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NOAA *Okeanos Explorer* Program

MAPPING DATA REPORT

CRUISE EX1004 Leg 4

Exploration Mapping: Bitung, Indonesia to Guam

August 14 -20, 2010

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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 combination of scientific and technological tools uniquely positions it to systematically explore new areas of our largely unknown ocean. These exploration cruises are explicitly designed to generate hypotheses and lead to further investigations by the wider scientific community.

Using a high-resolution multibeam sonar with water column capabilities, a deep water remotely operated vehicle, and telepresence technology, *Okeanos Explorer* provides NOAA the ability to foster scientific discoveries by identifying new targets in real time, diving on those targets shortly after initial detection, and then sending this information back 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 research and analysis

Through the *Okeanos Explorer* Program, NOAA's Office of Ocean Exploration and Research (OER) provides the nation with unparalleled capacity to discover and investigate new oceanic regions 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

The *Okeanos Explorer* Program combines the capabilities of the NOAA Ship *Okeanos Explorer* with shore-based high speed networks and infrastructure for systematic telepresence-enabled exploration of the world ocean. The ship 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. OER owns and is responsible for operating and managing the cutting-edge ocean exploration systems on the vessel (ROV, mapping and telepresence) and ashore including Exploration Command Centers and terrestrial high speed networks. The ship and shore-based infrastructure combine to be the only federal program dedicated to systematic telepresence-enabled exploration of the planet's largely unknown ocean.

Table of Contents

2. Report Purpose

The purpose of this report is to briefly describe the data acquisition and processing for EX1004 Leg 4 data, without going into a very detailed description of the multibeam and ancillary sensor setup. For details about setup of the various equipment/sensors, please refer to see appendix D and the ship's readiness report, which can be obtained by contacting the ships operations officer (ops.explorer@noaa.gov).

The talented and patient crew of the NOAA Ship *Okeanos Explorer* (*EX*) is greatly appreciated for their efforts in helping make the INDEX-SATAL 2010 mission a success.

3. Cruise Objectives

This cruise covered the transit back to US waters after the INDEX-SATAL 2010 expedition (Indonesia Exploration – Sangihe Talaud Region). Data collection occurred only after reentering US waters near Guam. The purpose of INDEX-SATAL was the exploration of an area specifically approved by the Indonesia government, located to the north of Sulawesi, Indonesia (shown in Figure 1). The area extends from 2°N to 6° 24'N, and 124° 45' E to 128°E, covering an patch of the seafloor approximately 80,000 square kilometers in size. The coordinates of INDEX-SATAL 2010 are provided in Table 1. See mapping reports for EX1004 Legs 1, 2, and 3 for additional information.

4. Participating Personnel (mapping related activities only)

NAME	ROLE	AFFILIATION
CDR Joseph Pica	Commanding Officer	NOAA Corps

Meme Lobecker	Expedition Coordinator / Mapping Team Lead	NOAA OER (ERT, Inc.)
Elaine Stuart	Senior Survey Technician	NOAA OMAO
Colleen Peters	Senior Survey Technician	NOAA OMAO
Shannon Hoy	Mapping Watchstander	NOAA OER/UCAR Intern

5. Cruise Statistics

Cruise Dates	August 14 – 20, 2010
Weather delays days	0
Line kilometers surveyed	233.2 km
Square kilometers mapped	1853 km^2
Number of multibeam files	4
Number of partial mapping days	1
Number of XBT casts	3
Number of CTD casts	0
Number of ROV dives	0
Beginning draft 7/22/10	FWD: 14’3”; AFT: 14’2.5”
Ending draft 8/14/10	FWD: 13’9”; AFT: 14’ 5.5”

6. Mapping Sonar Setup

The NOAA Ship *Okeanos Explorer* is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar. All sensors were powered down during the majority of this cruise, specifically during transit through the Exclusive Economic Zones (EEZs) of Indonesia, Palau, and Micronesia. EM302 bottom bathymetric and backscatter data collection began on August 19. No water column backscatter data were collected, as there were no water column anomalies detected.

