National Oceanography Centre, Southampton

Cruise Report No. 38

RRS *Discovery* Cruise D334

27 OCT-24 NOV 2008

RAPID mooring cruise report

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2009

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ABSTRACT

This report describes the mooring and underway operations conducted during RRS *Discovery* cruise D334 between 27 October and 24 November 2008.

These mooring operations were completed as a part of the United Kingdom Natural Environment Research Council (NERC) funded RAPID Programme to monitor the Atlantic Meridional Overturning Circulation at 26.5°N. The primary purpose of this cruise was to service the Eastern Boundary and Mid-Atlantic Ridge sections of the 26.5°N mooring array first deployed during RRS *Discovery* cruises D277 and D278 (SOC cruise report number 53), and serviced in 2005 during RRS *Charles Darwin* cruise CD177 (NOCS cruise report number 5), in 2006 on RRS *Discovery* cruise D304 (NOCS cruise report number 16) and FS *Poseidon* cruises P343 and P345 (NOCS cruise report number 28) and in 2007 on RRS *Discovery* cruise D324 (NOCS cruise report number 34).

Cruise D334 started and finished in Tenerife, Spain and covered the Eastern Boundary and Mid-Atlantic Ridge moorings deployed on D324 and P343. This cruise was the fourth annual refurbishment of the Eastern Boundary and Mid-Atlantic Ridge sections of the mooring array. The array will be further refined and refurbished during subsequent years.

The instruments deployed consist of a variety of current meters, bottom pressure recorders, CTD loggers and Inverted Echosounders, which, combined with time series measurements of the Florida Straits current and wind stress estimates, will be used to determine the strength and structure of the MOC at 26.5°N.
(http://www.noc.soton.ac.uk/rapidmoc)

KEYWORDS

Atlantic Ocean, bottom pressure recorder, BPR, CTD, cruise D334 2008, current meter, *Discovery,* North Atlantic, moorings, RAPID, RAPID-MOC, RAPID-WATCH, THC, thermohaline circulation, mooring array, MicroCAT, 26.5°N, MOC, meridional overturning circulation

ISSUING ORGANISATION

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Contents

Appendices

1 Ship's and Scientific Personnel

Name	**Rank**
Roger John Chamberlain	Master
John Woodruff Mitchell	C/O
Philip Thomas Oldfield	2/O
Aimee Louise Oakham	3/O
George Parkinson	C/E
Stephen John Bell	2/E
Ian Stuart Meldrum Collin	3/E
Geraldine Anne O'Sullivan	3/E
Robert Charles Masters	ETO
David Ralph Hartshorne	CPOD
Thomas Gregory Lewis	CPOS
Michael Minnock	CPOS
Michael John Drayton	POD
John Gerard Smyth	ERPO
Stephen Paul Day	SG1A
Robert Alexander Cumming	SG1A
Neil Kennedy	SG1A
Peter Smith	SG1A
John Haughton	H/Chef
Walter John Thomas Link	Chef
Simone Clark	Stwd

Table 1.1 *Officers and Crew*

Name	**Institute**	**Rank**
Stuart Andrew Cunningham	NOCS	PS
Maria Paz Chidichimo	MPI	Ph.D. Student
Damien Guy Daniel Desbruyeres	IFREMER	M.Sc. Student
Malte Heinemann	MPI	Ph.D. Student
Gerard Daniel McCarthy	NOCS	Ph.D. Student
Darren Rayner	NOCS	Scientist
Zoltan Bela Szuts	MPI	Scientist
Craig John Wallace	NOCS	Scientist
Martin Bridger	NOCS	Computer Tech.
David Childs	NOCS	Instrument Tech.
Christian Lee Crowe	NOCS	Instrument Tech.
Colin John Hutton	NOCS	Mooring Tech.
Robert Francis McLachlan	NOCS	Mooring Tech. (TLO)
Nicholas Jan Rundle	NOCS	Mooring Tech.
John Basil Wynar	NOCS	Mooring Tech.

Table 1.2 *Scientists and Technicians. Principal Scientist (PS), National Oceanography Centre Southampton (NOCS), Max Planck Institute for Meteorology, Hamburg (MPI), Institut Francais de Recherche pour L'exploitation de la Mer (IFREMER), Technical Liaison Officer (TLO).*

2 Itinerary

Depart Santa Cruz de Tenerife, Tenerife on Monday 27th October 2008. Arrive Santa Cruz de Tenerife, Tenerife on Monday 24th November 2008.

3 Acknowlegements

Stuart Cunningham

Master Roger Chamberlain was instrumental in the success of the first three RAPID cruises (D277, D278 and D279) so it is fitting that I can acknowledge his exemplary work on this cruise which is effectively the last in the first four year phase of RAPID. Roger's commitment to science and his shipboard team's professionalism are an outstanding contribution to this research and of course are a credit to NERC.

I would also like to acknowledge the RRS *Discovery*. Built by Hall Russell & Co. LTD (ship no. 899). Aberdeen and launched in 1962 she has provided an outstanding platform for global oceanography for over four decades; respected the world over for pioneering expeditions and discovery. Now in her final years there is a danger of an ignominious end because of the inoperability of the fitted winches. Fix these and this ship is still a fully capable science platform and of course will enable the retention of regular crew and technical staff: something that can be taken for granted, and often is.

It has been my pleasure to introduce several new students to working at sea and it was exciting to see them enjoy themselves and make a fine contribution to this cruise.

4 Introduction

The RAPID-MOC observing system has been operational since spring 2004. The purpose of this cruise was to recover and redeploy the mooring arrays deployed off the west coast of Africa and on either side of the mid-Atlantic Ridge. Fifteen tall moorings were deployed, four bottom pressure landers, and one pressure inverted echo sounder. An additional sediment trap mooring was deployed for Richard Lampitt (NOCS).

This cruise is the 16th in total since spring 2004. The cruises to date are shown in Table 4.1. The project web site is http://www.noc.soton.ac.uk/rapidmoc. The RAPID-MOC programme has, with this cruise, completed the initial four years of planned deployments and is now moving into a second phase (NERC Directed Programme RAPID-WATCH http://www.noc.soton.ac.uk/rapid) through to 2014.

4.1 Scientific Background and Description of the RAPID-MOC Observing System

The Atlantic Meridional Overturning Circulation (AMOC) at 26.5°N carries a northward heat flux of 1.3 PW. Northward of 26.5°N over the Gulf Stream and its extension much of this heat is transferred to the atmosphere and subsequently is responsible for maintaining UK climate about 5°C warmer than the zonal average at this latitude. However, previous sparse observations did not resolve the temporal variability of the AMOC and so it is unknown whether it is slowing in response to global warming as suggested by recent model results. In 2004 NERC, NSF and NOAA funded a system of observations in the Atlantic at 26.5°N to observe on a daily basis the strength and structure of the AMOC. Two papers ([*Cunningham, et al.*, 2007] & [*Kanzow, et al.*, 2007]) demonstrated that not only does the system of observations achieve a mass balance for the AMOC, it reveals dramatic and unexpected richness of variability. In the first year the AMOC mean strength and variability is 18.7±5.6 Sv. From estimates of the degrees-of-freedom the year-long mean AMOC is defined with a resolution of around 1.5 Sv so abrupt changes would be readily identified and long-term changes will be measured relative to the 2004-2005 average.

The NERC contribution to the first four years of continuous AMOC observations was funded under the directed programme RAPID Climate Change. Following an international review of the system NERC will continue funding to 2014 under the programme RAPID-WATCH. The NSF and NOAA have also continued funding and commitments so that the system can continue operating at the same level of activity as during the period 2004-2008.

The objectives of RAPID-WATCH are: To deliver a decade-long time series of calibrated and quality-controlled measurements of the Atlantic MOC from the RAPID-WATCH arrays and; To exploit the data from the RAPID-WATCH arrays and elsewhere to determine and interpret recent changes in the Atlantic MOC, assess the risk of rapid climate change, and investigate the potential for predictions of the MOC and its impacts on climate.

4.2 The AMOC system

The 26.5°N Atlantic section is separated into two regions: a western boundary region, where the Gulf Stream flows through the narrow (80km), shallow (800m) Florida Straits between Florida and the Bahamas, and a transatlantic mid-ocean region, extending from the Bahamas at about 77°W to Africa at about 15°W (Figure 4.1). Variability in Gulf Stream flow is derived from cable voltage measurements across the Florida Straits, and variability in wind-driven surface-layer Ekman transport across 26.5°N is derived from QuikSCAT satellite-based observations. To monitor the mid-ocean flow we deployed an array of moored instruments along the 26.5°N section. The basic principle of the array is to estimate the zonally integrated geostrophic profile of northward velocity on a daily basis from time-series measurements of temperature and salinity throughout the water column at the eastern and western boundaries. Inshore of the most westerly measurement of temperature and salinity, the transports of the Antilles current and deep western boundary current are monitored by direct velocity measurements.

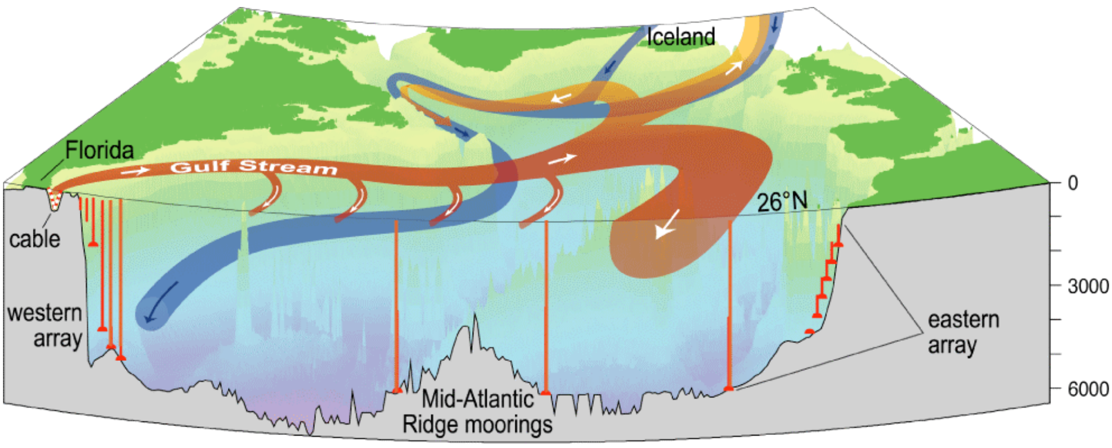


Figure 4.1 *Schematic of the principal currents of the Atlantic meridional overturning circulation. The vertical red lines across the Atlantic at 26.5°N indicate the main areas where moorings instrumented to measure the vertical density profile are located. The Gulf Stream transport is measured by submarine cable and the western boundary array includes current meters to directly measure transports of the shallow and deep western boundary currents. Bottom pressure recorders are located at several sites across the Atlantic to measure depth-independent fluctuations of the basin-wide circulation. Figure courtesy of Louise Bell & Neil White, CSIRO.*

4.3 Array Specification

The array as deployed in 2008-2009 consists of a total of twenty-one moorings, twelve landers and two inverted echo sounders. Figures 4.2, 4.3 and 4.4 are schematics showing each mooring and instrumentation in 2008-2009. The western boundary moorings were serviced in the spring by cruise SJ0803. Moorings are named in three sub-arrays. Western boundary **WB#** with mooring number increasing to the east; Mid-Atlantic Ridge **MAR#**; Eastern Boundary **EB#**. The letter **H** is a historical reference to moorings originally intended to be HOMER profilers. **M** indicates a mini-mooring consisting of a 10m length mooring with one CTD instrument. Bottom landers instrumented with pressure recorders are indicated by **L** in the name. **ADCP** indicates an Acoustic Doppler Current Profiler mooring.

4.4 Eastern Boundary Sub-array

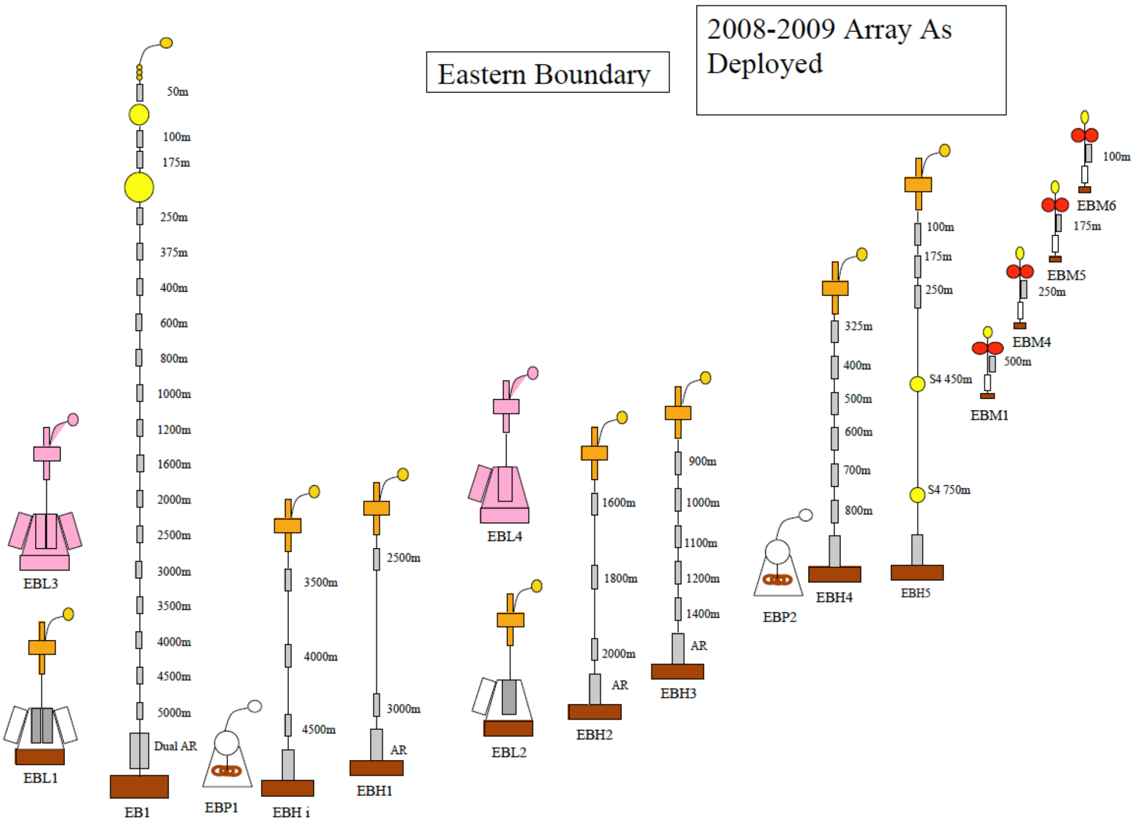


Figure 4.2 *Schematic of the Eastern Boundary mooring array as deployed for 2008 – 2009.*

The Eastern Boundary sub-array consists of one tall moorings **EB1** consisting of 18 CTDs and a series of shorter CTD moorings **EBHi**, **EBH1**, **EBH2**, **EBH3**, **EBH4,** and **EBH5** that step up the slope reducing the influence of bottom triangles when combined with the more offshore EB1 mooring. They construct a single full depth density profile. Inshore of EBH5 there are a series of four “mini-moorings”, **EBM1**, **EBM4**, **EBM5** and **EBM6** that each consist of a single CTD and are relatively inexpensive meaning likely losses in this heavily fished area have less of an impact on the array. Finally the Eastern array includes four bottom pressure landers; **EBL1** and **EBL3** – comprising two bottom pressure recorders (BPRS) each – at the site of EB1, and **EBL2** and **EBL4** – comprising one bottom pressure recorder each – at the site of EBH1. The landers are serviced in alternate years so that each recovery provides a two-year record with a year’s overlap with the previous lander to remove instrument drift. There are also two Inverted Echo Sounders with pressure sensors (PIES) deployed in the eastern boundary sub-array, **EBP1** at the site of EB1 and **EBP2** at the site of EBH4. Data from these are downloaded annually through acoustic telemetry but EBP1 was serviced on this cruise with EBP2 planned for turnaround in 2009.

4.5 Mid-Atlantic Ridge Sub-array

The sub-array at the Mid-Atlantic Ridge consists of one full depth mooring (**MAR1**), three shorter moorings (**MAR0**, **MAR2** and **MAR3**), and four landers (**MARL1**, **MARL2**, **MARL3** and **MARL4**). **MAR0** is a recent addition to the array and consists of three CTDs and a BPR to capture the Antarctic Bottom Water (AABW) to the west of the ridge. **MAR1** provides a full depth density profile through eighteen CTDs, with MAR2 acting as a backup to 1000m on the west of the ridge. MAR3 is sited to the east of the ridge and allows separation of the eastern and western basin MOC contributions. The landers are deployed as per those for the Eastern Boundary, with two at the site of MAR1, and two at the site of MAR3.

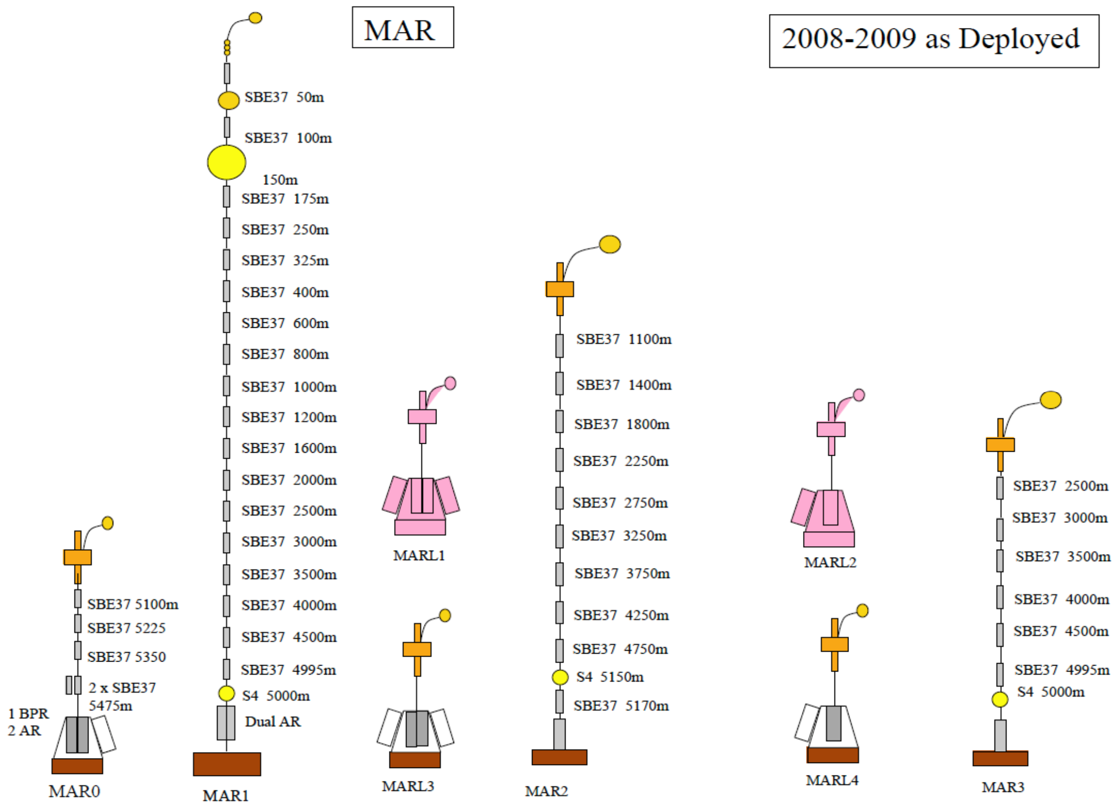


Figure 4.3 *Schematic of the Mid-Atlantic Ridge mooring array for 2007-2008*

4.6 Western Boundary Sub-array

At the western boundary, **WB2** is the pivotal mooring and provides a full depth density profile very close to the western boundary "wall". The resolution of the profile can be improved by merging data from the nearby **WB1**. WB2 comprises sixteen CTDs and seven current meters, whereas WB1 comprises fifteen CTDs and four current meters. Inshore of WB1 there is **WBADCP** that comprises a Longranger ADCP at a depth of 600m to measure the shallow Antilles current. East of WB2 is WBH2 consisting of three CTDs and four current meters. At the normal offshore extent of the Deep Western Boundary Current (DWBC) is **WB4**, which comprises fifteen CTDs and seven current meters. Further offshore is **WB6** – comprising three

CTDs and a bottom pressure recorder – which combined with MAR0 measures the contribution to the MOC of deep water below 5200m including the Antarctic Bottom Water. There are again four landers in this sub-array; **WBL1** and **WBL3** (two BPRs each) at the site of **WB2**; and **WBL2** and **WBL4** (one BPR each) at the site of WB4.

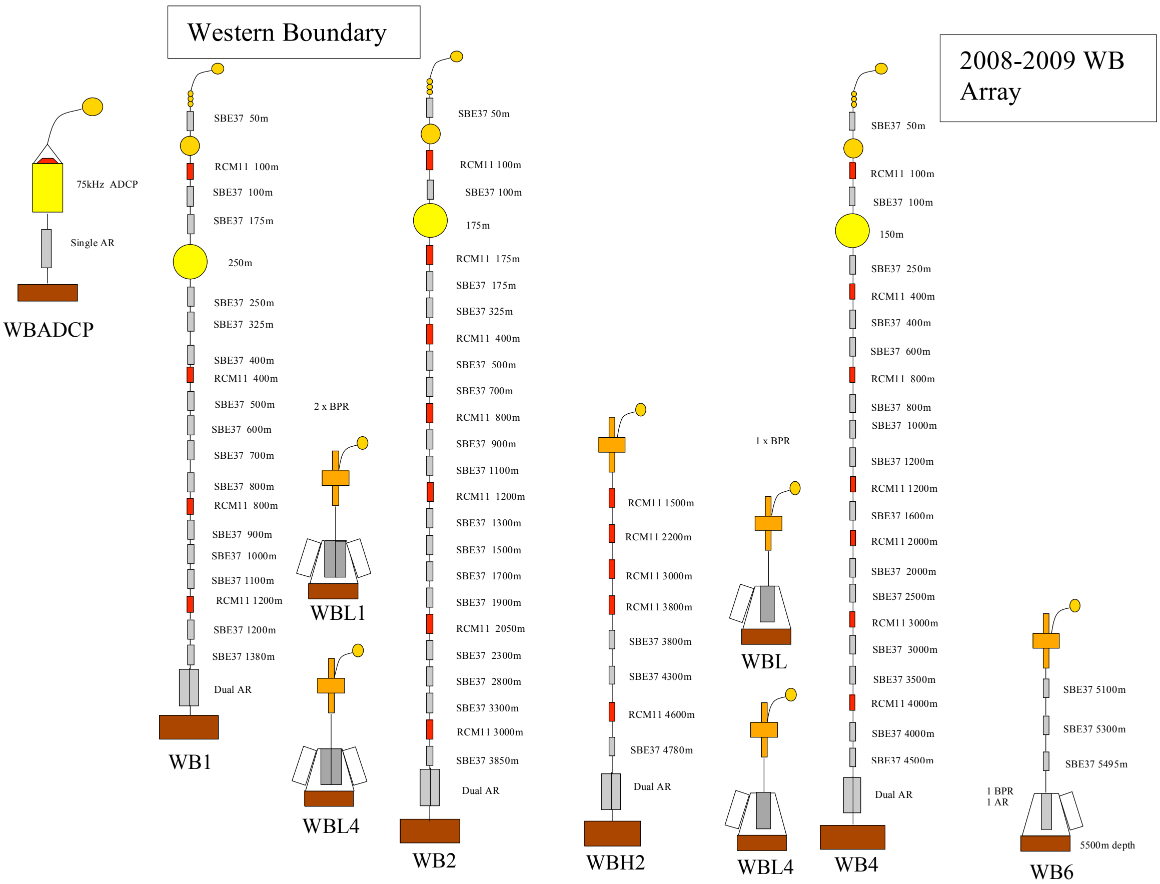


Figure 4.4 *Schematic of the Western Boundary mooring array for 2007-2008.*

In addition to the moorings listed above, the western boundary sub-array also contains three full depth moorings and four landers from the University of Miami. **WB0** comprising four CTDs and current meters and an upward looking ADCP. **WB3** is 22 km west of WB2 and so acts as a critical backup in case of loss of WB2. WB3 consists of seven CTDs and current meters. Combined with the other inshore moorings it provides the thermal-wind shear and measured velocities from the core of the deep western boundary current. **WB6** is located 500 km offshore and is instrumented with seventeen CTDs and provides the thermal-wind shear across the full width of the boundary currents including any recirculation.

Cruise	Vessel	Date	Objectives	Cruise Report
D277	RRS *Discovery*	Feb - Mar 2004	Initial deployment of Eastern Boundary and Mid-Atlantic Ridge moorings	RRS *Discovery* Cruise D277 and D278, Southampton Oceanography Centre, Cruise Report No. 53, 2005
D278	RRS *Discovery*	Mar 2004	Initial deployment of UK and US Western Boundary moorings	RRS *Discovery* Cruise D277 and D278, Southampton Oceanography Centre, Cruise Report No. 53, 2005
P319	RV *Poseidon*	Dec 2004	Emergency deployment of replacement EB2 following loss	Appendix in RRS *Charles Darwin* Cruise CD170 and RV *Knorr* Cruise KN182-2 National Oceanography Centre, Southampton, Cruise Report No. 2, 2006
CD170	RRS *Charles Darwin*	Apr 2005	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	RRS *Charles Darwin* Cruise CD170 and RV Knorr Cruise KN182-2 National Oceanography Centre, Southampton, Cruise Report No. 2, 2006
KN182-2	RV *Knorr*	May 2005	Service and redeployment of UK and US Western Boundary moorings and Western Boundary Time Series (WBTS) hydrography section	RRS *Charles Darwin* Cruise CD170 and RV Knorr Cruise KN182-2 National Oceanography Centre, Southampton, Cruise Report No. 2, 2006
CD177	RRS *Charles Darwin*	Nov 2005	Service and redeployment of key Eastern Boundary moorings	RRS *Charles Darwin* Cruise CD177. National Oceanography Centre, Southampton, Cruise Report No. 5, 2006
WS05018	RV *F.G. Walton Smith*	Nov 2005	Emergency recovery of drifting WB1 mooring	No report published
RB0602	RV *Ronald H Brown*	Mar 2006	Service and redeployment of UK and US Western Boundary moorings and Western Boundary Time Series (WBTS) hydrography section	RV *Ronald H. Brown* Cruise RB0602 and RRS *Discovery* Cruise D304, Southampton Oceanography Centre, Cruise Report No. 16, 2007
D304	RS *Discovery*	May - June 2006	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings	RV *Ronald H. Brown* Cruise RB0602 and RRS *Discovery* Cruise D304, Southampton Oceanography Centre, Cruise Report No. 16, 2007
P343	RV *Poseidon*	Oct 2006	Service and redeployment of key Eastern Boundary moorings	PS *Poseidon* Cruise P343 and P345, National Oceanography Centre, Southampton, Cruise Report No. 28, 2008
P345	RV *Poseidon*	Dec 2006	Emergency redeployment of EB1 and EB2 following problems on P343	PS *Poseidon* Cruise P343 and P345, National Oceanography Centre, Southampton, Cruise Report No. 28, 2008
SJ06	RV *Seward Johnson*	Sep - Oct 2006	Recovery and redeployment of WB2 and US Western Boundary moorings and Western Boundary Time Series (WBTS) hydrography section	Appendix G in RV *Ronald H. Brown* Cruise RB0701, National Oceanography Centre, Southampton, Cruise Report, No. 29
RB0701	RV *Ronald H. Brown*	Mar - Apr 2007	Service and redeployment of UK Western Boundary moorings and Western Boundary Time Series (WBTS) hydrography section	RV *Ronald H. Brown* Cruise RB0701, National Oceanography Centre, Southampton, Cruise Report, No. 29
D324	RRS *Discovery*	Oct - Nov 2007	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	RRS *Discovery* Cruise D277 and D278, Southampton Oceanography Centre, Cruise Report No. 53, 2005
SJ0803	RV *Seward Johnson*	Apr 2008	Service and redeployment of the Western Boundary moorings	RV *Seward Johnson* Cruise SJ0803, National Oceanography Centre, Southampton, Cruise Report No. 37, 2008

