NOAA *Okeanos Explorer* Program

MAPPING DATA ACQUISITION AND PROCESSING REPORT

CRUISE EX1104

Exploration, Cayman Trench

August 2 – 18, 2011
Balboa, Panama to Key West, Florida

Report Contributors:
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1. Introduction

The *Okeanos Explorer* Program

Commissioned in August 2008, the NOAA Ship *Okeanos Explorer* is the nation's only federal vessel dedicated to ocean exploration. With 95% of the world's oceans left unexplored, the ship's unique combination of scientific and technological tools positions it to systematically explore new areas of our largely unknown ocean. These explorations will generate scientific questions leading to further scientific inquiries.

Using a high-definition multibeam sonar with water column capabilities, a deep water remotely operated vehicle, and telepresence technology, *Okeanos Explorer* provides NOAA the ability to foster scientific developments by identifying new targets in real time, diving on those targets shortly after initial detection, then sending this information bac k to shore for immediate near-real-time collaboration with scientists and experts at Exploration Command Centers around the world. The subsequent transparent and rapid dissemination of information-rich products to the scientific community ensures that discoveries are immediately available to experts in relevant disciplines for better understanding.

Through the *Okeanos Explorer* Program, NOAA's Office of Ocean Exploration and Research provides the nation with important capabilities to discover and investigate new ocean areas and phenomena, conduct the basic research required to document discoveries, and seamlessly disseminate data and information-rich products to a multitude of users. The program strives to develop technological solutions and innovative applications to critical problems in undersea exploration and to provide resources for developing, testing, and transitioning solutions to meet these needs.

Okeanos Explorer Management – a unique partnership within NOAA

NOAA Ship *Okeanos Explorer* is operated, managed and maintained by NOAA's Office of Marine and Aviation Operations, which includes commissioned officers of the NOAA Corps and civilian wage mariners. NOAA's Office of Ocean Exploration and Research is responsible for operating the cutting-edge ocean exploration systems on the vessel. It is the only federal ship dedicated to systematic exploration of the planet's largely unknown ocean.

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2. Report Purpose

The purpose of this mapping report is to describe the mapping data collection and processing methods to enable maximum usability of the dataset. This report describes the data acquisition and processing for EX1104 data, without going into a finely detailed description of the multibeam and ancillary sensor setup. A detailed description of the setup of the various mapping equipment and sensors is provided in the 'NOAA Ship *Okeanos Explorer* 2011 Readiness Report' which can be obtained from the ship.

This report covers only the EM 302 multibeam mapping activities conducted during this cruise. Considerable other activities including Conductivity Temperature Depth (CTD) vertical casts and tow-yo's, Remotely Operated Vehicle (ROV) dives, as well as education and outreach activities were conducted which may be referred to in this report but details will not be provided here. A full cruise report describing these activities will be produced by the Expedition Manager.

The crew of the NOAA Ship *Okeanos Explorer* is greatly appreciated for their efforts in helping make the cruise a success.

3. Cruise Objectives

During the 2011 field season, *Okeanos Explorer* transited from San Francisco, California to Davisville, Rhode Island, incorporating exploration activities along the way. EX1104 began in Balboa, Panama, on the Pacific side of the Panama Canal. A standing objective of the Okeanos Explorer program is to continuously explore during transits between focused exploration sites. Thus, upon exiting the Panama Canal and entering the Caribbean Sea, the ship began collecting EM 302 mapping data. Mapping data is collected in all foreign Exclusive Economic Zones (EEZs) where marine research permits are in place. For EX1104, this included Panama, Nicaragua, Honduras, and the United Kingdom (Cayman Islands). Marine research permits were not obtained for the Colombian and Cuban EEZs.

The cruise objectives of the mapping team during transits included:

a. Continuous EM 302 bathymetric and seabed backscatter data collection.
b. Production of daily bathymetry and seabed backscatter mapping products, as defined in Section 9 of this report.
c. Testing ship-to-shore collaboration tools, including the *Okeanos Explorer* Portal and FTP site.

The cruise objectives of the mapping team within the focused exploration area over the Cayman Trench included:

a. Conduct evening and morning mapping operations to collect high resolution bathymetric and seabed backscatter data, and also EM 302 water column data as necessary.
b. Conduct mapping operations of defined areas chosen with daily input from shore-based scientists via telepresence.

4. Participating Personnel (Mapping)

NAME	ROLE	AFFILIATION
CDR Robert Kamphaus	Commanding Officer	NOAA Corps
LT Megan Nadeau	Field Operations Officer	NOAA Corps
Kelley Elliott	Cruise Coordinator	NOAA OER (20/20 Inc.)
Elizabeth "Meme" Lobecker	Mapping Team Lead	NOAA OER (ERT Inc.)
Elaine Stuart	Senior Survey Technician	NOAA OMAO
Colleen Peters	Senior Survey Technician	NOAA OMAO
Vincent Howard	Mapping Watchstander	NOAA OER / UCAR Intern
Karl McLetchie	Mapping Watchstander	NOAA OER / UCAR Intern

Tom Kok	Mapping Watchstander	NOAA OER / UCAR Intern
Jonathan Mefford	Mapping Watchstander	NOAA OER / UCAR Intern
Christopher Ritter	Mapping Watchstander	NOAA OER / UCAR Intern

5. Summary of Major Findings

Cruise Overview Map

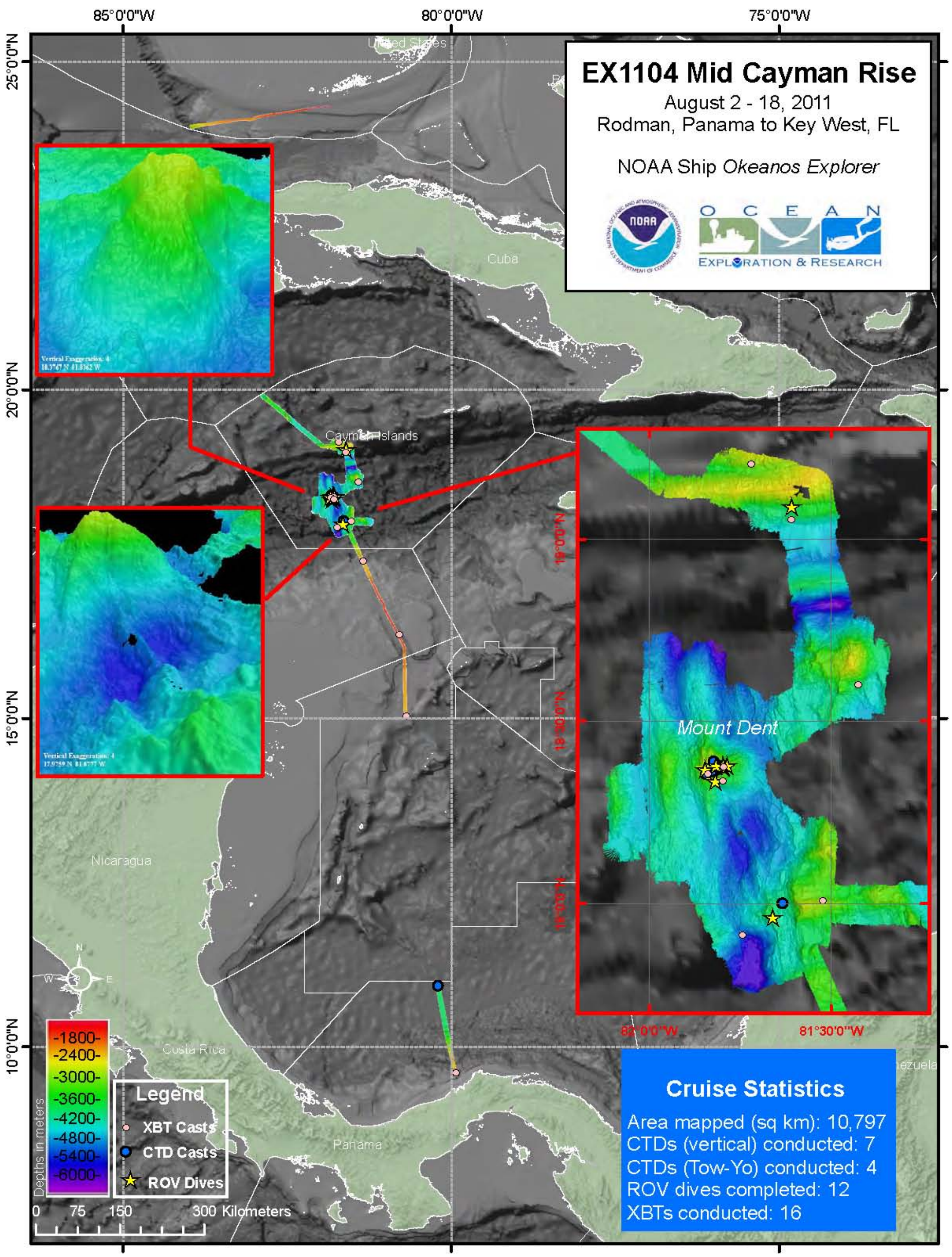

Figure 1. Map created in ArcMap showing overall cruise results.

Mid Cayman Rise Focused Exploration Area Map

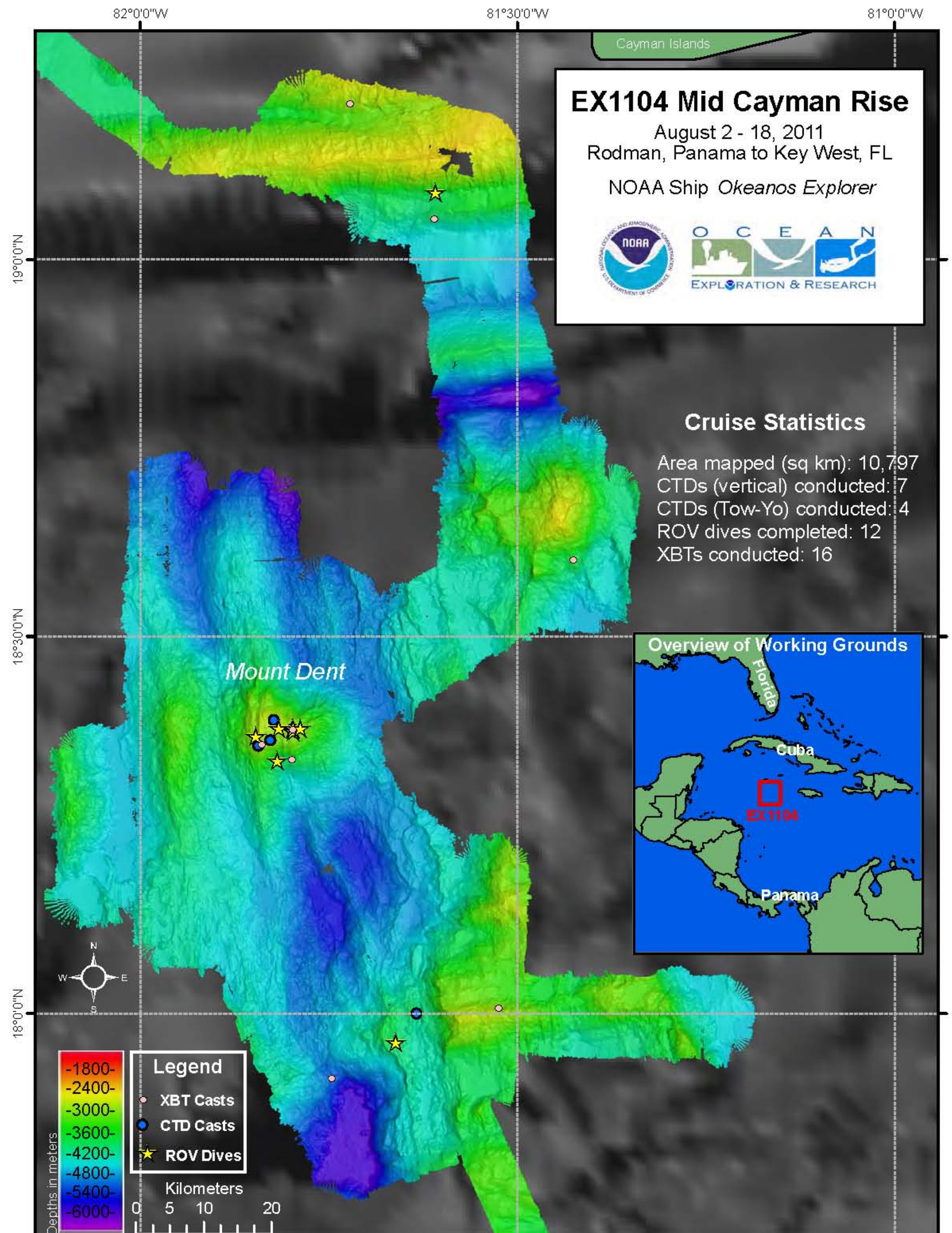

Figure 2. Map created in ArcMap showing focused exploration operations over Cayman Trench.

6. Mapping Statistics

Dates	August 2 - 18, 2011
Weather delays	0 days
Total non-mapping days	2 days
Total survey mapping days	9 partial days
Total transit mapping days	5 partial days
Line kilometers of survey	2553.5 km
Square kilometers mapped	10,797
Number of bathymetric multibeam files	107
Data volume of raw multibeam data files	11.6 MB
Number of water column multibeam files	0
Data volume of water column multibeam files	0
Number of XBT casts	16
Number of CTD casts - tow-yo	4
Number of CTD casts - vertical	7
Beginning draft	4.57 m (bow) 4.51 m (stern)
Ending draft	4.24 m (bow) 4.57 m (stern)
Average ship speed for survey	9.5 kts

7. Mapping Sonar Setup

The NOAA Ship *Okeanos Explorer* is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar capable of mapping the seafloor in 0 to 8000 meters of water. The system generates a 150° beam fan containing up to 432 soundings per ping in waters deeper than 3000 meters. In waters less than 3000 meters, the system is operated in multiping, or dual swath mode, and obtains up to 864 soundings per ping, by generating two swaths per ping cycle. Appendix J contains a detailed description of sonar system functionality and technical specifications, including crosstrack and alongtrack data resolutions.

The ship is also equipped with a Kongsberg EK 60 singlebeam fisheries sonar. The transducer operates at 18 kHz and transmits a 7° beam fan.

The ship is also equipped with a Knudsen 3260 subbottom profiler. The transducers produce a 3.5 kHz chirp signal.

8. Data Acquisition Summary

Transit exploration multibeam mapping using the EM 302 occurred in the EEZs of the following countries: Panama, Nicaragua, Honduras, the United Kingdom (Cayman Islands) and the U.S. Multibeam data files were changed when crossing EEZs to facilitate ease of data delivery to relevant coastal states. The ship transited through the EEZs of Colombia and Cuba but did not collected mapping data, as marine research permits were not in place. Focused exploration mapping occured over the Cayman Trench. Details are provided in the cruise calendar of this report. Tables listing all sonar files collected and products created during the cruise are provided in the appendices of this report. Tables listing all sound velocity files collected during the cruise are also provided.

Expendable bathythermographs were collected every two to four hours to correct multibeam data for changes in sound speed in the water column, and were applied in real time using Seafloor Information Software (SIS). A thermosalinograph seawater intake mounted on the hull at the EM 302 transducers was used to determine sound speed at the sonar head and was applied in realtime using SIS.

Background data used for exploration mapping included Sandwell and Smith satellite altimetry bathymetric data.

9. Multibeam Data Quality Assessment and Data Processing

Okeanos Explorer's annual multibeam patch test was conducted during the 2011 shakedown cruise (EX1101). The full results of the patch test can be found in the EX1101 mapping data report and in the ship's readiness report.

Multibeam data quality was monitored in realtime by acquisition watchstanders. Expendable bathythermographs (XBTs) were conducted every two to four hours as necessary to maintain data quality. Ship speed was adjusted to maintain data quality as necessary. Line spacing was planned to ensure ¼ to ½ overlap between lines at all times. Cutoff angles in SIS were generally set to 70° on both the port and starboard sides.

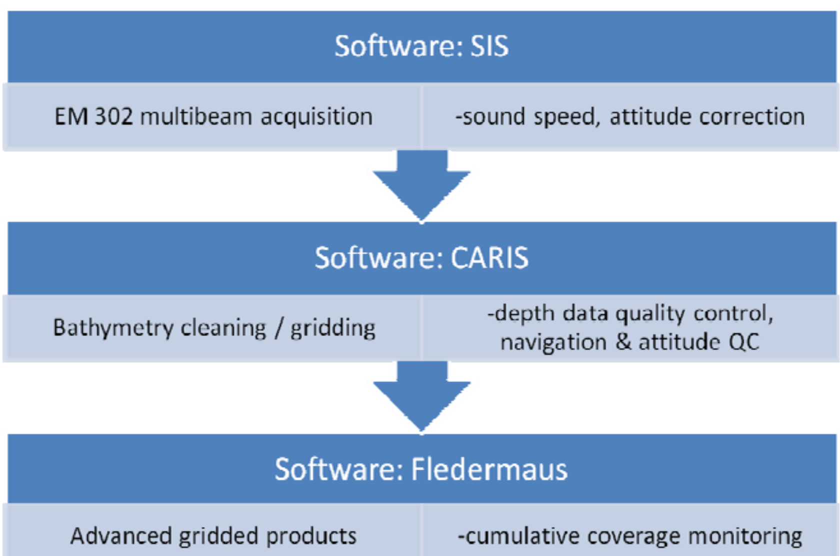

Figure 3. Shipboard multibeam data flow.

Raw multibeam bathymetry data files were acquired by SIS, and were imported into CARIS. In CARIS, attitude and navigation data stored in each file were checked, and erroneous soundings were removed using CARIS Swath Editor and Subset Editor. In general, data quality was very high, largely due to excellent environmental conditions for survey as the weather was mild throughout the cruise. A detailed weather log is provided in the appendix section of this report.

The following products were archived to the shoreside FTP on a daily basis to facilitate shoreside scientist participation:

Bathymetry:

- ASCII text file (xyz) containing cleaned, gridded multibeam depth data
- Fledermaus v.7 SD object containing cleaned, gridded multibeam depth data
- Geotiff of cleaned, gridded multibeam depth data
- Arc Grid of cleaned, gridded multibeam depth data
- GoogleEarth KMZ file containing cleaned, gridded multibeam depth data

Seabed backscatter:

- ASCII text file (xyb) containing gridded bottom backscatter data
- Fledermaus v.7 SD object containing bottom backscatter draped over cleaned, gridded bathymetry
- Geotiff of bottom backscatter data
- GoogleEarth KMZ file containing bottom backscatter data

The naming convention for daily mapping products was:
EX1104_MB_DLY##_50m_WGS84_YYYMMDD
EX1104_MB_DLY##_BBS_30m_WGS84_YYMMDD

A "readme" file was provided to indicate which daily products used in tandem provided cumulative data for the cruise.

