27A	SA27 – SA27A	SA26A – SA27A	SA26A – SA27
Maximum	0.182	0.118	0.004	0.072	0.097
Minimum	-0.125	-0.097	-0.075	-0.168	-0.104
Average	0.008	0.000	-0.031	-0.039	-0.008
Standard Deviation	0.045	0.025	0.018	0.033	0.024

H11647 survey used preliminary zones from both Lewes, DE; 8557380 (DB1A SA38, and SA44); and Atlantic City, NJ; 8534720 (SA37, SA35, SA28, SA36, and SA27A). Analysis of the H11647 multibeam data in **MVE** and in depth grids revealed significant jumps across the junction of zones based on Atlantic City, NJ (8534720) and the zones based on Lewes, DE (8557380). A spreadsheet was constructed to compare the two sets of NOAA preliminary zoning parameters. The results are summarized in Table A-3. For this analysis, observed verified water levels from 06 July 2007 through 18 November 2007 for both

stations were entered in the spreadsheet. Correctors were computed at 6-minute intervals for each zone. Differences (Table A-3) were computed for each zone on Lewes, DE (8557380) with the adjacent zone on Atlantic City, NJ (8534720).

Table A-3. Summary of Verified Tide Corrector Differences at Zone Boundaries for Atlantic City, NJ (8534720) and Lewes, DE (8557380)

Zones	SA38 – SA37	SA44 – SA37
Maximum Difference	0.248	0.307
Minimum Difference	-0.235	-0.327
Average Difference	0.000	0.000
Standard Deviation	0.088	0.128

This verified the observed significant difference in multibeam depths caused by differences in verified water level correctors at the zone boundaries depended on the stage of the tide and environmental factors (wind and rain). As a result of this analysis the water level zoning correctors based entirely on Atlantic City, NJ (8534720) were applied to all multibeam data for H11647. Zone DB1 was not used, and zone DB1A was extended slightly on the west to incorporate the one line of multibeam data extending across the Cape Henlopen area. All other zone boundaries were the preliminary boundaries provided by NOAA.

Zoning parameters for zones DB1A, SA28, SA37, SA38, and SA44 were modified to minimize water level corrector jumps across the zone boundaries using verified observed water level data from the Atlantic City, NJ (8534720) station. All final correctors are shown in Table A-4.

Table A-4. Water Level Zoning Parameters Applied on Sheets H11647, H11648, H11649, and H11650

Zone	Time Corrector (minutes)	Range Ratio	Reference Station
DB1A	+18.0	0.96	8534720
SA26	0	0.92	8534720
SA26A	0	0.87	8534720
SA27	+6	0.88	8534720
SA27A	+6	0.92	8534720
SA28	+12	0.92	8534720
SA35	+18	0.97	8534720
SA36	+18	0.93	8534720
SA37	+18	0.98	8534720
SA38	+12	0.99	8534720
SA44	+12	0.98	8534720

A spreadsheet was constructed to compare water level correctors across these zone boundaries for H11647 using the final zone parameters and the results are shown in Table A-5. In addition the multibeam data crossing these boundaries were compared in MVE and by observing the crossings in the depth grids.

Table A-5. Comparison of Water Level Correctors with Zoning Parameters for Station Atlantic City, NJ (8534720) for H11647

Zones	DB1A – SA44	SA38 – SA44	SA37 – SA44	SA37 – SA38	SA37 – SA35	SA28 – SA35	SA36 – SA35	SA36 – SA27A	SA28 – SA27A
Maximum Difference	0.091	0.019	0.103	0.096	0.019	0.076	0.004	0.182	0.153
Minimum Difference	-0.157	-0.001	-0.126	-0.143	-0.001	-0.173	-0.074	-0.125	-0.073
Average Difference	-0.016	0.008	0.000	-0.008	0.008	-0.039	-0.031	0.008	0.031
Standard Deviation	0.028	0.005	0.027	0.027	0.005	0.034	0.018	0.045	0.030

B. HORIZONTAL CONTROL

The survey data for sheets H11647, H11648, H11649, and H11650 were collected in horizontal datum NAD-83, using geodetic coordinates, while data display and products used the UTM Zone 18 projection. The following equipment was used for positioning on the *M/V Atlantic Surveyor*:

- TSS POS/MV, Serial Number 2575
- Trimble 4000 DS GPS Receiver, Serial Number 3504A09516

All antenna and transducer offsets were measured relative to the Position Orientation System/Marine Vessel (POS/MV) Inertial Measurement Unit (IMU). Offsets from the Reson 8101 transducer were then computed from these measurements. The POS/MV offsets Reference to Vessel are the same as the Reference to Reson 8101 transducer so that the vessel positions in the GSF multibeam files are the position of the transducer. Therefore, vessel offsets to the Trimble GPS antenna and to the A-Frame Tow Block are entered in the ISS-2000 as offsets from the Reson 8101 transducer. Tow Block Z is entered as height above the water for use in computing the tow fish layback. During the remobilization of the *M/V Atlantic Surveyor* in 2007, all antenna and transducer offsets were re-measured. The 2007 results are depicted in Table B-1 and Figure B-1.

Table B-1. 2007 *M/V Atlantic Surveyor* Antenna and Transducer Offsets (measurements in meters with 68% CI measurement uncertainties)

Sensor	Offset in ISS-2000		Offset in POS/MV	
Multibeam Reson 8101 Transducer Hull Mount (Ref to vessel lever arm)			X	-0.34 ±0.05
			Y	-0.12 ±0.05
			Z	+1.64 ±0.05
Reference to Heave (Ref to IMU lever arm)			X	0.00
			Y	0.00
			Z	0.00
POS/MV GPS Master Antenna (Ref to primary GPS lever arm)			X	4.28 ±0.05
			Y	-0.66 ±0.05
			Z	-6.34 ±0.05
Reference to Vessel			X	-0.34 ±0.05
			Y	-0.12 ±0.05
			Z	+1.64 ±0.05
Trimble GPS Antenna	X	+4.62 ±0.05		
	Y	+0.46 ±0.05		
	Z	-7.98 ±0.05		
A-Frame Tow Block (Z = Height above the Water)	X	-19.56 ±0.15		
	Y	+0.52 ±0.15		
	Z	-4.87 ±0.15		