Table 4.1 *Summary of previous Rapid-MOC cruises*

5 Bridge Timetable of Events

Roger Chamberlain

Date	Time (UT)	Event
25/10/08	0800	Mobilisation of D334 begins in SANTA CRUZ DE TENERIFE
26/10/08	0900	Scientists Join Vessel
	1030-1100	Familiarisation of all newly joined Scientific Personnel
	1100-30	Emergency and Lifeboat muster and instruction given in our pre-sailing activities – preparing to sail from Santa Cruz
27/10/08	0851	Pilot embarked
	0908	Vessel cleared berth
	0924	Pilot disembarked
	0930	Vessel clear of port limits and full away Course 180° T
	1006	Altered Course to 210° T 28 21.0 N 016 14.4 W
	1227	Altered Course to 270° T 27 58.0 N 016 30.0 W
	1248-56	PES Fish Deployed 27 58.1 N 016 33.3 W - resumed passage, Course 270° T
	1350	Altered Course to 284° T 27 58.1 N 016 44.0 W
	1540-1720	**Engaged in ADCP calibration off the South Coast of GOMERA – various courses at 8 knots in depths of less than 400 metres.**
	1720	ADCP calibration completed set Course 234° T @ best speed 28 00.6 N 017 18.4 W
	2110	Altered Course to 228° T 27 35.0 N 017 55.0 W
28/10/08	0000	Position Latitude 27 14.7 N Longitude 018 25.1 W
	1200	Position Latitude 25 42.0 N Longitude 020 20.6 W
	1810	Hove to on **CTD Station 01** 24 55.8 N 021 17.7 W
	1817-2312	**Station 01– CTD cast to 4400 m 24 56.8N 021 18.4W**
29/10/08	0004-0400	**Station 02– CTD cast to 4400 m 24 58.7N 021 19.4W**
	0617	Mooring **EBHi** released
	0727-0830	Recovering **EBHi**
	0830	Mooring **EBHi** on board 24 57.7 N 021 16.4 W
	0830-0937	Mooring EBHi being prepared for deployment.
	0937-1000	Deployment of Mooring EBHi
	1000	**MOORING EBHi DEPLOYED 24 57.11 N 021 16.11 W**
	1020	Commenced passage to site EB1 Course 248° T
	1200	Position Latitude 24 49.9 N Longitude 021 35.2 W
	1535-1942	**Station 03– CTD cast to 4500 m 24 34.8N 022 16.2W**
	1942-2016	sampling – remaining hove to in inclemement conditions
	2016	Resumed passage to site EB1 Course 248° T
30/10/08	0000	Position Latitude 24 19.6 N Longitude 022 59.9 W
	0620	Hove to at EB1 – too rough to release, considering our options 23 50.0 N 024 05.9 W
	0620-0843	**Downtime - weather**
	0843	set course for mooring EBL1 (recovery)
	0909	Mooring **EBL1** released
	0909-1040	Recovering **EBL1**
	1040	Mooring **EBL1** on board 23 53.8 N 024 05.0 W
	1130	set course for mooring EBL1 (deployment)
	1340-1745	Deployment of **Mooring EB1**

	1745	**MOORING EB1 DEPLOYED 23 45.44 N 024 07.70 W**
	1745-1825	Monitoring EB1 to the bottom
	1825	set course for mooring EBP1
	1923	Hove to at EBP1 – setting up to download data
	1927-2330	EBP1 – Acoustic telemetry data download 23 48.8 N 024 06.1 W
	2330	re-locating to CTD Station
31/10/08	0014	Hove to on **CTD Station 04** 23 49.6 N 024 09.1 W
	0032-0411	**Station 04– CTD cast to 4500 m 23 50.6N 024 09.4W**
	0500	Proceeding to EB1 (recovery)
	0600	Hove to at EB1 – awaiting daylight
	0732	Mooring **EB1** released
	0819-1130	Recovering **EB1**
	1130	Mooring **EB1** on board 23 52.8 N 024 04.9 W – securing deck
	1218	set course for mooring EB2 (recovery)
	1247	Hove to at EB2
	1255	Mooring **EB2** released
	1330-1625	Recovering **EB2**
	1625	Mooring **EB2** on board 23 57.0 N 024 01.7 W – securing deck
	1635	set course for mooring EBP1 (recovery)
	1752	Hove to at EBP1
	1810	Mooring **EBP1** released – Making ready Lander EBL1 (deployment)
	1825-31	Deployment of **Mooring EBL1 (Lander)**
	1831	**MOORING EBL1 DEPLOYED 23 48.14 N 024 06.82 W**
	2000-2011	Mooring EBP1 surfaced - Recovering **EBP1**
	2011	Mooring **EBP1** on board 23 48.5 N 024 06.7 W – securing deck
	2018	set course for the MAR 3 Site Course 270° T @ best speed
01/11/08	0100	Position Latitude 23 53.4 N Longitude 025 02.3 W
	1200	Position Latitude 23 53.3 N Longitude 027 21.7 W
02/11/08	0000	Position Latitude 23 53.1 N Longitude 029 51.1 W
	1200	Position Latitude 23 52.9 N Longitude 032 23.0 W
03/11/08	0100	Position Latitude 23 53.0 N Longitude 035 01.4 W
	1200	Position Latitude 23 52.5 N Longitude 037 14.5 W
	1410	Hove to on **CTD Station 05**
	1415-1752	**Station 05– CTD cast to 4500 m 23 53.3N 037 40.6W**
	1752	Proceeding to MAR 3 (recovery)
04/11/08	1106	Hove to at MAR 3
	1112	Mooring **MAR 3** released
	1152-1459	Recovering **MAR 3 (using the RIB)**
	1459	Mooring **MAR 3** on board 23 51.1 N 041 04.1 W – securing deck
	1459-1610	Releasing and approaching MARL4 (recovery)
	1610-43	Recovering **MARL4**
	1643	Mooring **MARL4** on board 23 51.5 N 041 05.4 W – securing deck
	1643-1714	Making ready Lander MARL4 (deployment)
	1714-16	Deployment of **Mooring MARL4 (Lander)**
	1716	**MOORING MARL4 DEPLOYED 23 51.60 N 041 06.00W**
	1716-1817	Making ready mooring MAR3 (deployment)
	1817-2023	Deployment of **Mooring MAR3**
	2023	**MOORING MAR3 DEPLOYED 23 52.24 N 041 05.30W**

	2023-2112	Relocating and stopping at CTD site
	2112-0038	**Station 06– CTD cast to 3500 m 23 52.5N 041 08.1W**
05/11/08	0038-0149	Sampling between casts
	0149-0531	**Station 07– CTD cast to 4500 m 23 53.4N 041 07.5W**
	0531-0700	relocating to the NOG sediment trap mooring (recovery)
	0700	Hove to at NOGST site
	0843	Mooring **NOGST** released
	0916-1056	Recovering **NOGST**
	1056	Mooring **NOGST** on board 23 46.9 N 041 05.5 W – securing deck
	1056-1154	Securing and re-locating for deployment of the NOGST mooring
	1154-1243	Making ready mooring NOGST (deployment)
	1243-1438	Deployment of **Mooring NOGST (sediment traps)**
	1438	**MOORING NOGST DEPLOYED 23 46.30 N 041 05.80W**
	1442	set course for the MAR 1 Site Course 273° T @ best speed
06/11/08	0000	Position Latitude 23 51.7 N Longitude 042 57.1 W
	1200	Position Latitude 23 58.2 N Longitude 045 17.9 W
07/11/08	0000	Position Latitude 24 04.9 N Longitude 047 40.8 W
	1023	Hove to at MAR 1 24 10.3N 049 43.7W
	1025	Mooring **MAR 1** released on noisy acoustics – NO RELEASE
	1025-1118	Various attempts at releasing MAR 1
	1118	Leaving MAR 1 for later release attempt – proceeding to MAR 2
	1136	Hove to at MAR 2 24 10.6N 049 45.3W
	1140	Mooring **MAR 2** released (recovery)
	1154-1451	Recovering **MAR 2 (difficult approach)**
	1451	Mooring **MAR 2** on board 24 12.4 N 049 43.9 W – securing deck
	1451-1605	Manoeuvring toward MAR 1 (recovery)
	1605-1855	Recovering **MAR 1**
	1855	Mooring **MAR 1** on board 24 13.4 N 049 42.7 W – securing deck
	1950-2345	**Station 08– CTD cast to 4500 m 24 13.9N 049 42.6W**
08/11/08	0050-0358	**Station 09– CTD cast to 3500 m 24 15.1N 049 42.0W**
	0500	Re-locating to the MARL3 site
	0830	Mooring **MARL3** released (recovery)
	0933-1007	Recovering **MARL3** Lander
	1007	Mooring **MARL3** on board 24 13.0 N 049 43.5 W – securing deck
	1100	Re-locating to the MAR1 deployment site.
	1200	Making ready mooring MAR1 (deployment)
	1224-1637	Deployment of **Mooring MAR1**
	1637	**MOORING MAR1 DEPLOYED 24 10.70 N 049 43.50W**
	1637-1750	Re-locating and making ready to deploy MAR 2 (deployment)
	1750-2043	Deployment of **Mooring MAR2**
	2043	**MOORING MAR2 DEPLOYED 24 10.59 N 049 45.36W**
	2048	Proceeding to MAR 0 site Course 294° T @ best speed
09/11/08	0000	Position Latitude 24 26.6 N Longitude 050 19.1 W
	0921	Hove to at MAR 0 25 05.9N 052 00.6W
	0921	Mooring **MAR 0** released (recovery)
	1045-1112	Recovering **MAR 0**
	1112	Mooring **MAR 0** on board 25 05.5 N 052 00.2 W – securing deck PRESSURISED INSTRUMENTS on mooring

	1112-52	Re-locating to a suitable CTD site.
	1152-1553	**Station 10– CTD cast to 5500 m 25 06.3N 052 00.9W**
	1553-1633	Sampling and re-locating to MAR 0 site (deployment)
	1633-1718	Deployment of **Mooring MAR 0**
	1718	**MOORING MAR 0 DEPLOYED 25 06.35 N 052 00.61W**
	1718	Proceeding to MARL3 site (deployment) Course 113° T @ best speed
10/11/08	0000	Position Latitude 24 39.5 N Longitude 050 52.0 W
	0624	Hove to at MARL3 24 12.3N 049 43.8W (deployment)
	0624-0900	awaiting daylight
	0830-0902	Deployment of **Mooring MARL3**
	0902	**MOORING MARL3 DEPLOYED 24 12.23 N 049 43.70W**
	0902-1012	Inspected MAR 1 site for any surface markers and triangulating moorings MAR1 and MAR2 sea bed anchor positions.
	1012	Proceeding to EBP1 site (deployment) Course 091° T @ best speed
	1200	Position Latitude 24 12.3 N Longitude 049 24.1 W
11/11/08	0000	Position Latitude 24 10.2 N Longitude 047 07.5 W
	1200	Position Latitude 24 08.1 N Longitude 044 45.9 W
12/11/08	0000	Position Latitude 24 05.9 N Longitude 042 21.2 W
	1200	Position Latitude 24 03.7 N Longitude 039 51.7 W
13/11/08	0000	Position Latitude 24 01.4 N Longitude 037 22.9 W
	1200	Position Latitude 23 59.2 N Longitude 034 53.6 W
14/11/08	0000	Position Latitude 23 56.9 N Longitude 032 28.7 W
	1200	Position Latitude 23 54.9 N Longitude 030 11.2 W
15/11/08	0000	Position Latitude 23 52.8 N Longitude 027 54.9 W
	1200	Position Latitude 23 50.7 N Longitude 025 36.2 W
	1950	Hove to at EPB1 23 49.3N 024 06.2W (deployment)
	1959	**MOORING EPB1 DEPLOYED 23 49.38 N 024 06.00W**
	1959-2124	Monitoring EPB1 through its descent and settling.
	2124	Proceeding to EBH1 site (recovery) Course 066° T @ best speed 23 49.2N 024 06.9W
16/11/08	0000	Position Latitude 23 59.5 N Longitude 023 42.0 W
	0856	Hove to for CTD Station 11
	0908-1315	**Station 11– CTD cast to 4500 m 24 34.8N 022 15.2W**
	1315-39	Sampling and allowing Satellite comms
	1339	Resuming passage to EBH1 site (recovery) Co 066° T @ best speed
17/11/08	0000	Position Latitude 25 14.8 N Longitude 020 33.6 W
	1200	Position Latitude 26 04.8 N Longitude 018 28.2 W
18/11/08	0000	Position Latitude 26 52.9 N Longitude 016 26.5 W
	0616	Hove to at EBH 1 27 16.8N 015 25.9W (recovery)
	0715	Mooring **EBH 1** released (recovery)
	0748-0837	Recovering **EBH 1**
	0837	Mooring **EBH 1** on board 27 16.9 N 015 26.5 W – securing deck Took opportunity to release mooring EBL 2
	0903	Hove to at EBL 2 27 16.4N 015 25.4W (recovery)
	0916-37	Recovering **EBL 2**

	0937	Mooring **EBL 2** on board 27 16.7 N 015 25.5 W – securing deck
	1000	Hove to at EBH 1 27 16.3N 015 26.2W (deployment)
	1036-1103	Deployment of **Mooring EBH 1**
	1103	**MOORING EBH 1 DEPLOYED 27 16.90 N 015 25.71W**
	1103-26	Making ready to deploy mooring EBL 2
	1126-1128	Deployment of **Mooring EBL 2**
	1128	**MOORING EBL 2 DEPLOYED 27 17.13 N 015 25.69W**
	1138-1342	Hydraulic hose renewal on starboard gantry - awaiting the fix.
	1342-1512	**Station 12– CTD cast to 500 m 27 12.8N 015 25.7W** Testing releases on the CTD frame whilst at 500 metres
	1512-24	Securing deck before departure – Wind NNE x 30-35 knots
	1524	Proceeding to EBH 2 site (recovery) Course 073° T @ 5 knots
19/11/08	0000	Position Latitude 27 33.0 N Longitude 014 26.2 W
	0312	Hove to at EBH 2 27 36.2N 014 13.0W (recovery)
	0312-0700	awaiting daylight
	0700-26	attempting to release EBH 2 – using overside transducer
	0726	Mooring **EBH 2** released (recovery)
	0742-0826	Recovering **EBH 2**
	0826	Mooring **EBH 2** on board 27 36.6 N 014 12.9 W re-locating to mooring EBH 2 deployment position
	0850	Hove to at EBH 2 27 36.3N 014 12.8W (deployment)
	0915-30	Deployment of **Mooring EBH 2**
	0930	**MOORING EBH 2 DEPLOYED 27 36.70 N 014 12.70W** Proceeding to EBH3 site (recovery) Course 063° T @ best speed
	1240	Hove to at EBH 3 27 48.5N 013 44.6W (recovery)
	1241	Mooring **EBH 3** released (recovery)
	1309-45	Recovering **EBH 3**
	1345	Mooring **EBH 3** on board 27 49.1 N 013 44.6 W re-locating to mooring EBH 3 deployment position
	1420	Hove to at EBH 3 27 48.5N 013 44.6W (deployment)
	1436-50	Deployment of **Mooring EBH 3**
	1450	**MOORING EBH 3 DEPLOYED 27 48.77 N 013 44.48W** Proceeding to EBH4 site (recovery) Course 078° T @ best speed
	1600	Hove to at EBH 4 27 50.7N 013 32.6W (recovery)
	1604	Mooring **EBH 4** released (recovery)
	1608-1709	Recovering **EBH 4**
	1709	Mooring **EBH 4** on board 27 51.5 N 013 32.2 W re-locating to mooring EBH 4 deployment position
	1729	Hove to at EBH 4 27 50.2N 013 32.9W (deployment)
	1749-1841	Deployment of **Mooring EBH 4**
	1841	**MOORING EBH 4 DEPLOYED 27 50.99 N 013 32.39W** Proceeding to EPB 2 site (Data download) Course 052°T @ best speed
	1901	Hove to at EBP 2 – setting up to download data
	1901-19	Re-locating upwind.
	1927-0312	**EBP2** – Acoustic telemetry data download 27 51.8 N 013 31.2 W
20/11/08	0312	Proceeding to EBM 1 site (listen only) @ best speed
	0400	Hove to on EBM 1 27 53.6N 013 24.3W (listen only)
	0421-28	Transducer outboard – listening for signals
	0428	Proceeding to EBM 6 site (listen only) @ best speed
	0500	Hove to on EBM 6 27 55.2N 013 19.9W (listen only)
	0507-14	Transducer outboard – listening for signals

0514	Proceeding to EBM 5 site (listen only) @ best speed
0530	Hove to on EBM 5 27 54.6N 013 21.6W (listen only)
0536-0621	Transducer outboard – listening for signals (no response)
0621	Proceeding to EBM 4 site (listen only) @ best speed
0633	Hove to on EBM 4 27 54.5N 013 22.1W (listen only)
0633-0726	Transducer outboard – listening for signals (no response)
0726	Proceeding to EBM 1 site (recovery) @ best speed
0754	Hove to at EBM 1 27 53.8N 013 24.3W (recovery)
0759	Mooring **EBM 1** released (recovery)
0815-30	Recovering **EBM 1**
0830	Mooring **EBM 1** on board 27 53.7 N 013 24.2 W re-locating to mooring EBM 4 for possible recovery
0858	Hove to on EBM 4 27 54.9N 013 22.0W (poss recovery)
0900-1020	Transducer outboard – listening for signals (no response)
1020	Proceeding to EBM 5 site (possible recovery) @ best speed
1056 `	Hove to on EBM 5 27 54.7N 013 21.6W (poss recovery)
1059-1110	Transducer outboard – listening for signals (no response)
1110	Proceeding to EBM 6 site (possible recovery) @ best speed
1140	Hove to at EBM 6 27 55.3N 013 19.9W (recovery)
1144	Mooring **EBM 6** released (recovery)
1148-1215	Recovering **EBM 6**
1215	Mooring **EBM 6** on board 27 55.1 N 013 20.1 W Proceeding to EPB 2 site (Data download) Course @ best speed
1330	Hove to at EBP 2 – setting up to download data
1332-1640	**EBP2** – Acoustic telemetry data download 27 51.8 N 013 31.2 W
1640-51	Preparing CTD for release testing
1651-1739	**Station 13– CTD cast to 500 m 27 51.9N 013 31.2W** Testing releases on the CTD frame whilst at 500 metres
1739	Proceeding to EBM 1 site (deployment) @ best speed
1831	Hove to at EBM 1 (deployment)
1831-44	Deployment of **Mooring EBM 1**
1844	**MOORING EBM 1 DEPLOYED 27 53.67 N 013 24.33W** Proceeding to EBM 4 site (deployment) @ best speed
1910	Hove to at EBM 4 (deployment)
1910-20	Deployment of **Mooring EBM 4**
1920	**MOORING EBM 4 DEPLOYED 27 54.46 N 013 22.08W** Proceeding to EBM 5 site (deployment) @ best speed
1930	Hove to at EBM 5 (deployment)
1930-35	Deployment of **Mooring EBM 5**
1935	**MOORING EBM 5 DEPLOYED 27 54.60 N 013 21.60W** Proceeding to EBM 6 site (deployment) @ best speed
1948	Hove to at EBM 6 (deployment)
1948-53	Deployment of **Mooring EBM 6**
1953	**MOORING EBM 6 DEPLOYED 27 54.20 N 013 19.89W** Proceeding to 100m depth CTD station
2010	Hove to on CTD station
2012-25	**Station 14– CTD cast to 91 m 27 55.2N 013 20.1W**
2025-2055	Proceeding to next CTD Station
2055	Hove to on CTD station
2055-2115	**Station 15– CTD cast to 262 m 27 54.8N 013 21.9W**
2115	Proceeding to next CTD Station
2132	Hove to on CTD station
2132-56	**Station 16– CTD cast to 360 m 27 54.9N 013 22.4W**
2156	Proceeding to next CTD Station
2248	Hove to on CTD station
2248-2316	**Station 17– CTD cast to 560 m 27 52.7N 013 25.1W**
2316	Proceeding to next CTD Station

21/11/08	0020	Hove to on CTD station		
	0023-0149	**Station 18– CTD cast to 1056 m**	**27 50.4N**	**013 33.2W**
	0149	Proceeding to next CTD Station		
	0325	Hove to on CTD station		
	0331-0454	**Station 19– CTD cast to 1531 m**	**27 48.9N**	**013 49.5W**
	0454	Proceeding to EBH 5 Site		

6 Mooring Operations

Rob McLachlan

MOORING No	MOORING ID	DEPLOYED	RECOVERED
2007/22	EB1	D324	D334
2007/21	EB2	D324	D334
2007/30	EBH1	D324	D334
2007/31	EBH2	D324	D334
2007/32	EBH3	D324	D334
2007/33	EBH4	D324	D334
2007/20	EBHi	D324	D334
2006/45	EBL1	2006	D334
2006/46	EBL2	2006	D334
2007/36	EBM1	D324	D334
2007/37	EBM4	D324	D334
2007/38	EBM5	D324	D334
2007/39	EBM6	D324	D334
2005/64	EBP1	CD177	D334
2007/27	MAR0	D324	D334
2007/28	MAR1	D324	D334
2007/29	MAR2	D324	D334
2007/24	MAR3	D324	D334
2006/24	MARL3	2006	D334
2006/25	MARL4	2006	D334
2007/23	NOG	D324	D334

Table 6.1 *Moorings recovered*

MOORING No	MOORING ID	DEPLOYED	RECOVERED
2008/23	EB1	D334	2009
2008/33	EBH1	D334	2009
2008/35	EBH2	D334	2009
2008/36	EBH3	D334	2009
2008/37	EBH4	D334	2009
2008/42	EBH5	D334	2009
2008/22	EBHi	D334	2009
2008/24	EBL1	D334	2010
2008/34	EBL2	D334	2010
2008/32	EBP1	D334	---
2008/38	EBM1	D334	2009
2008/39	EBM4	D334	2009
2008/40	EBM5	D334	2009
2008/41	EBM6	D334	2009
2008/31	MAR0	D334	2009
2008/28	MAR1	D334	2009
2008/29	MAR2	D334	2009
2008/26	MAR3	D334	2009
2008/30	MARL3	D334	2010
2008/25	MARL4	D334	2010
2008/27	NOG	D334	2009

Table 6.2 *Moorings deployed*

6.1 D334 Diary of Events

25th October 2008
Started and completed mobilization.

26th October 2008
Bolted down all deck equipment, plumbed in winches to ships hydraulic supply.
The winches were started up and ran to check operation.
Set up labs with instrumentation stands and equipment.
Un-packed instrumentation and checked over.
Wound on mooring EB1 ready for deployment.
Winch operating lever fixed and trialed successfully.

27th October 2008
Prepared mooring EBHI ready for deployment.
Installed batteries in to SeaBirds.
Finalized mooring diagrams.
Built up glass for EBHI and EB1.
CTD build completed, initial tests ok.

28th October 2008
Wound on MAR3 ready to deploy.
Instrumentation preparation.
Selected six releases for the 2 CTD casts tonight/early hours of 29th.

29th October 2008
All of the releases worked fine, for some reason the deck units do not work if they are plugged in to the clean supply but they do work on the dirty supply and on their own batteries, this could explain some of the problems encountered on previous cruises.
Recovered EBHI then deployed EBHI.
Set up deck ready for EB2 recovery in the morning.
Carried out the third CTD with 12 MicroCATs and 3 releases.
The three releases all worked fine as did the twelve MicroCATs, one of the MicroCATs went down without its blanking plug, but it was fine.

30th October 2008
Up at 06:00 to recover EB1, the recovery was put off due to bad weather so we headed for EBL1, communication was established with both releases, one being a RT661, the Lander has been down for two years. We also used this time to carry out some trial with the deck units and their power supplies. See release report further down.
Whilst the Lander was on its way up we started preparing for the EB1 deployment, this being the preferred option of the master due to the weather.
The Lander was recovered successfully. We then continued with preparing for EB1 deployment.
We then commenced deployment of EB1, all went well. The releases were watched down and a descent rate of 135m/min was recorded.
We then steamed to the first PIES site and started downloading the data, this finished at midnight and a CTD followed.

31st October 2008

Recovery of EB1 was started with both releases communicating well. The mooring was recovered with out incident.
We then started communication with EB2, it was released and then recovered, and all went well.
All the wires from EB1 and 2 can be weighed at NOC to establish the correct lengths.
We the headed to the PIES site and released the pies, whilst this was going on we prepared EBL1 ready for deployment.
EBL1 was then deployed.
The PIES were then recovered.

1st November 2008

We spent the day breaking down all of the recovered glass and inspecting them.
The PIES was opened up and inspected, new batteries installed
We separated the doubled up releases.
We then made up glass for MAR3 and MARL4.

Investigate acoustic release SN 318 when we get back to noc. See D324 report.

2nd November 2008

We wound on mooring MAR1 ready for deployment. Continued breaking down and inspecting all of the recovered glass.
Started building up Lander MARL4.

3rd November 2008

We wound on moorings MAR2 and NOG mooring ready for deployment.
Made up glass for NOG and some of the glass for MAR2.

4th November 2008

Arrived at MAR3 site, started communication with releases and fired. The buoyancy came up unusually distributed with the bottom floats arriving at the surface before most of the others. The small boat was deployed to assist with recovery. The mooring was then recovered with a few tangles that required chopping out.
We then headed for MARL4 site and started communication with releases, the releases were fired. Recovery went ok.
We deployed a replacement MARL4, all went well.
We then started deployment of MAR3, all went well.

5th November 2008

Recovered NOG mooring.
Deployed NOG mooring.

6th November 2008

Made up glass for MAR2, MAR1 and MARL3.

7th November 2008

Attempted communication with MAR1, no comms were established, we tried the release command but to no avail, whilst we were there we tried communication with MAR2 and this was successful, we headed for MAR2 and got good comms straight

away again and fired the release, it released ok, whilst we were there we tried MAR1 again and got good ranges straight away.
We recovered MAR2 ok then we headed back to where we had good comms with MAR1, comms with MAR1 were established and it was released and recovered ok.
5 glass spheres at 4750m were all imploded; there were also a lot of tangles on this mooring.

8th November 2008
Deployed MAR1 and deployed MAR2, no problems encountered, recovered MARL3, all went well.

9th November 2008
Established comms with MAR0 without difficulty, the release was fired, and recovery commenced. All recovered ok with some tangles to contend with.
We then carried out a CTD cast down to 5500m, there were at least two lays left on the drum probably four. The max load observed was 1.9t in a sea state of force 3 to 4 with wind gusts of 20 miles an hour.
We then deployed a replacement MAR0 with additional MicroCATs, all went well
We then readied MARL3 for deployment, eta 13 hours.

10th November 2008
Deployed MARL3, all went well.

11th – 14th November 2008
Sailing from the mid Atlantic to the east, servicing instrumentation, releases and glass spheres, wire winding and preparation of mooring hardware.

15th November 2008
Arrived at PIES site and deployed the pies.

16th November 2008
Readied the CTD frame with 5 releases and 9 MicroCATs.

17th November 2008
Steam to EBH1 site

18th November 2008
Recovered EBH1 and the deployed EBH1, recovered EBL2 and deployed EBL2.

19th November 2008
Recovered and deployed EBH2, recovered and deployed EBH3, recovered and deployed EBH4. We then carried out a wire test of seven LRTs, comms were difficult and eventually we managed to fire 3 of the 7.

20th November 2008
Overnight a search was conducted for the deployed mini moorings with not a lot of success, we started recovery of the mini moorings and we recovered EBM1 and EBM6, EBM 4 and 5 have been lost.
We then got four mini moorings ready for deployment EBM1, 4, 5 and 6.

A wire test of the 4 LRT's that had failed on the previous cast were re-tested and all of them fired OK.
We are also in the process of designing another mooring using the wires we have available on board.
We then deployed the mini moorings EBM1, 4, 5 and 6.

21st November 2008
Up early to get the new EBH5 mooring ready. Whilst this was going on a survey was carried out to find the correct depth for the mooring.
The new EBH5 was deployed with no problems.

We are now conducting a series of CTD casts with the remaining time left of the cruise.

22nd November 2008
Serviced the scrolling on both of the reeler winches.

23rd November 2008
Packed all of the equipment away, produced equipment lists started mooring report.

24th November 2008
Docked and disembarked.

6.2 Instrumentation details

The following pages identify which instruments (including serial numbers) are deployed on each mooring.

6.2.1 Instruments by Mooring

Instrument type	Manufacturer and model	Total intended for recovery	Total recovered	Total lost	Total deployed
CTD	Seabird SBE37 SMP MicroCAT Seabird SBE37 IMP MicroCAT RBR XR-420 CTD	58 30 2	56 30 2	2 0 0	83 0 0
Single point current meter	Interocean S4	3	3	0	5
BPR	Seabird SBE26 Seabird SBE53	4 3	4 3	0 0	3 4
PIES	University of Rhode Island, PIES	1	1	0	1

Table 6.3 *Instrument Summary Table*

6.2.2 Mini Mooring details

MOORING	SERIAL NUMBER	ACOUSTIC IDENTITY	FREQUENCY	CTD SN	VHF SN
EBM1	252343-003	002	1	4306	W03-115
EBM4	252343-001	007	1	3258	W03-111
EBM5	252343-005	006	1	3208	W03-114
EBM6	252343-007	001	1	3207	W03-112

Table 6.4 *Mini mooring release and VHF details*

SBE 37's

EB1 2008/23
3223, 3228, 3229, 3230, 3231, 3232, 3233, 4305, 3906, 3907, 3908, 3919, 3928, 3930, 3931, 3932, 3933 and 3934.