The Okeanos Explorer Digital Atlas, managed by the National Coastal Data Development Center, was updated daily with new multibeam bathymetry and bottom backscatter products.

Crossline Analysis

A multibeam crossline was collected on August 11 to verify multibeam data quality. Crossline 0057 was run perpendicular to mainscheme lines 0008 and 0026. The mainscheme lines were run at headings of 0° and 180°, and the crossline was run at a heading of 270°.

The cleaned, mainscheme data were gridded in CARIS and every accepted sounding was exported to text file. These text files were then gridded in Fledermaus DMagic, and the grid surface was compared to the raw .all crossline file using Fledermaus Crosscheck and the results are provided below.

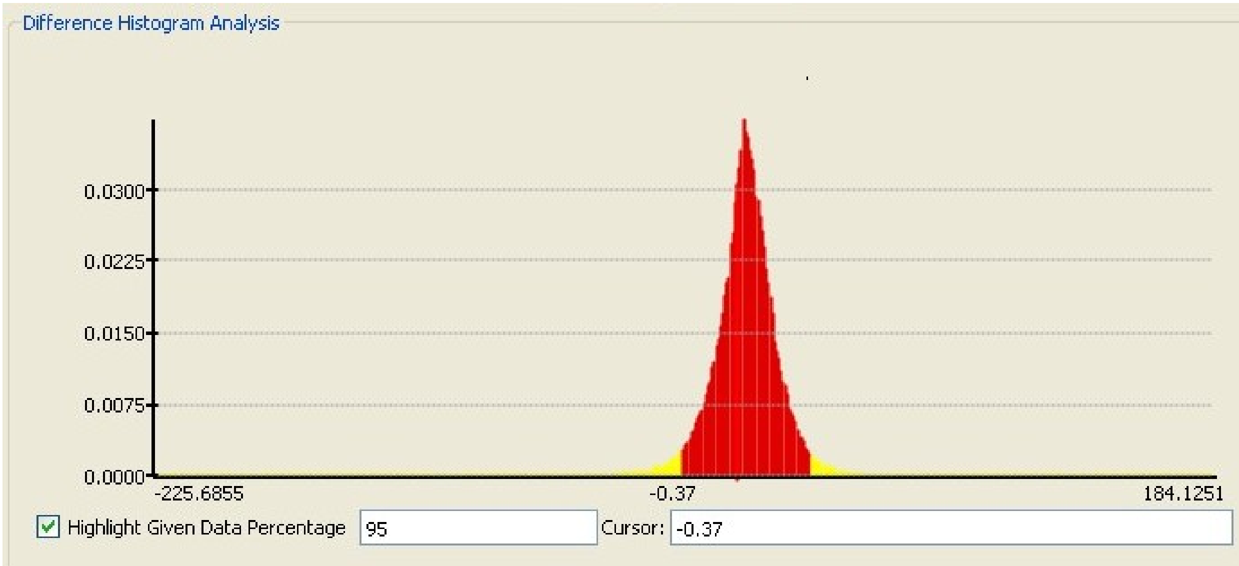

Figure 4. Screengrab of IVS Fledermaus Crosscheck crossline analysis results.

Depths in meters:

-2711.961005 # Data Mean
-2715.317929 # Reference Mean
3.356900 # Mean
3.562600 # Median
12.506000 # Std. Deviation
-4117.72 -2049.21 # Data Z - Range
-4114.33 -2062.72 # Ref. Z - Range
-225.69 184.13 # Diff Z - Range
28.368958 # Mean + 2*stddev
28.574610 # Median + 2*stddev

Built In System Tests (BIST)

BISTs were run periodically throughout the cruise to verify the integrity and performance of the multibeam echosounder electronics. All BISTs passed. A sample BIST is provided in the appendices of this report.

10. Data Archival Procedures

All data collected on the *Okeanos Explorer* is publically available in national archives. Raw and processed multibeam data for all *Okeanos Explorer* cruisese are available via the National Geophysical Data Center archives accessible through www.ngdc.gov. EX1104 data are available at
http://www.ngdc.noaa.gov/nndc/struts/results?op_0=eq&v_0=NEW1556&t=101378&s=8&d=70

&d=75&d=76&d=91&d=93&d=74&d=73&d=72&d=81&d=82&d=85&d=86&d=79&no_data=suppress.

All data collected during the cruise was archived in partnership with the National Coastal Data Development Center in adherence to NAO 212-15 "Management of Environmental and Geospatial Data and Information". Data collected within the EEZs of Panama, Nicaragua, and Honduras were provided to those states by the OER Expedition Coordinator. The full EX1104 Data Management Plan is included in the EX1104 Cruise Instructions, and can be obtained by contacting the ship.

11. Cruise Calendar

AUGUST 2011						
Sun	Mon	Tues	Wed	Thurs	Fri	Sat
July 31 New mission personnel arrives to ship, Balboa, Panama.	1 Ship in port: Balboa, Panama.	2 Depart dock at 1830 for Panama Canal, transit through Canal overnight.	3 Complete transit through Canal in the early morning, commence EM 302 multibeam mapping in Panama EEZ. Data not collected in Colombian EEZ.	4 Continue transit multibeam mapping exploration en route to Mid-Caymen Rise exploration area. Data collected in Nicaragua and Honduras EEZs.	5 Continue multibeam transit exploration mapping. Arrive Mid-Cayman Rise exploration area. Conducted first ROV dive of cruise. Conduct hull dive. Evening CTD ops.	6 Morning multibeam mapping. Daylight ROV ops. Evening mapping.
7 Morning mapping. Daylight ROV ops. Evening CTD ops.	8 Morning mapping. Daylight ROV ops. Evening CTD ops.	9 Morning mapping. Daylight ROV ops. Evening CTD ops.	10 Morning mapping. Daylight CTD ops. Evening mapping.	11 Morning mapping. Daylight ROV ops. CTD termination failure. Evening mapping.	12 Morning mapping. Daylight ROV ops. CTD termination failure. Evening mapping.	13 Morning mapping. Daylight ROV ops.
14 Morning mapping. Daylight ROV ops.	15 Mapping in Cayman Islands EEZ. Discontinue mapping in Cuba EEZ.	16 No data collection while in Cuba EEZ.	17 Mapping in US EEZ.	18 Arrive Key West, FL.	19	20

12. Daily Cruise Log

August 1, 2011

The following personnel arrived to the ship at Rodman Barracks in Balboa, Panama: OER Mapping Team Lead Meme Lobecker, OER Expedition Manager Kelley Elliot, and visiting scientists Chris German (WHOI), Paul Tyler (National Oceanography Center, Southhampton), and Cameron McIntyre (WHOI).

August 2, 2011
The mapping department prepared for data collection, which will commence once the ship exits the Panama Canal. RTS communications unit training was conducted for personnel new to the ship. The mapping watchstander schedule was established.

Personnel from the Panama Canal boarded the ship at 1830. The ship departed the dock at 1900 to commence transit through the Canal.

August 3, 2011
Mapping with the EM 302 multibeam sonar commenced at 0510 in the Panama EEZ after the ship exited the canal. At 1342, the EM 302 was secured just prior to entering the Colombia EEZ. Training for new mapping watchstanders from the ROV team commenced.

The marine research permit for Nicaragua was received.

A test CTD cast was conducted to ~1000 meters. The CTD data was processed by scientists onshore, and possible electrical problems were detected.

August 4, 2011
Multibeam data collection began when the ship crossed into the Nicaragua EEZ at 1130. Permission to continue mapping in the Honduras EEZ was received, and data collection continued in that EEZ for the remainder of the day.

Emergency drills were conducted including: fire / emergency, and abandon ship.

The Fledermaus v7 license was upgraded to be equipped with FMGIS capabilities, a requirement for the ROV team to export bathymetric contours to shapefiles for use in Hypack during ROV dives.

The EK60 / EM302 sync was confirmed. There was no interference in the EM 302 data while the EK60 was operating. The trigger from the EM 302 to the Knudsen subbottom was moved to the EK60 in preparation for cruise EX1105, the Gulf of Mexico water column exploration cruise. The trigger is now connected to serial port 3 of the EK60.

August 5, 2011
Mapping continued until 0700, when the ship arrived at t the first ROV dive of the cruise, the vent site“Von Damm”on Mount Dent. In the afternoon, the ROV was recovered early to allow divers to remove a suspected net from a strainer on the hull. CTD tow-yo operations began in the evening and occurred between the sites “Von Damm” and “Europa” for the remainder of the day.

August 6, 2011

Mapping occurred in the southern portion of mapping area “2a” from 0000 – 0700, until arrival at the second ROV dive site of the cruise. Mapping resumed at 2140 and continued into the morning of August 7th.

August 7, 2011
Mapping in the vicinity of Mount Dent and the ridge directly to the west continued through the morning until arriving at the ROV dive site at 0701.The western mapping area defined in the cruise plan was completed.

August 8, 2011
Mapping over Mount Dent and eastward commenced at 0023, just after the CTD was recovered, and continued until arriving at the ROV dive site at 0704.

August 9, 2011
Mapping commenced at 0008 after the CTD was on deck, and continued until arrival at the ROV dive site at 0657. Mapping occurred in the area south of previous EX coverage.

The permit from Florida Keys National Marine Sanctuary to deploy two XBTs within sanctuary bounds was received. The ship will transit through the sanctuary prior to pulling into Key West, Florida on August 18.

August 10, 2011
Mapping commenced at 0009 after the CTD was on deck, and continued until arrival at the ROV dive site at 0659. A holiday line over Mount Dent was filled, and a feature to the west of previous mapping coverage was developed. Swath coverage in the deepest section was less than expected, causing a small holiday between lines. A BIST was run, and all tests passed. Mapping operations resumed in the evening at 1915 and continued through the night into the following morning.

August 11, 2011
In the morning, mapping continued from the previous evening until arrival at the ROV dive site at 0712. Evening mapping operations commenced at 1842 after the ROV was on deck.

In the evening, mapping commenced at 1842 after the ROV came on deck and continued through the evening.

A workaround was found for when SIS will not launch SVP editor. In a command window, go to c:\\Prog~1\Kongsberg Maritime\SIS\japp. Run svpeditor.bat.

August 12, 2011
Mapping continued through the morning until arrival at the ROV dive site at 0701. A crossline was run. In the evening, mapping commenced at 1830 and continued through the evening. A BIST was run, and all tests passed.

August 13, 2011

Mapping continued through the morning until arrival at the ROV dive site at 0657. In the evening, mapping operations commenced at 2330 after the CTD was on deck.

August 14, 2011
Mapping continued through the morning until arrival at the ROV dive site at 0653. In the evening, mapping operations commenced at 2135 and continued through the evening.

August 15, 2011
Survey continued through the morning until the final ROV dive was conducted over the Cayman Fracture Zone. When the ROV came on deck in the evening, mapping recommenced and a portion of the Cayman Fracture Zone was mapped before the ship began transit to Key West, Florida. Mapping continued during transit through the Cayman (UK) EEZ.

August 16, 2011
Mapping continued until crossing into the Cuban EEZ at 0934. All scientific sensors were secured at that time and for the remainder of the day. SCS navigation data was sent to shore for NOAA Ship Tracker purposes.

August 17, 2011
Mapping commenced when the ship crossed into the US EEZ near Florida and continued until 0604. The multibeam was secured in 200 meters of water. The ship was alongside at the Key West Trumbo Point Coast Guard Station at 0845.

August 18, 2011
In port, Key West.

August 19, 2011
Mission personnel departed the ship.

13. References

EX1104 Cruise Report (forthcoming)
Kongsberg System Description
NOAA Ship *Okeanos Explorer* Readiness Report 2012

14. Appendices

Appendix A: Field products generated during cruise

Following are field products are developed for professional development and training purpose.

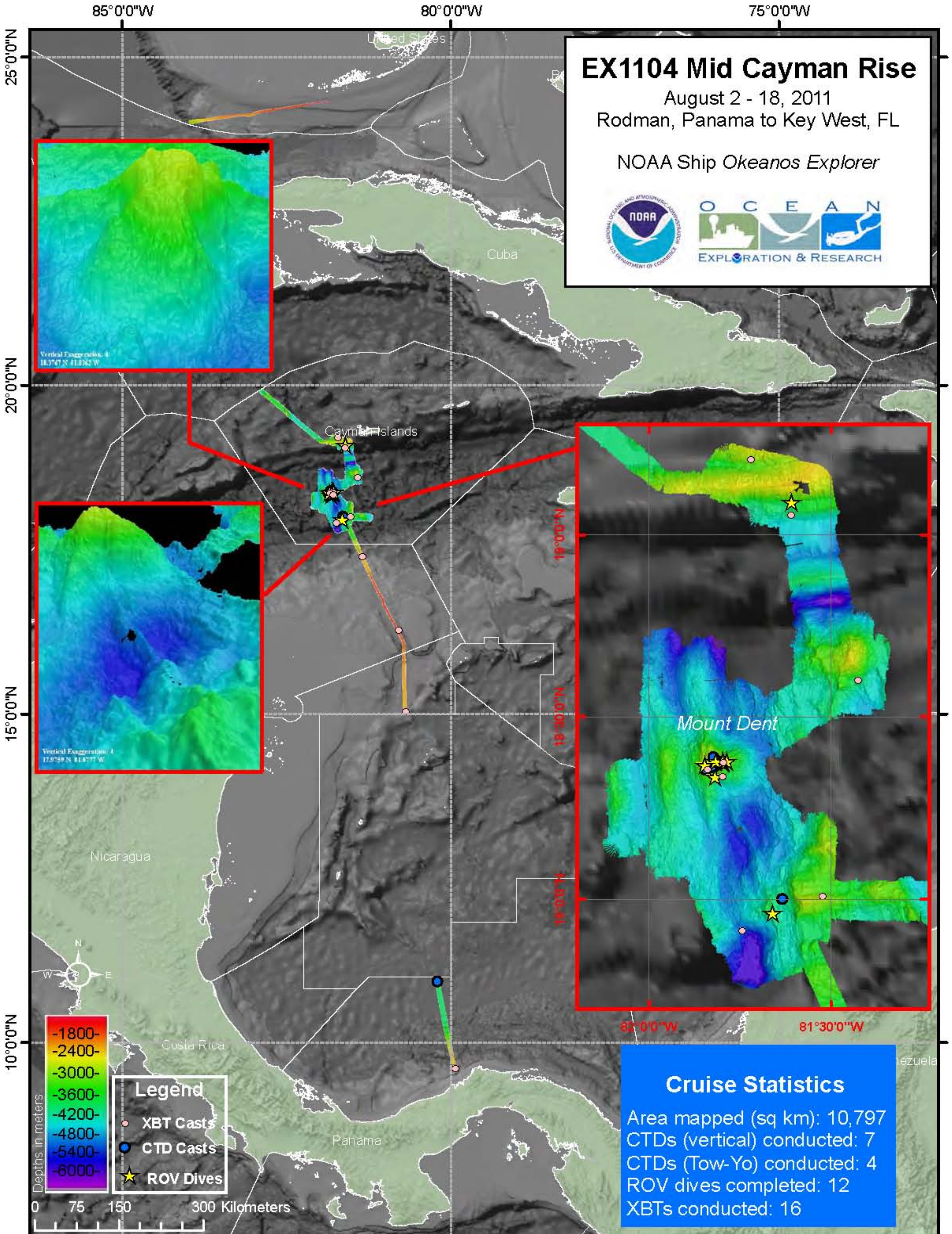

Figure 5. Overview map created by SST Colleen Peters in ArcMap showing all mapping data including transits and focused ops areas.

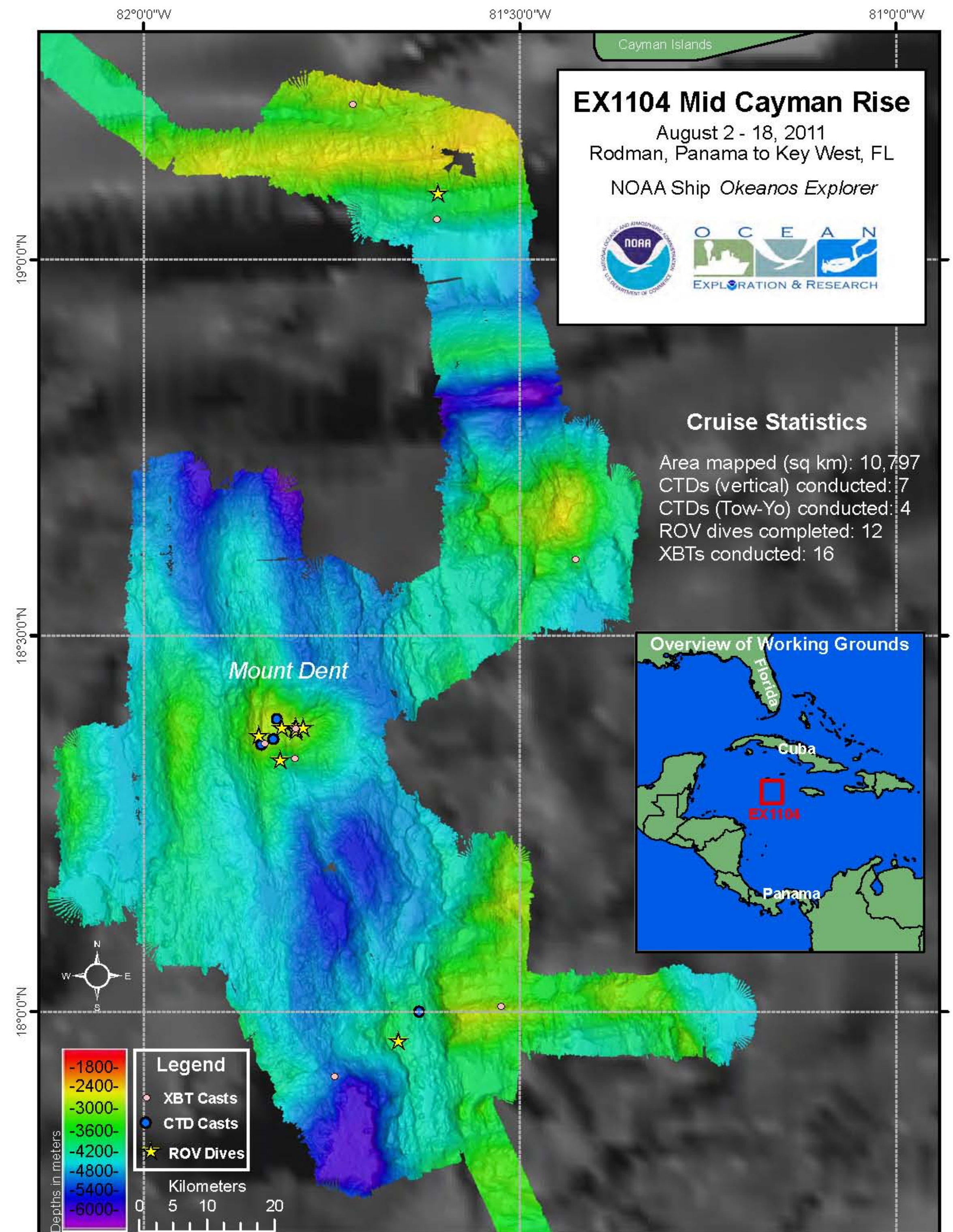

Figure 6. Map created by SST Colleen Peters in ArcMap showing focused operations area over the Mid Cayman Rise.