The ship used a POS MV version 4 to record and correct the multibeam data for any vessel motion. C-NAV GPS system provided DGPS correctors with positional accuracy expected to be better than 2.0 m.

All corrections (motion, sound speed profile, sound speed at sonar head, draft, sensor offsets) were applied during real time data acquisition. XBT casts (Deep Blue, maximum depth 760 m) were applied every six hours and/or as necessary to correct for sound speed. The expendable bathythermograph (XBT) cast data were converted to SIS compliant format using NOAA Velocipy. See Appendix A for a complete list of software used for data processing.

7. Data Acquisition Summary

Table 1 lists the transducer and attitude sensor offsets determined during the 2010 sea acceptance testing. For complete processing unit setup utilized for the cruise, refer to Appendix B.

	Roll	Pitch	Heading
TX Transducer	0.0	0.0	359.98
RX Transducer	0.0	0.0	0.03

Attitude	0	-0.8	0.0

Table 1. Angular offsets for Transmit (TX) and Receive (TX) transducer and attitude sensor.

The TX36 LC board in slot #16 of the EM302 transmit-receive unit remained in failed status throughout the cruise. An earlier attempt (during EX1004 Leg 2) to replace the board quickly revealed that slot #16 was still critically damaging transmit boards.

The TX36 slot #16 in the TRU has been consistently critically damaging transmit boards since the 2009 field season. As part of ongoing testing to determine the problem with TX36 slot #16, Kongsberg suggested swapping out the TX RIO board #8 and running a series of internal tests. The mapping department performed this test during the transit back to Guam after INDEX-SATAL data collection was finished. On August 19, after crossing into the US EEZ (Guam), the EM302 was powered on and testing was conducted, following guidance from Kongsberg engineers. See Appendix D for complete test steps. At the time of writing this report, Kongsberg analysis of test results was still pending.

8. Multibeam Data Processing, Data Quality Assessment and Archival Procedures

Field Data Processing

For quality control purposes, all raw multibeam data was imported, cleaned and gridded (50 meter cell size) in CARIS 6.1 at sea in near real time. Gridded data were exported to ASCII xyz text files. These xyz's were then used to generate Fledermaus v.6 *.sd objects via IVS Avggrid and DMagic. Each *.sd object was then exported to a georeferenced image (embedded geotiff).

Data Quality Assessment

Swath coverage and data quality were excellent throughout the cruise. This was largely due to excellent survey conditions, including calm seas and a generally highly acoustically reflective seafloor.

Visual comparison in CARIS to adjacent data collected during EX1004 Leg 1 showed excellent consistency between datasets, with less than 1% water depth differences in areas of coverage overlap.

Shore side Data Processing and Data Archiving

All field cleaning and processing was reviewed shoreside after the cruise was completed. Each bathymetry file was then exported to ASCII xyz text file, which contained every accepted sounding. These text files were then gridded (50 meter cell size) in Fledermaus DMagic, and an .sd object was generated. The .sd object was then exported to geotiff.

All raw and processed multibeam data will be archived with NGDC with individual metadata records. All processed data products are in latitude/longitude coordinates, WGS84 datum. All raw and processed multibeam data products will be accessible via www.ngdc.noaa.gov.

Archived multibeam products include:

1) Level 00
    a) Raw multibeam bathymetry files. (*.all)
2) Level 01
    a) ASCII xyz text file of each multibeam bathymetry line file, cleaned, not gridded. (*.txt)
3) Level 02
    a) ASCII xyz text file of all multibeam bathymetry gridded at 50 meter cell size. (*.xyz)
    b) Fledermaus v. 6 .sd object of 50 meter bathymetry grid. (*.sd)
    c) Georeferenced (geotiff) image of 50 meter bathymetry grid(*.tif)

9. Cruise Calendar

For a more detailed account of daily events, see *Daily Cruise Log (section 10).*