EBH1 2008/33
5246 and 5247.

EBH2 2008/35
6333, 6334 and 5245.

EBH3 2008/36
5243, 5244, 6328, 6329 and 6330.

EBH4 2008/37
4307, 5238, 5239, 5240, 5241 and 5242.

EBH5 2008/42
3212, 3213 and 3214.

EBHi 2008/22
3244, 3902 and 3905.

EBM1 2008/38
4306.

EBM4 2008/39
3258.

EBM5 2008/40
3208.

EBM6 2008/41
3207.

MAR0 2008/31
6327, 6321, 6331, 6322 and 6332.

MAR1 2008/28
6137, 6323, 6324, 6325, 6326, 6320, 6118, 6119, 6120, 6120, 6121, 6122, 6123, 6124, 6125, 6126, 6127, 6128, 6129.

MAR2 2008/29
6130, 6131, 6132, 6133, 6134, 6135, 6136, 6109, 6110 and 6111.

MAR3 2008/26
6112, 6113, 6114, 6115, 6116 and 6117.

S4's

EBH5 2008/42	35612576 and 35612577
MAR1 2008/28	35612568
MAR2 2008/29	35612567
MAR3 2008/26	35612565

BPR's

EBL1 2008/24	0004 and 0388.
EBL2 2008/34	0396.
MARL3 2008/30	0012 and 0035.
MARL4 2008/25	414.
MAR0 2008/29	0031

PIEs

EBP1 2008/32	136

Instrumentation deployed on the NOG mooring, (2008/27)
Two sediment traps SN's 11262-06 and 11262-07.
Two current meters (RCM 11), SN's 423 and 419.

Mooring	NMFD mooring number	Cruise	Anchor Drop Position		Deployment Date	Julian Day	GMT	Argos ID 1	Argos ID 2
			Lat °N	Long °W					
EBHi	2008/22	D334	24° 57.12'	21° 16.07'	29/10/08	303	10:00		
EB1	2008/23	D334	23° 45.44'	24° 07.69	30/10/08	304	17:46	82953	24335
EBL1	2008/24	D334	23° 48.13'	24° 06.82'	31/10/08	305	18:31		
MARL4	2008/25	D334	23° 51.57'	41° 06.00'	04/11/08	309	17:16		
MAR3	2008/26	D334	23° 52.24'	41° 05.31'	04/11/08	309	20:22		
NOGST	2008/27	D334	23° 46.29'	41° 05.77'	05/11/08	310	14:37		
MAR1	2008/28	D334	24° 10.72'	49° 43.47'	08/11/08	313	16:37	60202	46242
MAR2	2008/29	D334	24° 10.59'	49° 45.35'	08/11/08	313	20:43		
MARL3	2008/30	D334	24°12.23’	49°43.71’	10/11/08	315	9:03		
MAR0	2008/31	D334	25° 06.35'	52° 00.62'	09/11/08	314	17:19		
EBP1	2008/32	D334	23° 49.38'	24° 05.98'	15/11/08	320	19:57		
EBH1	2008/33	D334	27° 16.91'	15° 25.71'	18/11/08	323	11:03		
EBL2	2008/34	D334	27° 17.15'	15° 25.70'	18/11/08	323	11:27		
EBH2	2008/35	D334	27° 36.73'	14° 12.7'	19/11/08	324	9:28		
EBH3	2008/36	D334	27° 48.79'	13° 44.48'	19/11/08	324	14:51		
EBH4	2008/37	D334	27° 51.00'	13° 32.39'	19/11/08	324	18:41		
EBM1	2008/38	D334	27° 53.66'	13° 24.34'	20/11/08	325	18:44		
EBM4	2008/39	D334	27° 54.45'	13° 22.09	20/11/08	325	19:21		
EBM5	2008/40	D334	27° 54.60'	13° 21.61'	20/11/08	325	19:35		
EBM6	2008/41	D334	27° 55.21'	13° 19.89'	20/11/08	325	19:53		
EBH5	2008/42	D334	27° 50.36'	13° 32.81'	21/11/08	326	11:27		

Table 6.5 *Mooring deployment table*

6.2.3 CTD Calibration Dips

As with previous cruises all MicroCATs were lowered on the CTD frame to provide pre and post deployment cross calibrations with the shipboard CTD system. The instruments are clamped to the CTD rosette using bespoke brackets in place of 12 Niskin bottles. Table B1 in the Appendices gives a summary of the instruments on each cast.

6.2.4 Instrument Problems

Aside from those instruments that flooded (see below), all instruments collected full records. Some of the shallower instruments had light biofouling, which affected the temperature and conductivity measurements but this was no worse than previously recovered instruments.

A SBE53 BPR (sn: 0013) suffered a low-pressure flood on MARL3 that led to corrosion of the battery terminals and a short of one of the DD lithium cells. A similar flood has previously occurred with a SBE26 BPR recovered on cruise D324, and as with that one the upright orientation of the SBE53 probably saved the electronics from being damaged.

Two BPRs (SBE53 sn 0012 and SBE26 sn 419) displayed a bad pressure record. For sn 419, although the tidal signal is evident throughout the record there is a strong drift that starts approximately half way through and then a large jump before recovering back to a level similar to the start of the record. Seabird have been contacted and the instrument returned for repair. Sn 0012 has a lot of noise at the start of the record, which causes approximately 200db variations for around 200 days. The instrument then appears to be measuring the correct pressure but with a large drift. This instrument should have been returned to Seabird for inspection but unfortunately it was redeployed on MARL3 before this problem was spotted. More care needs to be taken in the future to better check the data from instruments that are intended to be turned around at sea.

Two Seabird MicroCATs (IMP sn 4181 and 4183) were recovered flooded from the MAR0 mooring. It is thought that this is a flood caused by a weld failure at the pressure sensor as these instruments are part of the same batch previously discussed with Seabird.

The new Seabird MicroCAT SMPs ordered for this cruise have a new firmware version (3.0d). This firmware has different commands to talk to the instrument compared to previous firmwares. A new setup instruction sheet was written to incorporate these changes but in the future the firmware version will need to be noted so that the correct commands can be used.

6.2.5 Problem encountered with TT801 acoustic release deck unit

We found that the deck unit could not communicate to releases on the CTD frame whilst attached to "clean" mains power from the ship's supply.

It worked fine if running off batteries and also if on the "dirty" supply. The same was found with both deck units, both power leads available, and a selection of sockets.
The decision was made to leave the deck unit charging on clean supply whilst not in use but then to unplug for communication with releases, whether during a wire test or for recovery.

During recovery of EBL1 we tried a few simple checks: Good communications were received when using the hull-mounted port transducer and powered off the deck unit's internal batteries.

The fish and starboard transducers gave a noticeably quieter audible outgoing signal and no replies from the releases. As soon as the transducer is switched back to port, the replies are good with both releases. We tried using the port transducer with "clean" external power and 5 times got no response from the releases. We removed power cable and ran off just batteries and received good replies for the 5 attempts made.

Release Type	Release sn	TT801 sn	Transducer	Power Source	Comms?
AR861	359	26	port	batteries	good
RT661	162	26	port	batteries	good
AR861	359	26	fish	batteries	nothing
AR861	359	26	starboard	batteries	nothing
AR861	359	26	port	External (clean)	nothing

Table 6.6 *Summary of problems with TT810 acoustic release deck unit.*

Conclusion: Use the port transducer with battery power only. Try a different deck unit but expect similar results. Try tests with "dirty" external power.

Darren also received an electric shock twice from the TT801 serial number 26. The first occurred when holding the 3 pin-plug of the power supply and the second when touching the headphone socket. Both occurred at the time of transmitting to the releases so some sort of connection is feeding electricity into the case of deck unit while comms are operating. Chris subsequently got shocked when touching one of the screws on the case.

6.2.6 Equipment Losses

The losses on this cruise were small and only occurred on the Mini Moorings; two were not recovered, EBM4 and EBM5.

There was a total of two SeaBird SBE37's (SNs 3941 and 3115), and two LRTs (SNs 245798-003 and 242200-003) lost

7 CTD Processing and Calibration

John Wynar

STATION NUMBER	YEAR YYYY	MONTH mm	DAY DD	TIME HHMMSS	LAT DEG	LAT MIN	LON DEG	LON MIN	PMIN DBAR	PMAX DBAR	DEPTH (M)
001	2008	10	28	210044	24	55.97	-21	17.76	2	4476	4508
002	2008	10	29	013341	24	58.72	-21	19.45	2	4472	4521
003	2008	10	29	170530	24	34.81	-22	16.18	2	4600	4738
004	2008	10	31	015944	23	50.56	-24	9.41	2	4562	5103
005	2008	11	3	154902	23	53.34	-37	40.62	2	4590	5602
006	2008	11	4	223023	23	52.54	-41	8.14	2	3572	4765
007	2008	11	5	030709	23	53.39	-41	7.50	2	4602	5010
008	2008	11	7	212641	24	13.89	-49	42.58	2	4600	4891
009	2008	11	8	015614	24	15.11	-49	42	2	3570	4695
010	2008	11	9	134632	25	6.26	-52	0.84	2	5638	5513
011	2008	11	16	103640	24	34.80	-22	15.19	2	4590	4737
012	2008	11	18	140053	27	17.81	-15	25.73	2	510	2993
013	2008	11	20	171513	27	51.86	-13	31.26	2	508	1017
014	2008	11	20	201809	27	55.25	-13	20.13	2	96	101
015	2008	11	20	210746	27	54.78	-13	21.96	2	268	279
016	2008	11	20	214610	27	55.01	-13	22.52	2	368	381
017	2008	11	20	230239	27	52.79	-13	25.14	2	570	562
018	2008	11	21	005604	27	50.35	-13	33.21	2	1070	1070
019	2008	11	21	041245	27	48.93	-13	49.50	2	1556	1546
020	2008	11	21	153252	27	37.27	-14	14	2	2042	2028
021	2008	11	21	203056	27	26.21	-14	51.38	2	2614	2588
022	2008	11	22	020727	27	13.75	-15	35.90	2	3182	3148
023	2008	11	22	073758	27	2.22	-16	6.86	2	3524	3486
024	2008	11	22	135456	26	48.18	-16	46.55	2	3670	3619
025	2008	11	22	210226	26	36.78	-17	28.63	2	3698	3656
026	2008	11	23	031930	26	23.29	-18	9.88	2	3656	3614
027	2008	11	23	091100	26	10.29	-18	50	2	3514	3464

Table 7.1 *Summary of CTD stations, times and positions.*

7.1 CTD System Configuration

One CTD system was prepared; the main water sampling arrangement was a NOC 24-way stainless steel frame system, (s/n SBE CTD6), and the sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-19817-0528
Sea-Bird 3P temperature sensor, s/n 03P-4381, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-3054, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 73299, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-4380, Frequency 3 (secondary)
Sea-Bird 4C conductivity sensor, s/n 04C-2841, Frequency 4 (secondary)
Sea-Bird 5T submersible pump, s/n 05T-3069, (primary)
Sea-Bird 5T submersible pump, s/n 05T-3067, (secondary)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-31240-0423

Sea-Bird 11plus deck unit, s/n 11P-24680-0587

7.1.1 Additional instruments

Ocean Test Equipment 10L ES-115B water samplers were used in alternate even positions i.e. 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, for all casts except cast #10 when the following additional bottles were used: 1, 3, 5, 7, 11 and 13. The term N/C appears on the log sheets where a bottle did not close or seal properly.
Sonardyne HF Deep Marker beacon, s/n 234002-002
NOC 10 kHz acoustic bottom finding pinger, s/n B7

7.1.2 Sea-Bird 9*plus* configuration

Sea-Bird 9*plus* configuration file D3340528.con was used for all CTD casts, and details are as follows:

Instrument configuration file:
`C:\Program Files\SeaBird\SeasaveV7\D334\D3340528.con`

```
Configuration report for SBE 911plus/917plus CTD
---------------------------------------------------------------------
      Frequency channels suppressed      0
      Voltage words suppressed           3
      Computer interface                 RS-232C
      Scans to average                   1
      NMEA position data added           Yes
      NMEA depth data added              No
      NMEA time added                    No
      NMEA device connected to           deck unit
      Surface PAR voltage added          No
      Scan time added                    Yes

1) Frequency 0, Temperature

      Serial number                      03P-4381
      Calibrated on                      28 May 2008
      G                                  4.42348689e-003
      H                                  6.44714876e-004
      I                                  2.25407335e-005
      J                                  1.94949471e-006
      F0                                 1000.000
      Slope                              1.00000000
      Offset                             0.0000

2) Frequency 1, Conductivity

      Serial number                      04C-3054
      Calibrated on                      14 March 2008
      G                                  -1.03617531e+001
      H                                  1.42436024e+000
      I                                  3.94774177e-004
      J                                  4.02241375e-005
      CTcor                              3.2500e-006
      CPcor                              -9.57000000e-008
      Slope                              1.00000000
      Offset                             0.00000
```

```
3) Frequency 2, Pressure, Digiquartz with TC

      Serial number                        73299
      Calibrated on                        18 April 2008
      C1                                   -5.087539e+004
      C2                                   2.199664e-002
      C3                                   1.589010e-002
      D1                                   3.721700e-002
      D2                                   0.000000e+000
      T1                                   3.011152e+001
      T2                                   -2.857091e-004
      T3                                   4.528990e-006
      T4                                   -5.484500e-011
      T5                                   0.000000e+000
      Slope                                0.99983000
      Offset                               -1.48410
      AD590M                               1.282870e-002
      AD590B                               -9.075590e+000

4) Frequency 3, Temperature, 2

      Serial number                        03P-4380
      Calibrated on                        28 May 2008
      G                                    4.37168057e-003
      H                                    6.54126629e-004
      I                                    2.31636698e-005
      J                                    1.73538404e-006
      F0                                   1000.000
      Slope                                1.00000000
      Offset                               0.0000




5) Frequency 4, Conductivity, 2

      Serial number                        04C-2841
      Calibrated on                        14 March 2008
      G                                    -1.02576859e+001
      H                                    1.41287091e+000
      I                                    7.35295780e-004
      J                                    1.97926108e-005
      CTcor                                3.2500e-006
      CPcor                                -9.57000000e-008
      Slope                                1.00000000
      Offset                               0.00000

6) A/D voltage 0, Free

7) A/D voltage 1, Altimeter

      Serial number                        6198-118171
      Calibrated on                        15 November 2006
      Scale factor                         15.000
      Offset                               0.000
----------------------------------------------------------------------
Pump Control
      This setting is only applicable to a custom build of the SBE
9plus.
      Enable pump on / pump off commands: NO
----------------------------------------------------------------------
```

```
Data Acquisition:
      Archive data                        YES
      Delay archiving                     NO
      Data archive:
      C:\ProgramFiles\SeaBird\SeasaveV7\D334\CTD data\CTD010.hex
      Timeout (secs) at startup           10
      Timeout (secs) between scans        10
----------------------------------------------------------------------
Instrument port configuration:
      Port                                COM1
      Baud rate                           19200
      Parity                              N
      Data bits                           8
      Stop bits                           1
----------------------------------------------------------------------
Water Sampler Data:
      Water Sampler Type                  SBE Carousel
      Number of bottles                   36
      Port                                COM2
      Enable remote firing                NO
      Firing sequence                     User input
      Tone for bottle fire confirmation uses PC internal speakers.
----------------------------------------------------------------------
Header information:
      Header Choice            Prompt for Header Information
            prompt 0           Ship
            prompt 1           Cruise
            prompt 2           Station
            prompt 3           CTD Cast
            prompt 4           Time (GMT)
            prompt 5           Latitude
            prompt 6           Longitude
            prompt 7           Water Depth (uncorrected)
            prompt 8           Principal Scientist
            prompt 9           Operator
----------------------------------------------------------------------
TCP/IP - port numbers
      Data acquisition
            Data port                     49163
            Status port                   49165
            Command port                  49164
      Remote bottle firing
            Command port                  49167
            Status port                   49168
      Remote data publishing
            Converted data port           9161
            Raw data port                 49160
----------------------------------------------------------------------
Miscellaneous data for calculations
      Depth and Average Sound Velocity
            Lat when NMEA is n/a          26.000
      Average Sound Velocity
            Minimum pressure [db]         20.000
            Minimum salinity [psu]        20.000
            Pressure window size [db]     20.000
            Time window size [s]          60.000
      Descent and Acceleration
            Window size [s]               2.000
      Plume Anomaly
            Theta-B                       0.000
            Salinity-B                    0.000
            Theta-Z / Salinity-Z          0.000
            Reference pressure [db]       0.000
```

```
      Oxygen
            Window size [s]                2.000
      Potential Temperature Anomaly
            A0                             0.000
            A1                             0.000
            A1 Multiplier                  Salinity
----------------------------------------------------------------------
Serial Data Output:
      Output data to serial port           NO
----------------------------------------------------------------------
Mark Variables
            Variables
            Digits      Variable Name [units]
            ------      -----------------------
            0           Scan Count
            4           Depth [salt water, m]
            7           Conductivity [S/m]
            5           Salinity [PSU]
----------------------------------------------------------------------
Shared File Output:
      Output data to shared file           NO
----------------------------------------------------------------------
TCP/IP Output:
  Raw data:
      Output raw data to socket            NO
      XML wrapper and settings             NO
      Seconds between raw data updates     0.000
      Converted data:
      Output converted data to socket      NO
      XML format                           NO
----------------------------------------------------------------------
SBE 11plus Deck Unit Alarms
      Enable minimum pressure alarm        NO
      Enable maximum pressure alarm        NO
      Enable altimeter alarm               NO
----------------------------------------------------------------------
SBE 14 Remote Display
      Enable SBE 14 Remote Display         NO
----------------------------------------------------------------------
PC Alarms
      Enable minimum pressure alarm NO
      Enable maximum pressure alarm        NO
      Enable altimeter alarm               NO
      Enable bottom contact alarm          NO
      Alarm uses PC sound card
----------------------------------------------------------------------
Options:
      Prompt to save program setup
      Changes                              YES
      Automatically save program setup
      changes on exit                      NO
      Confirm instrument configuration
       change                              YES
      Confirm display setup changes        YES
      Confirm output file overwrite        YES
      Check scan length                    NO
      Compare serial numbers               NO
      Max plot may cover Seasave           NO
```

7.1.3 Sea-Bird Data Processing

CTD cast data was post-processed according to guidelines established from BODC as per SOLAS parameters. Bottle fire scan duration was set to 5 seconds. Since most of the CTD casts were used for the purpose of calibrating SBE37 MicroCATs and/or testing acoustic releases, the time spent at various depths before bottle closure varied. These periods were not post-processed for removal from the final .cnv file. Bottle mapping details are provided on cast log sheets. As there was no DO sensor on the CTD, AlignCTD was not run, good weather and minimal sea states were experienced throughout the cruise, and therefore Filter, Loop Edit and Wild Edit were not necessary.

7.2 Other Instruments

Autosal salinometers

One salinometer was configured for salinity analysis, and the instrument details are as below:

Guildline Autosal 8400B, s/n 68958, installed in Constant Temperature Laboratory as the primary instrument, Autosal set point 24C.

Only the conductivity ratios were made a note of during analysis, these then being processed by the PS's own program and converted to salinity. The salinometer was standardized once at the beginning of the cruise and then left as per the PS's instructions. (This was to allow the drift of the instrument to be measured over time.) However, standard sea-water was used at the beginning and end of each measurement session, and after every 12 samples run. It was noticeable that the SSW (standard sea water) run at the beginning of a session would often be measured as low, subsequent SSW measuring as specified or very close to it. This anomaly may be an error contributed by the Autosal and will be investigated.

7.3 CTD Processing and Calibration

María Paz Chidichimo, Malte Heinemann

7.3.1 CTD Processing Path

Raw data from the CTD were directly logged to a PC from the SeaBird deck unit using the SeaBird software Seasave Win32 v7.18. The data then underwent the following routines in SBE Data Processing to apply instrument calibrations and convert from frequency data to physical units.

1. *Data conversion*: Converts raw data to engineering units from a .hex file and stores converted data in a .cnv file and a .ros file. Output format was selected as ASCII type. The scan range offset was set to be 0 and the scan range duration to be 0.001s. Files in: `CTDnnn.CON` (instrument configuration file), `CTDnnn.hex` (data file). Files out: `ctd334nnn.cnv, ctd334nnn.ros`.

2. *Bottle Summary*: Reads a .ros file created by Data Conversion and writes a bottle data summary to a .btl file. The `output.btl` file includes: bottle position and date/time; averaged variables, standard deviation, maximum and minimum value computed for each bottle from input variables. Files in: `ctdnnn.CON`, `ctd334nnn.ros`. File out: `ctd334nnn.btl`.

3. *Cell Thermal Mass*: Removes conductivity cell thermal mass effects from the measured conductivity with a recursive filter (alpha = 0.03, 1/beta = 7.0). File in/out: `CTD334nnn.cnv`.

4. *Derive*: Uses pressure, temperature, and conductivity from the input .cnv file to calculate salinity and potential temperature. File in/out: `ctd334nnn.cnv`.

5. *Bin Average*: Averages data, using averaging intervals based on pressure range and time range. File in: `ctd334nnn.cnv`. Files out: `ctd334nnn_2db.cnv` (bin type: pressure, bin size: 2dbar), `ctd334nnn_1hz.cnv` (bin type: seconds, bin size: 1), `ctd334nnn_2hz.cnv` (bin type: seconds, bin size: 0.5), `ctd334nnn_10s.cnv` (bin type: seconds, bin size: 10). In all cases the surface bin was not included.

The final conversion files (.cnv) were then transferred to the Rapid UNIX Machine via ftp for further processing in PSTAR, where the following executions were performed:

ctd0_D334: Reads the .cnv files into PSTAR format. Files in: `ctd334nnn.cnv`, `ctd334nnn_1hz.cnv`, `ctd334nnn_10s.cnv`, `ctd334nnn_2db.cnv`. Files out: `ctd334nnn.24hz`, `ctd334nnn.1hz`, `ctd334nnn.10s`, `ctd334nnn.2db`.

ctd3_MATLAB.m: For each cast, plot a set of diagnostic T/S and profile plots.

fir0: Reads SeaBird .ros file into PSTAR using header data extracted from .cnv file. The pstar file is then merged with the .10s file to create a firing file with one record per bottle fire. Each record is a 10s average of the CTD upcast data at the time of the bottle fire (5s before and after). Files in: `ctd334nnn.ros`, `ctd334nnn.cnv`, `ctd334nnn.10s`. File out: `fir334nnn`.

sam0: Creates a blank sample file, paste in firing data and heading data from the .24hz file. Files in: `fir334nnn`, `sam.masterD334`, `ctd334nnn.24hz`. File out: `sam334nnn`.

7.3.2 Salinity Sample Processing

The sample path consists of converting text files containing bottle salinities into PSTAR files that can then be used to calibrate the CTD. Bottle sample data are entered in an Excel file as text (tab delimited) files and then saved as .csv files. After that they are transferred to the Rapid UNIX system trough ftp.

`sal.exec`: Converts the .csv files into binary PSTAR format. File in: `sal334nnn.csv`. Files out: `sal334nnn`, `sal334nnn.txt`.

`passal`: Pastes salinity from the 'sal' files into the 'sam' files. File in: `sal334nnn`. File out: `sam334nnn`

`botcond.exec`: i) Calculates the salinity sample conductivity using CTD pressure and temperatures at the bottle stops, File out: `sam334nnn.cal`. ii) Creates an appended file of sample data from all casts, file out: `sam.append.cal.nn` (the two last digits indicate the version; e.g: `sam.append.cal`.AF).

7.3.3 CTD Calibration

CTD conductivities are calibrated by comparing them to bottle conductivities derived from salinity samples obtained during the CTD upcast. Bottle water samples for calibration were collected during the following CTD stations: 001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 018 and 024.

`CTD_cal_D334.m`: The MATLAB script reads the appended file to determine CTD calibration parameters.

Variables involved are: C_{BOT} (Bottle conductivity obtained from the measured bottle salinity), C_{CTD} (CTD upcast conductivity averaged over the 10 s around the bottle fire time), C_{BOT}/C_{CTD} (conductivity ratio), $C_{BOT} - C_{CTD}$ (conductivity difference).

As a first step to correct CTD conductivity, basic statistics were applied for rejecting bad data. Data were rejected when $|C_{BOT}-C_{CTD}| > 0.005$ mS/cm (Table 7.1).

The usual correction applied to CTD conductivity is a slope correction to account for sensor drift (usually to lower values with time). This is calculated following the Application note no. 31 from SBE (Sea-Bird Electronics inc.) as indicated by equation (1).

$$slope = \frac{\sum_{i=1}^{n} (C_{CTD}(i))(C_{BOT}(i))}{\sum_{i=1}^{n} (C_{CTD}(i))(C_{CTD}(i))} \qquad (1)$$

slope = 0.999997

and C_{CTD} corrected = C_{CTD}* slope.

Since the value for the slope was very close to 1 and the basic statistics before and after applying the slope correction didn't differ much, it was decided not to apply the slope correction. Therefore calibration was finished after rejecting bad data.

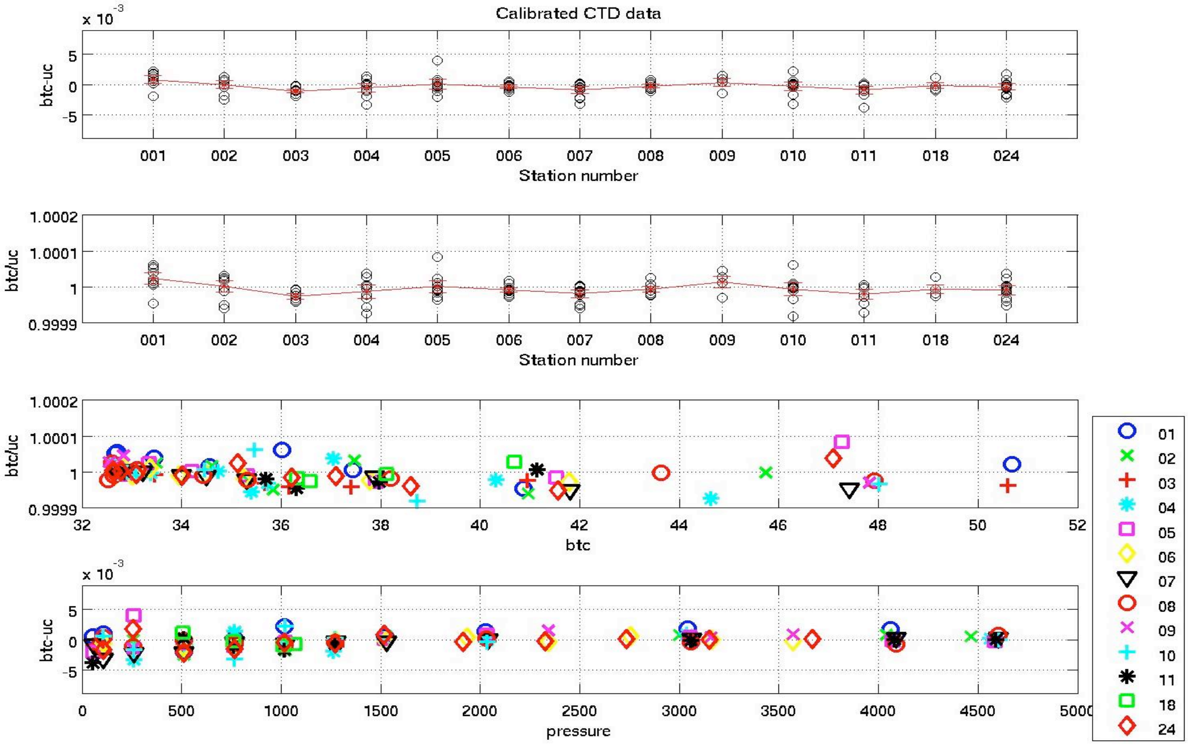


Figure 7.1 *Calibrated CTD data: i. (btc-uc) vs station number, ii. (btc/uc) vs station number, iii. (btc/uc) vs btc and, iv (btc-uc) vs pressure. btc is bottle conductivity and uc is CTD upcast conductivity.*

Station number	Sample number (bottle not closed)	Sample number (bottle data rejected)
001	1,6	10
002	-	11,12
003	1,2,10	5
004	2	11,12
005	-	10,11
006	-	11
007	-	-
008	-	12
009	5	3,6,8,9,10,12
010	8,9	15,16,17,18
011	4,5	
018	-	
024	-	

Table 7.2 *CTD Conductivity bottle samples not used for calibration.*

Station number	(C_{BOT}-C_{CTD}) [mS/cm] Mean	(C_{BOT}-C_{CTD}) [mS/cm] Std. Dev.	(C_{BOT}-C_{CTD}) [mS/cm] (P>2500dbar) Mean	(C_{BOT}-C_{CTD}) [mS/cm] (P>2500dbAR) Std. Dev.
001	0.0009	0.0012	0.0018	0.0907 10^{-3}
002	1.6 10^{-5}	0.0012	0.0007	0.1298 10^{-3}
003	-0.0010	0.0006	-0.0002	0
004	-0.0005	0.0015	0.0006	0.5046 10^{-3}
005	0.0001	0.0016	-4.28 10^{-6}	0.3690 10^{-3}
006	-0.0003	0.0005	0.0001	0.4240 10^{-3}
007	-0.0008	0.0011	0.0001	0.0345 10^{-3}
008	-0.0002	0.0006	-0.0001	0.7924 10^{-3}
009	0.0004	0.0013	0.0006	0.3422 10^{-3}
010	-0.0001	0.0020	0.0006	0.1074 10^{-3}
011	-0.0009	0.0013	-3.34 10^{-5}	0.0629 10^{-3}
018	-0.0002	0.0009	-	-
024	-0.0003	0.0011	0.0001	0.1132 10^{-3}

Table 7.3 *Mean and standard deviation of bottle-CTD conductivities station by station.*

8 The Lebus Winch

Stuart Cunningham

The Lebus winch was available as a substitute for the ship's fitted winches – none of which were operatonal during this cruise. This was fitted with an 8.03 mm Rochester Type: 1-H-314A-Steel Co-Ax cable. The immersed weight (in fresh water) of cable is 226 kg/km, and the allowable tension is 22.08 kN (2.25 tonnes) at a factor-of-safety of 2.5:1. The mechanical breaking strength is 55.2 kN (5.63 tonnes). Cable tension is reported in the winch cab on a dial readout but is not logged. Haul and veer speeds are also reported on a dial readout in the cab but not logged. For each station the pickup-on-deck weight, maximum wire out and weight at bottom of the down cast are recorded in the wire-log.