Appendix B: Tables of data files collected

Table 1. EM 302 Multibeam bathymetry / bottom backscatter files.

EX1104 MB ACQUISITION / FIELD PROCESSING LOG											
MB Line Filename	SVP File Applied	Julian Day	Date (GMT)	SOG (kts)	Heading	Northern Bounding Coordinate	Western Bounding Coordinate	Southern Bounding Coordinate	Eastern Bounding Coordinate	Level 01 Export (ASCII by Line, WGS84)	Level 02 Export (WGS84) (Gridded ASCII xyz, Fledermaus SD, geotiff, Google Earth KMZ)
0000_20110803_101031_EX1104_MB.all	EX1104_XBT02_20110803	215	08/03/11	10.5	350	10.727185N	080.199519W	09.664527N	079.918661W	EX1104_EXApril09_2011-215_0000_20110803_101031_EX1104_MB.txt	EX1104_1_50m_WGS84
0001_20110803_161037_EX1104_MB.all	EX1104_XBT02_20110803	215	08/03/11	10.5	350	10.947912N	080.233355W	10.716080N	080.126474W	EX1104_EXApril09_2011-215_0001_20110803_161037_EX1104_MB.txt	EX1104_1_50m_WGS84
0002_20110803_182723_EX1104_MB.all	EX1104_XBT02_20110803	215	08/03/11	10.5	350	10.979536N	080.240708W	10.919395N	080.167237W	EX1104_EXApril09_2011-215_0002_20110803_182723_EX1104_MB.txt	EX1104_1_50m_WGS84
0003_20110804_170346_EX1104_MB.all	EX1104_XBT05_20110804	216	8/04/11	11	000	15.929342N	080.727666W	15.093068N	080.669106W	EX1104_EXApril09_2011-216_0003_20110804_170346_EX1104_MB.txt	EX1104_2_50m_WGS84
0004_20110804_212857_EX1104_MB.all	EX1104_XBT05_20110804 EX1104_XBT06_20110804	216	8/04/11	11	360	16.419309N	080.891425W	15.928441N	080.685629W	EX1104_EXApril09_2011-216_0004_20110804_212857_EX1104_MB.txt	EX1104_2_50m_WGS84
0005_20110805_000004_EX1104_MB.all	EX1104_XBT06_20110804	217	8/05/11	12	340	17.496875N	081.414665W	16.408527N	080.868098W	EX1104_EXApril09_2011-217_0005_20110805_000004_EX1104_MB.txt	EX1104_2_50m_WGS84
0006_20110805_060005_EX1104_MB.all	EX1104_XBT06_20110804	217	8/05/11	12	335	17.593618N	081.464415W	17.483211N	081.366188W	EX1104_EXApril09_2011-217_0006_20110805_060005_EX1104_MB.txt	EX1104_2_50m_WGS84
0007_20110805_063823_EX1104_MB.all	EX1104_XBT06_20110804	217	8/05/11	11	335	18.383925N	081.827960W	17.575079N	081.405629W	EX1104_EXApril09_2011-217_0007_20110805_063823_EX1104_MB.txt	EX1104_3_50m_WGS84
0008_20110806_045649_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	8.9	180	18.404137N	081.861705W	18.252039N	081.777691W	EX1104_EXApril09_2011-218_0008_20110806_045649_EX1104_MB.txt	EX1104_3_50m_WGS84
0009_20110806_055712_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	8.8	270	18.290931N	081.903727W	18.206853N	081.786929W	EX1104_EXApril09_2011-218_0009_20110806_055712_EX1104_MB.txt	EX1104_3_50m_WGS84
0010_20110806_061844_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	9	0	18.514265N	081.920367W	18.249080N	081.832325W	EX1104_EXApril09_2011-218_0010_20110806_061844_EX1104_MB.txt	EX1104_3_50m_WGS84
0011_20110806_080211_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	9	270	18.554928N	081.954180W	18.476372N	081.844703W	EX1104_EXApril09_2011-218_0011_20110806_080211_EX1104_MB.txt	EX1104_3_50m_WGS84
0012_20110806_082935_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	9.5	180	18.292021N	081.970451W	18.212558N	081.896452W	EX1104_EXApril09_2011-218_0012_20110806_082935_EX1104_MB.txt	EX1104_3_50m_WGS84
0013_20110806_100256_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	9.8	270	18.499533N	081.962779W	18.255025N	081.882308W	EX1104_EXApril09_2011-218_0013_20110806_100256_EX1104_MB.txt	EX1104_3_50m_WGS84
0014_20110806_102034_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	9.8	0	18.352979N	082.013987W	18.213454N	081.939257W	EX1104_EXApril09_2011-218_0014_20110806_102034_EX1104_MB.txt	EX1104_3_50m_WGS84
0015_20110806_105731_EX1104_MB.all	EX1104_CTD02_110805	218	8/06/11	9.7	80	18.406817N	082.008878W	18.323332N	081.799628W	EX1104_EXApril09_2011-218_0015_20110806_105731_EX1104_MB.txt	EX1104_3_50m_WGS84

0016_20110807_024127_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.2	355	18.693559N	081.863393W	18.343017N	081.763045W	EX1104_EXApril09_2011-219_0016_20110807_024127_EX1104_MB.txt	EX1104_3_50m_WGS84
0017_20110807_045548_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.9	266	18.724707N	081.904296W	18.660218N	081.793650W	EX1104_EXApril09_2011-219_0017_20110807_045548_EX1104_MB.txt	EX1104_3_50m_WGS84
0018_20110807_051559_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.9	180	18.689959N	081.922423W	18.501691N	081.839752W	EX1104_EXApril09_2011-219_0018_20110807_051559_EX1104_MB.txt	EX1104_3_50m_WGS84
0019_20110807_062305_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.21	355	18.547419N	081.962974W	18.463774N	081.850618W	EX1104_EXApril09_2011-219_0019_20110807_062305_EX1104_MB.txt	EX1104_3_50m_WGS84
0020_20110807_064259_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.9	360	18.720811N	081.966982W	18.504860N	081.890475W	EX1104_EXApril09_2011-219_0020_20110807_064259_EX1104_MB.txt	EX1104_3_50m_WGS84
0021_20110807_075714_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.9	257	18.746159N	082.013846W	18.688634N	081.913255W	EX1104_EXApril09_2011-219_0021_20110807_075714_EX1104_MB.txt	EX1104_3_50m_WGS84
0022_20110807_081806_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.5	180	18.710431N	082.024433W	18.339421N	081.950470W	EX1104_EXApril09_2011-219_0022_20110807_081806_EX1104_MB.txt	EX1104_3_50m_WGS84
0023_20110807_103702_EX1104_MB.all	EX1104_DIVE03_CPCTD_110806	219	8/07/11	9.5	78	18.403956N	082.013131W	18.300262N	081.798313W	EX1104_EXApril09_2011-219_0023_20110807_103702_EX1104_MB.txt	EX1104_3_50m_WGS84
0024_20110808_052654_EX1104_MB.all	EX1104_CTD03_110807.asvp	220	8/08/11	8.5	192	18.380819N	081.852319W	18.174194N	081.738147W	EX1104_EXApril09_2011-220_0024_20110808_052654_EX1104_MB.txt	EX1104_3_50m_WGS84
0025_20110808_064808_EX1104_MB.all	EX1104_CTD03_110807.asvp	220	8/08/11	8.8	43	18.251489N	081.845985W	18.146783N	081.728323W	EX1104_EXApril09_2011-220_0025_20110808_064808_EX1104_MB.txt	EX1104_3_50m_WGS84
0026_20110808_072321_EX1104_MB.all	EX1104_CTD03_110807.asvp	220	8/08/11	9.8	0	18.573423N	081.811453W	18.235652N	081.718160W	EX1104_EXApril09_2011-220_0026_20110808_072321_EX1104_MB.txt	EX1104_3_50m_WGS84
0027_20110808_092654_EX1104_MB.all	EX1104_CTD03_110807.asvp	220	8/08/11	10	112	18.608464N	081.797433W	18.528679N	081.681525W	EX1104_EXApril09_2011-220_0027_20110808_092654_EX1104_MB.txt	EX1104_3_50m_WGS84
0028_20110808_095127_EX1104_MB.all	EX1104_CTD03_110807.asvp	220	8/08/11	10	180	18.551440N	081.749537W	18.300096N	081.662551W	EX1104_EXApril09_2011-220_0028_20110808_095127_EX1104_MB.txt	EX1104_3_50m_WGS84
0029_20110808_112001_EX1104_MB.all	EX1104_CTD03_110807.asvp	220	8/08/11	10	288	18.361940N	081.833591W	18.271568N	081.679412W	EX1104_EXApril09_2011-220_0029_20110808_112001_EX1104_MB.txt	EX1104_3_50m_WGS84
0030_20110809_050809_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.5	200	18.355763N	081.908439W	18.242354N	081.800379W	EX1104_EXApril09_2011-221_0030_20110809_050809_EX1104_MB.txt	EX1104_3_50m_WGS84
0031_20110809_054756_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.5	180	18.259870N	081.910517W	18.119389N	081.828533W	EX1104_EXApril09_2011-221_0031_20110809_054756_EX1104_MB.txt	EX1104_3_50m_WGS84
0032_20110809_063833_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.5	269	18.145853N	081.954166W	18.079215N	081.843628W	EX1104_EXApril09_2011-221_0032_20110809_063833_EX1104_MB.txt	EX1104_3_50m_WGS84
0033_20110809_070113_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.5	360	18.244084N	081.961176W	18.118207N	081.888069W	EX1104_EXApril09_2011-221_0033_20110809_070113_EX1104_MB.txt	EX1104_3_50m_WGS84
0034_20110809_074808_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.5	261	18.285830N	082.006780W	18.208706N	081.894109W	EX1104_EXApril09_2011-221_0034_20110809_074808_EX1104_MB.txt	EX1104_3_50m_WGS84
0035_20110809_081055_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.8	180	18.235439N	082.010936W	18.095681N	081.933694W	EX1104_EXApril09_2011-221_0035_20110809_081055_EX1104_MB.txt	EX1104_3_50m_WGS84
0036_20110809_090128_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.5	90	18.127044N	082.007785W	18.048705N	081.786104W	EX1104_EXApril09_2011-221_0036_20110809_090128_EX1104_MB.txt	EX1104_3_50m_WGS84
0037_20110809_100039_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.3	0	18.334114N	081.862246W	18.097792N	081.780407W	EX1104_EXApril09_2011-221_0037_20110809_100039_EX1104_MB.txt	EX1104_3_50m_WGS84
0038_20110809_113032_EX1104_MB.all	EX1104_CTD04_110808.asvp	221	8/09/11	9.0	30	18.380201N	081.856909W	18.322011N	081.777690W	EX1104_EXApril09_2011-221_0038_20110809_113032_EX1104_MB.txt	EX1104_3_50m_WGS84
0039_20110810_050859_EX1104_MB.all	EX1104_CTD04_110808.asvp	222	8/10/11	9.0	306	18.477337N	081.839604W	18.350689N	081.703674W	EX1104_EXApril09_2011-222_0039_20110810_050859_EX1104_MB.txt	EX1104_3_50m_WGS84
0040_20110810_055516_E	EX1104_CTD05_110809.a	222	8/10/	9.8	244	18.4770	082.0710	18.3213	081.8016	EX1104_EXApril09_2011-	EX1104_3_50m

X1104_MB.all	svp		11			12N	59W	12N	99W	222_0040_20110810_055516_EX1104_MB.txt	_WGS84
0041_20110810_072038_EX1104_MB.all	EX1104_CTD05_110809.asvp	222	8/10/11	9.0	180	18.346538N	082.083639W	18.154638N	081.985631W	EX1104_EXApril09_2011-222_0041_20110810_072038_EX1104_MB.txt	EX1104_3_50m_WGS84
0042_20110810_083729_EX1104_MB.all	EX1104_CTD05_110809.asvp	222	8/10/11	10	270	18.190588N	082.125414W	18.113808N	081.992604W	EX1104_EXApril09_2011-222_0042_20110810_083729_EX1104_MB.txt	EX1104_3_50m_WGS84
0043_20110810_085808_EX1104_MB.all	EX1104_CTD05_110809.asvp	222	8/10/11	9.0	0	18.344287N	082.118694W	18.146639N	082.036813W	EX1104_EXApril09_2011-222_0043_20110810_085808_EX1104_MB.txt	EX1104_3_50m_WGS84
0044_20110810_101150_EX1104_MB.all	EX1104_CTD05_110809.asvp	222	8/10/11	9.3	84	18.408668N	082.117890W	18.306961N	081.805486W	EX1104_EXApril09_2011-222_0044_20110810_101150_EX1104_MB.txt	EX1104_3_50m_WGS84
0045_20110811_003034_EX1104_MB.all	EX1104_XBT08_20110810.asvp	223	8/11/11	11.7	55	18.56998N	081.79325W	18.36641N	081.49335W	EX1104_EXApril09_2011-223_0045_20110811_003034_EX1104_MB.txt	EX1104_3_50m_WGS84
0046_20110811_015956_EX1104_MB.all	EX1104_XBT08_20110810.asvp	223	8/11/11	10	008	18.748593N	081.562191W	18.552004N	081.462419W	EX1104_EXApril09_2011-223_0046_20110811_015956_EX1104_MB.txt	EX1104_3_50m_WGS84
0047_20110811_030729_EX1104_MB.all	EX1104_XBT08_20110810.asvp	223	8/11/11	9.6	068	18.795573N	081.536968W	18.716466N	081.418729W	EX1104_EXApril09_2011-223_0047_20110811_030729_EX1104_MB.txt	EX1104_3_50m_WGS84
0048_20110811_033038_EX1104_MB.all	EX1104_XBT08_20110810.asvp	223	8/11/11	9.9	185	18.770249N	081.514972W	18.521874N	081.416733W	EX1104_EXApril09_2011-223_0048_20110811_033038_EX1104_MB.txt	EX1104_3_50m_WGS84
0049_20110811_044941_EX1104_MB.all	EX1104_XBT08_20110810.asvp	223	8/11/11	9.9	102	18.579319N	081.491286W	18.501261N	081.406594W	EX1104_EXApril09_2011-223_0049_20110811_044941_EX1104_MB.txt	EX1104_3_50m_WGS84
0050_20110811_050639_EX1104_MB.all	EX1104_XBT08_20110810.asvp EX1104_XBT09_20110811.asvp	223	8/11/11	10	006	18.764540N	081.468622W	18.538044N	081.378451W	EX1104_EXApril09_2011-223_0050_20110811_050639_EX1104_MB.txt	EX1104_3_50m_WGS84
0051_20110811_062640_EX1104_MB.all	EX1104_XBT09_20110811.asvp	223	8/11/11	9.8	212	18.793832N	081.466150W	18.714893N	081.380059W	EX1104_EXApril09_2011-223_0051_20110811_062640_EX1104_MB.txt	EX1104_3_50m_WGS84
0052_20110811_064857_EX1104_MB.all	EX1104_XBT09_20110811.asvp	223	8/11/11	10	188	18.731928N	081.474758W	18.614884N	081.401916W	EX1104_EXApril09_2011-223_0052_20110811_064857_EX1104_MB.txt	EX1104_3_50m_WGS84
0053_20110811_072635_EX1104_MB.all	EX1104_XBT09_20110811.asvp	223	8/11/11	10	040	18.728907N	081.480126W	18.579025N	081.33814W	EX1104_EXApril09_2011-223_0053_20110811_072635_EX1104_MB.txt	EX1104_3_50m_WGS84
0054_20110811_081049_EX1104_MB.all	EX1104_XBT09_20110811.asvp	223	8/11/11	10.2	187	18.697696N	081.431038W	18.528284N	081.335504W	EX1104_EXApril09_2011-223_0054_20110811_081049_EX1104_MB.txt	EX1104_3_50m_WGS84
0055_20110811_090839_EX1104_MB.all	EX1104_XBT09_20110811.asvp	223	8/11/11	10	278	18.578201N	081.474867W	18.502475N	081.352089W	EX1104_EXApril09_2011-223_0055_20110811_090839_EX1104_MB.txt	EX1104_3_50m_WGS84
0056_20110811_093837_EX1104_MB.all	EX1104_XBT09_20110811.asvp	223	8/11/11	9.5	237	18.580531N	081.755999W	18.354755N	081.467793W	EX1104_EXApril09_2011-223_0056_20110811_093837_EX1104_MB.txt	EX1104_3_50m_WGS84
0057_20110811_113127_EX1104_MB.all	EX1104_XBT10_20110811.asvp	223	8/11/11	9.6	270	18.171565N	081.784912W	17.873911N	081.607604W	EX1104_EXApril09_2011-223_0057_20110811_113127_EX1104_MB.txt	EX1104_3_50m_WGS84
0058_20110812_011243_EX1104_MB.all	EX1104_XBT10_20110811.asvp	224	8/12/11	10	158	18.356626N	081.855997W	18.151487N	081.710228W	EX1104_EXApril09_2011-224_0058_20110812_011243_EX1104_MB.txt	EX1104_3_50m_WGS84
0059_20110812_022759_EX1104_MB.all	EX1104_XBT10_20110811.asvp	224	8/12/11	10	160	18.171565N	081.784912W	17.875067N	081.607975W	EX1104_EXApril09_2011-224_0059_20110812_022759_EX1104_MB.txt	EX1104_3_50m_WGS84
0060_20110812_041001_EX1104_MB.all	EX1104_XBT10_20110811.asvp	224	8/12/11	10	092	17.926692N	081.651006W	17.854503N	081.539732W	EX1104_EXApril09_2011-224_0060_20110812_041001_EX1104_MB.txt	EX1104_3_50m_WGS84
0061_20110812_044347_EX1104_MB.all	EX1104_XBT10_20110811.asvp EX1104_XBT11_20110812.asvp	224	8/12/11	10	004	18.234067N	081.566015W	17.857723N	081.479903W	EX1104_EXApril09_2011-224_0061_20110812_044347_EX1104_MB.txt	EX1104_3_50m_WGS84
0062_20110812_063957_EX1104_MB.all	EX1104_XBT11_20110812.asvp	224	8/12/11	10	260	18.239513N	081.594312W	18.164545N	081.515946W	EX1104_EXApril09_2011-224_0062_20110812_063957_EX1104_MB.txt	EX1104_3_50m_WGS84