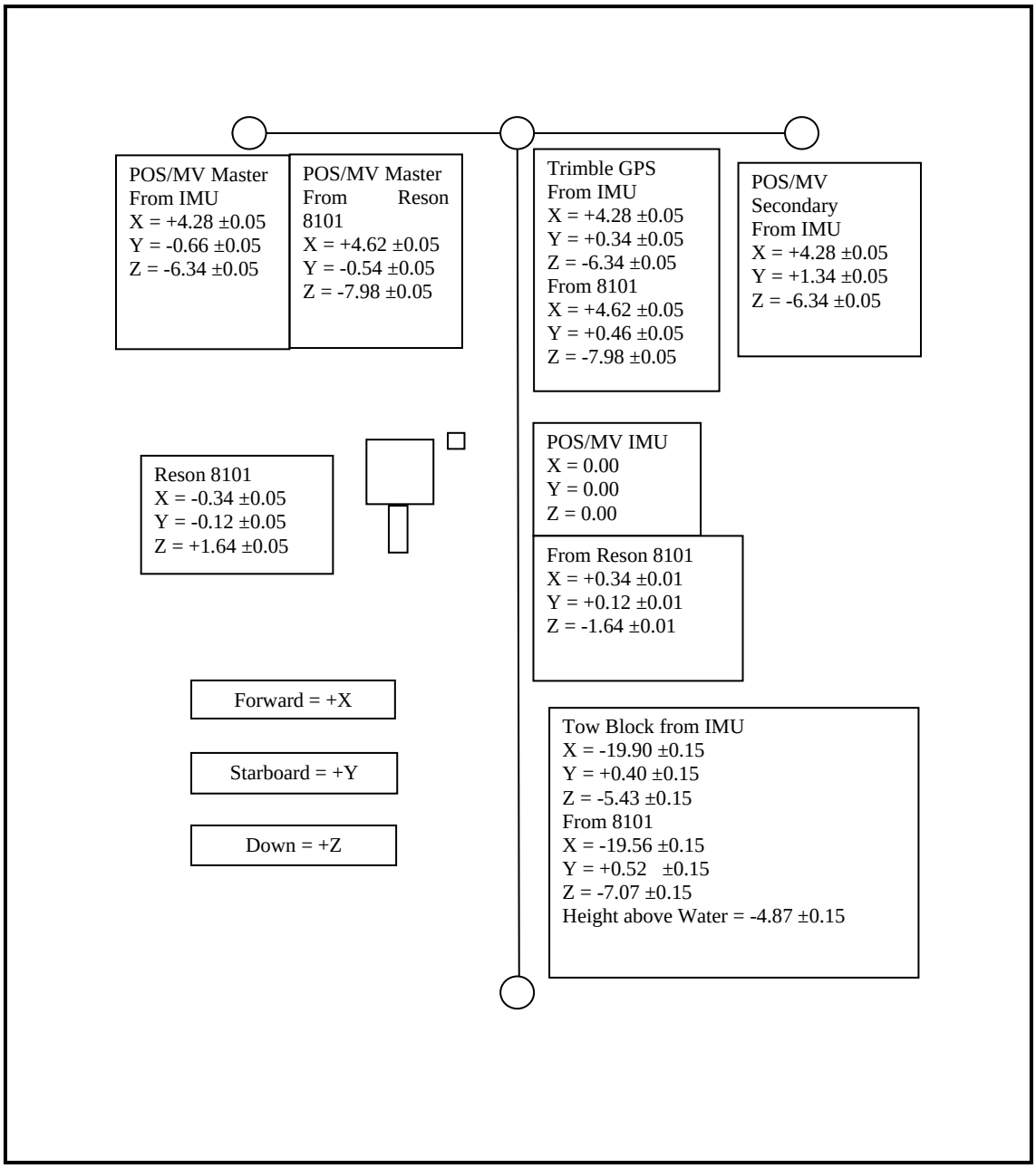

Figure B-1. 2007 Configuration and Offsets of the M/V Atlantic Surveyor Sensors (measurements in meters with 68% CI measurement uncertainties)

Daily position confidence checks were made by comparing the DGPS position from the POS/MV with the Trimble DGPS position. A real-time monitor automatically issued an alarm when the two DGPS positions differed by more than 10 meters horizontally. Positioning confidence checks were within an inverse distance of 1.80 meters as shown in Table B-2.

Table B-2. Positional Difference between Vessel Positions Determined by the POS/MV and the Trimble 4000 on the *M/V Atlantic Surveyor*

Julian Day	Sheet ID	Time of Day (UTC)	Positional Difference (m)
187	C	2013	0.46
188	C	0613	0.60
189	C	0821	0.56
190	C	0542	0.39
191	C	0431	1.13
192	C	0256	0.67
193	C	2008	0.47
194	C	0423	0.44
195	C	0243	0.91
196	C	0454	0.96
197	C	2049	0.65
198	C	1620	0.41
199	C	0536	0.42
200	C	1930	0.32
201	C	1041	0.46
202	C, D	0317	0.73
203	D	0226	0.69
204	D	0012	0.49
205	D	1202	0.59
206	D	0645	0.62
207	D	1620	0.52
208	D	0450	0.77
209	D	0238	0.53
210	D	1045	0.63
211	D	2032	0.60
212	D	0230	0.31
213	D	0057	0.40
214	D	1400	0.58
215	D	0213	0.54
216	D	1000	0.43
217	D	1815	0.78
218	D	2110	0.48
219	D	1408	0.52
220	D	0215	0.46
221	D	1818	0.75
222	D	1150	0.70
224	D	0324	0.57
225	D	1638	0.69
226	D	0812	0.58
229	D, E	1410	0.53
230	E	0454	0.73
231	E	0805	0.70
241	E	1950	0.35
242	E	1134	0.65
243	E	2007	0.56
244	E	0635	0.84
245	E	0234	0.58
246	E	0806	0.57
247	E	1623	0.44
248	E	0017	0.81
249	E	2000	0.67
250	E	0405	0.49
251	E	1810	0.89
252	E	1600	0.58
253	E	0817	0.56
254	E	0203	0.82
255	E	0233	1.80
256	E	2002	0.54
257	E	0626	0.56
258	E	0032	0.67
259	E	2022	0.61
260	E	1507	0.56
270	E	1659	0.48
271	E	1024	0.50
272	E,F	0543	0.48
273	E,F	1400	0.54
274	F	0934	0.62
275	F	0200	0.69
276	F	0619	0.61
277	F	1457	0.48
278	F	1634	0.38
279	F	0411	0.87
280	F	1849	0.60
281	C,D,E	1435	0.54
282	C,F	1131	0.62
283	F	0136	0.91
286	F	2006	0.77
287	F	0850	0.55
288	D,F	1609	0.33
289	F	0411	0.88
290	F	0033	0.70
291	F	1638	0.62
292	F	1242	0.29
294	F	0433	0.52
295	F	1141	0.67
296	F	1841	0.92
297	F	0015	1.24
317	C,D,E	1712	0.44
318	E,F	0157	0.52
319	F	0213	0.67
321	C,D,E	1713	0.50
322	E,F	1127	0.73