August 2010						
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
					14 Depart Port of Bitung, North Sulawesi, Indonesia	15 Continue transit to Guam. All scientific sensors secured.
16 Continue transit to Guam. All scientific sensors secured.	17 Continue transit to Guam. All scientific sensors secured.	18 Continue transit to Guam. All scientific sensors secured.	19 Commence EM302 testing and mapping operations.	20 Arrive Guam. Tied up at dock 0807		

10. Daily Cruise Log

ALL DATES AND TIMES IN SHIP TIME

August 14, 2010
Departed Port of Bitung, North Sulawesi, Indonesia. Heading to Guam. Expected arrival in Guam in the morning on August 19.

August 15, 2010
In transit to Guam. All scientific sensors secured in foreign EEZs.

August 16, 2010
In transit to Guam. All scientific sensors secured in foreign EEZs.

August 17, 2010
In transit to Guam. All scientific sensors secured in foreign EEZs.

August 18, 2010
In transit to Guam. All scientific sensors secured in foreign EEZs.

August 19, 2010
In transit to Guam. Crossed into US EEZ (Guam). Tested EM302 with new TX RIO board and new TX 36 LC board in slot 16. Results were sent immediately to Kongsberg technicians for analysis.

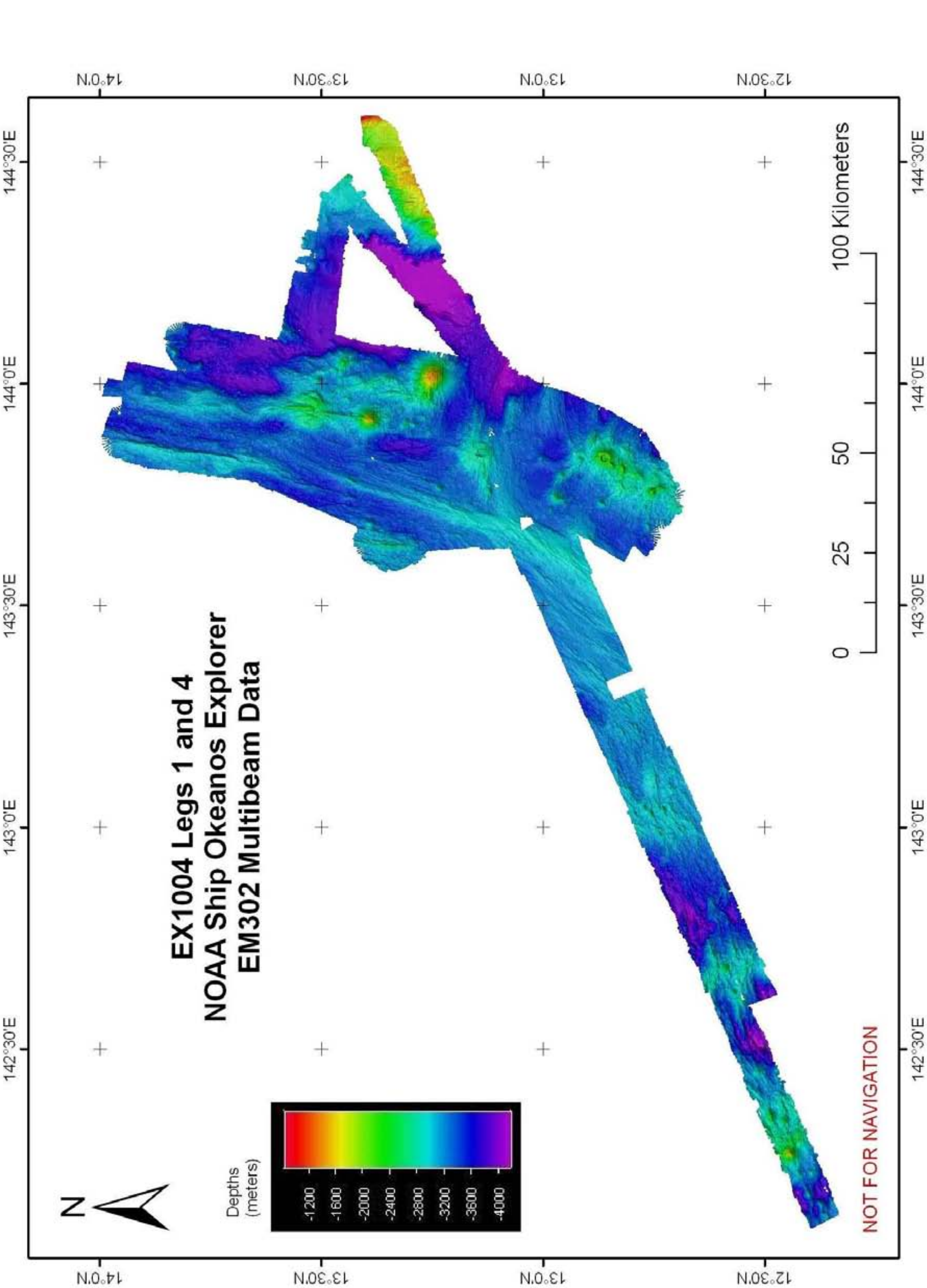
Throughout all testing, the three status lamps in SIS were green. After running the final tests, it was discovered that the SH (sonar head) lamp had turned red. The power was cycled on the TRU, the EM302 computer, and the circuit breaker regulating TRU power. Pinging was started and data quality looked good, with no noise and excellent swath coverage, and BISTs showed normal numbers, so survey was commenced. The TRU was restarted with the 1800 XBT was taken, and all lamps in SIS came up green. Survey continued overnight.