0063_20110812_065543_EX1104_MB.all	EX1104_XBT11_20110812.asvp	224	8/12/11	10	184	18.197942N	081.613275W	17.938332N	081.528730W	EX1104_EXApril09_2011-224_0063_20110812_065543_EX1104_MB.txt	EX1104_3_50m_WGS84
0064_20110812_082723_EX1104_MB.all	EX1104_XBT11_20110812.asvp	224	8/12/11	10.8	344	18.066954N	081.662137W	17.905498N	081.547752W	EX1104_EXApril09_2011-224_0064_20110812_082723_EX1104_MB.txt	EX1104_3_50m_WGS84
0065_20110812_091411_EX1104_MB.all	EX1104_XBT11_20110812.asvp	224	8/12/11	8.1	004	18.207070N	081.664336W	18.064742N	081.568007W	EX1104_EXApril09_2011-224_0065_20110812_091411_EX1104_MB.txt	EX1104_3_50m_WGS84
0066_20110812_101604_EX1104_MB.all	EX1104_XBT11_20110812.asvp	224	8/12/11	10.1	318	18.293532N	081.678630W	18.201295N	081.580283W	EX1104_EXApril09_2011-224_0066_20110812_101604_EX1104_MB.txt	EX1104_3_50m_WGS84
0067_20110812_104609_EX1104_MB.all	EX1104_XBT11_20110812.asvp	224	8/12/11	9.9	328	18.337664N	081.716888W	18.243434N	081.644347W	EX1104_EXApril09_2011-224_0067_20110812_104609_EX1104_MB.txt	EX1104_3_50m_WGS84
0068_20110812_110729_EX1104_MB.all	EX1104_XBT11_20110812.asvp	224	8/12/11	9.9	290	18.386887N	081.848368W	18.292352N	081.686731W	EX1104_EXApril09_2011-224_0068_20110812_110729_EX1104_MB.txt	EX1104_3_50m_WGS84
0069_20110813_000627_EX1104_MB.all	EX1104_XBT12_20110812.asvp	225	8/13/11	9.2	152	18.321845N	081.743510W	18.129420N	081.599023W	EX1104_EXApril09_2011-225_0069_20110813_000627_EX1104_MB.txt	EX1104_3_50m_WGS84
0070_20110813_011611_EX1104_MB.all	EX1104_XBT12_20110812.asvp	225	8/13/11	10.4	274	18.203862N	081.840195W	18.101584N	081.594644W	EX1104_EXApril09_2011-225_0070_20110813_011611_EX1104_MB.txt	EX1104_3_50m_WGS84
0071_20110813_021926_EX1104_MB.all	EX1104_XBT12_20110812.asvp	225	8/13/11	9.4	159	18.170407N	081.826187W	17.802240N	081.645570W	EX1104_EXApril09_2011-225_0071_20110813_021926_EX1104_MB.txt	EX1104_3_50m_WGS84
0072_20110813_043303_EX1104_MB.all	EX1104_XBT12_20110812.asvp	225	8/13/11	9	261	17.866521N	081.741722W	17.791287N	081.669243W	EX1104_EXApril09_2011-225_0072_20110813_043303_EX1104_MB.txt	EX1104_3_50m_WGS84
0073_20110813_045132_EX1104_MB.all	EX1104_XBT12_20110812.asvp EX1104_XBT13_20110813.asvp	225	8/13/11	8.5	342	18.092460N	081.850913W	17.818544N	081.685330W	EX1104_EXApril09_2011-225_0073_20110813_045132_EX1104_MB.txt	EX1104_3_50m_WGS84
0074_20110813_064945_EX1104_MB.all	EX1104_XBT13_20110813.asvp	225	8/13/11	8.3	255	18.116466N	081.899434W	18.046865N	081.798913W	EX1104_EXApril09_2011-225_0074_20110813_064945_EX1104_MB.txt	EX1104_3_50m_WGS84
0075_20110813_071428_EX1104_MB.all	EX1104_XBT13_20110813.asvp	225	8/13/11	8.18	156	18.083186N	081.897879W	17.778067N	081.713977W	EX1104_EXApril09_2011-225_0075_20110813_071428_EX1104_MB.txt	EX1104_3_50m_WGS84
0076_20110813_092913_EX1104_MB.all	EX1104_XBT13_20110813.asvp	225	8/13/11	7.65	73.0	17.872260N	081.768141W	17.752881N	081.549412W	EX1104_EXApril09_2011-225_0076_20110813_092913_EX1104_MB.txt	EX1104_3_50m_WGS84
0077_20110813_104737_EX1104_MB.all	EX1104_XBT13_20110813.asvp	225	8/13/11	8.3	306	17.913358N	081.686401W	17.809166N	081.571925W	EX1104_EXApril09_2011-225_0077_20110813_104737_EX1104_MB.txt	EX1104_3_50m_WGS84
0078_20110813_112739_EX1104_MB.all	EX1104_XBT13_20110813.asvp	225	8/13/11	8.4	0	17.967747N	081.709535W	17.864562N	081.632757W	EX1104_EXApril09_2011-225_0078_20110813_112739_EX1104_MB.txt	EX1104_3_50m_WGS84
0079_20110814_042657_EX1104_MB.all	EX1104_CTD06_110813.asvp	226	8/14/11	9	090	18.017083N	081.640974W	17.927908N	081.217502W	EX1104_EXApril09_2011-226_0079_20110814_042657_EX1104_MB.txt	EX1104_3_50m_WGS84
0080_20110814_070333_EX1104_MB.all	EX1104_CTD06_110813.asvp	226	8/14/11	8.5	358	18.048383N	081.257184W	17.934342N	081.181976W	EX1104_EXApril09_2011-226_0080_20110814_070333_EX1104_MB.txt	EX1104_3_50m_WGS84
0081_20110814_072703_EX1104_MB.all	EX1104_CTD06_110813.asvp	226	8/14/11	8.9	270	18.061614N	081.504714W	17.979806N	081.220068W	EX1104_EXApril09_2011-226_0081_20110814_072703_EX1104_MB.txt	EX1104_3_50m_WGS84
0082_20110814_091636_EX1104_MB.all	EX1104_CTD06_110813.asvp	226	8/14/11	10.4	315	18.188818N	081.691971W	17.991358N	081.491187W	EX1104_EXApril09_2011-226_0082_20110814_091636_EX1104_MB.txt	EX1104_3_50m_WGS84
0083_20110814_103043_EX1104_MB.all	EX1104_CTD06_110813.asvp	226	8/14/11	9.5	331	18.375545N	081.808666W	18.158270N	081.640486W	EX1104_EXApril09_2011-226_0083_20110814_103043_EX1104_MB.txt	EX1104_3_50m_WGS84
0084_20110815_023245_EX1104_MB.all	EX1104_CTD07_110814.asvp	227	8/15/11	9.7	039	18.529896N	081.853204W	18.345445N	081.666403W	EX1104_EXApril09_2011-227_0084_20110815_023245_EX1104_MB.txt	EX1104_3_50m_WGS84
0085_20110815_035227_EX1104_MB.all	EX1104_CTD07_110814.asvp	227	8/15/11	9.2	057	18.604302N	081.705879W	18.485535N	081.556629W	EX1104_EXApril09_2011-227_0085_20110815_035227_EX1104_MB.txt	EX1104_3_50m_WGS84
0086_20110815_044239_E	EX1104_CTD07_110814.a	227	8/15/	9.0	004	18.7473	081.6096	18.5492	081.5153	EX1104_EXApril09_2011-	EX1104_3_50m

X1104_MB.all	svp		11			13N	70W	46N	94W	227_0086_20110815_044239_EX1104_MB.txt	_WGS84
0087_20110815_055119_EX1104_MB.all	EX1104_CTD07_110814.asvp	227	8/15/11	8.9	352	19.091306N	081.654972W	18.746322N	081.517514W	EX1104_EXApril09_2011-227_0087_20110815_055119_EX1104_MB.txt	EX1104_3_50m_WGS84
0088_20110815_081416_EX1104_MB.all	EX1104_XBT14_20110815.asvp	227	8/15/11	6.2	345	19.163071N	081.657303W	19.082731N	081.577893W	EX1104_EXApril09_2011-227_0088_20110815_081416_EX1104_MB.txt	EX1104_3_50m_WGS84
0089_20110815_084442_EX1104_MB.all	EX1104_XBT14_20110815.asvp	227	8/15/11	9.2	279	19.201528N	081.801588W	19.108461N	081.622313W	EX1104_EXApril09_2011-227_0089_20110815_084442_EX1104_MB.txt	EX1104_3_50m_WGS84
0090_20110815_094819_EX1104_MB.all	EX1104_XBT14_20110815.asvp	227	8/15/11	8.9	189	19.200831N	081.842233W	19.096915N	081.770097W	EX1104_EXApril09_2011-227_0090_20110815_094819_EX1104_MB.txt	EX1104_3_50m_WGS84
0091_20110815_100530_EX1104_MB.all	EX1104_XBT14_20110815.asvp	227	8/15/11	9.9	99	19.150957N	081.812856W	19.069432N	081.635664W	EX1104_EXApril09_2011-227_0091_20110815_100530_EX1104_MB.txt	EX1104_3_50m_WGS84
0092_20110815_110233_EX1104_MB.all	EX1104_XBT14_20110815.asvp	227	8/15/11	9.2	278	19.093782N	081.691872W	19.019459N	081.644431W	EX1104_EXApril09_2011-227_0092_20110815_110233_EX1104_MB.txt	EX1104_3_50m_WGS84
0093_20110815_112152_EX1104_MB.all	EX1104_XBT14_20110815.asvp	227	8/15/11	9.6	188	19.128320N	081.678993W	19.017672N	081.599141W	EX1104_EXApril09_2011-227_0093_20110815_112152_EX1104_MB.txt	EX1104_3_50m_WGS84
0094_20110815_113708_EX1104_MB.all	EX1104_XBT14_20110815.asvp	227	8/15/11	2.7	19	19.096547N	081.730309W	19.024189N	081.658146W	EX1104_EXApril09_2011-227_0094_20110815_113708_EX1104_MB.txt	EX1104_3_50m_WGS84
0095_20110815_233505_EX1104_MB.all	EX1104_DIVE12_CPCTD_110815.asvp	227	8/15/11	9.1	119	19.127432N	081.606785W	19.056191N	081.533643W	EX1104_EXApril09_2011-227_0095_20110815_233505_EX1104_MB.txt	EX1104_3_50m_WGS84
0096_20110815_234916_EX1104_MB.all	EX1104_DIVE12_CPCTD_110815.asvp	227	8/15/11	10.2	171	19.086455N	081.603745W	18.763482N	081.486269W	EX1104_EXApril09_2011-227_0096_20110815_234916_EX1104_MB.txt	EX1104_3_50m_WGS84
0097_20110816_014021_EX1104_MB.all	EX1104_DIVE12_CPCTD_110815.asvp	228	8/16/11	10.1	78	18.803542N	081.539369W	18.739262N	081.437756W	EX1104_EXApril09_2011-228_0097_20110816_014021_EX1104_MB.txt	EX1104_3_50m_WGS84
0098_20110816_015915_EX1104_MB.all	EX1104_DIVE12_CPCTD_110815.asvp	228	8/16/11	10	350	19.195400N	081.563755W	18.776466N	081.431820W	EX1104_EXApril09_2011-228_0098_20110816_015915_EX1104_MB.txt	EX1104_3_50m_WGS84
0099_20110816_042203_EX1104_MB.all	EX1104_DIVE12_CPCTD_110815.asvp EX1104_XBT15_20110816.asvp	228	8/16/11	10	382	19.253106N	081.788805W	19.142001N	081.535876W	EX1104_EXApril09_2011-228_0099_20110816_042203_EX1104_MB.txt	EX1104_3_50m_WGS84
0100_20110816_054521_EX1104_MB.all	EX1104_XBT15_20110816.asvp	228	8/16/11	10	217	19.252755N	081.852980W	19.112164N	081.757365W	EX1104_EXApril09_2011-228_0100_20110816_054521_EX1104_MB.txt	EX1104_3_50m_WGS84
0101_20110816_062233_EX1104_MB.all	EX1104_XBT15_20110816.asvp	228	8/16/11	10.1	272	19.177949N	081.959531W	19.110841N	081.840978W	EX1104_EXApril09_2011-228_0101_20110816_062233_EX1104_MB.txt	EX1104_3_50m_WGS84
0102_20110816_070132_EX1104_MB.all	EX1104_XBT15_20110816.asvp	228	8/16/11	10.7	311	19.952431N	082.914698W	19.843991N	082.795976W	EX1104_EXApril09_2011-228_0102_20110816_070132_EX1104_MB.txt	EX1104_3_50m_WGS84
0103_20110816_130129_EX1104_MB.all	EX1104_XBT15_20110816.asvp	228	8/16/11	10.8	311	19.884062N	082.837753W	19.121213N	081.940119W	EX1104_EXApril09_2011-228_0103_20110816_130129_EX1104_MB.txt	EX1104_3_50m_WGS84
0104_20110817_210934_EX1104_MB.all	EX1104_XBT15_20110816.asvp EX1104_XBT17_20110817_2.asvp EX1104_XBT18_20110818.asvp	229	8/17/11	9.5	82.0	24.165652N	083.990118W	23.969986N	082.953250W	EX1104_EXApril09_2011-229_0104_20110817_210934_EX1104_MB.txt	EX1104_3_50m_WGS84
0105_20110818_030932_EX1104_MB.all	EX1104_XBT18_20110818.asvp	230	8/18/11	9	80	24.0.31533N	82.9651667W	24.1355N	81.9855W	EX1104_EXApril09_2011-229_0105_20110818_030932_EX1104_MB.txt	EX1104_3_50m_WGS84
0106_20110818_090931_EX1104_MB.all	EX1104_XBT18_20110818.asvp	230	8/18/11	9.1	81	24.336666N	81.986W	24.304333N	81.84416667W	EX1104_EXApril09_2011-229_0106_20110818_090931_EX1104_MB.txt	EX1104_3_50m_WGS84

Table 2. Sound Velocity Profile files

EX1104 SVP LOG				
DATE (GMT)	TIME (GMT)	XBT/CTD FILE NAME	LAT/LONG (WGS84)	NOTES
8/3/2011	09:57:32	EX1104_XBT01_20110803	09 36.272N 079 55.850W	very spikey, not used, a lot of lighting
8/3/2011	10:02:25	EX1104_XBT02_20110803	09 36.272N 079 55.850W	looked okay. A little spikey
8/4/2011	16:44:33	EX1104_XBT03_20110804		bad, tangled in fishing line
8/4/2011	16:49:22	EX1104_XBT04_20110804		bad, tangled in fishing line
8/4/2011	16:54:57	EX1104_XBT05_20110804	15 2.332N 080 41.626W	
8/4/2011	23:15:21	EX1104_XBT06_20110804	16 16.30762N 080 48.2266W	
8/5/2011	05:23:34	EX1104_XBT07_20110805	17 23.8811N 081 20.94727W	
8/6/2011	00:40:15	EX1104_CTD02_110805	18 22.59N 081 47.89W	
8/6/2011	17:40:46	EX1104_DIVE03_CPCTD_110806	18.372355N 081.793170W	
8/8/2011	00:00:03	EX1104_CTD03_110807	18 21.70N 081 49.63W	
8/8/2011	23:57:12	EX1104_CTD04_110808	18 21.26N 081 50.57W	
8/10/2011	00:10:00	EX1104_CTD05_110809.asvp	18 23.31N 081 49.34W	
8/11/2011	00:23:06	EX1104_XBT08_20110810	18 22.56299N 081 47.88672W	
8/11/2011	05:28:32	EX1104_XBT09_20110811	18 36.06653N 081 25.61182W	
8/12/2011	01:06:39	EX1104_XBT10_20110811.EDF	18 21.39734N 081 50.39404W	
8/12/2011	05:27:50	EX1104_XBT11_20110812	18 0.39893N 081 31.52588W	
8/12/2011	23:27:09	EX1104_XBT12_20110812	18 20.22351N 081 47.95166W	
8/13/2011	05:31:36	EX1104_XBT13_20110813	17 54.83704N 081 44.78271W	
8/14/2011	01:23:32	EX1104_CTD06_110813	17 59.99N 081 37.99W	
8/14/2011	23:50:53	EX1104_CTD07_110814	18 22.58N 081 47.89W	
8/15/2011	07:54:44	EX1104_XBT14_20110815	19 3.21509N 081 36.62012W	

8/15/2011	13:35:22	EX1104_DIVE12_CPCTD_110815	19 5.373N 081 36.575W	
8/16/2011	05:24:59	EX1104_XBT15_20110816	19 12.37988N 081 43.34473W	
8/17/2011	21:03:04	EX1104_XBT16_20110817	23 59.3689N 083 59.36816W	
8/17/2011	21:33:58	EX1104_XBT17_20110817_2	24 0.86182N 083 54.44727W	
8/18/2011	03:16:44	EX1104_XBT18_20110818	24 9.43286N 082 56.41992W	