Prior to use we made a basic estimate of the package weights we anticipated (Table 8.1 and Table 8.2). The on deck weight at pick-up was estimated at 440 kg but was reported by the load cell to be 800 kg or so. From Table 8.2 we felt that in calm conditions casts to 4500 m wire out with an estimated total inboard load of about 1.4 tonnes was well within the cable specification. Indeed during the cruise the deepest station (010) reached 5531 m (5640dbar) with a reported inboard weight of 1.9 tonnes. We experience one problem however on this station. As the tension reduced when the CTD package was landed on deck, the wire twisted (due to stored energy during the deployment) and was caught between the gantry and the extender arm. As the extender was brought in-board it crushed the wire causing a short circuit and the alarm on the CTD deck unit sounded due to a fuse blowing.

The total length of wire available was unknown. With a wire out reading of 5500 m – the CTD was actually at 5531 m – there was at least 2.5 layers of cable remaining. So now we have reduced the uncertainty of this unknown – the wire is long enough for casts in excess of 5500 m.

I recommend that this winch is provided with a fully calibrated load cell and method of recording and displaying this information to improve the safety of operation, the envelope of operating conditions and to prevent unnecessary damage to the wire. This is a highly capable winch and a critical component for *Discovery*. Haul and veer speeds reported in the winch cab are also in error, under-reading by around 10-20m/min when the CTD shows speeds of around 60m/min. A potentiometer type control must be provided for the winch operators so even haul and veer speeds can be maintained – the winch is operated on a dead-mans handle. A few easy and cheap improvements would mean the winch could be used regularly and would also provide an extremely capable alternative or backup when the ship's fitted CTD winches are made operational.

Item	**Weight in water (kg)**	**Weight in air (kg)**
Frame	174.4	200
SBE CTD, pinger and altimeter	24	37.5
Niskin bottle (full)	1.3	10.8
8mm wire / 1000m	226	272
MicroCAT	4	4.1
Release	25	50

Table 8.1 *Known weights of CTD Frame and instrumentation to be attached to frame from manufacturers data sheets. The frame weight is given by UKORS. The total air weight of the package is around 440 kg with empty Niskin bottles.*

Item	**Weight of package in water (kg)**	**Weight of package in air with full bottles (kg)**
Frame	174.4	200
MicroCATs (12 off)	48	49.2
releases (3 off)	75	150
Niskin bottles (12 off)	15.6	129.6
SBE 9-11 CTD (1 off)	24	37.5
Sub Total	**337**	**566.3**
4500m of wire	1017	0
TOTAL	**1354**	**566.3**

Table 8.2 *Estimate of inboard weight [kg] with 4500m wire out and on deck with Niskin bottles full.*

9 Ship's Data Logging, Computing and Instrumentation

Martin Bridger

9.1 Techsas Overview D334

Following the *Discovery* refit early 2008, Techsas has completely replaced all level A and B hardware. The Techsas software is installed on an industrial based system with a high level of redundancy. The operating system is Red Hat Enterprise Linux Edition Release 3. The system itself logs data on to a RAID 0 disk mirror and is also backed up from the Level C using a 200GB / 400GB LTO 2 Tape Drive. The Techsas interface displays the status of all incoming data streams and provides alerts if the incoming data is lost. The ability exists to broadcast live data across the network via NMEA.

The storage method used for data storage is NetCDF (binary) and also pseudo-NMEA (ASCII).

9.2 NetCDF & rvs Datafiles

There are currently two methods of transferring data from Techsas to LevelC.

1.Realtime.
Using the newly developed fromtechsas/portgrabber software, it is possible to listen to the Techsas network broadcasts on the LevelC, and populate rvs data files in real time. This is not without its caveats, one being that there is no two way to ensure data consistency, and no way to backtrack to reclaim data that has been broadcast but not picked up by this software. The advantages are that rvs datafiles are updated in realtime, and lookd can be used in the usual fashion. The disadvantages are that if for any reason the program stops, or some data goes 'missing' there is no way to pause, or stop it temporarily to collect the missing data.

2. Manual
Using a series of unix scripts, the NetCDF files are first converted to listit format, then inconsistent variable names are corrected before converting back to rvs datafiles. The advantages are that the intermediate text files can be used as a data source, and final archiving. All streams can be reproduced from the source NetCDF files at any time, were any data inconsistencies noticed. The disadvantages are that each conversion takes time, it introduces the possibility for human error during the conversion, and that there are no live updating data streams.

9.3 Acquisition and Logging

Techsas has two main processes to handle incoming data, and archiving to disk. The Acquisition process monitors the serial ports for data and broadcasts the data over the network. The Logging process monitors the network for broadcasts and logs the data. This means several Techsas systems can all be logged on one central Techsas logger, as well as to local disk. This also has the benefit of live data being broadcast over the network in XML format for any other systems to listen in to. Techsas cannot log data without the broadcast. The broadcast message is part of the interprocess communications link between the acquisition process, and the recording process.

10 Science Party Computing

Stuart Cunningham

The principal computer for processing cruise data was a Sun workstation (rapid) running OS 5.10 Generic_127127-11 sun4u sparc SUNW,A70. Rapid is a dual disk machine so that the OS and all programmes and data are mirrored to the second disk. The following NERC packages were installed `emacs/ gmt/ nag/ openoffice/ studio/ utilities/ ferret/ MATLAB (v2007a)/ netcdf/ pexec/ uniras/`. The user id for data processing was pstar.

During the cruise several data partitions from the ship's network were cross-mounted giving ready access to raw data and for the purposes of backing up the rapid local disk each day.

Four Mac mini computers were networked to act as terminals to rapid. Running Xquartz 2.1.1 - (xorg-server 1.3.0-apple22) they could display the common desk-top-environment with full functionality. A cshell script was used to execute the CDE. The example below was taken from a Macbook Pro laptop.

```
#!/bin/csh -f
/bin/rm -r /tmp/.X3-lock
/usr/X11/bin/xset       +fp       tcp/192.171.133.240:7100       &&
/usr/X11R6/bin/Xnest +kb -query 192.171.133.240 -geometry 1280x1024 -
depth 24 :3 &
```

Additional to this core of terminals several Mac laptops and PC laptops were used by the science party.

The rvs software was copied to: `/local/users/pstar/Data/rpdmoc/d334/shipexec`. Even as su I was unable to install this in `/nerc/packages`. I used `set PATH /local/users/pstar/Data/rpdmoc/d334/shipexec/rvs/bin:${PATH}` in .login to obtain direct access to things like datapup.

11 Salinity Sample Collection and Analysis Procedure

Malte Heinemann

This Section aims at describing the collection and analysis of the salinity samples taken from i) the Niskin bottles mounted on the CTD frame, and ii) the Thermal Salinograph (TSG).

The salinity sample analysis is performed using the Guildline AUTOSAL 8400B Laboratory Salinometer (serial number 68958) in the constant temperature (CT) lab. The water bath temperature T is set to 24°C; the laboratory temperature is maintained between 21.0°C and 22.3°C.

11.1 Sample Collection and Analysis

On the CTD casts, one salinity sample is drawn per Niskin bottle. Each TSG measurement also consists of one sample. Samples are taken in 200ml glass bottles, rinsed three times, and sealed with disposable plastic stoppers and screw on caps. The sample bottles are then stored in the CT laboratory for at least 24 hours to allow for equilibration to the laboratory temperature.

The salinity samples for the CTD casts 1 and 2 were analysed according to the standard procedure (i.e. following the salinometer software). An IAPSO standard seawater (SSW) sample was used to calibrate the salinometer, before the samples were analysed. The salinities were computed internally by the salinometer and written out electronically. Every 12 samples, a new standard was measured and the instrument recalibrated if necessary.

This procedure has the risk of erroneous salinities for twelve bottle samples in case one of the IAPSO salinity standards is bad. Therefore, all CTD cast samples (after casts 1 and 2) and all TSG samples were analysed following a different procedure. As before, one SSW sample is measured every 12 samples. But instead of using the salinities as computed by the salinometer, the 2*K15 conductivity ratios $2R_T$ are written down (T indicates the salinity sample temperature, i.e. the water bath temperature). The K15 conductivity ratios R_T are then used to compute the practical salinities S using the relationship

$$S = \sum_{i=0}^{5} a_i R_T^{\,i/2} + \frac{T-15}{1+0.0162(T-15)} \sum_{i=0}^{5} b_i R_T^{\,i/2}$$

where

$a_0 = 0.0080$ $b_0 = 0.0005$
$a_1 = -0.1692$ $b_1 = -0.0056$
$a_2 = 25.3851$ $b_2 = -0.0066$
$a_3 = 14.0941$ $b_3 = -0.0375$
$a_4 = -7.0261$ $b_4 = 0.0636$
$a_5 = 2.7081$ $b_5 = -0.0144$.

If the measured SSW conductivity differed from the value the SSW should have had according to its label, we corrected the measured CTD and TSG sample conductivities to account for this difference. However, as opposed to the standard way of analysing the salinities, this method allows the later identification of bad standards, and to exclude them from the calibration process. We excluded the too low SSW samples 4 and 7 (see Section 11.3 'Salinometer Performance'), which are the initial standards of TSG1 and CTD cast 5.

11.2 Salinometer Performance

To assess the accuracy of the salinity measurements and to estimate the quality of the standard seawater (SSW) samples, we compared all conductivity measurements that were performed on SSW samples.

a) *b)*

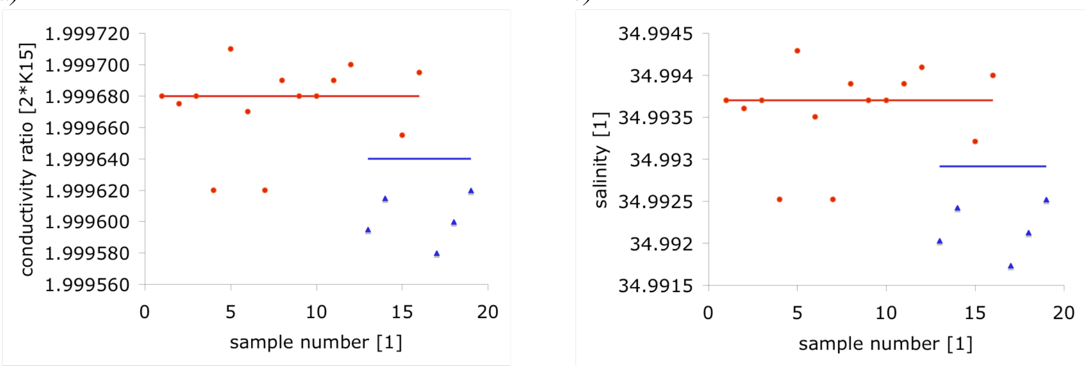


Fig. 11.1 *(a) Conductivities as measured for each SSW sample; red dots correspond to samples from batch 148, which should have a conductivity of 1.99968 (red line); blue triangles correspond to samples from batch 149, which should have a conductivity of 1.99964 according to their labels (blue line). (b) Corresponding salinities.*

Fourteen SSW samples originate from batch 149, which should have a K15 of 0.99984 (2*K15=1.99968) according to their labels. Five SSW samples originate from batch 148, which should have a K15 of 0.99982 (2*K15=1.99964) according to their labels.

Most measured batch 149 SSW sample conductivities compare quite well to the labelled values (Fig. 11.1). Samples 4 and 7 appear as outliers measuring too low conductivities. However, both too low measurements show a positive trend for their measurement sequences and are possibly not well equilibrated (sample 4: 1.99925 49 53 60 62 62; sample 7: 1.99960 61 63). The mean conductivity of all batch 149 SSW samples amounts to 1.999675, which is only $5x10^{-6}$ lower than the labelled value. The standard deviation amounts to $27x10^{-6}$. The corresponding mean salinity amounts to 34.9936+/-0.0001, which is one standard deviation (0.0001) lower than the salinity according to the labelled conductivity.

All measured batch 148 SSW sample conductivities are smaller than the labelled conductivities, their mean amounts to 1.999605+/-0.000014, which is 0.000035 lower than it should be. The corresponding mean salinity amounts to 34.9922+/-0.0003, which is more than two standard deviations (0.0007) lower than the salinity according to the labelled conductivity.

12 Bathymetry

Malte Heinemann

Instruments:

The bathymetry data were obtained using a Simrad EA500 hydrographic echosounder with a precision echosounding transducer (PES) mounted on a Fish (see Figure 12.1).

Operation:

Initially the EA500 used an echosounder transducer mounted on the ship's hull. After leaving Tenerife we removed some broken plastic clamps on the fairing of the Fish's wire, the Fish was deployed, and the EA500 was switched to the PES on the Fish.

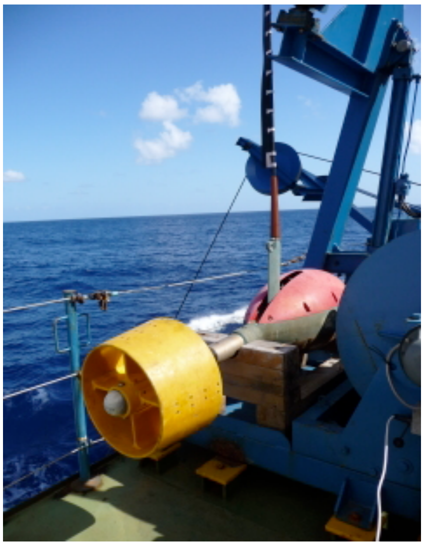


Figure 12.1 *Picture shows a PES fish on deck; the crane in the background holds the fish actually deployed on this cruise; ship's speed when taking picture about 10 knots; 10m of wire below sea surface.*

Data processing:

i) The echosounder output (file `ea500d1`) contains the water depth as computed from the ping return time assuming a constant speed of sound of 1500 m/s. This uncorrected water depth is corrected for regional variations of the velocity of sound using the Carter tables (script `prodep`, output file `sim334`*nn*, *nn* denoting running number).

ii) The data is converted to 'pstar' format (script `simexec0`, output file `sim334`*nn*`.cal`).

iii) The most time-consuming part of the data processing is the manual editing of the data to remove erroneous bottom detections. This is done by comparison of the electronic data to the direct EA500 printout, which helps to judge the electronic data (manual editing via GUI started by the script `plxyed`, output file `sim334`*nn*`.cal`).

iv) Missing data is interpolated. This interpolation may be a large error source. The EA500 often does not detect the bottom correctly at steep slopes (to me it seems especially ascending slopes). If a steep mountain is not detected correctly and the wrong datapoints are deleted from the dataset, it is possible that 'no correct bottom' is converted into 'flat bottom'. Finally, the bathymetry data is merged with the navigational data obtained from the Trimble 4000 GPS, and averaged into five minute intervals (interpolation, merging, and averaging done by script `simexec1`, output files `sim324`*nn*`.nav` and `sim324`*nn*`.5min`).

13 D334 Navigation

Gerard McCarthy

13.1 Navigation Summary

High quality navigation data is essential for making accurate underway measurements of ocean current and various meteorological parameters. Ship location is necessary to orient measurements in space while ship speed and heading are necessary to create absolute measurements of ocean currents and winds that are measured relative to ship motion. The *RRS Discovery* has three GPS receivers: the Trimble 4000 (GPS_4000), which is a differential GPS; the Ashtech (GPS_ash & adu2); and the GPS G12 (GPS_g12). The ship also uses a gyrocompass (gyronmea) and Chernikeeff Doppler log (log_chf) to measure speed and heading. GPS – from both the Trimble 4000 and the G12, gyro and attitude data from the Ashtech were processed after the daily download from the TECHSAS data logging system.

13.2 Trimble 4000 and Ashtech GPS G12

Data from the Trimble 4000 and GPS G12 were logged each second to give ship position and speed. Each day, old master GPS files were deleted and new master files `GPS433401`, `GPSg1233401` and `GPSg1233401.5min` (data averaged into 5 minute bins) were created (as opposed to appending daily) to ensure continuous calculation of distrun (distance run) for the duration of the cruise. GPS data from the Trimble 4000 were extracted and processed using the PEXEC script `GPS4exec0`. Values considered poor for positioning are removed in `GPS4exec0` according to the parameter PDOP (Position Dilution of Position, a unitless figure of merit) when values are greater than 5. Data from the Ashtech GPS G12 were extracted and processed for the duration of the cruise using the PEXEC script `GPSg12exec0`. Data with values of PDOP > 5 were removed in `GPSg12exec0` by the PEXEC datpik. Also, following developments on D324, where investigation of ship speeds produced by the G12 revealed frequent erroneous spikes when recorded values of longitude and latitude momentarily dropped to 0, `GPSg12exec0` was subsequently edited to remove data with longitude and latitude outside the ranges of -100 to -1 and 1 to 90 respectively. While this edit is appropriate for the geographical location of D334, appropriate editing should be performed when location changes and special caution when the location of the cruise crosses the equator or the Greenwich Meridian.

13.3 Gyrocompass

The ship's gyrocompass provides a reliable estimate of ship's heading (i.e. not dependent on transmissions external to the ship). However the instrument is subject to a latitudinal dependent error, heading dependent error and has an inherent oscillation following a change in heading. Measurements computed using Gyrocompass data (e.g. OS75 ocean currents) require a correction from the more accurate but less reliable Ashtech ADU2 heading. Ship's gyrocompass data was logged every second on the TECHSAS system. Incremented files were created every day. The length of these files was chosen to match the length of the Ashtech files with which they were merged. For example, the start of the gyro was chosen as one second after the end of the previous day's file (the start of the file for the first day) until the end of the shortest stream be that the gyro or the adu2. The gyro was consistently the shorter stream on D334 due to the order of the transfer from TECHSAS to the network. Gyrocompass data was extracted and processed using PEXEC script `gyroexec0`, including removal of data with headings outside the 0-360 degree range.

13.4 Ashtech 3DF GPS Attitude Detection Unit (ADU)

The Ashtech GPS comprises four antennae mounted on the bridge top. Every second, the Ashtech calculates ship attitude (heading, pitch and roll) by comparing phase differences between the four incoming satellite signals

Ashtech data were processed daily after transfer from the TECHSAS system. A new incremental file was created each day and a master file `ash334i1.int` was updated daily using `papend`. As mentioned with the gyro, care was taken to process data streams of equal length to avoid gaps in the data when gyro and Ashtech files were merged.

The calculation of the *a-ghdg* quantity was very important for the PEXEC route of processing the ADCP data as this provided correction for the known offsets and Schuller oscillations inherent in the gyro data.

Processing

`ashexec0` Acquire Ashtech data

`ashexec1` Merge gyro and Ashtech data, calculate a-ghdg, set difference in range -180 to 180, creates .mrg file.

`ashexec2` Quality control data using datpik, creates .edit file, data removed outside following limits

hdg	0	360
pitch	-5	5
roll	-7	7
attf	-0.5	0.5
a-ghdg	-7	7
mrms	0.00001	0.01
brms	0.00001	0.1

Create 2 minute averaged .ave file. Further quality control using datpik, data removed outside following limits

pitch	-2	2
mrms	0	0.004
a-ghdg	-10	10

`plxyed` Use `ash.pdf` to manually edit remaining outliers in a-ghdg. Outliers generally corresponded to where large discrepancies between the gyro

	and the adu. These spikes in the *a-ghdg* were removed. Sometimes, the *a-ghdg* spikes corresponded to spikes in the pitch. These points were also removed.
`pintrp`	Interpolate across missing data points.

Finally, the `final.ave` file was appended to a master file `ash334i1.int` using *papend*.

14 Ocean Surveyor 75kHz Shipboard ADCP

Gerard McCarthy

14.1 Setup

The 75kHz ADCP is a narrow band phased array with a 30-degree beam angle. Data were logged on a PC, using RDI data acquisition software, VMDAS. The instrument was configured – while in water track mode – to sample over 2 second intervals, with 65 bins each of 16m thickness, and a blank beyond transmit of 8 m. The depth of the transducer was set at 5.3m. After investigation, the misalignment angle was set to 0º. The angle had been set to 60º in previous configurations but this was found to lead to a correction of over 60º in post processing. Setting the misalignment angle to 0º led to a degree or so of misalignment correction in post-processing. The tilt corrections were all disabled. Reference bins were not enabled.

The data from each single ping were recorded in files of extension .ENX, .ENS, ENR. Data were averaged into 2 minute averaged files (Short Term Averaging, file extension STA) and 10 minute averaged files (Long Term Averaging, file extension LTA). The software logs the PC clock time and its offset from GPS time. The instrument was configured to use gyro heading as the primary heading source ($HEHDT messages) and Trimble 4000 as the primary GPS information ($GPGGA messages). The direct feed of the GPS to the ADCP means that it does not suffer the loss of accuracy during conversion to delayed mode that is reported elsewhere in this report. Both of these were logged into the .N1R navigation file along with the $PADCP message which contains the PC offset from UTC. Backup attitude data were logged to the N2R files. Originally this was configured to log $PRDID messages which provides three messages: pitch, roll and heading. The $PRDID message is a secondary product from the Ashtech adu2 data stream. The $PRDID message looks at the $GPPAT message produced by the Ashtech and extracts solely the pitch, roll and heading information from this message. It does not provide any quality flags.

A problem was flagged with the $PRDID message on day 307: the message was failing to produce three figure headings so that all headings were in the range of 0 – 99. A temporary fix was incorporated which had the Ashtech writing messages direct to the ADCP. This led to many different messages in the N2R file: $GPPAT, $PASHR etc. While the fix was functionary, it was not ideal. The VMDAS software is known to choke when sent too many messages (University of Hawaii ADCP Documentation). The $PRDID message was subsequently repaired (it had been configured to expect a plus/minus sign instead of the first digit of the heading) and reset as the backup heading source. ADCP data were unaffected directly by this fault as it only affected the *backup* heading source.

While the PRDID message worked correctly from day 307 onwards, the CODAS software for reading it had a bug in it, which meant headings were only read to the nearest degree. The problem lay with the `serasc2bin.py` script. It was searching for a checksum at the end of the PRDID message, which was not present on *Discovery*. Due to this problem and a recommendation from the University of Hawaii in the CODAS documentation for not using PRDID as the secondary heading, a fix was implemented which would provide the GPPAT message as the secondary heading in the N2R files. This message is superior to the PRDID message as it has quality control present. The fix was also such that *only* the GPPAT message was sent to the N2R file so no clogging of VMDAS should occur. This was implemented on day 319. A PASHR, ATT message is the most preferable message from the Ashtech as it contains a useful reacquisition flag (quality control). This message was unfortunately not available on *Discovery*.

File Numbers	**Status**
1-7	$PRDID missing 3rd digit
8	Transitional; Useless N2R
9,10,11	$GPPAT, $PASHR etc.
12-15	Transitional; Useless N2R
16-21	$PRDID functioning
22+	$GPPAT functioning

Table 14.1 *Problems with $PRDID files*

14.2 Processing

The processing of ADCP data on D334 took two paths: the tried and tested PSTAR route and a trial of CODAS suite for processing ADCP data developed by the University of Hawaii (UH). The ADCP data were logged on the OS75 PC with RDI VMDAS software. From there, they were transferred to the network where the PSTAR processing was performed on the UNIX machine *rapid*. The data were then transferred to an Intel MacBook where the UH software was installed.

The processing steps are quite similar between both methods; they both read in the data, rotate the dataset correcting for gyro errors, rotate the dataset by a constant misalignment found from bottom track and/or water track calculations and perform further editing. However, the order of these steps is different and there are differences at the editing stage.

14.2.1 UH Processing

CODAS (Common Oceanographic Data Access System) is a system of programs in MATLAB and Python that streamline processing of ADCP data. The software is available for Windows (98 or later), Linux and Mac OSX. Processing for D334 took place on a MacBook running OSX.

Running `quick_adcp.py`

The Python script `quick_adcp.py` performs the main processing steps. `Quick_adcp` is a wrapper that performs the scan, load, navsteps and preliminary calibration. It is a good starting point for CODAS processing but more in depth editing usually requires using the core programs. A directory was set up for the data from D334. The data need not be stored in this directory – this is the directory where the processing will be performed. From a terminal window in the D334 directory, run `adcptree.py`. This sets up the main directory and other subdirectories where the software will place the processed data, navigation data, calibration and more. At this stage, set the type of data which you wish to process. The software can handle LTA, STA and ENX (single ping) data.

```
adcptree.py dirname --datatype sta
```

Where 'dirname' is the directory name. Change to this directory to run `quick_adcp.py`. This requires a control file where you specify items such as yearbase, the data directory, the datatype (LTA, STA or ENX) and more. Heading offset angles and amplitudes may also be applied at this stage also or more often at a later stage. An example of a control file is included below.

```
# q_py.cnt is
## comments follow hash marks; this is a comment line
--yearbase 2008
--dbname os_75
--datadir  /Users/gdm2v07/Desktop/ADCP/D334_watertrack
--datafile_glob     *.STA
--instname os75
--instclass          os
--datatype           sta
--auto
--rotate_angle 0.68
--rotate_amplitude 1.004
# end of q_py.cnt
```

The command to run `quick_adcp.py` is:

```
quick_adcp.py --cntfile q_py.cnt
```

Provided the script ran successfully, the data are now loaded to the subdirectories.

Time Dependent Heading Correction

There are two types of heading correction that may need to be applied to ADCP data: a time dependent heading correction where the gyro (primary heading) is corrected for errors with a secondary heading source and a constant offset due to the orientation of the ADCP transducer with respect to the hull. The heading needs to be accurate to within 0.1° to get accurate currents from an ADCP. For example, for a ship travelling at 10 knots, a 1° heading error causes cross track errors of 10 cm/s. The gyro is chosen as the primary heading source because it provides continuous smooth headings however it is subject to known biases and oscillations. There are biases due to latitude, speed and an inherent oscillation -- called a Schuller oscillation -- with a period of 86 minutes after a change in heading or speed. These can be corrected with a more accurate but less reliable GPS heading. On D334, this was provided from the Ashtech ADU2 unit.

The procedure for generating a time dependent heading correction from VMDAS is described in the documentation and the relevant MATLAB script is `get_headcorr.m`. A python script `serasc2bin` can be configured to access the secondary heading in the

.N2R files and also extract the pc clock time at which they were logged. These are then converted to rbin files which MATLAB can read. This gyro heading and pc clock is accessed using `ensgyro2rbin` from the .ENS files. The two heading sources are merged to create a heading correction in the sense **gyro-secondary**. The sense of this heading is vital. The heading correction is interpolated onto the timestamps used by CODAS and recorded in `head_corr.ang` in the cal/rotate subdirectory of the processing directory. In this directory, `rotate.tmp` was copied to `rotate1.tmp`, edited to include the time dependent heading correction file and ran using

```
rotate rotate1.tmp
```

Returning to the main processing directory, `quick_adcp.py` is then rerun, this adjusts the water/bottom track calibration (*calib*) and the navigation (*navsteps*). The command is

```
quick_adcp.py --yearbase 2008 --steps2rerun
calib:navsteps
```

from the terminal window.

Problems arose with this procedure on D334. As mentioned, there were problems with the $PRDID message at the beginning of the cruise. Also, after the problems were fixed, the UH software failed to read the secondary heading to the required accuracy. It was only reading the secondary heading to the nearest degree, not the 0.1º accuracy required. The problem was with the `serasc2bin` routine.

The solution was to use the *a-ghdg* data stream from the navigation processing. The **negative** of this was then interpolated onto the timestamps used in the UH software to produce a `head_corr.ang` file. The `rotate` and the `quick_adcp.py` script was then rerun as above.