August 20, 2010
Surveyed in morning until reaching pilot buoy in the morning. Alongside in Guam at 0807. We arrived one day later than planned due to head currents.

11. Appendices

Appendix A: Field Products

Summary Map of EX1004 Legs 1 and 4 EM302 Multibeam Data



EX1004 Legs 1 and 4
NOAA Ship Okeanos Explorer
EM302 Multibeam Data
Depths (meters)
-1200
-1600
-2000
-2400
-2800
-3200
-3600
-4000
N
0
25
50
100 Kilometers
NOT FOR NAVIGATION
14°0'N
13°30'N
13°0'N
12°30'N
142°30'E
143°0'E
143°30'E
144°0'E
144°30'E

Appendix B: Tables of Files Collected during EX1004 Leg 4

EX1004 LEG 4 MULTIBEAM FILE LOG					
DATE (GMT)	**MB LINE FILENAME**	**SVP FILE APPLIED**	**JULIAN DAY**	**SOG (kts)**	**HDG (deg)**
8/19/2010	0000_20100819_030250_EX.all	XBT_081910_02.asvp	231	8	067
08/19/2010	0001_20100819_085330_EX.all	XBT_081910_03.asvp; XBT_081910_04.asvp	231	7.5	070
8/19/2011	0002_20100819_145332_EX.all	XBT_081910_04.asvp	231	8	065
8/19/2011	0003_20100819_185306_EX.all	XBT_081910_04.asvp	231	5	010

EX1004 LEG 4 SVP LOG				
DATE (GMT)	**TIME (GMT)**	**XBT/CTD FILE NAME**	**LAT/LONG (WGS84)**	**NOTES**
8/19/2010	02:52:00	XBT #1	12 29.99255N 142 35.29492E	Bad cast
8/19/2010	02:54:15	XBT_081910_02.asvp	12 30.1134N 142 35.56738E	
8/19/2010	08:29	XBT_081910_03.asvp	12 48.5228N 143 17.6952E	
8/19/2010	14:35	XBT_081910_04.asvp	13 8.3856N 144 2.8486E	

Appendix C: List of acronyms

BIST – Built In System Test

BJIV – Baruna Jaya IV

BPPT - Badan Pengkajian Dan Penerapan Teknologi (Indonesian Agency for the Assessment and Application Technology)