Appendix C: List of acronyms

- ASCII – American Standard Code for Information Interchange
- AUV – autonomous underwater vehicle
- BIST – built in system test
- BRD – Blake Ridge Diapir
- CDR – Commander
- CFD – Cape Fear Diapir
- CO – Commanding Officer
- CTD – conductivity, temperature, depth
- CW – continuous wave
- DNP – do not process
- ECS – Extended Continental Shelf
- ERT – Earth Resources Technology Inc.
- ET – Electronics Technician
- EX – NOAA Ship *Okeanos Explorer*
- FM – frequency modulated / modulation
- FTP – file transfer protocol
- GMT – Generic Mapping Tools
- HTC – Hatteras Transverse Canyon
- kHz – kilohertz
- km – kilometer
- kts – knots
- LT – Lieutenant
- MB – multibeam sonar
- MB – megabytes
- NCDDC – National Coastal Data Development Center
- NGDC – National Geophysical Data Center
- NMEA – National Marine Electronics Association
- NOAA – National Oceanic and Atmospheric Administration
- NODC – National Oceanographic Data Center
- NOPP – National Ocean Partnership Program
- OER – NOAA Office of Ocean Exploration and Research
- OMAO – NOAA Office of Marine and Aviation Operations
- OPS – Operations Officer
- ROV – remotely operated vehicle
- SBP – subbottom profiler
- SCS – scientific computer system
- SIS – Seafloor Information System
- SVP – sound velocity profile
- TRU – transceiver unit
- TSG - thermosalinograph
- UCAR – University Corporation for Atmospheric Research
- UPS – uninterruptable power supply
- USBL – ultrashort baseline
- USGS – United States Geological Survey
- XBT – expendable bathythermograph
- XO – Executive Officer
- WD – water depth
- WHOI – Woods Hole Oceanographic Institution

Appendix D: EM302 PU Parameters in use during cruise

#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved: 2011.08.05 18:53:02

#// Build info:
#* SIS: [Version: 3.6.4, Build: 174 , DBVersion 16.0 CD generated: Mon Mar 30 2009 14:00:00]
[Fox ver = 1.6.29]
[db ver = 16, proc = 16.0]
[OTL = 4.0.-95]
[ACE ver = 5.5]
[Coin ver = 2.4.4]
[Simage ver = 1.6.2a]
[Dime ver = DIME v0.9]
[STLPort ver = 513]
[FreeType ver = 2.1.9]
[TIFF ver = 3.8.2]
[GeoTIFF ver = 1230]
[GridEngine ver = 2.3.0]

#* Language [3] #// Current language, 1-Norwegian, 2-German,3-English, 4-Spanish

#* Type [302]
#* Serial no. [101]
#* Number of heads [2]
#* System descriptor [50331648] #// 03000000

#// ***
#// Installation parameters

#{ Input Setup #// All Input setup parameters

#{ COM1 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [9600]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [0]
#* GGK [1] [0]
#* GGA [1] [1]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [1] [1]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM1

#{ COM2 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [19200]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [1]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [1] [1]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [0] [0]
#* DBT Depth [0] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [0] [0]
#* Height, special purp [0] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM2

#{ COM3 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [4800]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [1]
#* GGK [1] [0]
#* GGA [1] [0]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [1] [1]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM3

#{ COM4 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#* Baud rate: [9600]
#* Data bits [8]
#* Stop bits: [1]
#* Parity: [NONE]
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [1]
#* GGK [1] [0]
#* GGA [1] [0]
#* GGA_RTK [1] [0]
#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} COM4

#{ UDP2 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [1] [1]
#* GGK [1] [0]
#* GGA [1] [0]
#* GGA_RTK [1] [0]

#* SIMRAD90 [1] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [0] [0]
#* DBT Depth [0] [0]
#* EA500 Depth [1] [0]
#* ROV. depth [0] [0]
#* Height, special purp [0] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} UDP2

#{ UDP3 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [1]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [1] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} UDP3

#{ UDP4 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [1]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [1] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [1] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [1] [0]
#* DBT Depth [1] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [1] [0]
#* Height, special purp [1] [0]
#* Ethernet AttVel [0] [0]
#} Input Formats

#} UDP4

#{ UDP5 #// Link settings.

#{ Com. settings #// Serial line parameter settings.
#// N/A
#} Com. settings

#{ Position #// Position input settings.
#* None [0] [0]
#* GGK [0] [0]
#* GGA [0] [0]
#* GGA_RTK [0] [0]
#* SIMRAD90 [0] [0]
#} Position

#{ Input Formats #// Format input settings.
#* Attitude [0] [0]
#* MK39 Mod2 Attitude, [0] [0]
#* ZDA Clock [0] [0]
#* HDT Heading [0] [0]
#* SKR82 Heading [0] [0]
#* DBS Depth [0] [0]
#* DBT Depth [0] [0]
#* EA500 Depth [0] [0]
#* ROV. depth [0] [0]
#* Height, special purp [0] [0]
#* Ethernet AttVel [1] [1]
#} Input Formats

#{ Attitude Velocity settings #// Only relevant for UDP5 on EM122, EM302 and EM710, currently
#* Attitude 1 [1] [1]
#* Attitude 2 [1] [0]
#* Use Ethernet 2 [1] [1]
#* Port: [5602]
#* IP addr.: [192.168.2.20]
#* Net mask: [255.255.255.0]
#} Attitude Velocity settings

#} UDP5

#{ Misc. #// Misc. input settings.
#* External Trigger [1] [0]
#} Misc.

#} Input Setup

#{ Output Setup #// All Output setup parameters

#* PU broadcast enable [1] [1]
#* Log watercolumn to s [1] [1]

#{ Host UDP1 #// Host UDP1 Port: 16100

#{ Datagram subscription #//
#* Depth [0] [0]
#* Raw range and beam a [0] [0]
#* Seabed Image [0] [0]
#* Central Beams [0] [0]
#* Position [0] [0]
#* Attitude [0] [0]
#* Heading [0] [0]
#* Height [0] [0]
#* Clock [0] [0]
#* Single beam echosoun [0] [0]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [1]
#* Installation Paramet [0] [1]
#* BIST Reply [0] [1]
#* Status parameters [0] [1]
#* PU Broadcast [0] [0]
#* Stave Display [0] [0]
#* Water Column [0] [0]
#* Internal, Range Data [0] [0]
#* Internal, Scope Data [0] [0]
#} Datagram subscription

#} Host UDP1

#{ Host UDP2 #// Host UDP2 Port: 16101

#{ Datagram subscription #//
#* Depth [1] [1]
#* Raw range and beam a [1] [1]
#* Seabed Image [1] [1]
#* Central Beams [1] [0]
#* Position [1] [1]
#* Attitude [1] [1]
#* Heading [1] [1]
#* Height [1] [1]
#* Clock [1] [1]
#* Single beam echosoun [1] [1]
#* Sound Speed Profile [0] [1]
#* Runtime Parameters [0] [1]
#* Installation Paramet [0] [1]
#* BIST Reply [1] [1]
#* Status parameters [0] [1]
#* PU Broadcast [1] [0]
#* Stave Display [0] [1]
#* Water Column [0] [1]
#* Internal, Range Data [1] [0]
#* Internal, Scope Data [1] [0]
#} Datagram subscription

#} Host UDP2

#{ Host UDP3 #// Host UDP3 Port: 16102

#{ Datagram subscription #//
#* Depth [0] [1]
#* Raw range and beam a [0] [0]
#* Seabed Image [0] [0]
#* Central Beams [0] [0]
#* Position [0] [0]
#* Attitude [0] [1]
#* Heading [0] [0]
#* Height [0] [1]
#* Clock [0] [0]
#* Single beam echosoun [0] [1]
#* Sound Speed Profile [0] [1]

```
      #* Runtime Parameters   [0] [0]
      #* Installation Paramet [0] [1]
      #* BIST Reply           [0] [0]
      #* Status parameters    [0] [0]
      #* PU Broadcast         [0] [0]
      #* Stave Display        [0] [0]
      #* Water Column         [0] [0]
      #* Internal, Range Data [0] [0]
      #* Internal, Scope Data [0] [1]
    #} Datagram subscription

  #} Host UDP3


  #{ Host UDP4 #// Host UDP4 Port 16103

    #{ Datagram subscription #//
      #* Depth                [1] [1]
      #* Raw range and beam a [1] [0]
      #* Seabed Image         [1] [0]
      #* Central Beams        [1] [0]
      #* Position             [1] [0]
      #* Attitude             [1] [0]
      #* Heading              [1] [0]
      #* Height               [1] [0]
      #* Clock                [1] [0]
      #* Single beam echosoun [1] [0]
      #* Sound Speed Profile  [1] [0]
      #* Runtime Parameters   [1] [0]
      #* Installation Paramet [1] [0]
      #* BIST Reply           [1] [0]
      #* Status parameters    [1] [0]
      #* PU Broadcast         [1] [0]
      #* Stave Display        [1] [0]
      #* Water Column         [1] [0]
      #* Internal, Range Data [1] [0]
      #* Internal, Scope Data [1] [0]
    #} Datagram subscription

  #} Host UDP4


  #{ Watercolumn #// Host UDP4 Port 16103

    #{ Datagram subscription #//
      #* Depth                [1] [1]
      #* Raw range and beam a [1] [1]
      #* Seabed Image         [1] [1]
      #* Central Beams        [1] [0]
      #* Position             [1] [1]
      #* Attitude             [1] [1]
      #* Heading              [1] [1]
      #* Height               [1] [1]
      #* Clock                [1] [1]
      #* Single beam echosoun [1] [1]
      #* Sound Speed Profile  [1] [1]
      #* Runtime Parameters   [1] [1]
      #* Installation Paramet [1] [1]
      #* BIST Reply           [1] [1]
      #* Status parameters    [1] [1]
      #* PU Broadcast         [1] [0]
      #* Stave Display        [1] [0]
      #* Water Column         [1] [1]
      #* Internal, Range Data [1] [0]
      #* Internal, Scope Data [1] [0]
    #} Datagram subscription

  #} Watercolumn

#} Output Setup
```

```
#{ Clock Setup #// All Clock setup
parameters

  #{ Clock #// All clock settings.
    #* Source:            [1] #// External ZDA
Clock
    #* 1PPS Clock Synch.   [1] [1]
    #* Offset (sec.):      [0]
  #} Clock

#} Clock Setup

#{ Settings #// Sensor setup parameters

  #{ Positioning System Settings #// Position
related settings.

    #{ COM1 #// Positioning System Ports:
      #* P1T              [0] #// System
      #* P1M              [0] #// Enable
position motion correction
      #* P1D              [0.000] #// Position
delay (sec.):
      #* P1G              [WGS84] #// Datum:
      #* P1Q              [1] #// Enable
      #* Pos. qual. indicator [] #//
    #} COM1

  #} Positioning System Settings

  #{ Motion Sensor Settings #// Motion
related settings.

    #{ COM2 #// Motion Sensor Ports:
      #* MRP              [RP] #// Rotation
(POSMV/MRU)
      #* MSD              [0] #// Motion Delay
(msec.):
      #* MAS              [1.00] #// Motion
Sensor Roll Scaling:
    #} COM2

  #} Motion Sensor Settings

  #{ Active Sensors #//
    #* APS              [0] [COM1] #//
Position:
    #* ARO              [2] [COM2] #// Motion:
    #* AHE              [2] [COM2] #// Motion:
    #* AHS              [3] [COM3] #//
Heading:
  #} Active Sensors

#} Settings

#{ Locations #// All location parameters

  #{ Location offset (m) #//

    #{ Pos, COM1: #//
      #* P1X              [0.00] #// Forward (X)
      #* P1Y              [0.00] #// Starboard
(Y)
      #* P1Z              [0.00] #// Downward
(Z)
    #} Pos, COM1:

    #{ Pos, COM3: #//
      #* P2X              [0.00] #// Forward (X)
```

```
      #* P2Y              [0.00] #// Starboard
(Y)
      #* P2Z              [0.00] #// Downward
(Z)
    #} Pos, COM3:

    #{ Pos, COM4/UDP2: #//
      #* P3X              [0.00] #// Forward (X)
      #* P3Y              [0.00] #// Starboard
(Y)
      #* P3Z              [0.00] #// Downward
(Z)
    #} Pos, COM4/UDP2:

    #{ TX Transducer: #//
      #* S1X              [6.147] #// Forward
(X)
      #* S1Y              [1.822] #// Starboard
(Y)
      #* S1Z              [6.796] #// Downward
(Z)
    #} TX Transducer:

    #{ RX Transducer: #//
      #* S2X              [2.497] #// Forward
(X)
      #* S2Y              [2.481] #// Starboard
(Y)
      #* S2Z              [6.790] #// Downward
(Z)
    #} RX Transducer:

    #{ Attitude 1, COM2: #//
      #* MSX              [0.00] #// Forward
(X)
      #* MSY              [0.00] #// Starboard
(Y)
      #* MSZ              [0.00] #// Downward
(Z)
    #} Attitude 1, COM2:

    #{ Attitude 2, COM3: #//
      #* NSX              [0.00] #// Forward
(X)
      #* NSY              [0.00] #// Starboard
(Y)
      #* NSZ              [0.00] #// Downward
(Z)
    #} Attitude 2, COM3:

    #{ Waterline: #//
      #* WLZ              [1.838] #//
Downward (Z)
    #} Waterline:

  #} Location offset (m)

#} Locations

#{ Angular Offsets #// All angular offset
parameters

  #{ Offset angles (deg.) #//

    #{ TX Transducer: #//
      #* S1R              [0.00] #// Roll
      #* S1P              [0.00] #// Pitch
      #* S1H              [359.98] #// Heading
    #} TX Transducer:
```

```
    #{ RX Transducer: #//
      #* S2R                [0.00] #// Roll
      #* S2P                [0.00] #// Pitch
      #* S2H                [0.03] #// Heading
    #} RX Transducer:

    #{ Attitude 1, COM2: #//
      #* MSR                [0.00] #// Roll
      #* MSP                [-0.725] #// Pitch
      #* MSG                [0.00] #// Heading
    #} Attitude 1, COM2:

    #{ Attitude 2, COM3: #//
      #* NSR                [0.00] #// Roll
      #* NSP                [0.00] #// Pitch
      #* NSG                [0.00] #// Heading
    #} Attitude 2, COM3:

    #{ Stand-alone Heading: #//
      #* GCG                [0.00] #// Heading
    #} Stand-alone Heading:

  #} Offset angles (deg.)

#} Angular Offsets

#{ ROV. Specific #// All ROV specific parameters

  #{ Depth/Pressure Sensor #//
    #* DSF                [1.00] #// Scaling:
    #* DSO                [0.00] #// Offset:
    #* DSD                [0.00] #// Delay:
    #* DSH                [NI] #// Disable Heave Sensor
  #} Depth/Pressure Sensor

#} ROV. Specific

#{ System Parameters #// All system parameters

  #{ System Gain Offset #//
    #* GO1                [0.0] #// BS Offset (dB)
  #} System Gain Offset

  #{ Opening angles #//
    #* S1S                [0] #// TX Opening angle:
    #* S2S                [1] #// RX Opening angle:
  #} Opening angles

#} System Parameters

#//
*****************************************************************
#// Runtime parameters


#{ Sounder Main #//

  #{ Sector Coverage #//

    #{ Max. angle (deg.): #//
      #* MPA                [75] #// Port
      #* MSA                [75] #// Starboard
    #} Max. angle (deg.):

    #{ Max. Coverage (m): #//
      #* MPC                [5000] #// Port
      #* MSC                [5000] #// Starboard
    #} Max. Coverage (m):

    #* ACM                [1] #// Angular Coverage mode: AUTO
    #* BSP                [2] #// Beam Spacing: HIDENS EQDIST

  #} Sector Coverage

  #{ Depth Settings #//
    #* FDE                [1250] #// Force Depth (m)
    #* MID                [500] #// Min. Depth (m):
    #* MAD                [5000] #// Max. Depth (m):
    #* DSM                [2] #// Dual swath mode: DYNAMIC
    #* PMO                [0] #// Ping Mode: AUTO
    #* FME                [1] #// FM enable
  #} Depth Settings

  #{ Stabilization #//
    #* YPS                [1] #// Pitch stabilization
    #* TXA                [0] #// Along Direction (deg.):

    #{ Yaw Stabilization #//
      #* YSM                [2] #// Mode: REL. MEAN HEADING
      #* YMA                [300] #// Heading:
      #* HFI                [1] #// Heading filter: MEDIUM
    #} Yaw Stabilization

  #} Stabilization
#} Sounder Main

#{ Sound Speed #//

  #{ Sound Speed at Transducer #//
    #* SHS                [0] #// Source SENSOR
    #* SST                [15000] #// Sound Speed (dm/sec.):
    #* Sensor Offset (m/sec [0] #//
    #* Filter (sec.):      [5] #//
  #} Sound Speed at Transducer

#} Sound Speed

#{ Filter and Gains #//

  #{ Filtering #//
    #* SFS                [1] #// Spike Filter Strength: WEAK
    #* PEF                [0] #// Penetration Filter Strength: OFF
    #* RGS                [0] #// Range Gate: SMALL
    #* SLF                [1] #// Slope
    #* AEF                [0] #// Aeration
    #* STF                [1] #// Sector Tracking
    #* IFF                [1] #// Interference
  #} Filtering

  #{ Absorption Coefficient #//
    #* ABC                [6.521] #// 31.5 kHz
  #} Absorption Coefficient

  #{ Normal incidence sector #//
    #* TCA                [7] #// Angle from nadir (deg.):
  #} Normal incidence sector


  #{ Mammal protection #//
    #* TXP                [0] #// TX power level (dB): Max.
    #* SSR                [4] #// Soft startup ramp time (min.):
  #} Mammal protection
#} Filter and Gains

#{ Data Cleaning #//
  #* Active rule:        [STANDARD] #//
  #{ STANDARD #//
    #* PingProc.maxPingCountRadius [10]
    #* PingProc.radiusFactor [0.050000]
    #* PingProc.medianFactor [1.500000]
    #* PingProc.beamNumberRadius [3]
    #* PingProc.sufficientPointCount [40]
    #* PingProc.neighborhoodType [Elliptical]
    #* PingProc.timeRule.use [false]
    #* PingProc.overhangRule.use [false]
    #* PingProc.medianRule.use [false]
    #* PingProc.medianRule.depthFactor [0.050000]
    #* PingProc.medianRule.minPointCount [6]
    #* PingProc.quantileRule.use [false]
    #* PingProc.quantileRule.quantile [0.100000]
    #* PingProc.quantileRule.scaleFactor [6.000000]
    #* PingProc.quantileRule.minPointCount [40]
    #* GridProc.minPoints [8]
    #* GridProc.depthFactor [0.200000]
    #* GridProc.removeTooFewPoints [false]
    #* GridProc.surfaceFitting.surfaceDegree [1]
    #* GridProc.surfaceFitting.tukeyConstant [6.000000]
    #* GridProc.surfaceFitting.maxIteration [10]
    #* GridProc.surfaceFitting.convCriterion [0.010000]
    #* GridProc.surfaceDistanceDepthRule.use [false]
```

#* GridProc.surfaceDistanceDepthRule.depthFactor [0.050000]
#* GridProc.surfaceDistancePointRule.use [false]
#* GridProc.surfaceDistancePointRule.scaleFactor [1.000000]
#* GridProc.surfaceDistanceUnitRule.use [false]
#* GridProc.surfaceDistanceUnitRule.scaleFactor [1.000000]
#* GridProc.surfaceDistanceStDevRule.use [false]
#* GridProc.surfaceDistanceStDevRule.scaleFactor [2.000000]
#* GridProc.surfaceAngleRule.use [false]
#* GridProc.surfaceAngleRule.minAngle [20.000000]
#* SonarProc.use [false]
#* SonarProc.gridSizeFactor [4]
#* SonarProc.mergerType [Average]
#* SonarProc.interpolatorType [TopHat]
#* SonarProc.interpolatorRadius [1]
#* SonarProc.fillInOnly [true]
#} STANDARD

#{ Seabed Image Processing #//
#* Seabed Image Process [1] [0]
#} Seabed Image Processing
#} Data Cleaning

#{ Advanced param. #//
#} Advanced param.