Differential correctors used for H11647, H11648, H11649, and H11650 online data were from the U.S. Coast Guard Stations at Reedy Point DE, Annapolis MD, Driver VA, and Sandy Hook, NJ. The differential receiver was set to only receive data from these four corrector stations; however the POS/MV reported that it used additional stations during online data collection. Station 19 (Cape Canaveral, FL), station 22 (Key West, FL), and station 48 (Macon, GA) or erroneous station identification codes were reported as used by the POS/MV for a total of 2.369 minutes of online data collection for sheet H11648. Sheet H11649 reported station 18 (Cape Canaveral, FL) and station 48 (Macon, GA) or erroneous station identification codes were reportedly used by the POS/MV for a total of 2.382 minutes of online data collection. Sheet H11650 the POS/MV reported that it used other stations during online data collection. Station 18 (Cape Canaveral, FL), station 110 (Pickford, MI), and station 48 (Macon, GA) were reportedly used by the POS/MV for a total of 5.5 minutes of online data collection.

SAIC believes that the incorrect station identification codes may have been sent from the beacon receiver. When an incorrect station identifier was noted during survey operations, a check on the reference station coordinates received and output by the receiver and the station transmit frequency set in the receiver were verified. In all cases the coordinates and transmit frequency matched one of the stations programmed into the receiver. This behavior has been previously observed in the POS/MV system.

C. APPROVAL SHEET

01 August 2008

LETTER OF APPROVAL

REGISTRY NUMBERS: H11647, H11648, H11649, and H11650

This Horizontal and Vertical Control Report for project OPR-D302-KR-07, Mid-Atlantic Corridor, Coast of Delaware - Maryland Project is respectfully submitted.

Field operations and data processing contributing to the accomplishment of this survey, H11647, H11648, H11649, and H11650 were conducted under my supervision and that of lead hydrographers Gary R. Davis, Paul L. Donaldson & Tom Waddington with frequent personal checks of progress and adequacy. This report has been closely reviewed and is considered complete and adequate as per the Statement of Work.

Reports previously submitted to NOAA for this project include:

Report	Submission Date
Descriptive Report H11650, SAIC Doc 07-TR-011	02 May 2008
Data Acquisition and Processing Report, SAIC Doc 07-TR-012	02 May 2008
Descriptive Report H11649, SAIC Doc 07-TR-010	13 June 2008
Descriptive Report H11647, SAIC Doc 07-TR-008	03 July 2008

Reports concurrently submitted to NOAA for this project include:

Report	Submission Date
Descriptive Report H11648, SAIC Doc 07-TR-009	01 August 2008

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

Jason M. Infantino

Digitally signed by Jason M. Infantino
DN: cn=Jason M. Infantino, o=MSTD, ou=SAIC, email=infantinoj@saic.com, c=US
Date: 2008.08.01 09:23:06 -04'00'

Gary R. Davis, Paul L. Donaldson, Jason M. Infantino & Tom Waddington
Lead Hydrographers
Science Applications International Corporation
01 August 2008