BRKP - Indonesia Agency for Marine and Fisheries Research

CDR - Commander

CIMS – Cruise Information Management System

CO – Commanding Officer

CTD – conductivity temperature and depth

CW – continuous wave

dB – decibels

DGPS –Differential Global Positioning System

DTM – digital terrain model

ECS – Extended Continental Shelf

EEZ –Exclusive Economic Zone

ET – Electronics Technician

EX – NOAA Ship *Okeanos Explorer*

FM – frequency modulation

FOO – Field Operations Officer

INDEX-SATAL – Indonesia Exploration–Sangihe Talaud Region

kHz - kilohertz

Km – kilometers

KM – Kongsberg Maritime AS

Kt(s) – knots

MBES – multibeam echosounder

NCDDC – National Coastal Data Development Center

NGDC – National Geophysical Data Center

NOAA – National Oceanic and Atmospheric Administration

NODC – National Oceanographic Data Center

OER – Office of Ocean Exploration and Research

OMAO – Office of Marine and Aviation Operations

PMEL – Pacific Marine Environmental Laboratory

PS – physical scientist

ROV – Remotely Operated Vehicle

RX – receive

SST – Senior Survey Technician

SV – sound velocity

TNI –Tentara Nasional Indonesia (Indonesian Navy)

TRU – transmit and receive unit

TSG - thermosalinograph

TX – transmit

UNCLOS – United Nations Convention on the Law of the Sea

UNH-CCOM/JHC – University of New Hampshire Center for Coastal and Ocean Mapping / Joint Hydrographic Center

UPS – uninterruptable power supply

USBL – ultra-short base line

WD – water depth

WHOI – Woods Hole Oceanographic Institution

XBT – expendable bathythermograph

Appendix D: EM302 description and operational specs

EM 302 : Ideal for Ocean Exploration

There are several features of the Okeanos Explorer's 30 kHz multibeam that 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. Moreover, operational experience on the *Okeanos Explorer* has shown consistent EM 302 bottom detection at depth ranges in excess of 8000m.

High Density Data

In multibeam data, the denser the data, the finer resolution maps you can produce. 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 soundings on the seafloor per ping.

Full Suite of 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.

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 from. The receive angle for the receive transducer on the Okeanos Explorer EM302 is 1°, 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. For 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 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 2. Calculated across track EM 302 beam 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 3. 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 4. 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					
Water depth (m)	**Swath Width (m)**	**Ping Rate**	**Alongtrack distance between profiles (m)**		
			@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 5. 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