Appendix E: EM 302 Built-In-System-Test (BIST) EX1104_03.txt; August 3, 2011

Saved: 2011.08.03 18:50:34

Sounder Type: 302, Serial no.: 101

Date Time Ser. No. BIST Result

2011.08.03 18:43:09.282 101 0 OK

Number of BSP67B boards: 2
BSP 1 Master 2.3 090702 4.3 070913 4.3 070913
BSP 1 Slave 2.3 090702 6.0 080902
BSP 1 RXI FPGA 3.6 080821
BSP 1 DSP FPGA A 4.0 070531
BSP 1 DSP FPGA B 4.0 070531
BSP 1 DSP FPGA C 4.0 070531
BSP 1 DSP FPGA D 4.0 070531
BSP 1 PCI TO SLAVE A1 FIFO: ok
BSP 1 PCI TO SLAVE A2 FIFO: ok
BSP 1 PCI TO SLAVE A3 FIFO: ok
BSP 1 PCI TO SLAVE B1 FIFO: ok
BSP 1 PCI TO SLAVE B2 FIFO: ok
BSP 1 PCI TO SLAVE B3 FIFO: ok
BSP 1 PCI TO SLAVE C1 FIFO: ok
BSP 1 PCI TO SLAVE C2 FIFO: ok
BSP 1 PCI TO SLAVE C3 FIFO: ok
BSP 1 PCI TO SLAVE D1 FIFO: ok
BSP 1 PCI TO SLAVE D2 FIFO: ok
BSP 1 PCI TO SLAVE D3 FIFO: ok
BSP 1 PCI TO MASTER A HPI: ok
BSP 1 PCI TO MASTER B HPI: ok
BSP 1 PCI TO MASTER C HPI: ok
BSP 1 PCI TO MASTER D HPI: ok
BSP 1 PCI TO SLAVE A0 HPI: ok
BSP 1 PCI TO SLAVE A1 HPI: ok
BSP 1 PCI TO SLAVE A2 HPI: ok
BSP 1 PCI TO SLAVE B0 HPI: ok
BSP 1 PCI TO SLAVE B1 HPI: ok
BSP 1 PCI TO SLAVE B2 HPI: ok
BSP 1 PCI TO SLAVE C0 HPI: ok
BSP 1 PCI TO SLAVE C1 HPI: ok
BSP 1 PCI TO SLAVE C2 HPI: ok
BSP 1 PCI TO SLAVE D0 HPI: ok
BSP 1 PCI TO SLAVE D1 HPI: ok
BSP 1 PCI TO SLAVE D2 HPI: ok
BSP 2 Master 2.3 090702 4.3 070913 4.3 070913
BSP 2 Slave 2.3 090702 6.0 080902
BSP 2 RXI FPGA 3.6 080821
BSP 2 DSP FPGA A 4.0 070531
BSP 2 DSP FPGA B 4.0 070531
BSP 2 DSP FPGA C 4.0 070531
BSP 2 DSP FPGA D 4.0 070531
BSP 2 PCI TO SLAVE A1 FIFO: ok
BSP 2 PCI TO SLAVE A2 FIFO: ok
BSP 2 PCI TO SLAVE A3 FIFO: ok
BSP 2 PCI TO SLAVE B1 FIFO: ok
BSP 2 PCI TO SLAVE B2 FIFO: ok
BSP 2 PCI TO SLAVE B3 FIFO: ok
BSP 2 PCI TO SLAVE C1 FIFO: ok
BSP 2 PCI TO SLAVE C2 FIFO: ok
BSP 2 PCI TO SLAVE C3 FIFO: ok
BSP 2 PCI TO SLAVE D1 FIFO: ok
BSP 2 PCI TO SLAVE D2 FIFO: ok
BSP 2 PCI TO SLAVE D3 FIFO: ok
BSP 2 PCI TO MASTER A HPI: ok
BSP 2 PCI TO MASTER B HPI: ok
BSP 2 PCI TO MASTER C HPI: ok
BSP 2 PCI TO MASTER D HPI: ok
BSP 2 PCI TO SLAVE A0 HPI: ok
BSP 2 PCI TO SLAVE A1 HPI: ok
BSP 2 PCI TO SLAVE A2 HPI: ok
BSP 2 PCI TO SLAVE B0 HPI: ok
BSP 2 PCI TO SLAVE B1 HPI: ok
BSP 2 PCI TO SLAVE B2 HPI: ok
BSP 2 PCI TO SLAVE C0 HPI: ok
BSP 2 PCI TO SLAVE C1 HPI: ok
BSP 2 PCI TO SLAVE C2 HPI: ok
BSP 2 PCI TO SLAVE D0 HPI: ok
BSP 2 PCI TO SLAVE D1 HPI: ok
BSP 2 PCI TO SLAVE D2 HPI: ok

2011.08.03 18:43:10.799 101 1 OK

High Voltage Br. 1

TX36 Spec: 90.0 - 145.0
0-1 119.7
0-2 119.7
0-3 119.3
0-4 119.3
0-5 119.3
0-6 118.4
0-7 119.3
0-8 118.0
0-9 119.3
0-10 119.3
0-11 119.7
0-12 118.0
0-13 120.1
0-14 119.3
0-15 120.1
0-16 119.7
0-17 118.4
0-18 119.3
0-19 118.8
0-20 118.8
0-21 118.8
0-22 119.7
0-23 118.4
0-24 119.3

High Voltage Br. 2

TX36 Spec: 90.0 - 145.0
0-1 119.3
0-2 118.9
0-3 118.9
0-4 118.4
0-5 118.9
0-6 118.9
0-7 118.4
0-8 118.4
0-9 119.3
0-10 119.3
0-11 118.9
0-12 119.3
0-13 118.0
0-14 119.3
0-15 119.7
0-16 119.3
0-17 118.9
0-18 119.3
0-19 118.4
0-20 118.9
0-21 119.3
0-22 119.7
0-23 118.9
0-24 118.9

Input voltage 12V

TX36 Spec: 11.0 - 13.0
0-1 11.9
0-2 11.9
0-3 11.9
0-4 11.9
0-5 11.9
0-6 11.9
0-7 11.9
0-8 11.9
0-9 11.9
0-10 11.9
0-11 11.9
0-12 11.9
0-13 11.9
0-14 11.9
0-15 11.9
0-16 12.0
0-17 11.9
0-18 11.9
0-19 11.8
0-20 11.9
0-21 11.9
0-22 11.9
0-23 11.8
0-24 11.9

Digital 3.3V

TX36 Spec: 2.8 - 3.5
0-1 3.3
0-2 3.3
0-3 3.3

0-4 3.3
0-5 3.3
0-6 3.3
0-7 3.3
0-8 3.3
0-9 3.3
0-10 3.3
0-11 3.3
0-12 3.3
0-13 3.3
0-14 3.3
0-15 3.3
0-16 3.3
0-17 3.3
0-18 3.3
0-19 3.3
0-20 3.3
0-21 3.3
0-22 3.3
0-23 3.3
0-24 3.3

Digital 2.5V

TX36 Spec: 2.4 - 2.6
0-1 2.5
0-2 2.5
0-3 2.5
0-4 2.5
0-5 2.5
0-6 2.5
0-7 2.5
0-8 2.5
0-9 2.5
0-10 2.5
0-11 2.5
0-12 2.5
0-13 2.5
0-14 2.5
0-15 2.5
0-16 2.5
0-17 2.5
0-18 2.5
0-19 2.5
0-20 2.5
0-21 2.5
0-22 2.5
0-23 2.5
0-24 2.5

Digital 1.5V

TX36 Spec: 1.4 - 1.6
0-1 1.5
0-2 1.5
0-3 1.5
0-4 1.5
0-5 1.5
0-6 1.5
0-7 1.5
0-8 1.5
0-9 1.5
0-10 1.5
0-11 1.5
0-12 1.5
0-13 1.5
0-14 1.5
0-15 1.5
0-16 1.5
0-17 1.5
0-18 1.5
0-19 1.5
0-20 1.5
0-21 1.5
0-22 1.5
0-23 1.5
0-24 1.5

Temperature

TX36 Spec: 15.0 - 75.0
0-1 43.2
0-2 43.2
0-3 43.2
0-4 42.8
0-5 43.2
0-6 43.6
0-7 44.0
0-8 44.0
0-9 44.0
0-10 41.2
0-11 40.8
0-12 41.2
0-13 42.4
0-14 44.4
0-15 42.8
0-16 43.2
0-17 43.2
0-18 44.0
0-19 43.2
0-20 43.6
0-21 43.2
0-22 42.4
0-23 42.8
0-24 42.8

Input Current 12V

TX36 Spec: 0.3 - 1.5
0-1 0.6
0-2 0.6
0-3 0.6
0-4 0.5
0-5 0.5
0-6 0.5
0-7 0.6
0-8 0.5
0-9 0.6
0-10 0.5
0-11 0.6
0-12 0.6
0-13 0.6
0-14 0.6
0-15 0.6
0-16 0.5
0-17 0.8
0-18 0.7
0-19 0.6
0-20 0.6
0-21 0.7
0-22 0.5
0-23 0.6
0-24 0.6

TX36 power test passed

IO TX MB Embedded PPC Embedded
PPC Download
2.11 One CPU1.13 Reduced Performance: 1
voice/Mar 5 2007/1.07 Jun 17 2008/1.11

TX36 unique firmware test OK

2011.08.03 18:43:10.982 101 2
OK

Input voltage 12V

RX32 Spec: 11.0 - 13.0
7-1 11.6
7-2 11.7
7-3 11.7
7-4 11.7

Input voltage 6V

RX32 Spec: 5.0 - 7.0
7-1 5.7
7-2 5.7
7-3 5.7
7-4 5.7

Digital 3.3V

RX32 Spec: 2.8 - 3.5
7-1 3.3
7-2 3.3
7-3 3.3
7-4 3.3

Digital 2.5V

RX32 Spec: 2.4 - 2.6
7-1 2.5
7-2 2.5
7-3 2.5
7-4 2.4

Digital 1.5V

RX32 Spec: 1.4 - 1.6
7-1 1.5
7-2 1.5
7-3 1.5
7-4 1.5

Temperature

RX32 Spec: 15.0 - 75.0
7-1 48.0
7-2 49.0
7-3 49.0

7-4   46.0

Input Current 12V

RX32   Spec: 0.4 - 1.5
7-1   0.7
7-2   0.7
7-3   0.7
7-4   0.7

Input Current 6V

RX32   Spec: 2.4 - 3.3
7-1   2.7
7-2   2.8
7-3   2.8
7-4   2.8

RX32   power test passed

IO   RX   MB Embedded   PPC Embedded
PPC Download
1.12 Generic1.14 GenericMay 5 2006/1.06
May 5 2006/1.07 Apr 25 2008/1.11

RX32 unique firmware test OK

2011.08.03 18:43:11.115 101   3
OK

High Voltage Br. 1

TX36   Spec: 90.0 - 145.0
0-1   119.7
0-2   119.7
0-3   119.3
0-4   119.3
0-5   119.3
0-6   118.4
0-7   119.3
0-8   118.0
0-9   119.3
0-10   119.3
0-11 119.7
0-12 118.0
0-13 120.1
0-14 118.8
0-15 120.1
0-16 119.7
0-17 118.8
0-18 119.3
0-19 118.8
0-20 118.8
0-21 118.8
0-22 119.7
0-23 118.4
0-24 119.3

High Voltage Br. 2

TX36   Spec: 90.0 - 145.0
0-1   119.3
0-2   119.3
0-3   118.9
0-4   118.4
0-5   118.9
0-6   118.9
0-7   118.4
0-8   118.4
0-9   119.3
0-10   119.3
0-11 118.9
0-12 119.3
0-13 118.0
0-14 119.3
0-15 119.7
0-16 119.3
0-17 119.3
0-18 118.9
0-19 118.4
0-20 118.9
0-21 119.3
0-22 119.7
0-23 118.9
0-24 119.3

Input voltage 12V

TX36   Spec: 11.0 - 13.0
0-1   11.9
0-2   11.9
0-3   11.9
0-4   11.9
0-5   11.9
0-6   11.9
0-7   11.9
0-8   11.9
0-9   11.9
0-10   11.9
0-11   11.9
0-12   11.9
0-13   11.9
0-14   11.9
0-15   11.9
0-16   12.0
0-17   11.9
0-18   11.9
0-19   11.8
0-20   11.9
0-21   11.9
0-22   11.9
0-23   11.8
0-24   11.9

RX32   Spec: 11.0 - 13.0
7-1   11.6
7-2   11.7
7-3   11.7
7-4   11.7

Input voltage 6V

RX32   Spec: 5.0 - 7.0
7-1   5.7
7-2   5.7
7-3   5.7
7-4   5.7

TRU power test passed

2011.08.03 18:43:11.299 101   4
OK

EM 302 High Voltage Ramp Test
Test Voltage:20.00 Measured Voltage:
19.00 PASSED
Test Voltage:40.00 Measured Voltage:
39.00 PASSED
Test Voltage:60.00 Measured Voltage:
59.00 PASSED
Test Voltage:80.00 Measured Voltage:
79.00 PASSED
Test Voltage:100.00 Measured Voltage:
100.00 PASSED
Test Voltage:120.00 Measured Voltage:
121.00 PASSED
Test Voltage:120.00 Measured Voltage:
121.00 PASSED
Test Voltage:100.00 Measured Voltage:
106.00 PASSED
Test Voltage:80.00 Measured Voltage:
85.00 PASSED
Test Voltage:60.00 Measured Voltage:
65.00 PASSED
Test Voltage:40.00 Measured Voltage:
45.00 PASSED

11 of 11 tests OK

2011.08.03 18:45:45.157 101   5
OK

BSP 1 RXI TO RAW FIFO: ok
BSP 2 RXI TO RAW FIFO: ok

2011.08.03 18:45:49.474 101   6
OK

Receiver impedance limits [600.0 1000.0]
ohm
Board 1   2   3   4

1:	855.7	847.4	820.0	850.6
2:	827.8	856.7	821.0	849.7
3:	814.4	846.3	847.4	819.3
4:	838.6	830.3	835.8	850.3
5:	844.1	842.4	799.7	847.8
6:	850.2	850.1	829.3	840.9
7:	829.6	846.4	832.9	847.5
8:	839.4	839.2	849.0	761.4
9:	835.1	840.9	826.8	864.6
10:	816.7	852.3	782.6	835.8
11:	836.7	832.1	832.5	850.2
12:	846.4	823.6	845.5	853.3
13:	840.3	833.1	816.4	831.9
14:	825.5	834.9	852.8	840.8
15:	820.8	839.1	840.5	820.8
16:	845.9	826.1	850.6	872.2
17:	823.2	875.2	852.5	858.0
18:	842.7	843.2	854.0	827.6
19:	812.6	835.1	838.5	839.7
20:	827.1	863.0	844.1	851.2
21:	856.0	839.8	877.8	876.3
22:	874.0	844.6	831.5	840.2
23:	865.5	860.9	851.2	860.1
24:	877.4	877.2	867.6	853.9
25:	837.8	836.5	837.2	865.9
26:	841.1	827.4	845.7	851.0
27:	824.3	834.2	838.6	847.8
28:	813.1	834.3	815.5	839.5
29:	812.3	847.8	835.2	837.3
30:	850.7	827.9	838.4	0.0*
31:	826.3	830.1	849.8	837.4
32:	848.6	871.3	848.9	868.6

Transducer impedance limits [250.0 2000.0] ohm

Board	1	2	3	4
1:	329.1	345.6	346.7	346.8
2:	345.7	345.2	350.1	342.2
3:	331.4	326.6	361.9	350.1
4:	334.4	347.6	369.7	342.3
5:	328.4	350.5	361.7	338.6
6:	320.3	336.1	342.9	351.1
7:	332.7	342.1	374.5	356.1
8:	323.9	332.4	348.3	389.6
9:	355.9	350.7	366.7	347.5
10:	347.5	340.5	367.9	339.6
11:	320.0	351.3	352.1	354.7
12:	330.7	355.7	345.6	341.3
13:	330.3	340.3	371.4	354.0
14:	354.5	340.3	362.6	341.5
15:	323.5	334.7	359.2	336.2
16:	321.8	348.9	363.1	353.4
17:	323.0	350.4	345.6	352.7
18:	338.3	341.1	353.3	362.3
19:	345.8	347.9	349.8	360.5
20:	339.2	336.1	348.6	340.4
21:	336.5	340.7	340.2	351.1
22:	347.7	350.8	362.5	351.2
23:	356.9	336.3	349.0	355.5
24:	354.6	352.8	343.6	336.5
25:	334.9	355.3	352.0	343.7
26:	341.8	359.6	357.8	348.2
27:	334.2	349.2	353.0	340.8
28:	349.1	355.3	359.8	335.5
29:	345.6	350.7	370.3	362.5
30:	321.7	336.1	339.2	0.0*
31:	336.7	354.1	348.1	352.4
32:	331.2	346.2	349.0	350.3