Constant Heading Correction

Bottom Tracking

The cruise track of D334 left Tenerife and dropped quickly over the edge of the continental shelf. The ADCP was configured in bottom track mode. It performed admirably and detected the bottom as far as 1000m depth. To aid calibration of the ADCP, a detour was taken around the west of the Canary Island of Gomera. This provided a couple of hours worth of bottom track data.

Due to the investigation into the transducer misalignment, there is a constant difference of 60º rotation between these bottom tracking files and subsequent water track files which hinder them being merged.

The CODAS software automatically calculates the amplitude and phase correction if bottom track data is present. The calculation is stored in `btcaluv.out` in the `cal/botmtrk` folder in the processing directory. There are also plots of the data points, depth, heading and speed automatically created in this directory.

As seen in Figure 14.1 in the lower panel, the ADCP picked up the bottom near Santa Cruz and Gomera. The top panel shows the effect of the time dependent heading correction on the calibration statistics and highlights the importance of this step. We recall that the accuracy required is of the order of 0.1° and the heading correction applied is often an order of magnitude greater than this.

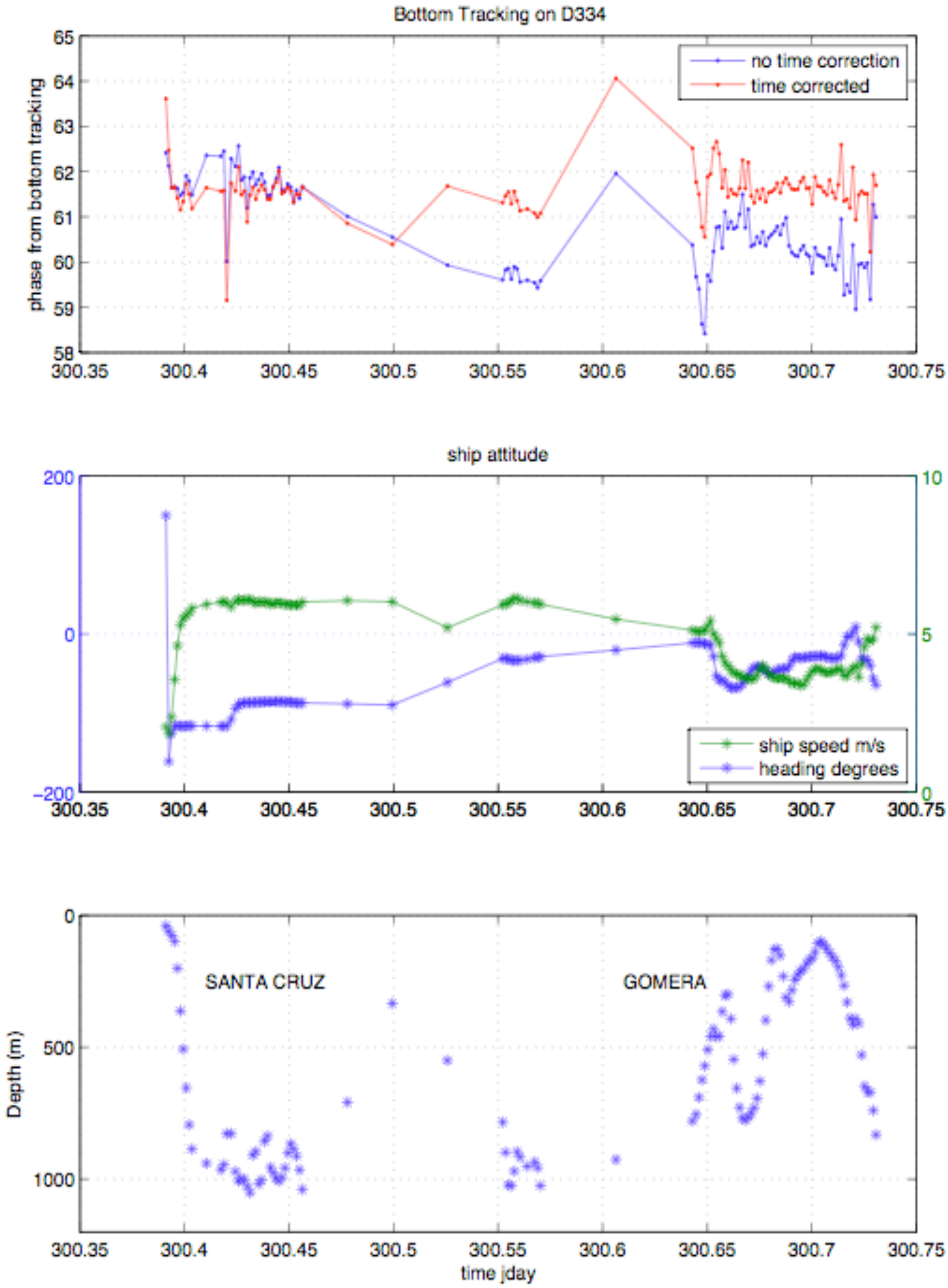


Figure 14.1 *Calibration of the ADCP using Bottom Track Data. The top figure shows the difference between the time corrected and uncorrected calibrations. The middle figure shows the ship's heading and speed corresponding to each bottom track point and the bottom panel shows the depth detected by the ADCP for each point.*

The statistics derived from bottom tracking are shown in Table 14.2. The 60º offset in comparison with the water track files is present in Figure 14.1 but it is only the difference from 60º we are interested and is displayed in Table 14.2. The mean and median agree to within 0.01º and the standard deviation is small in comparison with water track statistics.

Phase Angle	***Bottom Track***	***5 ensembles (WT)***	***7 ensembles (WT)***	***9 ensembles (WT)***
Median	1.55	1.66	1.707	1.617
Mean	1.56	1.787	1.651	1.653
St. Dev.	0.28	1.28	0.956	0.727
No. good/ No. bad points	63/118	22/33	36/41	37/44

Table 14.2 *Statistics derived from bottom tracking.*

Water Tracking

Water tracking calibration is also available via the UH software. The default method of calculation of the water track statistics is by comparing on and off station data. The software looks for a number of consecutive points straddling a transition from off station to on station. The number of points chosen can be edited. It takes the first two points (steaming points) and the last two points (stationary points) and compares them to ascertain the offset. The software may also be configured to provide calibration between two contrasting periods of reciprocal cruise track. The calculation is automatically outputted into the `adcpcal.out` with the individual data points stored in `os_75_X.cal`, where the x stands for the number of points used.

The number of points used can be edited by altering `timslip.tmp` in the `cal/watertrk` directory. The options are already in the file and you just need to edit it to choose your preferred number of points. Make sure to also change the output file to `os_75_X.cal` as above. Then, from the terminal, run

```
timslip timslip.tem
```

Start MATLAB, and run `adcpcal.m` to investigate the effect of variation in the calibration, which is stored in `adcpcal.out`. The various results are shown in Table 14.2 and the effect of choosing different numbers of points is shown in Figure 14.2.

Final Application of the Rotation

This is applied by rotating the dataset using `quick_adcp.py` with a control file of the sort:

```
#q_pyrot.cnt
--yearbase 2008
--rotate_angle 1.56
--rotate_amplitude 1.00
--steps2rerun rotate:navsteps:calib:matfiles
--auto
```

```
# end q_pyrot.cnt
```

- The final angle rotated by was 1.56º taken from the bottom track data as these provided a consistent angle of rotation. Water track calibration showed large spread and the routines may have been imprecise on D334 as, on a moorings cruise, there are lots of times when the ship is not fully stationary e.g. when deploying a mooring. The software may have mistaken these times as on station times and consequently a spread in the data resulted.
- There was no amplitude correction applied to the data on D334 as the amplitude was consistently very close to one. There was no variation until the second or third decimal place in general.
- It is important that this correction is applied after the time-dependent heading correction.

Further Editing Using `gautoedit`

CODAS software provides an automatic editing tool called `gautoedit` to flag bad profiles from the data. This program automatically removes the effect of jittery navigation, wire interference, low percentage good pings and other criteria that can be chosen by the user to exclude bad data. The jitter parameter is a measure of how much smoothing has been applied to the navigation. Wire interference is a common problem when on station; the CODAS suite has built in guards against this and automatically removes these anomalies. Further editing is available with the *rzap* and *pzap* tools which manually flag bad profiles and bad bins.

Manually applied flags are listed to disk automatically in preparation for being applied to the database. The automatic editing flags must be applied to each gautoedit window by pressing *list to disk*. When this process is completed, `quick_adcp` is rerun using the command

```
quick_adcp.py --use_refsm --yearbase 2008 --steps2rerun
apply_edit:navsteps:calib --auto
```

All editing steps have, at this stage, been applied to the database. To access the data in MATLAB and apply the data quality flags commands such as those below are used

```
data = run_agetmat('editdir', '../dbname/edit'
      ,'ddrange',[0 365]);
data = apply_flags(data, data.pflag);
```

14.2.2 PSTAR Processing

This was performed on files 4, 5, 6 and 7 only to provide a comparison between PSTAR and CODAS.

`surexec0` Reads data into PSTAR format from RDI data file and edits header information. Writes water track data into the form `sur334`*`nn`*`.raw` where nn is a user defined code. Scales velocities to cm/s, tracking depth and beam range to metres. Sets bindepth including an offset for depth of transducer and blank beyond transmission – which have all

	been listed above. Calculates time in seconds and combines GPS data to correct for PC clock drift. This was run on each of the files. The outputs were all merged together using `papend` to create a master file `sur334i1`. All further processing was performed on this file.
`surexec1`	Edits out bad data and replace with absent data (-999). Removes data where beam one status (status1) is flagged as one (bad data) and 2+bmbad parameter is > 25% (percentage of pings where two or more beams were bad therefore no velocity computed). Time stamp moved to end of each ensemble.
`surexec2`	Merge data with Ashtech-Gyro heading correction (from master Ashtech file `ash334i1.int`, see section 13.4) to correct heading and find true North and East components of current velocity.
`surexec3`	Calibrate velocities by scaling factor A and by ADCP misalignment angle phi. These were calculated separately via the UH software.
`surexec4`	Calculate absolute current velocities by merging with navigation data and removing ship speed over ground from calibrated velocities. Navigation data came from the Trimble 4000 instrument.

14.2.3 Comparison of Processing Methods

A comparison of the two methods of processing was performed. It is worth recalling at this stage the various steps performed by each routine. VMDAS has taken the raw data and produced velocities in earth co-ordinates. What remains to be done is the finer time-dependent calibration of the heading, adjustment for constant misalignment of the ADCP and merging with the navigation. These are the routines performed in post-processing by both routes.

No baroclinic adjustments are made in post processing and both methods should be equal to within a constant velocity through the water column. This is true as seen in Figure 14.4.

One difference was noted between the timestamps from both methods. In the PSTAR route, `surexec1` moves the timestamp to the end of the ensembles. CODAS keeps the timestamp in the middle of the ensemble. Also when more than one file is processed at a time, there are differences around the transition between files. This can be seen in Figure 14.3, where there are more ensembles in the PSTAR data at the transition between files (identified by the extreme profiles in the PSTAR output).

Another difference between the two routes is the use of data external to VMDAS. The PSTAR routines use independent data streams from the ADU2 unit and the Trimble 4000. The CODAS suite uses only data from *within* VMDAS. The secondary heading comes from the .N2R file (when everything works) and the navigation comes from the files being processed. In this sense, CODAS is a more self-contained processing suite. For example, it is highlighted elsewhere in this document that the delayed mode navigation data loses accuracy of up to 20m. As VMDAS uses the raw data feed it is insulated from this error. The PSTAR route, however, is not.

One distinct advantage in the CODAS processing route is the `gautoedit` processing tool which includes built in automatic editing.

14.2.4. Results from CODAS processing

The data is shown after the processing steps above. Figure 14.7 shows the main section plots averaged in 0.1º longitude bands. The far eastern boundary is shown in a separate panel as the currents in this section are stronger than in the mid ocean. A problem was encountered in the along track velocities while steaming and is an identical problem to that which was encountered on D324. There was an anomalous scattering layer at 450m which caused an s-shaped velocity profile in the along track velocities. The effect is shown in Figure 14.5. The phenomenon is described more in Analysis of shipboard ADCP data from RRS Discovery Cruise D324: RAPID Array Eastern Boundary (C. Atkinson, National Oceanography Centre, Southampton, Internal Document No. 12) The CODAS software contains a developmental bias parameter, which attempts to flag this error. The phenomenon does not affect cross track velocities and it can be seen in Figure 14.6, that, for meridional velocities, results are in baroclinic agreement.

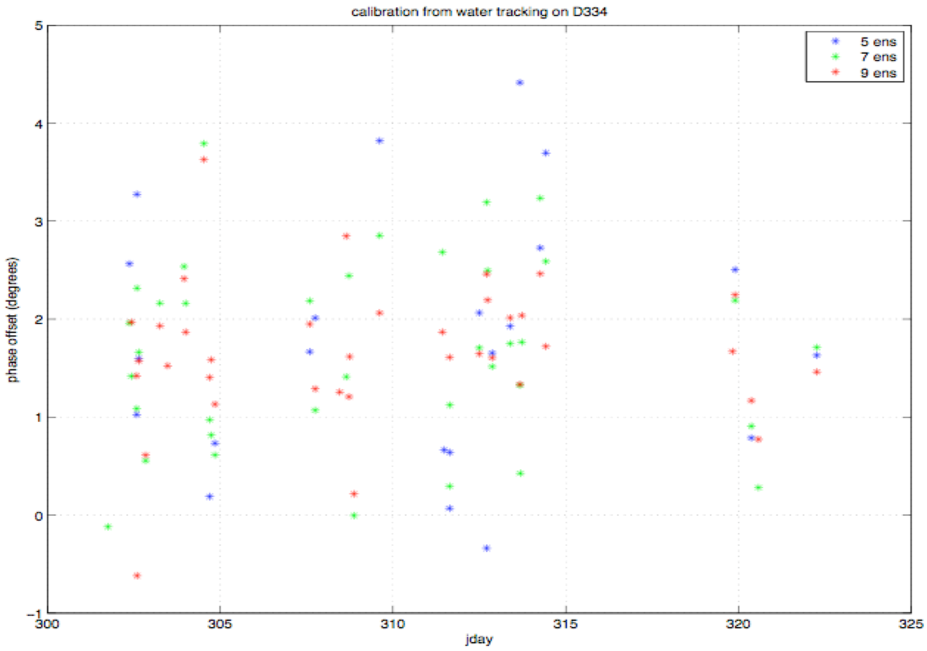


Figure 14.2 *Variation in the water track calibration is shown for three different calculations of the value: using 5, 7 and 9 ensembles respectively. The software considers the first two points as 'steaming' points and the last two as 'on station' points. Varying the number of ensembles chosen has the effect of varying the number of points discarded in between 'steaming' and 'on station'.*

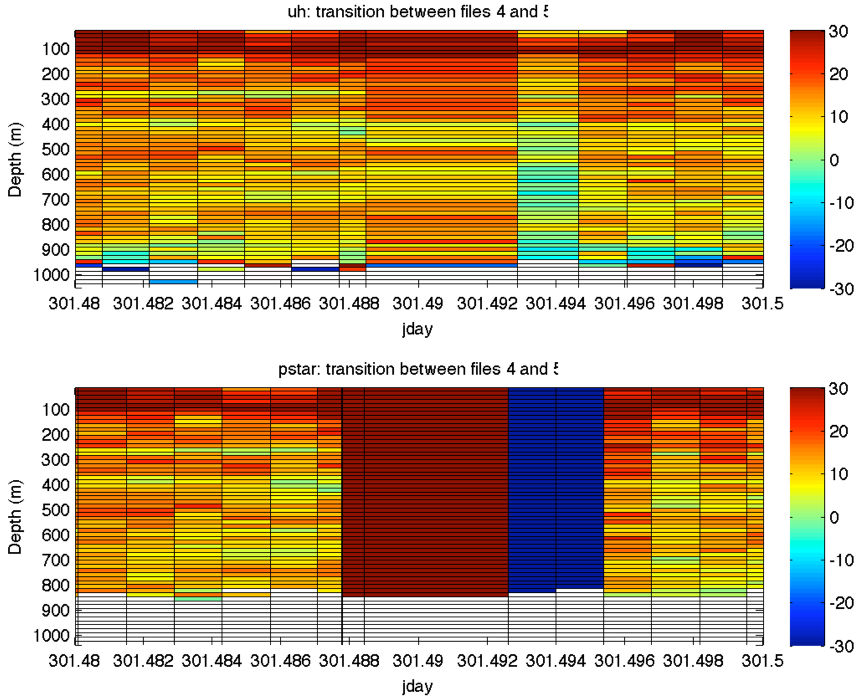


Figure 14.3 *An illustration of the difference between the CODAS and pstar processed files at the transition between two adcp files. For the most part the output data is the same . However the pstar path produces anomalous velocities at the file transition. Also notworthy is the location of the timestamp: pstar moves it to the timestamp to the end of the ensemble while CODAS keeps it in the middle.*

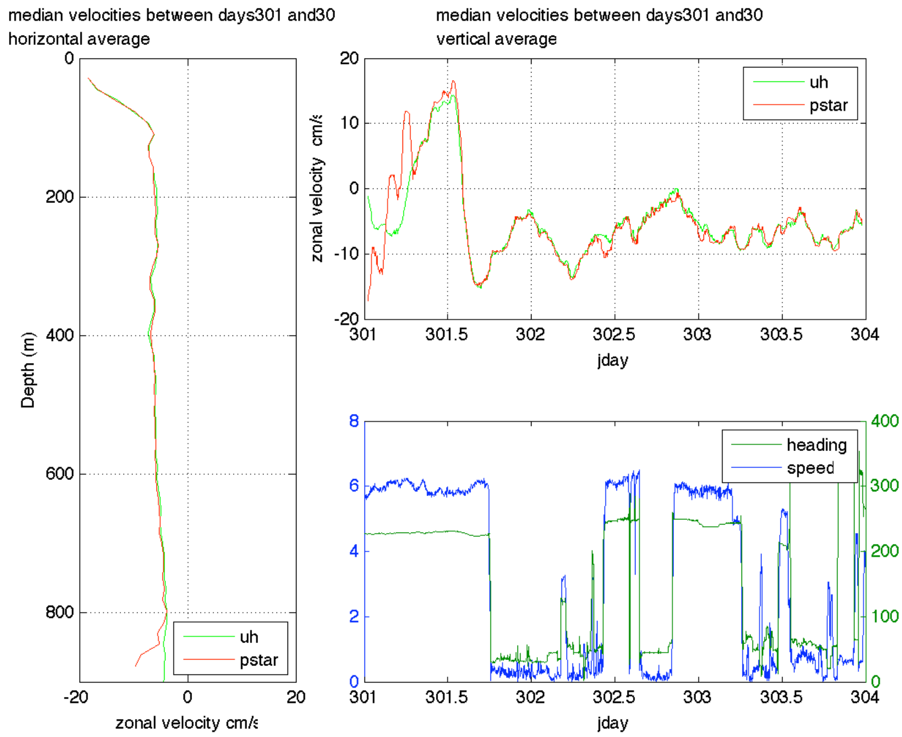


Figure 14.4 *A comparison of the uh processed output and the pstar output. No baroclinic adjustment is made by either processing path and the baroclinic agreement is good as seen in the left hand panel. Some variation is seen barotrpically (top right). Heading and speed is included for comparison.*

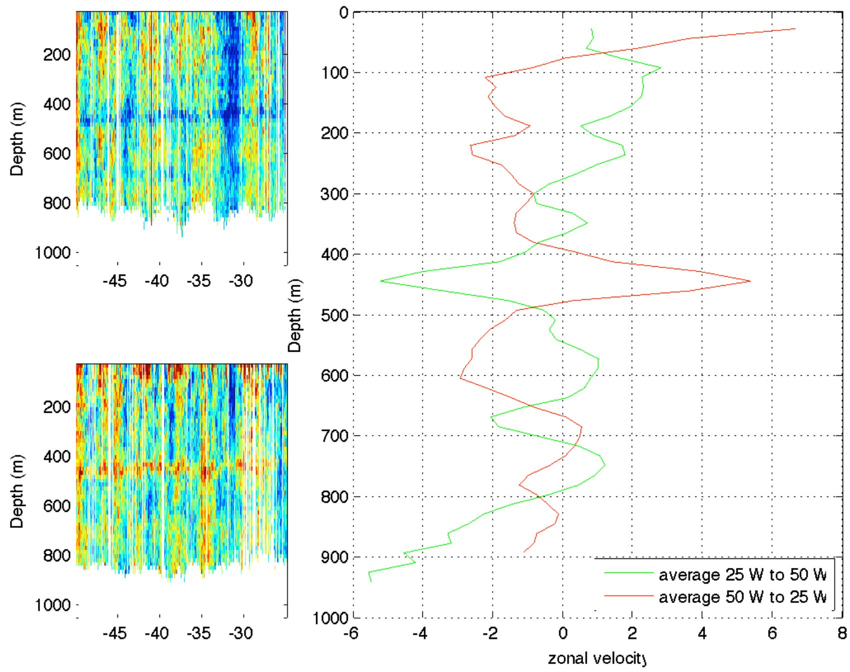


Figure 14.5 *A section showing the zonal velocity – essentially along track velocity to and from the MAR. The large spike around 450m is attributed to an anomalous scattering layer.*

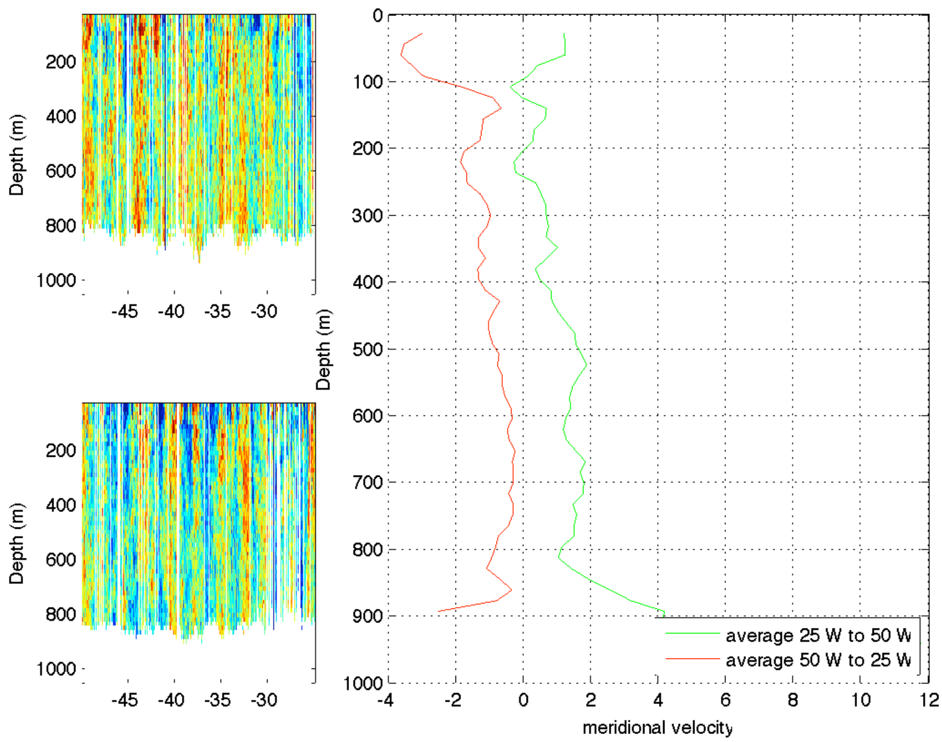


Figure 14.6 *A section showing the meridional velocity (cross-track velocity) to and from the MAR. Baroclinic agreement between the two sections is good. However there does appear to be a barotropic offset to the data.*

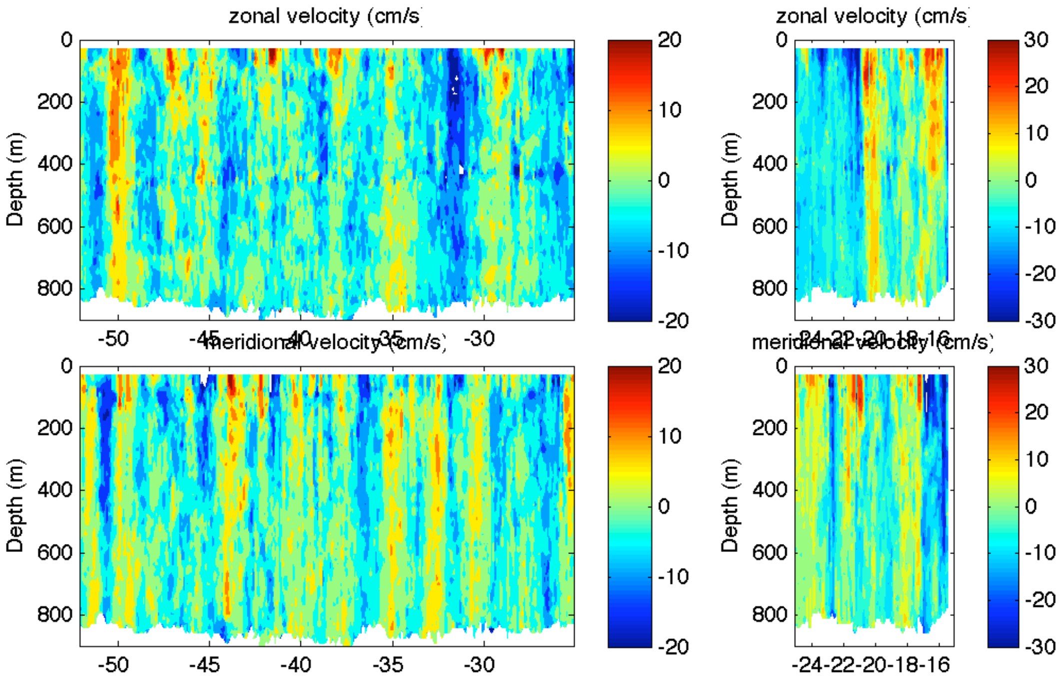


Figure 14.7 *The final full meridional and zonal velocities for all of D334. Since D334 has essentially a reciprocal track to and from the MAR, the velocities from the out and return legs of the cruise were averaged together. This will have an negating effect on the anomalous scattering layer which affects the zonal velocity. Also, for the meridional velocity, the averaging should provide a good estimate of the mean state along the cruise track.*

15 Surface Meteorology Data

Damien Desbruyères

The meteorological data was processed using the following execs available from previous cruises :

smtexec0 transfers the underway surfmet data from RVS to PSTAR format

smtexec1a changes absent data values from 99999 to -999, computes the surface salinity and merges in bestnav positions of GPS4000. It also applies the new calibrations.

smtexec1b merges the underway data with the heading files, gyro and ash-gyro.

smtexec2 computes vessel speed and subtracts this from relative winds to get the new variables true wind speed and true wind direction.

smt_plot.m plots the surfmet data and applies basic quality control. Changes time in seconds to julian days.

The processing was firstly done on a daily basis. Some calibrations of newly replaced instruments were however needed and the exec files smtexec1a and smtexec2 were modified to take into account these corrections. This work was completed on day 323. Surface meteorological data were then re-processed in one block from day 299 to day 323 and on a daily basis from day 324 to day 328 (end of the cruise). Note that salinity calibration (see section 16 - Surface Temperature and Salinity) has been applied directly to the output variable 'salin'. A new variable 'salin_c' was then created and refers to the calibrated salinity values.

All surfmet data were appended in one master file `smt334i1.master.met`, which was created to facilitate the loading of the data into other programs (MATLAB). In addition, a master file `smt334i1.master.av` was created and used for the calibration of underway salinity.

The meteorological sensors configuration is given in table 15.1 . A new calibration has been applied for those sensors which have been replaced before the cruise. Note that the sensors 'Anemometer WAA' and 'Wind Vane WAV' used in previous cruises have been replaced by a 'Windsonic' sensor.

SENSOR	**MANUFACTER**	**SERIAL NO**	**COMMENTS**	**CALIBRATION $Y = A + BX + CX^2$**
OTM temperature	FSI	1339	TSG Housing (temp_h) – new calib	A = -0.0136685 B = 1.0007 C = -0.0000431229
OTM temperature	FSI	1401	Remote (r_temp)	Not calibrated
OCM conductivity	FSI	1339	TSG Housing	
Barometer PTB100A	Vaisala	U1420016	New calib	A = 0.351188 B = 0.999218 C = 0
Temp / humidity HMP45	Vaisala	C1320001	New calib	A = 0 / 1.41607 B = 1 / 0.955558 C = 0 / 0.000364511
PAR	Sky	28561	Port, new calib	B = 0.980392
PAR	Sky	28562	Stb, new calib	B = 0.980392
TIR CMB6	Kipp and Zonen	973135	Port, new calib	B = 0.857633
TIR CMB6	Kipp and Zonen	973134	Stb, new calib	B = 0.922509
Windsonic	Gill	071123	Port foremast	A = -180

Table 15.1 *Meteorological sensors configuration*

16 Surface Temperature and Salinity

Damien Desbruyères

A high precision FSI sensor, located five metres below the surface at the ship's bow was used to measure sea surface temperature. Measurements of conductivity and again temperature were performed on the same water after passing a de-bubbling system. In addition, water samples were taken approximately every four hours between 8:00 and 20:00 from the uncontaminated water supply. No sampling was performed during CTD stations or mooring operations, when the ship was stationary. Overall, one to four samples have been taken per day with an average of ~2.8 samples per day. The collected water samples were then analyzed in the constant temperature lab with a salinometer. Data were appended in excel files and saved in a unique CSV file '`tsg33401.csv`' and then converted into a PSTAR format for further processing (calibration of underway measured salinity).