Appendix E: EM302 PU Parameters in use during EX1004 Leg 4

```
#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved:  2010.08.06 15:34:49

#// 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 [-0.80] #// 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 [4500] #// Force Depth (m)
#* MID [50] #// Min. Depth (m):
#* MAD [7000] #// Max. Depth (m):
#* DSM [0] #// Dual swath mode: OFF
#* PMO [0] #// Ping Mode: AUTO
#* FME [1] #// FM enable
#} Depth Settings

#{ Stabilization #//
#* YPS [1] #// Pitch stabilization
#* TXA [-2] #// 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 [2] #// Spike Filter Strength: MEDIUM
#* PEF [0] #// Penetration Filter Strength: OFF
#* RGS [0] #// Range Gate: SMALL
#* SLF [1] #// Slope
#* AEF [1] #// Aeration
#* STF [1] #// Sector Tracking
#* IFF [1] #// Interference
#} Filtering

#{ Absorption Coefficient #//
#* ABC [6.279] #// 31.5 kHz
#} Absorption Coefficient

#{ Normal incidence sector #//
#* TCA [6] #// Angle from nadir (deg.):
#} Normal incidence sector

#{ Mammal protection #//
#* TXP [0] #// TX power level (dB): Max.
#* SSR [0] #// 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 F: Software versions in use during EX1004 Leg 4

Software	Version	Purpose
CARIS HIPS and SIPS	6.1 Service Pack 2	Multibeam processing
ECDIS		Ship line keeping
ESRI – ArcMap	9.3	Map products
Fledermaus	6.7.0h Build 419 Pro	Multibeam QC, Line planning
Fledermaus	7.2.0 Build 411 Pro, 32 bit Edition	
Hypack	9.0.0.22	Survey planning
Hypack	9.0.4.0	Realtime monitoring
Kongsberg SIS (installed 2/12/10)	3.6.4 build 174	EM302 data acquisition
Velocipy (NOAA)	10.7	XBT processing

Appendix G: EM302 Testing Steps

TEST STEPS FOR EX1004 Leg4 TXRIO / TX36 LC #16 TESTING
Internal BISTs – Impedance Checks

- Keep BIST log

1. RUN BISTS WITH OLD TX RIO, FRIED TX36LC #16
   a. HYPERTERMINAL/TELNET/INTERNAL BIST *(Okeanos_Explorer_Internal_BIST_old_txrio_old_tx36LC_081910_1.TXT)*

   b. REGULAR BIST *(081910_1.txt)*
2. REPLACE TX RIO WITH SPARE
3. RUN BISTS WITH NEW TX RIO, FRIED TX36LC # 16
   a. HYPERTERMINAL/TELNET/INTERNAL BIST *(Okeanos_Explorer_Internal_BIST_new_txrio_old_tx36LC_081910_2.TXT, Okeanos_Explorer_Internal_BIST_new_txrio_old_tx36LC_081910_3.TXT)*
   b. REGULAR BIST *(081910_2.txt)*
4. REPLACE FRIED TX36LC #16 WITH SPARE
5. ****DO NOT PING****
6. RUN BISTS WITH NEW TX RIO, NEW TX36LC #16
   a. HYPERTERMINAL/TELNET/INTERNAL BIST *(Okeanos_Explorer_Internal_BIST_new_txrio_new_tx36LC_081910_4.TXT)*
   b. REGULAR BIST *(081910_3.txt)*
7. PUT OLD FRIED TX36#16 BOARD BACK IN UNTIL KONGSBERG EVALUATES RESULTS OF BISTS *(081910_4.txt)*
8. OK TO LEAVE THE NEW TXRIO IN THE TRU AND PING

HYPERTERMINAL/TELNET BIST PROCEDURE:

Please start up Hyper-Terminal session and proceed as follows:

Name – BIST
Connect using - “TCP/Winsock”
Host Address - 157.237.14.60
Port - Default (23)
This basically is a telnet session through Hyper-Terminal

Now click on Transfer and select “Capture Text”

This will bring up a window which allows you to save a file and where to save file, browse to your desk top and save file as < Okeanos_Explorer_Internal_BIST_xxx > (xxx is to identify Old Board or New Board) select <save> then on next window select <start>

To start the actual test procedure you should see on your screen at present is - >

Type in bist and then < enter >

Now on screen should see the following –

bist

=========== EMX BIST menu ========

0: BSP test	7: TX channels
1: TX36 test	8: RX noise level
2: RX32 test	9: RX noise spectrum
3: Power Supply	15: Software date/version
5: Nibble bus test	20: SingleChannels
6: RX channels	-1: Quit

Detailed reports:
30: TX channels slot 1 - 5 35: RX noise level graphical view
31: TX channels slot 6 - 10 36: RX noise spectrum graphical view
32: TX channels slot 11 - 15
33: TX channels slot 16 - 20
Select test:

After the “Select test:” type in 30 and then < enter > (this will run test #30)
Once completed type in 31 and then < enter > to run test #31
Repeat for 32 , then 33
Once all done will need to exit out of this BIST menu by typing in -1 < enter >
This should take you back to the prompt - > at which point you can exit out of Hyper-Terminal

Once all tests are run go to your desk top and verify that the file you created at the beginning < Okeanos_Explorer_Internal_BIST_xxx > contains all the results of the tests you have just run. If all looks good please send files to us -