Receiver Phase limits [-50.0 20.0] deg

Board	1	2	3	4
1:	-2.2	2.3	4.6	-1.2
2:	1.6	-4.5	3.6	-2.8
3:	3.6	-2.5	-0.9	3.7
4:	-0.5	2.2	1.6	-3.6
5:	-1.0	0.6	4.9	0.7
6:	-3.0	-2.4	0.5	0.9
7:	2.5	0.1	2.9	-1.0
8:	-1.6	0.5	-3.4	13.0
9:	-0.8	2.5	2.9	-2.1
10:	3.2	-2.6	7.7	-0.9
11:	-2.6	2.2	-1.0	0.4
12:	-1.6	2.0	-3.4	-1.8
13:	0.5	1.3	4.3	3.9
14:	2.0	0.0	-0.5	0.4
15:	1.2	-2.9	-0.4	3.7
16:	-2.0	2.9	-2.4	-5.1
17:	0.6	-3.2	-3.4	-0.2
18:	-3.0	1.5	-3.1	3.3
19:	2.3	2.4	-3.3	2.1
20:	2.0	-2.3	-0.8	1.0
21:	-0.5	2.7	-5.5	-2.9
22:	-2.3	-1.1	1.5	0.0
23:	0.2	-3.4	-0.5	-1.1
24:	-2.7	-2.8	-3.8	-2.0
25:	-0.4	2.0	1.5	-3.8
26:	-1.1	4.7	-3.2	-1.9
27:	1.9	-0.9	0.2	-3.0
28:	5.6	-1.0	2.0	0.8
29:	2.9	1.6	0.8	2.9
30:	-2.8	1.1	-0.4	200.9*
31:	1.2	1.3	-1.8	1.7
32:	-3.3	-4.1	-1.4	-5.0

Transducer Phase limits [-100.0 0.0] deg

Board	1	2	3	4
1:	-34.5	-36.6	-35.4	-39.2
2:	-36.0	-39.6	-32.6	-43.5
3:	-31.0	-40.7	-35.8	-39.7
4:	-38.2	-35.9	-38.5	-37.7
5:	-37.8	-40.0	-38.6	-37.0
6:	-36.3	-35.9	-36.5	-37.6
7:	-33.4	-38.4	-37.4	-40.1
8:	-36.2	-38.9	-42.4	-32.6
9:	-38.9	-36.0	-36.6	-41.5
10:	-41.6	-38.5	-29.6	-33.2
11:	-37.8	-38.7	-43.2	-39.0
12:	-35.2	-37.9	-44.9	-40.2
13:	-34.8	-42.0	-33.9	-43.3
14:	-36.7	-43.5	-36.2	-38.1
15:	-29.8	-44.9	-38.0	-30.1
16:	-37.1	-38.8	-37.2	-36.8
17:	-28.0	-37.5	-40.3	-36.3
18:	-33.3	-35.4	-39.4	-37.5
19:	-35.2	-36.0	-36.9	-39.3
20:	-33.2	-40.6	-40.9	-38.4
21:	-32.3	-37.8	-35.8	-38.8
22:	-36.3	-40.8	-32.7	-35.3
23:	-35.5	-42.4	-35.5	-35.7
24:	-37.2	-40.7	-40.2	-32.4
25:	-29.6	-35.7	-35.8	-39.0
26:	-40.2	-37.1	-36.1	-40.9
27:	-32.3	-38.6	-34.6	-41.3
28:	-36.7	-39.3	-34.3	-37.4
29:	-37.7	-40.4	-39.1	-35.3
30:	-33.9	-39.5	-38.3	-126.7*
31:	-39.5	-41.3	-35.5	-31.8
32:	-39.9	-40.5	-35.9	-40.8

Rx Channels test passed

2011.08.03 18:46:16.476 101   7
OK

Tx Channels test passed

2011.08.03 18:49:10.869 101   8
OK

RX NOISE LEVEL

Board No:	1	2	3	4	
0:	46.3	42.6	43.6	45.7	dB
1:	45.0	42.0	42.8	45.0	dB
2:	44.4	42.3	43.6	45.6	dB
3:	43.6	41.3	42.1	44.0	dB
4:	43.4	43.6	44.5	46.5	dB
5:	42.8	42.5	44.8	45.6	dB
6:	43.4	42.9	44.1	44.5	dB
7:	42.7	42.2	43.9	46.6	dB
8:	42.2	44.6	45.8	51.9	dB
9:	42.5	42.0	45.0	47.2	dB
10:	42.7	42.9	44.7	47.6	dB
11:	42.1	43.9	43.7	46.7	dB
12:	42.7	44.3	45.0	46.5	dB
13:	42.4	43.3	44.9	46.6	dB
14:	41.4	43.6	44.5	46.2	dB
15:	42.1	43.3	45.5	45.4	dB
16:	40.1	41.7	42.3	44.1	dB
17:	41.5	41.5	42.5	43.4	dB
18:	40.9	42.1	43.7	44.0	dB
19:	41.3	41.1	44.2	42.9	dB
20:	41.4	42.5	49.2	43.9	dB
21:	42.4	42.3	54.3	45.3	dB
22:	43.4	41.6	51.1	45.4	dB
23:	43.1	44.1	53.6	45.9	dB
24:	42.4	41.7	48.4	46.2	dB
25:	43.0	43.6	47.0	45.4	dB
26:	42.8	43.3	45.1	46.4	dB
27:	43.2	42.5	44.0	46.8	dB
28:	43.0	43.4	44.7	47.9	dB
29:	41.8	43.4	44.0	61.7	dB
30:	41.1	43.8	43.9	49.6	dB
31:	41.8	44.9	45.2	50.9	dB

Maximum noise at Board 4 Channel 29
Level: 61.7 dB

Broadband noise test

Average noise at Board 1   42.8 dB   OK
Average noise at Board 2   43.0 dB   OK
Average noise at Board 3   46.8 dB   OK
Average noise at Board 4   49.6 dB   OK

2011.08.03 18:49:16.569 101 9
OK

RX NOISE SPECTRUM

Board No:	1	2	3	4	
26.1 kHz:	49.2	50.5	53.6	63.1	dB
26.3 kHz:	45.8	47.4	50.6	51.1	dB
26.5 kHz:	43.8	44.1	50.7	47.8	dB
26.7 kHz:	44.5	44.4	51.1	49.1	dB
26.9 kHz:	43.2	43.1	51.4	48.3	dB
27.1 kHz:	44.1	45.1	52.5	50.5	dB
27.3 kHz:	43.2	42.8	50.5	47.1	dB
27.5 kHz:	42.9	43.3	50.2	47.5	dB
27.7 kHz:	42.1	42.5	48.6	46.3	dB
27.9 kHz:	42.5	42.2	48.2	45.9	dB
28.1 kHz:	43.0	42.3	48.8	45.8	dB
28.3 kHz:	42.6	43.0	49.0	45.3	dB
28.5 kHz:	42.1	42.7	48.0	45.3	dB
28.7 kHz:	42.3	42.7	49.1	45.9	dB
28.9 kHz:	42.7	42.1	47.7	45.9	dB
29.1 kHz:	42.7	43.0	47.7	47.3	dB
29.3 kHz:	41.6	43.0	47.6	48.2	dB
29.5 kHz:	41.7	42.7	48.1	48.2	dB
29.7 kHz:	41.9	42.1	46.6	47.8	dB
29.9 kHz:	41.2	42.4	47.6	48.0	dB
30.1 kHz:	42.3	43.0	48.3	47.4	dB
30.3 kHz:	43.2	43.7	46.9	47.6	dB
30.5 kHz:	43.4	43.1	46.9	46.0	dB
30.7 kHz:	46.3	44.4	48.6	47.1	dB
30.9 kHz:	41.9	42.2	47.0	45.8	dB
31.1 kHz:	41.3	41.9	47.1	46.5	dB
31.4 kHz:	41.4	42.5	46.4	47.1	dB
31.6 kHz:	40.9	42.0	46.6	44.7	dB
31.8 kHz:	40.6	41.5	45.2	45.0	dB
32.0 kHz:	40.8	41.8	44.8	45.2	dB
32.2 kHz:	41.0	41.1	45.8	44.7	dB
32.4 kHz:	40.7	41.2	45.3	44.4	dB
32.6 kHz:	40.4	41.2	45.0	44.1	dB
32.8 kHz:	40.7	40.6	44.1	43.9	dB
33.0 kHz:	40.0	40.9	43.4	43.7	dB
33.2 kHz:	39.8	40.3	43.0	43.3	dB
33.4 kHz:	39.2	40.4	43.2	43.0	dB
33.6 kHz:	38.7	40.2	42.7	44.7	dB
33.8 kHz:	39.0	39.5	43.2	42.8	dB
34.0 kHz:	38.2	39.0	44.2	43.0	dB

Maximum noise at Board 4 Frequency 26.1 kHz Level: 63.1 dB

Spectral noise test

Average noise at Board 1 42.7 dB OK
Average noise at Board 2 43.2 dB OK
Average noise at Board 3 48.2 dB OK
Average noise at Board 4 49.8 dB OK

2011.08.03 18:49:22.270 101 10
OK

CPU: KOM CP6011
Clock 1795 MHz
Die 42 oC (peak: 55 oC @ 2011-08-03 - 10:57:59)
Board 45 oC (peak: 50 oC @ 2011-08-03 - 11:05:35)
Core 1.34 V
3V3 3.30 V
12V 12.05 V
-12V -12.04 V
BATT 3.50 V
Primary network: 157.237.14.60:0xffff0000
Secondary network: 192.168.2.20:0xffffff00

2011.08.03 18:49:22.403 101 15
OK

EM 302

BSP67B Master: 2.2.3 090702
BSP67B Slave: 2.2.3 090702
CPU: 1.4.8 091110
DDS: 3.4.9 070328
RX32 version : Apr 25 2008 Rev 1.11
TX36 LC version : Jun 17 2008 Rev 1.11
VxWorks 5.5.1 Build 1.2/2-IX0100 May 16 2007, 11:31:17

Appendix G: Permits and Cruise Correspondence

Permit to conduct XBT operations in Florida Keys National Marine Sanctuary

FLORIDA KEYS NATIONAL MARINE SANCTUARY
RESEARCH & EDUCATION PERMITS

GUIDELINES FOR SUBMITTING PERMIT REPORTS
Interim Report & Final Report

Please submit all the requested information electronically (MS Word, rich text format, or PDF) to Scott Donahue (Scott.Donahue@noaa.gov) and Joanne Delaney (Joanne.Delaney@noaa.gov).

Permit number:
Date:
Permittee name and contact information (affiliation, address, phone, fax, e-mail):

Type of report: (contents are the same)
☐ Interim report
☐ Final report

Please provide a 1-2 page (max.) project summary, which includes topics listed below. Please indicate if any of the information contained in your project summary **should not be made available to the public** in Sanctuary research summaries or other literature.

- Goal(s) of project
- Significance of project and connection to Sanctuary management issues
- Hypotheses (if applicable) & methods (brief description)
- Results/findings to date
- Table, graph, photos as appropriate
- List of publications resulting from permitted activities

Additionally, if permitted activities included collection of organisms, provide the following information (list, table or chart is acceptable):

For stony coral and/or sea fan collections:	For non-coral species collections (fish, regulated invertebrates, algae, etc.):
• Dates of collection	• Dates of collection
• Species	• Location of collections (GPS coordinates)
• Quantity	• Names of organisms and approximate quantity collected
• Size(s)	
• Method of collection	
• Location of collection (GPS coordinates)	
• Fate of all specimens collected	
• Mitigation completed, if any	

Please briefly describe any other permitted activities conducted (date and description of activity performed) that were not mentioned above (list, table or chart).

Please briefly describe any deviations from permitted activities.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

Florida Keys National Marine Sanctuary
33 East Quay Road
Key West, FL 33040

August 9, 2011

Ms. Elizabeth Lobecker
NOAA Office of Ocean Exploration and Research
24 Colovos Rd.
UNH-IOCM
Durham, NH 03824

Dear Ms. Lobecker:

The National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries (ONMS) has approved the issuance of permit number FKNMS-2011-097 to conduct activities within Florida Keys National Marine Sanctuary (sanctuary) for research purposes. Activities are to be conducted in accordance with the permit application and all supporting materials submitted to the sanctuary, and the terms and conditions of permit number FKNMS-2011-097 (enclosed).

This permit is not valid until signed and returned to the ONMS. Retain one signed copy and carry it with you while conducting the permitted activities. Additional copies must be signed and returned, by either mail or email, to the following individuals within 30 days of issuance and before commencing any activity authorized by this permit:

Scott Donahue
Associate Science Coordinator
Florida Keys National Marine Sanctuary
33 East Quay Road
Key West, FL 33040
Scott.Donahue@noaa.gov

National Permit Coordinator
NOAA Office of National Marine Sanctuaries
1305 East-West Highway (N/ORM6)
SSMC4, 11th Floor
Silver Spring, MD 20910
nmspermits@noaa.gov

Your permit contains specific terms, conditions and reporting requirements. Review them closely and fully comply with them while undertaking permitted activities.

If you have any questions, please contact Joanne Delaney at Joanne.Delaney@noaa.gov. Thank you for your continued cooperation with the ONMS.

Sincerely,

Sean Morton
Superintendent

Enclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE

Florida Keys National Marine Sanctuary
33 East Quay Road
Key West, FL 33040

FLORIDA KEYS NATIONAL MARINE SANCTUARY
RESEARCH PERMIT

Permittee:
Ms. Elizabeth Lobecker
NOAA Office of Ocean Exploration and Research
24 Colovos Rd.
UNH-IOCM
Durham, NH 03824

Permit Number: FKNMS-2011-097
Effective Date: August 9, 2011
Expiration Date: August 31, 2011

Project Title: NOAA Ship Okeanos Explorer cruise EX1104, Exploration - Cayman Trench

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This permit is issued for activities in accordance with the National Marine Sanctuaries Act (NMSA), 16 USC §1431 *et seq.*, and regulations thereunder (15 CFR Part 922). All activities must be conducted in accordance with those regulations and law. No activity prohibited in 15 CFR Part 922 is allowed except as specified in the activity description below.

Subject to the terms and conditions of this permit, the National Oceanic and Atmospheric Administration (NOAA), Office of National Marine Sanctuaries (ONMS) hereby authorizes the permittee listed above to conduct research activities within Florida Keys National Marine Sanctuary (FKNMS or sanctuary). All activities are to be conducted in accordance with this permit and the permit application received July 25, 2011. The permit application is incorporated into this permit and made a part hereof; provided, however, that if there are any conflicts between the permit application and the terms and conditions of this permit, the terms and conditions of this permit shall be controlling.

Permitted Activity Description:
The following activities are authorized by this permit:

1. Discharge of up to two (2) eXpendable Bathy Thermographs (XBTs) within waters of FKNMS.

No further violation of sanctuary regulations is allowed.

Permitted Activity Location:
The permitted activity is allowed in FKNMS waters of west of Key West, FL (west of 81.80° W longitude).

Special Terms and Conditions:

1. No other materials are authorized for discharge or deposit into the Sanctuary.

2. NOAA Ship Okeanos Explorer may not enter the Area To Be Avoided (ATBA).

3. The permittee must submit a final report of activities thirty (30) days after the permit expires or (30) days prior if a renewal is desired. The report shall consist of a 1-2 page summary of activities conducted under this permit that follows the attached permit report guidelines. The report shall be submitted to: Scott Donahue (Scott.Donahue@noaa.gov), FKNMS Associate Science Coordinator, and Joanne Delaney (Joanne.Delaney@noaa.gov), FKNMS Permit Coordinator.

4. Any scientific publications and/or reports resulting from activities conducted under the authority of this permit must include the notation that the activity was conducted under permit number FKNMS-2011-097. Additionally, the permittee and her respective institution(s) are required to acknowledge during any media coverage (press releases, video/photo, or other means) that research activities occurred within the FKNMS and under permit. Boilerplate language on the sanctuary is available by request; contact Karrie Carnes at Karrie.Carnes@noaa.gov.

General Terms and Conditions:

1. Within 30 (thirty) days of the date of issuance, the permittee must sign and date this permit for it to be considered valid. Once signed, the permittee must send copies, via mail or email, to the following individuals:

Scott Donahue
Associate Science Coordinator
Florida Keys National Marine Sanctuary
33 East Quay Road
Key West, FL 33040
Scott.Donahue@noaa.gov

National Permit Coordinator
NOAA Office of National Marine Sanctuaries
1305 East-West Highway (N/ORM6)
SSMC4, 11th Floor
Silver Spring, MD 20910
nmspermits@noaa.gov

2. It is a violation of this permit to conduct any activity authorized by this permit prior to the ONMS having received a copy signed by the permittee.

3. This permit may only be amended by the ONMS. The permittee may not change or amend any part of this permit at any time. The terms of the permit must be accepted in full, without revision; otherwise, the permittee must return the permit to the sanctuary office unsigned with a written explanation for its rejection. Amendments to this permit must be requested in the same manner the original request was made.

4. All persons participating in the permitted activity must be under the supervision of the permittee, and the permittee is responsible for any violation of this permit, the NMSA, and sanctuary regulations for activities conducted under, or in junction with, this permit. The permittee must assure that all persons performing activities under this permit are fully aware of the conditions herein.

5. This permit is non-transferable and must be carried by the permittee at all times while engaging in any activity authorized by this permit.

6. This permit may be suspended, revoked, or modified for violation of the terms and conditions of this permit, the regulations at 15 CFR Part 922, the NMSA, or for other good cause. Such action will be communicated in writing to the applicant or permittee, and will set forth the reason(s) for the action taken.

7. This permit may be suspended, revoked or modified if requirements from previous ONMS permits or authorizations issued to the permittee are not fulfilled by their due date.

8. Permit applications for any future activities in the sanctuary or any other sanctuary in the system by the permittee might not be considered until all requirements from this permit are fulfilled.

9. This permit does not authorize the conduct of any activity prohibited by 15 CFR § 922, other than those specifically described in the "Permitted Activity Description" section of this permit. If the permittee or any person acting under the permittee's supervision conducts, or causes to be conducted, any activity in the sanctuary not in accordance with the terms and conditions set forth in this permit, or who otherwise violates such terms and conditions, the permittee may be subject to civil penalties, forfeiture, costs, and all other remedies under the NMSA and its implementing regulations at 15 CFR Part 922.