The underway salinity data was processed using the following execs:

tsg.exec reads .csv file to a txt file and converts it to PSTAR format for further processing.

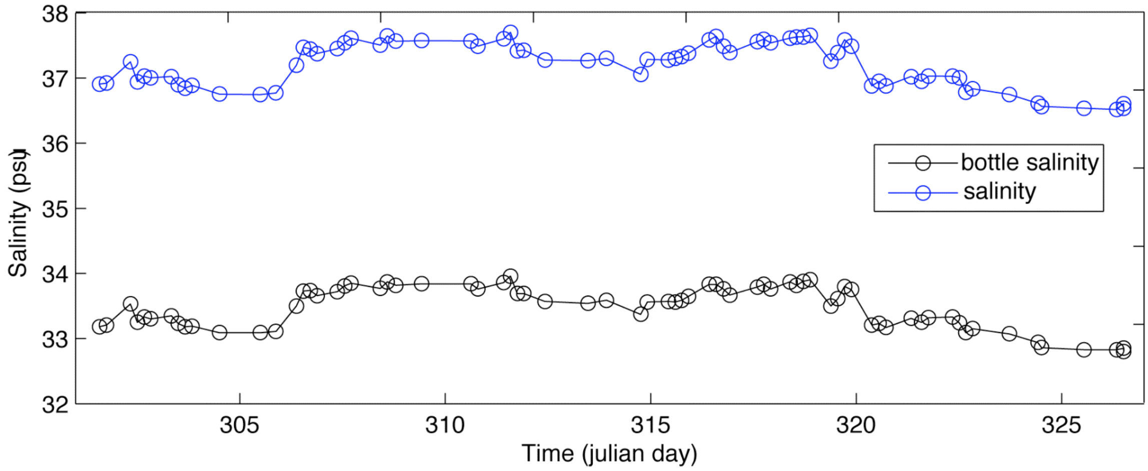
tsg.2exec calculates time in seconds from julian day (jday,hh,mm,ss) and appends the data to the master data file.

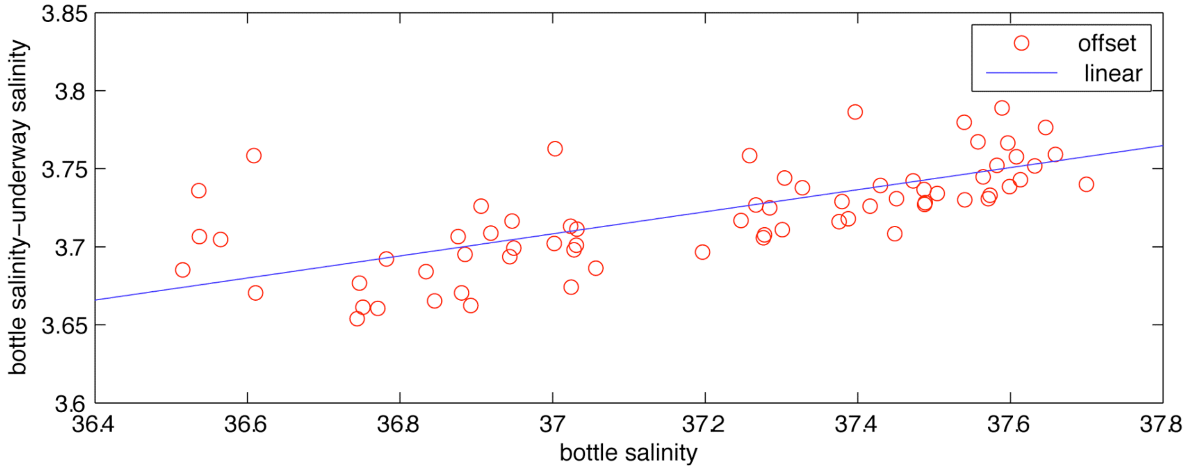
tsg3.exec merges the 10 min averages of the smt.av master file into the tsg master file '`334tsg_sample.mrg`'.

calib_salin.m calibrates conductivity using sw_c3515. Saves time and the filtered difference in conductivity as ASCII for conversion to PSTAR. Used only for sanity check and to see if the data are biased.

tsgcalib.exec creates a PSTAR file from the saved MATLAB ascii files and merges with smt.av master file.

Figure 16.1 shows the time-series of the measured underway salinity (from the FSI sensor) and the time-series of salinity measured with the salinometer (from bottle water samples). This suggests a large error associated with the underway measurement which presents a bias of ~ 3.72 p.s.u to the salinity from bottle samples.





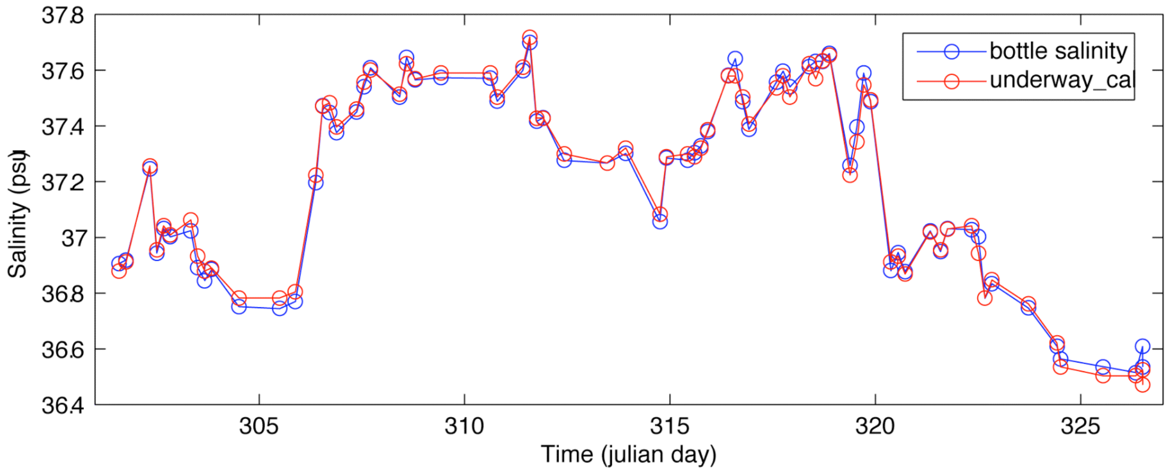


Figure 16.1a *Time series of underway salinity measured with the salinometer compared with bottle data.*
Figure 16.1b *Calibration coefficient deduced from linear fit.*
Figure 16.1c *Salinity after calibration.*

17 PIES Processing

Zoltan Szuts

PIES stands for Pressure and Inverted Echo Sounder. The instrument itself is a 43 cm glass sphere that holds an acoustic transponder and electronics (the inverted echo sounder, also capable of data telemetry) and an integrated Paroscientific pressure sensor. It is built and sold by the University of Rhode Island, Narragansett, Rhode Island, USA.

Because the first PIES recovery in the RAPID programme was during cruise D334, it was necessary to develop processing software at sea. This is a two part procedure as detailed below. The example data is shown from the EBP1_1_200564 mooring, which was PIES serial number 136. All paths are relative to `rapid:/local/users/pstar/Data/rpdmoc/rapid/data/`. The processing files are found in `exec/moor/stage1/pies/` or `exec/moor/stage2/bpr_processing/`, and all output files are saved to `moor/ebp1_1_200564/pies/`. Both scripts read the info file `moor/proc/ebp1_1_200564/ebp1_1_200564info.dat` to obtain general information about the deployed mooring.

17.1 Processing

1) Stage 1 processing
`pies2rodb.m`

The first script loads the raw ascii (in `moor/raw/d334/pies/EBP1/Data/`) data into MATLAB. Three raw data files contain the travel time data (`T136_1.DAT`), the pressure data (`P136_1.DAT`), and the engineering data (`E136_1.DAT`). The data formats and time of sampling is slightly different in each of the files: the travel time data is in bursts of four measurements every ten minutes, the pressure data is pressure and temperature pairs every ten minutes, and the engineering data is a suite of system checks saved every 24 hours after the data sampling at 23:50. The travel time and pressure data is saved every ten minutes regardless of whether the sampling occurs every ten minutes (as set by user). This script needs to be modified if the sampling interval is different than ten minutes. More details can be found in the "IES User's Manual (IES Model 6.2)" or in comments in `pies2rodb.m`.

The script loads the three data streams, checks for consistency, and outputs them on the same time grid in RODB format to `ebp1_1_200564_136.raw`, with a plot of the raw data saved to `ebp1_1_200564_136.raw.ps`. Four travel time variables are created (`TT1', `TT2', `TT3', `TT4') for the four bursts, and the engineering variables are zero except for the entries at 23:50. The engineering data saved represent the release battery current drain (`Irel'), the system battery current drain (`Isys'), the release battery voltage (`Vrel'), and the system battery voltage (`Vsys'). The four travel time and engineering variables needed to be created in the RODB library, which was done by modifying `rodbhead.m` appropriately. All units are in standard units (seconds, decibars, degrees C, amperes, or volts), and the dummy value output to the RODB file is -999. The info file for the mooring needs to be modified so that the start and end times occur after the deployment period and before the recovery period. A log of the processing is saved to `stage1_log`.2) Stage 2 processing

```
pies_processing_002.m
purge_bp_003.m
```

The base script `pies_processing_002.m` was based on `ttproc.m` (written by Torsten Kanzow, 26/03/2005) for the travel time processing and on `seagauge_processing_002.m` for the pressure processing.

The travel time data is smoothed by calculating hourly medians of each of the four channels, and then by calculating medians of the hourly values. The pressure processing is the same as that used for the seagauge processing and uses `purge_bp_003.m`: removal of launch and recovery periods, despiking, followed by fitting of either an exponential plus linear or just a linear pressure offset to the two-day low-pass filtered data. The exponential plus linear offset typically gives a better fit, resolving the 50-100 day exponential adjustment of the pressure sensor to the high pressure signal. If the exponential decay coefficient is outside of a reasonable range (30-10 days) then the fitting procedure may remove oceanic signal in addition to the exponential sensor adjustment.

Two RODB files are saved because the processed pressure data is at a higher temporal resolution than the travel time data. The first file `ebp1_1_200564_136.use` contains hourly values of travel time (as the `TT' RODB variable) and pressure data subsampled every hour (both the data as `P' and the fitted offset as `PFIT'). The second file `ebp1_1_200564_136_p.use` contains the ten minute resolution pressure data only. Because the engineering data included in the Stage 1 RODB file is purely for diagnostic purposes, no further processing is done on them nor are they saved to the stage 2 output file. A log of the processing is recorded in `stage2_log`.

Four graphics are generated and saved: 1) `ebp1_1_200564_136.use.1.eps`, which contains the raw pressure and temperature data, 2) `ebp1_1_200564_136.use.2.eps`, which contains the filtered, fitted, and de-drifted pressure and filtered temperature data (same as in Figure 19.1, 19.2 and 19.3 for the seagauge processing), 3) `ebp1_1_200564_136.use.tt.eps`, which shows the raw and two-day low-pass filtered hourly median travel times (shown in Figure 17.1), `ebp1_200564_136.use.tt_spectra.eps`, which shows power density spectra of the raw and filtered hourly median travel time data.

Until further processing of the travel time data, it remains to be seen whether the steps taken here are sufficient to obtain meaningful data. In their current state the files are a first step that can be refined as necessary with further experience.

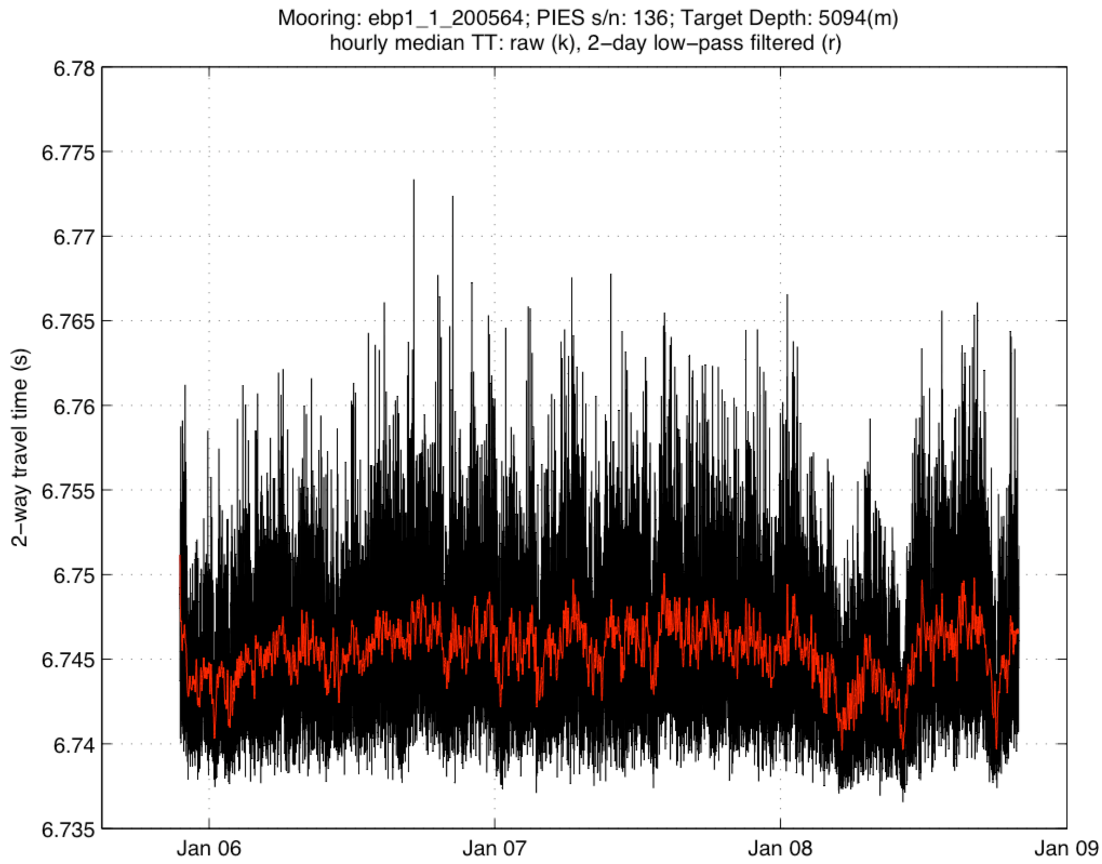


Figure 17.1 *The file* `ebp1_1_200564_136.use.tt.eps`*, showing the raw and 2-day low-pass filtered hourly median travel times.*

17.2 File Telemetry at EBP2_1_200565

The data from the EBP2 PIES instrument were downloaded acoustically instead of recovering the mooring. Unlike EBP1, the battery of EBP2 is not expected to be depleted early and so it is left in place for at least one more year. The acoustic downloading is similar to that performed in previous cruises (D304 in May 2006 and CD177 in Nov. 2005).

A Benthos DS-7000 deck unit was attached to a laptop and a transducer (Benthos model XTD-LF). The transducer was suspended from the deck with a 10 m long rope and cable. The MATLAB routines `PPDTb_v3.m` and `PPlotPDT.m` were used to process and plot the incoming signals. The former is a modified version of the URI-provided files to make it more robust to unexpected signals (noise).

For EBP2_1_200565, the CLEAR signal is 76 and the TELEM signal is 66 on the DS-7000. The operations are listed below for the two days of telemetry operations starting on 19/11/2008 (yearday 324). The ship positioned itself upwind and drifted over the station with echosounder and bow-thrusters turned off. Once the signal reception deteriorated, the PIES telemetry was stopped with the CLEAR command, we repositioned upwind, and transmission was continued with the TELEM command.

The yeardays received are often in error by +/-1 or 2 days. The values can be verified by counting down or up from the beginning or end of transmission and by making sure 34 days are included in each 15 minute transmission block. The yeardays given below are the best estimate given the transmission record.

Download started on 19/11/2008	
19:30	Started 0.5 nm upwind of the station, PIES sampling signals are audible
19:42:40	TELEM command received
19:50:21	first sample received, 21 s late (indicating PIES clock drift), first yearday (yd) 325 in 2008
	received up to yearday 87
22:16	CLEAR command received
	repositioning ship
22:49	sent TELEM command, reception unclear
23:10:25	received first LSB data (yd 65), having missed the initial MSB record at 23:05:20 (yd 53)
23:38:47	last LSB received (yd 352 in 2007), PIES shuts down for end of day processing
	repositioning ship
00:13:48	TELEM command received
00:22:32	MSB received (yd 348)
00:56:16	LSB received (yd 277)
	CLEAR command received
	repositioning ship
	TELEM command sent, reception unclear
	CLEAR command sent and received, before trying to fix computer problem

Table 17.1 *Transmission record for file telemetry at EBP2.*

Downloading was stopped because of a very low wireless signal, which caused MATLAB to shut down once it lost the network license from the server. The following morning the router in the instrument lab was found to have been faulty, and replacement with a new one gave a strong signal that allowed downloading to continue that afternoon. To save time, we positioned over the site and maintained position with the bow thrusters. The received signals were only marginally noisy, and so the remaining data were downloaded without further interruptions for repositioning.

Download resumed on 20/11/2008	
13:34:12	CLEAR command received
13:35:33	TELEM command received, waiting for next sampling time (every 10 minutes) for telemetry to resume
13:42:28	first MSB received (yd 248 in 2007)
16:37:11	last LSB received (yd 241 in 2006)
16:37:37	CLEAR command received

Table 17.2 *Transmission record for continuation of file telemetry at EBP2.*

18 SBE 37 MicroCAT Processing

Craig Wallace

18.1 Introduction

The Seabird MicroCAT 37 is a high-accuracy conductivity, temperature and pressure logger, and is widely deployed on Rapid MOC moorings. This section describes the procedures and MATLAB scripts used on cruise D334 to process data recovered from these instruments logged on either calibration CTD casts, Section 18.2, or from actual Rapid moorings, Section 18.3.

18.2 Calibration Dips

A total of 14 CTD casts carried SBE 37 MicroCATs for calibration, either after they had been recovered from moorings ('post-deployment' instruments) or in preparation for imminent deployment ('pre-deployment' instruments). The processing technique is identical for both. Recovered data from each sensor participating in the cast were firstly placed on the rapid Unix workstation in the following path:

```
/local/users/pstar/path/Data/rpdmoc/rapid/data/moor/raw/d
334/microcat_cal_dip/castx/
```

where x denotes the D334 cast number.

For each cast, an `'info.dat'` file was constructed containing cast metadata and serial numbers/instrument codes for each of the MicroCATs involved in the cast. For reference, a sample `'info.dat'` is shown in Fig. 18.1. Completed `'info.dats'` follow the nomenclature `'castxinfo.dat'` (where x, again, denotes cast number) and are placed under the `'proc_calib'` directory:

```
/local/users/pstar/Data/rpdmoc/rapid/data/moor/proc_calib/d334/
cal_dip/
```

Within this directory a further path, `/MicroCAT/castx/` (again x = cast number) was generated, to contain the output of the processing scripts described beneath. Unlike MicroCAT data recovered from mooring deployments (see 18.3) there is only one stage to CTD cast MicroCAT processing.

Stage 1 Processing:

i: The MATLAB script invoked to process the CTD cast MicroCAT data was:

```
/local/users/pstar/Data/pdmoc/rapid/data/exec/moor/stage1/micro
cat/mc_call_calib2_noCTD.m
```

ii: Within this script, string variable 'moor' was set to castx (where x = the cast number on this cruise).

iii: Variables 'inpath', 'outpath' and 'infofile' were checked to ensure they pointed to the correct directory structure for the raw data, the output location, and the `info.dat` file respectively. For reference, and guidance on future cruises, these settings were:

```
inpath   = [basedir 'moor/raw/d334/MicroCAT_cal_dip/
            ',moor,'/'];
outpath  = [basedir 'moor/proc_calib/d334/cal_dip/MicroCAT/
            ',moor,'/'];
infofile = [basedir 'moor/proc_calib/d334/cal_dip/
            ',moor,'info.dat'];
```

where the code <,`moor,`> appends the moor variable set in 'ii'

iv: `mc_call_calib2_noCTD` was run to convert the MicroCAT ascii data files into 'rodb' format by calling the `'microcat2rodb_2'` routine.

```
Mooring             = calib6
Latitude            = 23 52.73 N
Longitude           = 41 08.08 W
WaterDepth          = 4806
StartDate           = 2008/11/04
StartTime           = 21:12
EndDate             = 2008/11/05
EndTime             = 00:38
Columns             = z:instrument:serialnumber:deployment
0   337  3479 1
0   337  3480 1
0   337  3482 1
0   337  3225 1
0   337  3234 1
0   337  3224 1
0   337  3247 1
0   337  3252 1
0   337  3254 1
0   337  3255 1
0   337  3256 1
0   337  3257 1
0   337  4475 1
0   337  4718 1
0   337  4719 1
0   337  5244 1
0   330  9656 1
0   330  9657 1
```

Figure 18.1 *Example* `castxinfo.dat` *file containing cast information and instrument details needed by the CTD MicroCAT processing script.*

Output is placed in the following directory:

```
/local/users/pstar/Data/rpdmoc/rapid/data/moor/proc_calib/d334/
cal_dip/microcat/castx/
```

and is comprises of:

* a data file showing the raw data for each MicroCAT in the cast:

`castx_snsn.raw` (where snsn = the unique MicroCAT serial number)

* a postscript file for each MicroCAT showing conductivity, temperature and pressure time series for the duration of the logging:
`castx_snsn.raw.ps` (see Fig. 18.2 for an example plot)

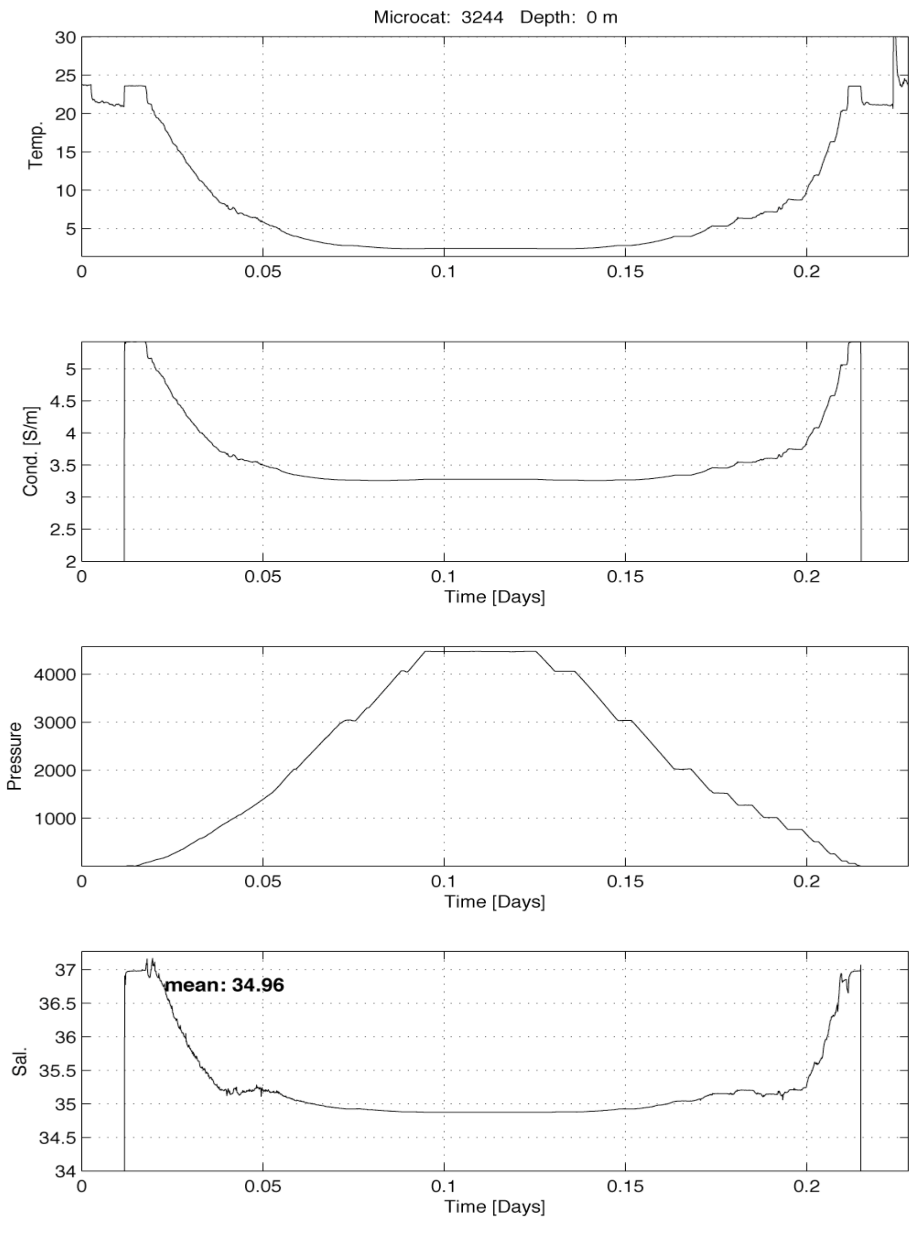


Figure 18.2 *Example output postscript figure of individual MicroCAT pressure, temperature and conductivity measurements during a CTD cast. As produced by the* `mc_call_calib2_noCTD.m` *script.*

* a postscript file for each measured variable (i.e. pressure, conductivity and temperature) showing time series for all MicroCATS:

```
castx_all_pres.ps (see Fig. 3 as an example)
castx_all_temp.ps
castx_all_cond.ps
```

18.3 Mooring Data

To an extent, the processing procedure applied to data recovered from mooring MicroCATs is similar to that used for the CTD data. Ascii .dat files of recovered data for each MicroCAT were placed in the following directory path:

```
/local/users/pstar/Data/rpdmoc/rapid/data/moor/raw/d334/
microcat/
```

As with the processing of the CTD MicroCAT data, an `'info.dat'` file was created detailing the mooring location, time series start and end dates, water depth and the serial numbers of attached sensors. An example mooring `'info.dat'` is shown in Figure. 18.3. The naming convention of the `'info.dat'` file follows the format `eb1_6_200722info.dat` (as an example). The first three digits refer to the mooring code. The fourth digit refers to the number of times it has been deployed during the Rapid programme. The final six digits are the year of deployment and the NMFD code for the deployment – 22 in this case. All these data can be obtained from deployment log sheets. The mooring info.dat files were saved in the mooring 'proc' directory:

```
/local/users/pstar/Data/rpdmoc/rapid/data/moor/proc
/xxx_x_xxxxxx/
```

with the final folder being named according to which mooring was processed. A final sub-directory, `microcat,` was then created in which to place the output of the processing.

```
Mooring          = mar2_4_200729
WaterDepth       = 5200
Start_Date       = 2007/10/28
Start_Time       = 02:25
End_Date         = 2008/11/07
End_Time         = 11:00
Latitude         = 24 10.94 N
Longitude        = 49 45.01 W
Columns          = z:instrument:serialnumber
   1100   337   3918
   1400   337   3910
   1800   337   3282
   2250   337   4461
   2750   337   4462
   3250   337   4464
   3750   337   4714
   4250   337   4715
   4750   337   4717
   5150   302   35612576
   5160   337   4466
```

Figure 18.3 *Example mooring 'info.dat' file*

Two MATLAB scripts were then used to process the MicroCAT data, to first convert the data into 'rodb' format and then produce time series of the raw, and low-pass filtered, time series.

Stage 1 Processing:

The first MATLAB script, `mc_call_2_002.m`, converting the source ascii `.dat` files into rodb format, was located in the following path:

```
/local/users/pstar/Data/rpdmoc/rapid/data/exec/moor/
stage1/microcat/
```

i: Within this script, the variable 'moor' was changed to the unique mooring code – eg. `eb1_6_200722.`

ii: Further script variables - `'basedir', 'inpath', 'outpath'` and `'infofile'` – were checked to ensure the raw data and the `'info.dat'` files could be located, and that the correct path for the script output had been set. These paths were set as follows:

```
basedir  = ['~/Data/rpdmoc/rapid/data/'];
inpath   = [basedir 'moor/raw/d334/microcat/'];
outpath  = [basedir 'moor/proc/',moor,'/microcat/'];
infofile = [basedir 'moor/proc/',moor,'/',moor,'info.dat'];
```

note, again that the code <,`moor,`>, appends the string variable set in step 'i'.

iii: Prior to running the script, the MATLAB directory was switched to `/local/users/pstar/` (i.e. the home directory, ~) and the startup command sent to MATLAB to ensure paths needed to access any subroutines were set. The working directory in MATLAB was then switched back to:

```
/local/users/pstar/Data/rpdmoc/rapid/data/exec/moor/stage1
/microcat/
```

iv: The script was executed. Output files from the script are placed in:

```
/local/users/pstar/Data/rpdmoc/rapid/data/moor/proc/
eb1_6_200722/microcat/
```

with the mooring directory changed to match the mooring being processed.