10. Any publications and/or reports resulting from activities conducted under the authority of this permit must include the notation that the activity was conducted under National Marine Sanctuary Permit FKNMS-2011-097 and be sent to the ONMS officials listed in general condition number 1.

11. This permit does not relieve the permittee of responsibility to comply with all other federal, state and local laws and regulations, and this permit is not valid until all other necessary permits, authorizations, and approvals are obtained. Particularly, this permit does not allow disturbance of marine mammals or seabirds protected under provisions of the Endangered Species Act, Marine Mammal Protection Act, or Migratory Bird Treaty Act. Authorization for incidental or direct harassment of species protected by these acts must be secured from the U.S. Fish and Wildlife Service and/or NOAA Fisheries, depending upon the species affected.

12. The permittee shall indemnify and hold harmless the Office of National Marine Sanctuaries, NOAA, the Department of Commerce and the United States for and against any claims arising from the conduct of any permitted activities.

13. Any question of interpretation of any term or condition of this permit will be resolved by NOAA.

Your signature below, as permittee, indicates that you accept and agree to comply with all terms and conditions of this permit. This permit becomes valid when you, the permittee, countersign and date below. Please note that the expiration date on this permit is already set and will not be extended by a delay in your signing.

E. Lobecker — Aug. 9, 2011

Ms. Elizabeth Lobecker — Date
NOAA Office of Ocean Exploration and Research

August 9, 2011

Sean Morton — Date
Superintendent
Florida Keys National Marine Sanctuary

1 document attached.

Appendix H: Additional Logs

Table 3. Built In System Tests

EX1104 BIST LOG												
BIST FILE NAME	DATE (UTC)	TIME (GMT)	BIST TYPE	SHIP HDG	LAT N / LONG W (WGS84)	SPEED (kts)	Max RX Noise (dB) / Board / Channel	Avg RX Noise Board 1 (dB)	Avg RX Noise Board 2 (dB)	Avg RX Noise Board 3 (dB)	Avg RX Noise Board 4 (dB)	NOTES
EX1104_01	8/2/11	2257	All	231	8.953/79.575	00.0	71.3/4/31	67.6	67.6	67.9	68.7	At the pier in Panama
EX1104_02	8/3/11	0924	All	342	9.672/79.945	10.0	64.2/4/1	59.3	59.5	59.8	60.3	Just left Panama Canal
EX1104_03	8/3/11	1843	All	350	10.974/80.209	10.0	61.7/4/29	42.8	43.0	46.8	49.6	At the Columbia EEZ
EX1104_04	8/4/11	1629	All	001	15.092/80.694	11.0	53.6/4/31	41.0	42.3	44.8	46.7	Columbia/Nicaruaga EEZ
EX1104_05	8/5/11	1208	All	359	18.376/81.790	05.2	61.7/4/29	40.1	39.2	39.9	48.3	Cayman EEZ
EX1104_06	8/10/11	1214	All	075	18.378/81.806	11.0	58.4/1/17	55.0	52.3	50.0	51.8	Cayman EEZ
EX1104_07	8/12/11	2351	All	151	18.303/81.720	11.0	54.1/1/0	47.5	45.1	43.8	43.3	Cayman EEZ
EX1104_08	8/16/11	1420	All	309	19.929/82.894	11.0	61.7/4/29	44.8	43.6	44.4	50.5	Cayman/Cuba EEZ
EX1104_09	8/18	1007	All	224	24.338/81.831	7	61.7/4/29	45.0	44.5	44.5	49.6	Final BIST - outside Key West

Table 4. Weather Log

EX1104 Weather Log								
Local Date	**Local Time**	**UTC Time**	**Wind Direction (deg)**	**Wind Speed (kts)**	**Swell Height (ft)**	**Swell Direction (deg)**	**Wave Height (ft)**	**Wave Direction (deg)**
8/3/2011	0615	1115	047	11.0	2-4	020	0-1	020
8/3/2011	0900	1400	050	12.0	2-4	050	1-2	050
8/3/2011	1200	1700	070	10.0	3-5	040	2-4	070
8/3/2011	1500	2200	060	4.0	3-5	030	2-4	060
8/4/2011	1207	1707	000	9.0	2-3	050	0-1	000
8/4/2011	1500	2000	330	9.0	2-3	060	1-2	330
8/4/2011	1800	2300	025	7.0	2-3	040	1-2	025
8/4/2011	2100	0200	350	7.0	2-3	030	1	350
8/5/2011	0000	0500	020	7.0	-	-	-	-
8/5/2011	0300	0800	var	3.0	-	-	-	-
8/5/2011	0600	1100	060	7.0	2-3	040	1-2	060
8/5/2011	1800	2300	090	5.0	1-2	060	1	090
8/5/2011	2100	0200	100	8.0	1-2	060	1	100
8/6/2011	0000	0500	110	13.0	-	-	-	-

8/6/2011	0300	0800	150	12.0	-	-	-	-
8/6/2011	0416	0916	118.5	14.1	2	-	1-2	-
8/6/2011	0600	1100	120	14.0	3-4	110	2-3	120
8/6/2011	2200	0300	090	12.0	3-4	110	2-3	090
8/7/2011	0100	0600	090	18.0	-	-	-	-
8/7/2011	0400	0900	100	16.0	-	-	-	-
8/7/2011	0700	1200	100	13.0	5-6	120	3-4	100
8/7/2011	1900	0000	080	15.0	4-6	110	2-4	080
8/7/2011	2200	0300	070	17.0	4-6	110	2-4	070
8/8/2011	0100	0600	060	13.0	-	-	-	-
8/8/2011	0400	0900	090	14.0	-	-	-	-
8/8/2011	0700	1200	090	16.0	4-6	130	1-2	090
8/9/2011	0000	0500	090	10.0	-	-	-	-
8/9/2011	0347	0847	083	16.0	-	110	4-6	-
8/9/2011	0600	1100	080	14.0	4-5	110	2-3	080
8/9/2011	1900	0000	080	4.0	3-5	130/160	1-2	080
8/9/2011	2200	0300	030	15.0	3-5	140	1	030
8/9/2011	2335	0435	080	7.0	3-4	130	1-3	080
8/10/2011	0100	0600	100	10.0	-	-	1-2	100
8/10/2011	0400	0900	100	10.0	-	-	2-3	100
8/10/2011	0700	1200	100	10.0	3-4	130	2-3	100
8/10/201	2000	0300	060	11.0	2-4	120	1-2	060
8/10/2011	2252	0352	290	15.0	3-4	120	1-2	-
8/11/2011	0200	0700	080	10.0	-	-	1-2	080
8/11/2011	0500	1000	090	8.0	-	-	1-2	090
8/11/2011	2017	0117	061	10.0-11.0	2-3	130	1-2	060
8/11/2011	2300	0400	070	9.0	2-3	130	1-2	070
8/12/2011	0300	0800	070	10.0	-	-	1-2	070
8/12/2011	0700	1200	090	6.0	3-4	130	1-2	090
8/12/2011	1900	0000	090	11.0	3-4	134	1-2	090
8/12/2011	2200	0300	100	16.0	3-5	140	1-2	100
8/13/2011	0100	0600	120	15.0	-	-	2-3	120
8/13/2011	0400	0900	120	16.0	4-5	130	2-3	120
8/13/2011	0700	1200	100	16.0	3-5	105	2-3	100
8/13/2011	2000	0100	080	17.0	4-6	115	3-5	080
8/13/2011	2300	0400	060	18.0	4-6	090	3-5	060
8/14/2011	0200	0700	060	14.0	4-6	110	3-5	060
8/14/2011	0500	1000	070	14.0	4-6	120	2-4	070
8/14/2011	2200	0300	070	15.0	3-5	120	1-2	070
8/15/2011	0100	0600	090	11.0	-	-	1-2	090
8/15/2011	0400	0900	050	7.0	2-3	120	1-3	050

8/15/2011	0700	1200	050	13.0	3-4	090	1-2	050
8/15/2011	1900	0000	080	12.0	2-3	130	1-2	080
8/15/2011	2200	0300	080	14.0	2-4	080	1-2	080
8/16/2011	0100	0600	080	12.0	-	-	1-2	080
8/16/2011	0500	0900	100	9.0	-	-	1-2	100
8/16/2011	0800	1200	080	9.0	1-3	090	1-2	080
8/17/2011	1700	2100	L/V	L/V	Calm	-	<1	-
8/17/2011	2000	0000	030	8.0	Calm	-	<1	030
8/17/2011	2300	0300	100	12.0	-	-	-	100
8/18/2011	0200	0600	140	15.0	-	-	1-2	140

Table 5. Software versions in use during the cruise.

Software	**Version**	**Computer**	**Hot fix**
Caris HIPS	6.1	MBPROC1, MBPROC2	None--1-8 downloaded but not applied
C-NAV	3.0.45	N/A	N/A
DP Line Conversion Utility (Matlab)	1	N/A	N/A
ESRI ArcMap	9.3	MBPROC2	N/A
Fledermaus (IVS 3D)	7	MBPROC2	N/A
Fledermaus (IVS 3D)	6.7.0	MBPROC3	N/A
Global Mapper	11.01	EXSCSCL2	N/A
Hydro_MI	8.3	MBPROC1 & 2	N/A
Hypack	9.0.0.22 (hypack admin) - 9.0.5.3 (survey)	Hypack	N/A
KAP Converter	5.7.2	N/A	N/A
Knudsen SBP, Sounder Suite Echo Control Server and Client	Software: V 2.07 Firmware: V.2.04	Knudsen SBP	N/A
MapInfo	10	MBPROC1 & 2	Release Build 35
NOAA Chart Reprojector	2.0.6	N/A	N/A

POS Controller	320 MV V4 SN# 2572 Firmware: 4.0.2.0	Hypack	N/A
Pydro	9.4	MBPROC2	N/A
SCS	4.3.4	SCS-A	N/A
Seasave	7.18	CTD	seabird.com
SIS EM 302	3.6.4	Multibeam	N/A
Snagit	9.1.2	MBPROC1 & SURVEY2	N/A
SonarWiz	4004.0034	MBPROC2	N/A
TRU EM 302	BSV 2.2.3 090702, PSV 1.4.8 091110	N/A	N/A
Velociwin	8.92 Plus	MBPROC1	N/A

Appendix I: Data Management Plan

Okeanos Explorer

EX-11-04: Mid-Cayman Rise Exploration

Data Management Plan

Document Purpose

This document is an addendum to the overarching Okeanos Explorer FY11 Data Management Plan (Appendix VII) and is specific to the EX-11-04 mission entitled "Mid-Cayman Rise Exploration" For more detailed information on the data management effort for the Okeanos Explorer in FY11, please refer to that document.

Data Management Overview

The fourth *Okeanos Explorer (EX)* mission of the FY11 field season will take the ship from Balboa, Panama to Key West, Florida and along the way, will explore the Mid-Cayman Rise in British waters around the Cayman Islands. During transits to and from the primary operating area, underway meteorological and oceanographic data and multibeam mapping survey data will be collected. During the approximately ten days at the Mid-Cayman Rise, multibeam mapping, CTD/rosette casts and ROV dive operations will be performed. High-definition imagery, water samples, gas chromatography, CTD and multibeam data will be generated and managed from this mission. The ship will segment bathymetric survey tracks when crossing over EEZ areas so that each coastal state through whose waters the EX cruises will receive a data package of all data collected in their waters after the mission is complete. The expedition coordinator will mark the dates/times of the EEZ crossings so that the data management team can segment the underway data for the coastal states data delivery. No data, underway or operational, will be collected in Columbian or Cuban waters during this mission.

Assumptions

All data from the entire mission will be publicly releasable. No protected sites have been identified.

Data Management Objectives

The DMT's objectives for this mission are:

- Develop ISO metadata for collection-level and dataset-level records (multibeam, CTD, SCS, gas chromatograph, water sample analysis, imagery, and video) for NOAA and for delivery with foreign data sets.

- Ensure the near real-time update of the *Okeanos Atlas* with
  - Add new data layers as contextual data to the display, including primary operating area, planned survey boundaries, and any other appropriate data layers found.
  - Ship track and hourly observations received via email.

- CTD launch sites and profiles received via URI SRS. DMT will post-process and thin the profiles for quicker display on the site.
- Daily logs pulled from URI through RSS feeds and links to related images on oceanexplorer.noaa.gov website.
- Daily cumulative bathymetric image overlays received via URI SRS.
- Test new ship track KML received via URI SRS, if applicable.

- Cross train backup personnel in SOPs.

- Post-Mission:
  - Execute multibeam data, METOC data, and video/image data pipelines.
  - Deliver ISO metadata and corresponding data collected within the EEZ of foreign coastal states to those states.

Expedition Principals for Data Management
Kelley Elliott, OER Expedition Coordinator
Lt. Megan Nadeau, OMAO, Okeanos Explorer Operations Officer
Webb Pinner, OER Telepresence, EX Data and Information Lead
Sharon Mesick, NCDDC, Federal Program Manager, IPT Chair
Susan Gottfried, NCDDC, OER Data Management Coordinator
Andrew Navard, NCDDC, Okeanos Atlas Developer
David Fischman, NGDC, Geophysical Data Officer
Thomas Ryan, NODC, Oceanographic Data Officer
Anna Fiolek, NCL, Multimedia Librarian

Appendix J: EM 302 Kongsberg EM 302 Multibeam Sonar Description and Operational Specifications

Several features of the *Okeanos Explorer's* 30 kHz multibeam make it an excellent tool for ocean exploration. The following is a brief description of these features.

Depth Range

The system is designed to map the seafloor in water depths of 10 to 7000 meters. This leaves only the deepest parts of the deeper ocean trenches out of the EM 302's reach. In fact, when the ship transited over the Mariana Trench going to and from Indonesia in 2010, the system was able to detect the bottom at depths of up to 8000 meters.

High Density Data

In multibeam data, the denser the data, the finer resolution maps can be produced. In water deptsh 3000 meters and shallower, the system can operate in dual swath, or multiping mode, which results in increased along track data density. This is achieved by detecting two swaths per ping cycle, resulting in up to 864 beams per ping.

The *Okeanos Explorer* mapping team typically operates the multibeam in high density equidistant ping mode, which results in up to 864 evenly spaced soundings on the seafloor per ping.

Multiple Data Types Collected

The system collects seafloor backscatter data, which provides information about the character of the seafloor in terms of bottom type.

The system also collects water column backscatter data, which has the ability to detect gaseous plumes in the water column. The full value of this feature is still being realized.

FM chirp mode is utilized in water depths greater than 1000 meters, and allows for the detection of the bottom further out from nadir than with previous 30 kHz systems. This results in wider swath widths, giving a higher likelihood of new discoveries as well as efficiency of survey operations.

Multibeam Primer

The area of the seafloor covered, or ensonified, by a single beam within a pulse of sound, or ping, is called the beam footprint. This beam footprint is defined in terms of the across track and along track values. Both of these values are dependent on water depth and the beam width at which the sound pulse is transmitted and received. The across track beam width value is also dependent on the receive angle, or "listening" angle, of the system, and the angle from nadir which it is received. The transmit angle for the transmit transducer is 0.5°, which is the smallest possible angle currently available for the EM302 system. The further out from nadir a sounding occurs, the larger the footprint will be. The receive angle for the receive transducer is 1°. As an example, as seen in Table 1 below, in 2000 meters of water, a beam footprint will have a radius of 18 meters at nadir but 25 meters by the time it hits the seafloor at an angle 140 degrees out from nadir.

Calculated acrosstrack acoustic beam footprint in meters for EM 302 (high density ping mode, 432 soundings/profile)

Water depth (m)	**Angle from nadir**			
50	1 deg RX center	90 deg	120 deg	140 deg
100	1	0.5	1	1
200	2	1	2	3
400	4	2	3	5
1000	7	4	6	10
2000	18	9	16	25
4000	35	19	32	-
6000	70	37	-	-
7000	105	56	-	-

Table 6. Calculated EM 302 beam across track footprint. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 17.

Calculated acrosstrack sounding density for EM 302 (high density ping mode, 432 soundings/profile)			
Water depth (m)	**Swath Width**		
50	90 deg	120 deg	140 deg
100	0.2	0.4	0.9
200	0.5	0.8	1.7
400	0.9	1.6	3.5
1000	1.9	3.2	6.9
2000	4.6	8.1	17.4
4000	9.3	16.2	-

Table 7. Calculated across track EM 302 sounding density. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 17.

Acrosstrack sounding density describes the spacing between individual soundings on the seafloor in the acrosstrack direction. The maximum swath of the EM 302 is 150 degrees. At this swath, the sounding density will be the least dense, since the beams will be spread out over a larger horizontal distance over the seafloor. As the swath angle (width) is decreased, the sounding density will increase, as the same number of beams are now spread out over a smaller horizontal distance over the seafloor.

Calculated ping rate and alongtrack resolution for EM 302					
140 deg swath, one profile per ping					
			Alongtrack distance between profiles (m)		
Water depth (m)	**Swath Width (m)**	**Ping Rate (pings/second)**	**@4 kts**	**@8 kts**	**@12 kts**
50	275	3.2	0.7	1.2	1.9
100	550	1.8	1.1	2.2	3.3
200	1100	1	2.1	4.2	6.3
400	2200	0.5	4.1	8.2	12.2
1000	5500	0.2	10	20	30
2000	8000	0.1	15.2	30.5	45.7
4000	8000	0.06	19.2	38.5	57.7

6000	8000	0.04	24.5	49	73.4

Table 8. Calculated ping rate and along track EM 302 sounding density, one profile per ping. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 15.

Calculated ping rate and alongtrack resolution for EM 302					
140 deg swath, two profiles per ping					
			Alongtrack distance between profiles (m)		
Water depth (m)	Swath Width (m)	Ping Rate	@4 kts	@8 kts	@12 kts
50	275	3.2	0.3	0.6	0.9
100	550	1.8	0.6	1.1	1.7
200	1100	1	1.1	2.1	3.2
400	2200	0.5	2	4.1	6.1
1000	5500	0.2	5	10	15
2000	8000	0.1	7.6	15.2	22.8

Table 9. Calculated ping rate and along track EM 302 sounding density, two profiles per ping. Reference: Kongsberg Product description, Kongsberg document 302675 Rev B, Date 14/06/06, p. 15.

Reference: Kongsberg Product Description: EM 302 multibeam echosounder