Output comprise:

* a file containing raw data conductivity, temperature and pressure data for each MicroCAT recovered from the mooring:
`xxx_x_xxxxxx_snsn.raw`, (where 'x' corresponds to the mooring code and 'snsn' to the instrument serial number)

* a post script plot, for each MicroCAT, of the conductivity, pressure and temperature time series:
`xxx_x_xxxxxx_snsn.raw.ps`

Stage 2 Processing:

Stage 2 processing truncates the MicroCAT data time series so that data are not contaminated by erroneous readings during the deployment and recovery operations. Stage 2 processing also low-pass filters the time series with a cut off frequency of 2 days. The MATLAB script used to perform these functions was:

```
/local/users/pstar/Data/rpdmoc/rapid/data/exec/moor/stage2/
microcat/microcat_raw2use_003.m
```

i: Variable 'moor' (line 19) was changed to match the mooring code (`eb1_2_200727`, for example).

ii: the 'plot_interval' vector was altered to provide sensible start and end dates for the time series plots the script produces. Start and end dates were obtained from the deployment and recovery log sheets respectively.

iii: Finally, variables 'inpath', 'outpath' and 'infofile' pointing to the source data, the desired output path and the info.dat file respectively were configured to match the cruise directory structure:

```
inpath   = ['~/Data/rpdmoc/rapid/data/moor/proc/
              ',moor,'/microcat/'];
outpath  = ['~/Data/rpdmoc/rapid/data/
              moor/proc/',moor,'/microcat/'];
Infofile = ['~/Data/rpdmoc/rapid/data/
              moor/proc/',moor,'/',moor,'info.dat'];
```

iv: the script was executed, placing output in the designated output path:

```
/local/users/pstar/Data/rpdmoc/rapid/data/moor/proc/
xxx_x_xxxxxx/MicroCAT/
```

Three files were produced for each instrument:

* a file of the truncated time series data:
`xxx_x_xxxxxx_snsn.use` *(where snsn = the unique serial number for each MicroCAT)*

* a postscript plot of the truncated conductivity, temperature and depth time series:
`xxx_x_xxxxxx_snsn.use.ps`

* a postscript plot of the truncated and low-pass filtered time series:
`xxx_x_xxxxxx_snsn.lowpass.ps`

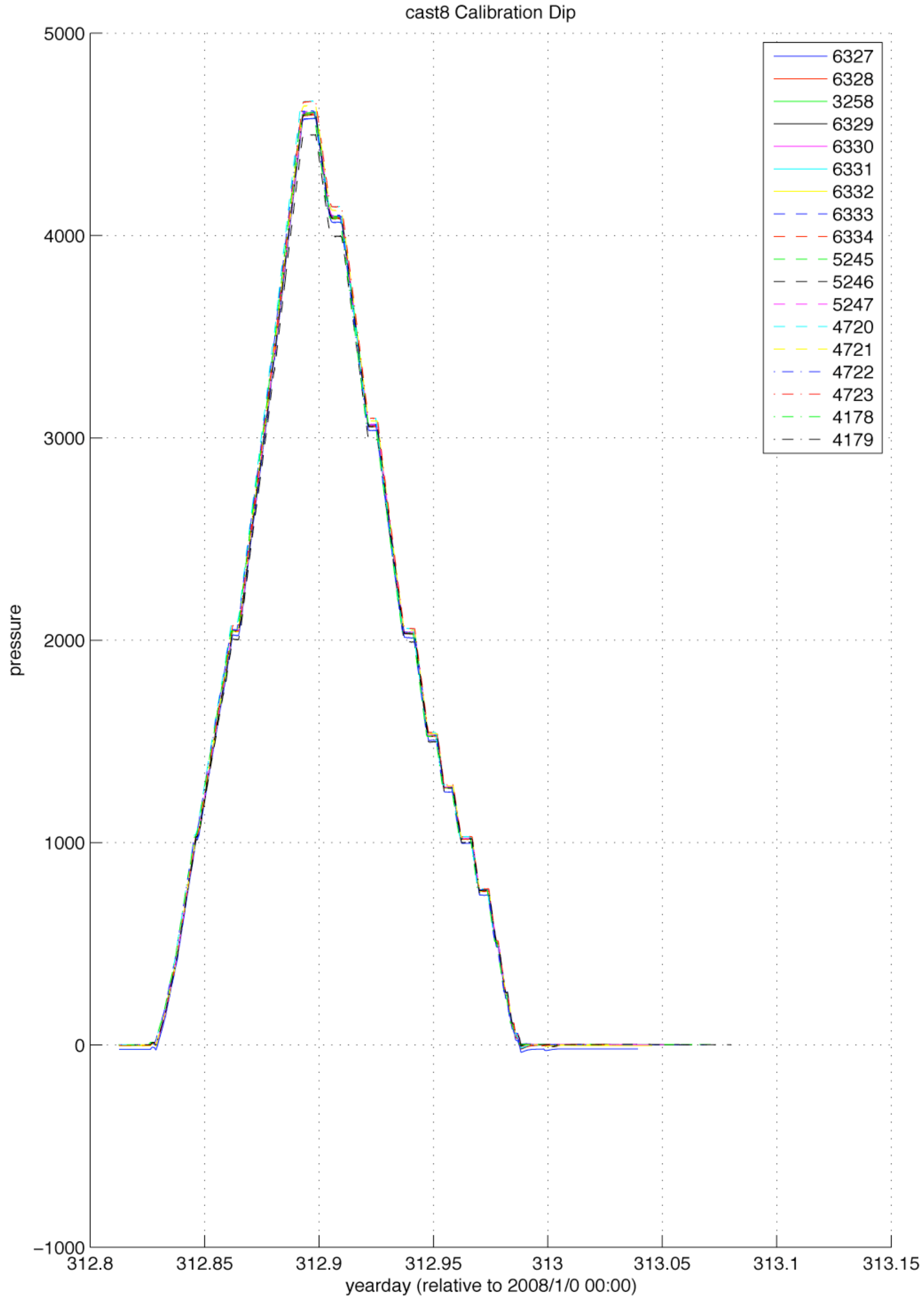


Figure 18.4 *Example output postscript figure depicting measurements of pressure for all MicroCATs participating in a CTD cast. As produced by the* `mc_call_calib2_noCTD.m` *script*

18.4 MicroCAT Pressure Sensor Drifts

Zoltan Szuts

The MicroCAT pressure drifts were investigated for two reasons: 1) for initial determination of whether, and how, the drifts should be removed as part of the processing procedure, and 2) to determine whether the Druck and Paine pressure sensors have different response characteristics to deployment on moorings.

Significant pressure sensor drift will degrade the accuracy of vertical positioning of the density measurements. Although pressure drift removal is critical for bottom pressure recorders (BPRs), it has a less direct role on the calculation of between-mooring density gradients. Namely, the MicroCAT pressure is used for fitting a vertical density profile at each mooring, and it is the density profile that is used for subsequent analysis. The density fitting procedure is based on multiple instruments in the vertical however, so the influence of each instrument is lessened than for BPRs. This assumes that the pressure sensor drifts are random. The stated accuracy of the Druck sensors is 0.1% of full scale for "initial accuracy" and 0.05% of full scale per year for "typical stability" (Sea-Bird Electronics, `37SMP_RS232_010.pdf` user's manual). For the two pressure ranges used in the RAPID-MOC project, 3500 or 7000 db maximum pressure, the initial (typical) accuracies are 3.5 db (1.75 db) or 7 db (3.5) db.

Most immediately, we want to evaluate whether Seabird's switch to Paine pressure sensors from Druck will be apparent in the sensor response to year-long mooring deployment. Seabird switched to Paine pressure sensors because Druck sensors had a weak weld, which resulted in a 20% flooding rate over one year on the RAPID-MOC project. This analysis is a preliminary attempt to characterize the instrumental drift of MicroCAT pressure sensors.

We find that there are strong signals in MicroCAT pressure records (1-2 db) that are highly coherent in the vertical for each mooring. The amplitude of exponential decay and the time-linear change in pressure are largest at the top of the mooring and decay towards the bottom. That the exponential response occurs in the first 50 days and that the linear response occurs over the entire deployment period suggests that the mooring cable stretches with two modes of plastic deformation. Further analysis is needed to extract the pressure sensor drift from the apparent mooring stretching.

18.4.1 Calculating MicroCAT Pressure Sensor Drifts

This first part of the analysis considered the apparent drift signals to be solely caused by random sensor response, and so proceeds under this assumption. Different assumptions than those made below may be more appropriate given that the signal is ultimately believed to be caused by mooring stretch.

Pressure drift was calculated for MicroCATs recovered during cruise D334, since these are the moorings from which the comparison between Druck and Paine sensors can be made. The script `mc_pres_drift_census.m` performs the comparison. It is based on the scripts for bottom pressure recorders (BPRs, `seagauge_processing_002.m` and `purge_bp.m`) with numerous modifications as necessary for processing MicroCATs. The function `purge_pmc_003.m` performs the fitting and is similar to `purge_bp_003.m` (see section 19 on processing BP data). The tolerances for despiking are different than for BPRs, the most important difference being a fixed minimum pressure cutoff (-8 db) and a depth-dependent upper limit (25 db at a depth of 50 m to 9 db at 5000 m). Near-surface MicroCATs are blown down further than deep MicroCATs. The shorter record lengths (one year) and deployment on moorings introduce significant complications in determining the drift than compared to BPRs.

The tidal signal in moored sensors is not symmetric because of mooring motion: downward displacements can have much larger amplitudes than upward displacements, as the mooring is either vertical or pushed over to one side or the other. The fitting algorithm has trouble converging if given the low-pass filtered pressure signal, as done for BPRs. A more robust input is the filtered lower envelope of pressure. The envelope is found by the running-minimum despiked pressure value over a tidal period (set at 12.0 hours). The lower envelope is filtered with a two-day low-pass filter (`auto_filt.m`) for subsequent analysis.

The fitting coefficients are defined differently than in `exp_lin_fit2.m`, the program used for BPRs. The coefficients defined in the BPR census section are used here, which are of the form:

$$f(t) = a_1 \exp((t - t_1)/a_2) + a_3(t - t_{\mathrm{avg}}) + a_4 + a_5(t - t_{\mathrm{avg}})^2$$

With this definition, the sign of the exponential amplitude a_1 is the same as the exponential pressure perturbation, the exponential decay a_2 is in units of days and is negative for the expected decaying signal, and the polynomial fit is centered in time (relative to the center of the record, t_{avg}). If the quadratic coefficient a_5 is set to 0, the coefficient a_4 is equivalent to the best estimate of the sensor's pressure. The quadratic coefficient a_5 is included if the pressure record has a significant quadratic component. With inclusion of a_5, however, the mean depth of the instrument has to include the time-averaged contribution of the quadratic term and is equal to $a_4 + a_5 (t_{avg}-t_1)^2 / 12$.

The fitting algorithms used are:

`exp_lin_fit3.m` this calculates coefficients a_1–a_4 in one minimization procedure, analogous to `exp_lin_fit2.m` but for the redefined coefficients. a_5 is set to 0.

`exp_lin_fit_seq3.m` this calculates coefficients a_1–a_4 in a multi-step iterative procedure: 1) remove a linear fit over the latter portion of the data, 2) fit an exponential to the beginning portion of data, 3) fit a second linear fit to the original data minus the initial exponential fit, 4) fit a final exponential to the original data minus the second linear fit over the beginning of the data, and 5) fit a third and final linear fit to the original data minus the final exponential fit. The beginning and ending portions of the record for parts 1), 2), and 4) are specified as inputs. a_5 is set to 0.

`exp_quad_fit_seq3.m` this calculates coefficients a_1–a_5 in a multi-step procedure that is the same as for `exp_lin_fit_seq3.m` except that the linear fits are replaced by quadratic fits.

Residuals of linear and quadratic sequential fits from the `_seq3.m` files contain residual polynomials on the order of numerical precision (smaller than 10^{-14}).

The rational behind the sequential fitting procedures is that the exponential decay will only be visible in the beginning of the record. The variance of the exponential decay is only larger than the signal variance in the beginning of the record. Fitting the exponential over the whole data length (as with `exp_lin_fit3.m`) allows the algorithm to attempt to minimize oceanic variance, which is at odds with the goal of only removing the pressure sensor drift. The beginning interval over which to fit the exponential decay is intended to capture the sensor response but to exclude significant oceanic signals. Empirically, the interval varies from 40–80 days and helps determine convergence of the fitting algorithm. The MATLAB function used for the non-linear minimization, `nlinfit.m`, is very sensitive to the starting coefficients and to the fitting interval. First attempts to fit an exponential decay over the entire record often failed to converge and prompted the use of the more restrictive procedure presented here. In general, however, it is not possible to separate an unknown sensor decay from an unknown oceanic signal, but we hope that the sensor decay is large and consistent enough that the fit is not significantly biased by oceanic signal.

The beginning interval of exponential sensor decay is typically the same for instruments on the same mooring, because low-frequency (weekly periods and longer) oceanic signals are generally vertically coherent. The first polynomial fit in (step 1) is performed over the section of the record excluding the beginning region, while in later steps (3 and 5) the polynomial fit includes the full data record after removal of the exponential signal.

The form of the fit is selected individually for each instrument, as some instruments exhibit a very weak exponential signal or seem to have a quadratic component to the baseline drift. The default fit is an exponential-linear fit, otherwise an exponential-quadratic, a linear, or a quadratic fit can be chosen. Visual inspection is necessary to verify the quality of the fit, to determine the fitting intervals, and to determine the form of the fit, which are then hard-coded into `mc_pres_drift_census.m`. Although it is conceivable that a quantitative 'goodness-of-fit' measure could be determined, the difficulty involved is not practical for the brief nature of this investigation.

One example of the fitting procedure is shown in Figure 18.5. The fits are made to the filtered lower envelope (black line), and include a linear fit (green), a fit from exp_lin_fit3 (blue), and a fit from exp_lin_fit_seq3 (red). The fit from exp_lin_fit3 doesn't entirely capture the sensor response: the exponential decay has a longer time-constant (a_2=-61) than compared to exp_lin_fit_seq3.m (red line, a_2=-16) because the fit minimizes variance later in the record. The influence of using the improper fit is seen in the residual (Figure 18.5, right), where there is a positive and negative oscillation at the beginning of the record with a period twice that of the unresolved sensor response. This brief oscillation is more obvious for other sensors but is consistently present if there is low-frequency content (especially quadratic) in the record. This example was chosen because it shows how ex_lin_fit3 minimizes variance over the entire record.

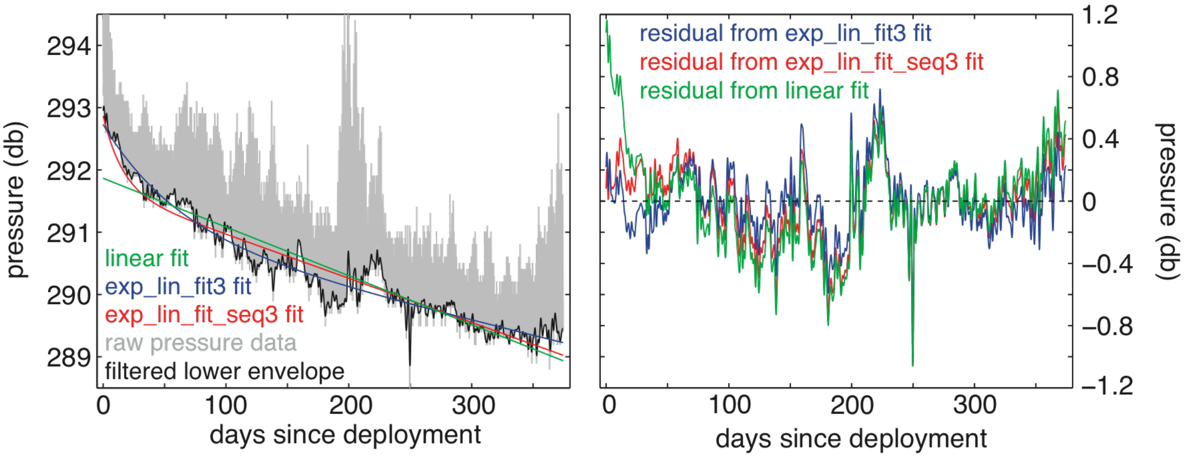


Figure 18.5 *Fits (left) and residuals (right) for the filtered lower-envelope pressure signal (black line, left) from MicroCAT sn 3272 on mooring EB1_6_200722. The coefficients from exp_lin_fit_seq3 are a_1=1.2 db, a_2=-15.9 days, a_3=-0.00708 db/day, a_4=290.4 db and the exponential fit is performed over the first 60 days, and the coefficients from exp_lin_fit3.m are a_1=1.70 db, a_2=-60.7 days, a_3=-0.00482 db/day, a_4=290.1 db. In both cases a_5 is set to 0.*

18.4.2 Vertical Coherence of MicroCAT Pressure Sensor Drifts

Before statistics of the sensor drifts can be considered for Druck and Paine sensors, for instance that only the Druck sensors appeared to have a quadratic component in the drift, the vertical relationship of sensor drifts should be considered for instruments located on the same mooring.

Quadratic or exponential-quadratic fits are only chosen for instruments around the Mid-Atlantic Ridge: MAR3_4_200724 has three MicroCATs with quadratic fits, MAR2_4_200729 has six instruments at the top with exponential-quadratic fits, and MAR1_4_200728 has thirteen instruments (twelve at the top) with exponential-quadratic fits. This tight clustering of instruments with an apparent quadratic component suggests that the quadratic component is not a random signal.

Further insight is gained by considering the fitted coefficients as a function of depth, as shown in Figure 18.6 for mooring MAR2_4_200729. Except for the exponential decay time, which was nudged towards the expected value (10s of days) by the fitting procedure, all coefficients decrease in magnitude with depth. The same trend is found in most of the nine moorings included in this census. This result strongly suggests that the fitted coefficients are not random, and instead are related to the instrument's vertical position on the mooring.

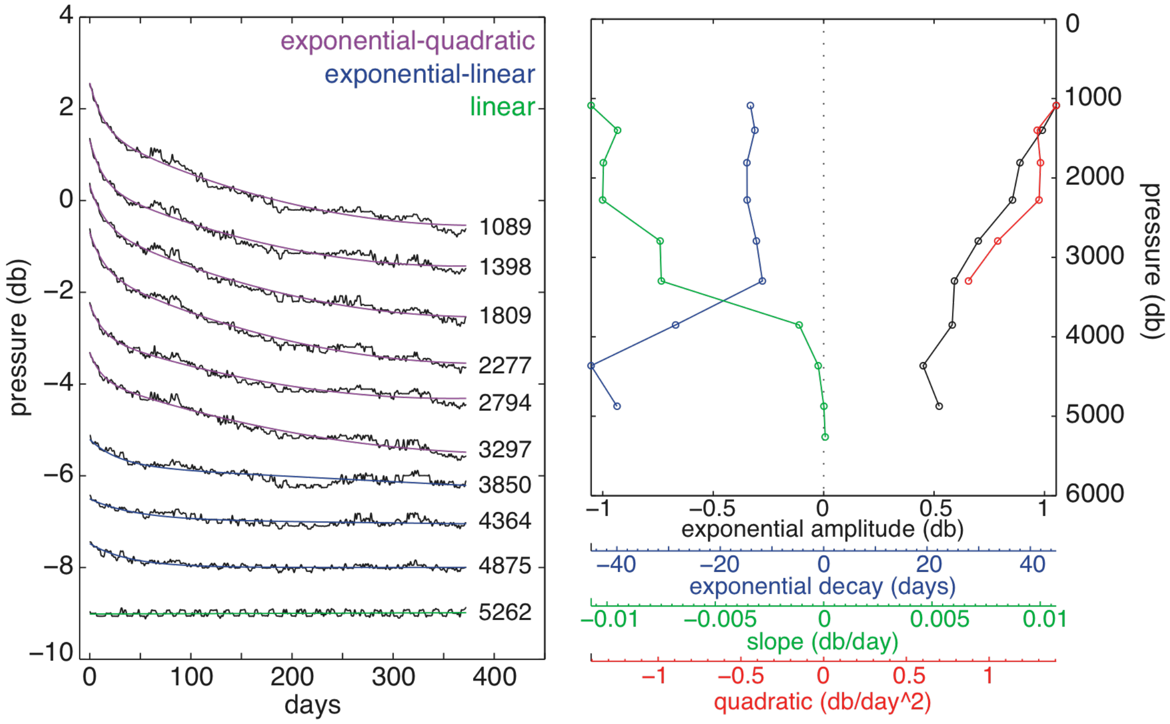


Figure 18.6 *Pressure records from mooring MAR2_4_200729. (left) The filtered lower-envelope of pressure (black) and the selected fit (purple for an exponential-quadratic fit, blue for an exponential-linear fit, and green for a linear fit). The means of all records are removed and they are offset by 1 db for visualization purposes. The average sensor pressure is shown by the number to the right. (right) The fitted coefficients as a function of depth.*

The most obvious reason for this vertical structure is that the mooring itself stretches under the high tension necessary for keeping it taught. This hypothesis is consistent with the decrease in pressure with time and with the shallowest sensors rising the most. Two modes of deformation are implied: one a relatively fast exponential signal over the first 50 days, and the second a slower linear or quadratic response over the entire deployment period. The existence of two modes of elongation was also found for polyester and high modulus polyethylene (HMPE) ropes by Smeets *et al.* (Proceedings of Oceans 2001 MTS/IEEE, vol 1-4, pp. 685-690) and Huntley and Whitehall (Proceedings of Oceans 1999 MTS/IEEE, vol 1-3, pp. 681-689), respectively, although the exponential stretch occurs on a time scale of order minutes for these synthetic fibres.

19 Seabird SBE26 SeaGauge or SBE53 BPR Processing

Zoltan Szuts

The Seabird SBE26 Seagauge and SBE53 BPR (Bottom Pressure Recorer) measures bottom pressure. The two processing files mentioned below come from previous cruises and only needed modification of directories to work during cruise D334. Example files and figures are shown for SBE26 serial number 0014, recovered from the MARL3 mooring — generalization should be obvious. All paths are relative to `rapid:/local/users/pstar/Data/rpdmoc/rapid/data/`. The processing files are found in `exec/moor/stage1/seagauge/` or `exec/moor/stage2/bpr_processing/`, and all output files are saved to `moor/marl3_1_200624/seagauge/`. Both scripts read the info file (`moor/proc/marl3_1_200624/marl3_1_200624info.dat`) to obtain general information about the deployed mooring.

1) Stage 1 processing
`seagauge2rdb_002.m`

This script loads the ascii (`moor/raw/d334/seagauge/0014_data.tid`) data into MATLAB. It checks for time offsets in the clock offset file (`moor/raw/d334/clock_offset.dat`) if it exists. Wrapped pressure data can be corrected with input from the user. This has not been necessary for recoveries of EBL1_2_200645, MARL4_1_200625, or MARL3_1_200624. The RODB output file is `marl3_1_200624_00014.raw`, a figure of the raw pressure is output to `mooring_00014.raw.eps`, and a log file is saved to `stage1_log`.

2) Stage 2
seagauge_processing_002.m
purge_bp_003.m

Aside from basic errors of timing that the scripts generate, the main evaluation of the data is to make sure that the pressure sensor does not have unexpected drifts that perturb the signal. A few recovered sensors suffered from such problems. All sensors with good data were best fit with an offset from the exponential plus linear form. If the pressure signal does not have any obvious perturbations, it is worth checking that the exponential decay coeffcient (a_2 as described below) has a reasonable value of tens of days. The values observed ranged from 35 to 70 days, with one sensor being fit with a value of 135 days (the marl3_1_200624 example used here).

The script `seagauge_processing_002.m`:
- loads the stage 1 RODB file
- checks for a clock offset in `moor/raw/d334/seagauge/bpr_clock_offset.data` (different from the stage 1 processing!)
- calls `purge_bp.m`
- asks the operator whether to use the exponential plus linear or the linear offset (fits calculated by `purge_bp.m`) and saves the coefficients of the fit in the log file.

- saves two figures, the first with raw pressure and temperature (`marl3_1_200624_0014.use.1.eps`), and the second with two-day low-passed pressure and the two offsets, the pressure with the selected offset removed, and the 2-day low-passed temperature (`marl3_1_200624_0014.use.2.eps`). The second file is shown in Figure 19.1.
- saves the RODB output as `marl3_1_200624_0014.use`.

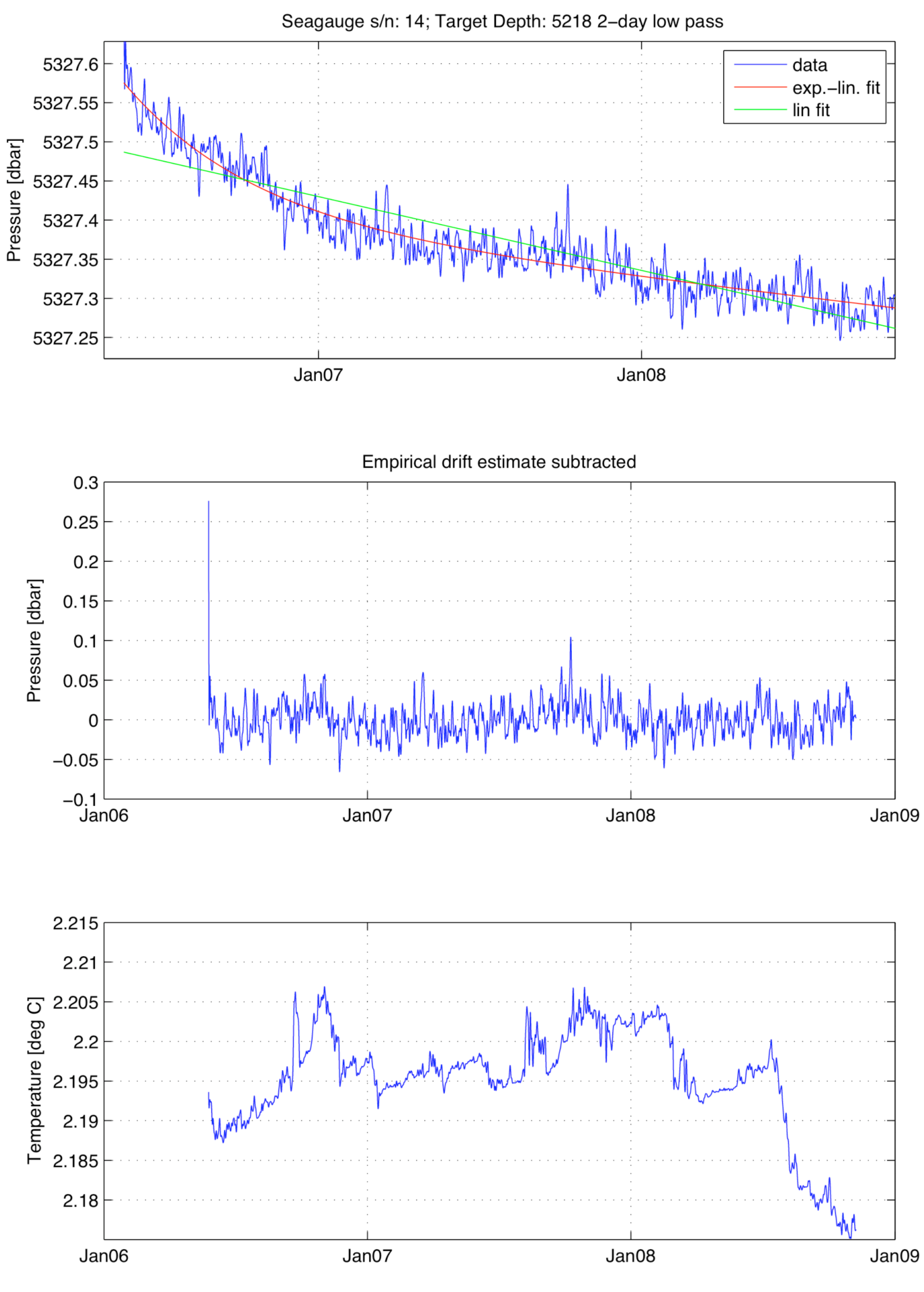


Figure 19.1 *The output file* `marl3_1_200624_0014.use.2.eps`*, showing the (top) 2-day low-pass filtered pressure with fits for an exponential plus linear offset (red) and for a linear offset (green), (middle) after subtraction of the exponential plus linear trend, and (bottom) the two-day low-pass filtered temperature data.*

The script `purge_bp.m`:
- removes the launch and recovery periods based on the dates and times in the info file, which are modified during processing to make sure that the start-up and recovery transients are removed.
- despikes the data with `ddspike.m`, writes the number of spikes removed in the stage2 log file.
- interpolates the pressure onto integer minutes and filters (two-day low pass with `auto_filt.m`)
- calculates an exponential plus linear (f) and a linear fit (g) on the interpolated and filtered pressure of forms:

$$f(t) = a_1 \cdot \left[1 - \exp\left(-a_2(t - t_1)\right)\right] + a_3(t - t_1) + a_4$$

$$g(t) = a_3(t - t_1) + a_4$$

19.1 Distribution of fitted coefficients

In an effort to understand if the value of the coefficients from the exponential plus linear fit are within the expected ranges, a census was made of all RAPID-MOC data with the script `bp_drift_census.m`. There are 36 data records that were included.

Different definitions of the coefficients were used, such as is calculated by exp_lin_fit3.m and exp_lin_fun3.m. The form that is used is

$$f(t) = a_1 \exp\left(-(t - t_1)/a_2\right) + \left(t - t_{avg}\right) + a_4$$

With this definition, the sign of the exponential amplitude a_1 is the same as the exponential pressure perturbation, the exponential decay a_2 is in units of days, and the linear fit is relative to the centroid. This makes the offset a_4 be the offset at the center of the record with the exponential fit removed — equivalent physically to the best estimate of the sensor's pressure.

Of the 36 records, nine records that use exponential fits are fit just as accurately with linear fits. The exponential amplitude and exponential decay periods from these nine records do not agree with those from the other sensors: five have negative exponential amplitudes (from -0.5 to 0 db), and four have large exponential decays (> 200 days, 335, 455, 881, 60600 days). Because these values lie outside the distribution curves, these nine exponential fits are replaced with linear fits for the analysis below.

For valid exponential plus linear fits, the exponential amplitude is almost always positive (with one exception, a_1=-0.09, the BPR on MARL1_1_200525, sn 394), and is centered at a median of 0.12 db with a standard deviation of 0.075 db. The exponential decay is between 9.5 and 150 days and has a median of 38 days and lower and upper quartiles of 25 and 70 days. There are three clusters: 15 values centered around 29 day, five around 72 days, and four around 138 days. The slope is centered at -0.000034 db/day (median), with upper and lower quartiles of -0.00023 and 0.00011 db/day and a standard deviation of 0.0070 db/day. The offset depends on the depth of deployment, and so doesn't indicate sensor performance.

Based on these distributions, fits of bottom pressure sensors are expected to have an exponential amplitude of 0.1 db, an exponential decay of 30–70 days, and have a small linear slope that is randomly distributed about zero for this small sample size. Values much outside of this range – those listed above which were replaced with linear fits, for instance – indicate that the fitting procedure is not responding to sensor performance.

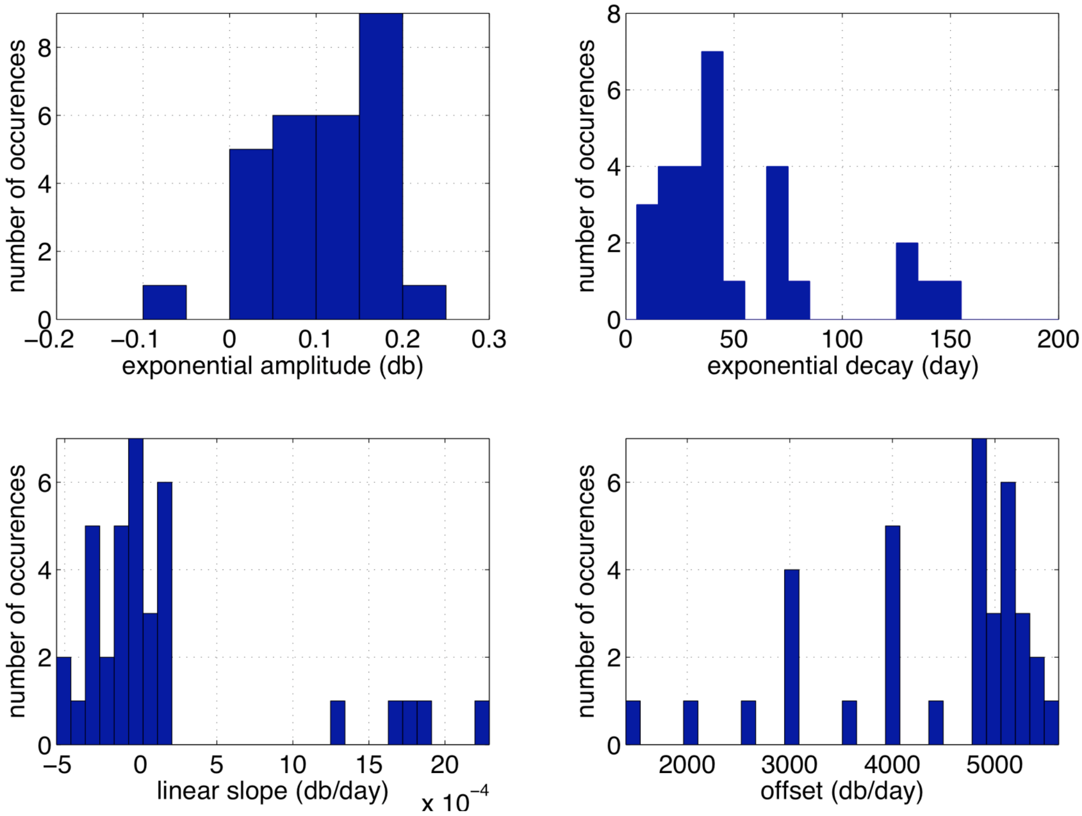


Figure 19.2 *The distribution of the four coefficients used for the exponential plus linear fitting of bottom pressure.*

20 Comparison of RBR to SBE Data

Malte Heinemann and Darren Rayner

20.1 Motivation

This section aims at comparing two different CTD instruments. The first instrument is the Sea-Bird Electronics MicroCAT (SBE, instrument number 337, see Fig. 20.1), the second instrument is the Richard Brancker Research Ltd. XR-420-CTD (RBR, instrument number 330, see Fig. 20.2).

Fig. 20.1 *SBE37 MicroCAT CTD*

Fig. 20.2 *RBR XR-420 CTD*

A previous comparison of RBR to SBE data recovered from eb2 5 200620 has shown that RBR and SBE temperatures and pressures compare relatively well, while the RBR shows first a large positive conductivity offset of more than 1 mS/cm, and second a nonlinear positive conductivity drift. Subsequently, the RBR has been modified: a white coating (see Fig. 20.2) has been added around the conductivity cell in an attempt to reduce conductivity drift.

Here, we use pairs of SBE and RBR data from two moorings, eb2_7_200721 at a depth of 250m and ebhi_4_200720 at a target depth of 4000m, and data from two CTD calibration dips, D324 cast 4 and D334 cast 6. All RBR data shown here are based on the 'coated' RBRs with the serial numbers 9656 and 9657. Table 20.1 shows the specifications for each instrument.

		Seabird SBE37 SMP MicroCAT	**RBR XR420-CTD**
Conductivity (mS/cm)	Measurement range	0 to 70	0 to 70
	Initial Accuracy	0.003	0.003
	Resolution	0.0001	<0.0001
Temperature (ºC)	Measurement range	-5 to 35	-5 to 35
	Initial Accuracy	0.002	0.002
	Resolution	0.0001	<0.00005
Pressure (dbar)	Measurement range	0 to 7000 (see note)	0 to 6600 (see note)
	Initial Accuracy	7	3.3
	Resolution	0.14	0.066

Table 20.1 *Manufacturer's instrument specifications. Note: Pressure range can be selected when ordering; these are the actual ranges of the instruments used during the inter-comparison.*

20.2 Results

20.2.1 EB2

Mooring eb2_7_200721 as recovered during this cruise included SBE3252 and RBR9657 both at a depth of ~250m. The temperature timeseries agree very well (not shown). Both instruments show a pressure decrease of about 2 dbar during the first 80 days (Fig. 20.3). After about 80 days, the RBR records a sudden pressure change of 4 dbar. The temporal means of the RBR and the SBE conductivities compare quite well, there is no strong offset. However, the RBR seems to drift by 0.25mS(cm year)-1, while this drift mostly occurs during the first 40 days and the last 80 days (Figs. 20.4 and 20.6).

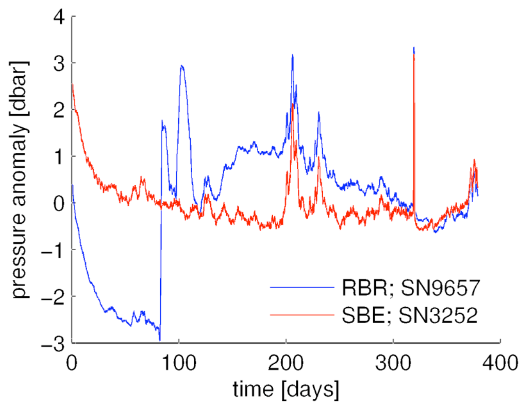


Fig. 20.3 *Pressure anomaly for instruments from EB2(difference from temporal mean).*

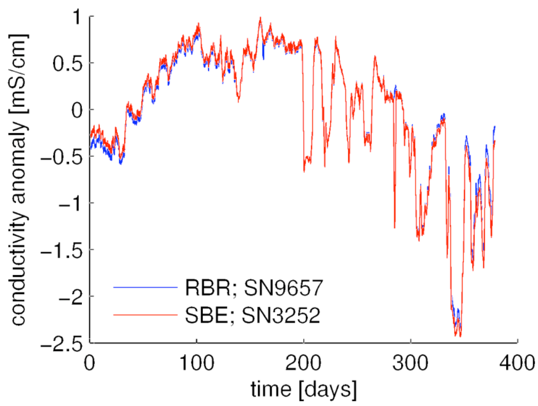


Fig. 20.4 *Conductivity anomaly for instruments from EB2.*

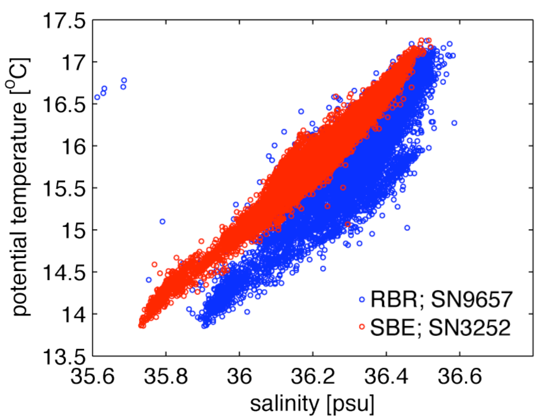


Fig. 20.5 *Temperature-salinity plot for instruments from EB2.*

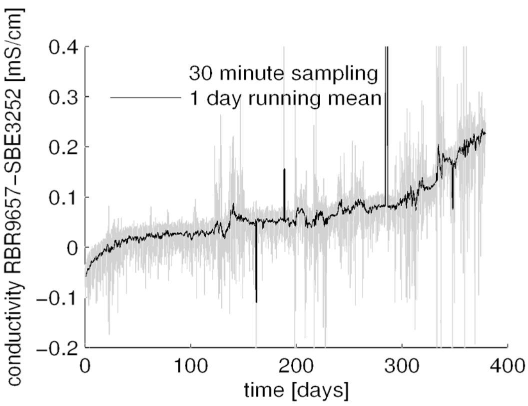


Fig. 20.6 *Conductivity difference between the RBR and the SBE on EB2.*

20.2.2 EBHi

Mooring ebhi_4_200720 as recovered during this cruise contained the SBE3480 and the RBR9656 both at a target depth of 4000m. The measured temperatures agree well, apart from an offset of about 0.006K (not shown).

The SBE measured pressure timeseries shows a mostly exponentially shaped drift that lasts for the entire deployment period. The RBR pressure sensor seems to equilibrate much faster (Fig. 20.7).

The temporal mean SBE conductivity amounts to about 32.66mS/cm (Fig. 20.7). The RBR measures on average 0.53mS/cm lower conductivity than the SBE (Fig. 20.11). The RBR conductivity drifts by about 0.028mS/cm/year (Fig. 20.9). The RBR conductivity measurement shows larger short-term variability (Fig. 20.7). This variability can also be seen in the T-S plot (Fig. 20.10).

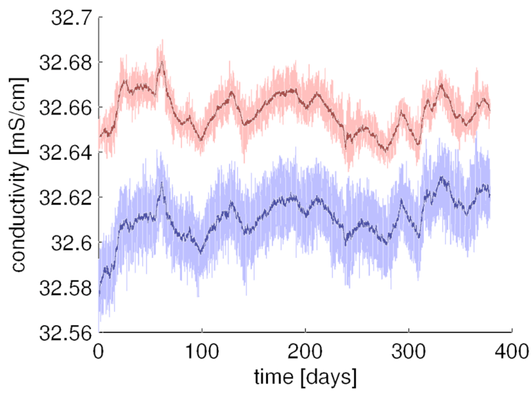


Fig. 20.7 *SBE (red) and RBR (blue) conductivity for EBHi; dark lines indicate one-day running means; RBR conductivity has been shifted by +0.48mS/cm for readability.*

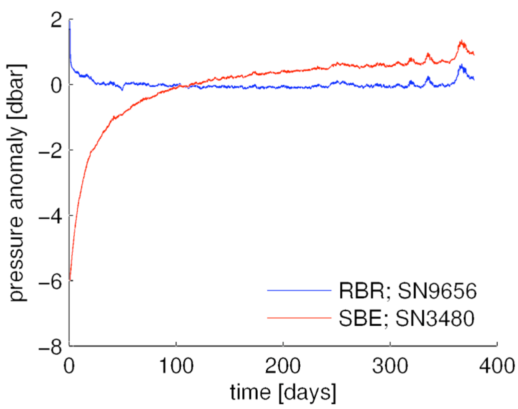


Fig. 20.8 *Pressure anomaly for instruments from EBHi (difference from temporal mean).*

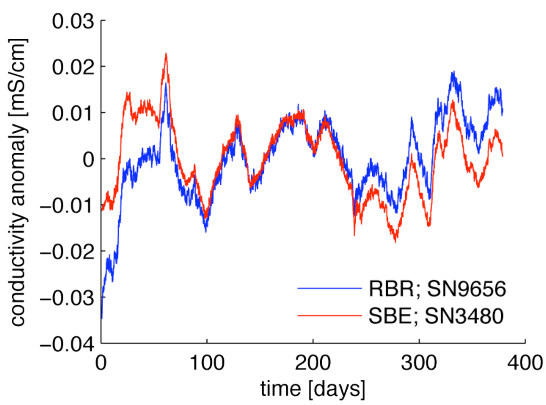


Fig. 20.9 *Conductivity anomaly for instruments on EBHi*

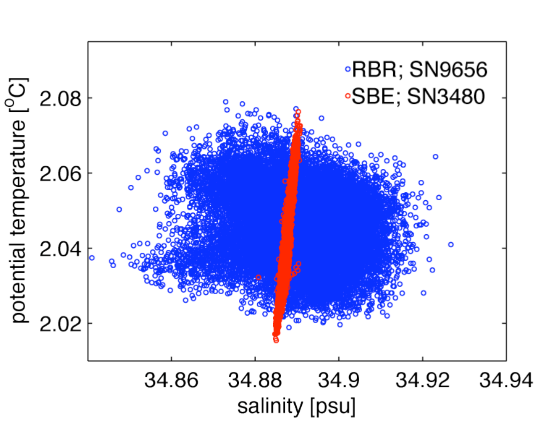


Fig. 20.10 *Temperature-salinity plot for EBHi; the RBR salinity is computed with a 0.53mS/cm higher conductivity to account for the offset (see Fig. 21.10).*

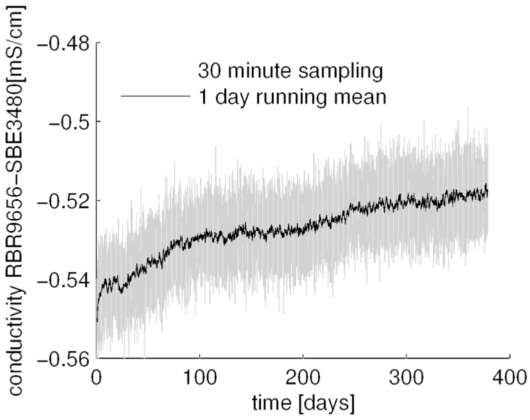


Fig. 20.11 *Conductivity difference between the RBR and the SBE on EBHi.*

20.2.3 CTD casts

Prior to deployment and following recovery all the moored CTDs used during these comparisons were lowered on a CTD cast to allow cross calibration with the shipboard CTD in the relatively stable deep waters. The pre-deployment calibration cast was cast 4 on cruise D324, and the post-deployment calibration was on cast 6 on D334.

During these calibration dips, the instruments went down to a depth of approximately 3600m. During the upcast, the CTD frame stopped at certain depths for five-minute bottle stops. To estimate the performance of the RBRs and the SBEs, we compare their temperature, conductivity, and pressure measurements to the measurement of the shipboard CTD as a reference, which was calibrated for salinity throughout the cruise by analyzing collected water samples.

Figure 20.12 shows the resultant T-S plot for the two casts using the moored instruments conductivity with the shipboard CTD temperature to minimize the effect of the slower response of the temperature sensors on the moored instruments.

Ignoring the shallower waters where there is more variability, the MicroCATs both agree very well with the shipboard CTD. There is variation caused by the less frequent sampling and slower response rate of the moored instruments but the overall shape of the T-S plot is maintained. The RBRs display a hysteresis in the T-S profile from cruise D324 which may be accounted for by the lag in the conductivity cell response compared to the shipboard CTD, but they also do not match the shape of the T-S profile for the shipboard CTD or MicroCATs. Serial number 9656 has a large offset as already seen in the moorings time series, and both RBRs display a shift in the lower section of the T-S plot in the deeper waters.

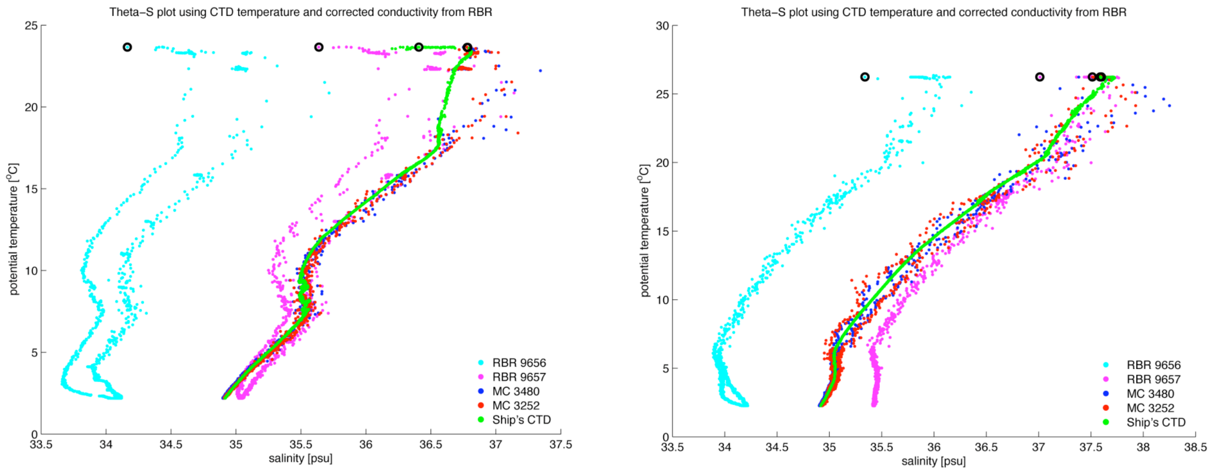


Fig. 20.12 *Potential Temperature-Salinity plot for D324 CTD cast 4 (left), and D334 cast6 (right). Black circle indicates staring point.*

The moored instruments are not designed for profiling quickly as per the shipboard CTD but it is standard practice for the RAPID-MOC project to lower the moored MicroCATs on the CTD frame before and after mooring deployments. This allows the data from the mooring deployment to be corrected for any offset found when comparing to the highly accurate shipboard CTD at the two end-points. During this calibration procedure only data from the bottle stops is used so that the moored instruments have sufficient time to stabilize at the low sampling rate relative to the shipboard CTD (sampling at 24Hz).

The offset is found through averaging the difference between the shipboard CTD and the moored instrument over a user-defined depth range. The offset is then applied to the mooring data either as a linear trend between the pre- and post-deployment casts or as a fixed value taken from just one cast.

Figure 20.13 shows the output from the calibration routines for a selection of MicroCATs on cast 6 on D334, and Figure 20.14 shows the corresponding plots for the RBRs on the same cast. Note the change in scale for the two figures when looking at conductivity. For temperature and conductivity the MicroCATs have a similar offset for all the deep bottle stops (>750m) compared to the shipboard CTD. The RBRs however have both a larger drift with increasing pressure and a larger total offset.

The RBRs suffer from hysteresis the method for obtaining pre- and post-deployment calibrations may be invalid, although for cast 6 on D334 this hysteresis is much less pronounced.

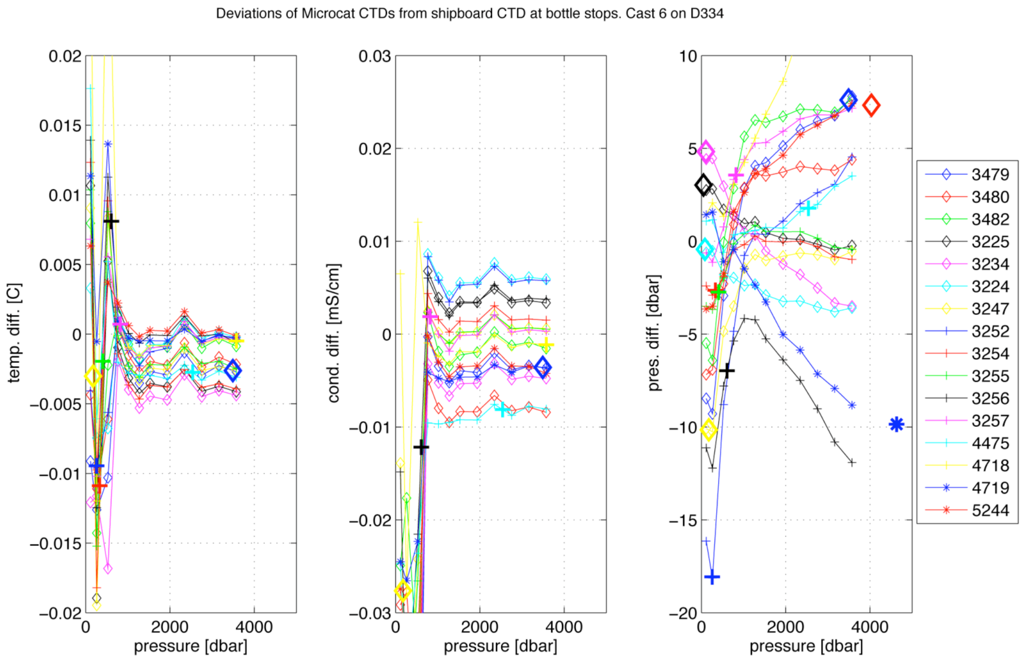


Fig. 20.13 *Deviations of MicroCAT CTDs from shipboard CTD at bottle stops for cast 6 on cruise D334*

20.3 Conclusions

The RAPID-MOC project has extensive experience with the SeaBird MicroCAT having deployed over 500 of them during the first five years of the project. It has proven to be a reliable instrument and has become our standard moored CTD. There have been a number of RBR XR-420 CTDs deployed but we have had limited success with these. The two instruments deployed in 2007 have had the conductivity cell covered with a white material by RBR with the aim of improving the conductivity measurements in deep waters.

The temperature sensors on the RBRs agree well with both the MicroCATs on the mooring deployments and the shipboard CTD (aside from an apparent pressure dependent drift) so these will not be discussed further.

For conductivity the RBR deployed at 250m depth on EB2 compared reasonably well to the MicroCAT in the highly variable shallower waters. However, the RBR deployed at 4500m on EBHi had a significant offset and large amount of noise compared to the corresponding MicroCAT. The poorer performance of the RBR conductivity cell relative to the MicroCATs is further highlighted by the results from lowering the moored instruments on the shipboard CTD frame. At bottle stops greater than 750m depth the MicroCATs have a maximum discrepancy of 0.01 mS/cm when compared to the shipboard CTD. The MicroCATs are also in close agreement with each other. The RBRs on the other hand are in error by up to 1mS/cm for the bottle stop at 750m, do not agree well with each other, and display a significant pressure dependant drift in the conductivity.

The coating of the conductivity cells appears not to have sufficiently improved the performance of the conductivity cells.

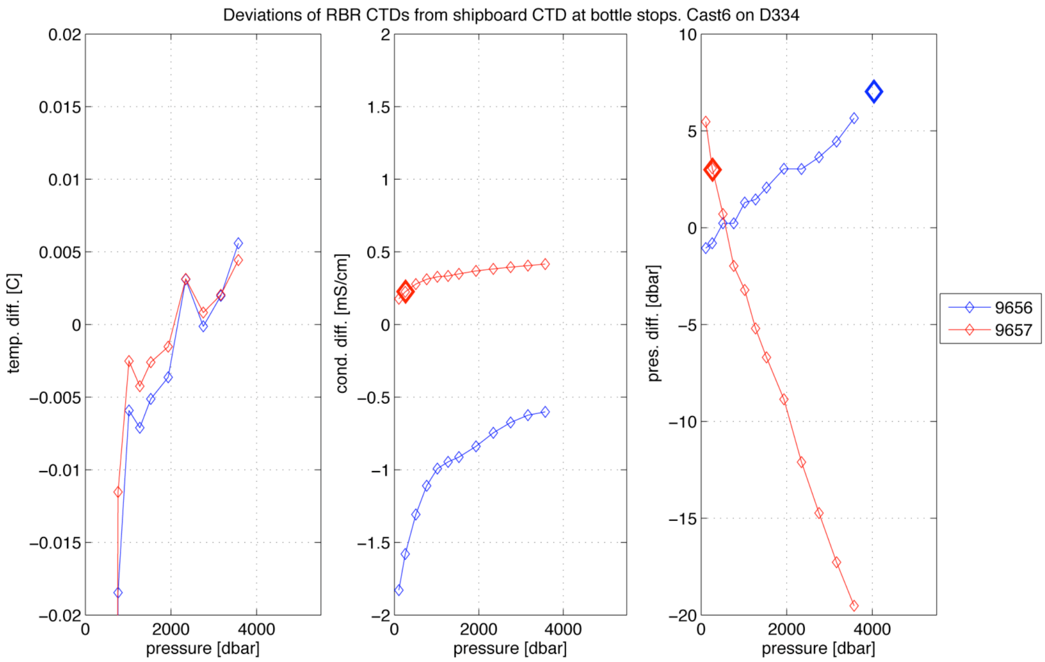


Fig. 20.14 *Deviations of RBR CTDs from shipboard CTD at bottle stops for cast 6 on cruise D334*

Appendix A Instrument Record Lengths

Mooring	Instrument	Serial number	Approx. depth (m)	Recovered ?	Date of first useable record	Date of last useable record
EB2	SBE 37	3225	50	Yes	18/10/2007	31/10/2008
	SBE 37	3234	100	Yes	18/10/2007	31/10/2008
	SBE 37	3247	175	Yes	18/10/2007	31/10/2008
	SBE 37	3252	250	Yes	18/10/2007	31/10/2008
	SBE 37	3254	325	Yes	18/10/2007	31/10/2008
	SBE 37	3255	400	Yes	18/10/2007	31/10/2008
	SBE 37	3256	600	Yes	18/10/2007	31/10/2008
	SBE 37	3257	800	Yes	18/10/2007	31/10/2008
	SBE 37	3265	1000	Yes	18/10/2007	31/10/2008
	SBE 37	3266	1200	Yes	18/10/2007	31/10/2008
	SBE 37	3269	1600	Yes	18/10/2007	31/10/2008
	SBE 37	3270	2000	Yes	18/10/2007	31/10/2008
	SBE 37	3271	3000	Yes	18/10/2007	31/10/2008
	SBE 37	3274	4000	Yes	18/10/2007	31/10/2008
	SBE 37	3277	4650	Yes	18/10/2007	31/10/2008
EB1	SBE 37	3224	50	Yes	18/10/2007	31/10/2008
	SBE 37	3251	100	Yes	18/10/2007	31/10/2008
	SBE 37	3268	175	Yes	18/10/2007	31/10/2008
	SBE 37	3272	250	Yes	18/10/2007	31/10/2008
	SBE 37	3484	325	Yes	18/10/2007	31/10/2008
	SBE 37	5484	400	Yes	18/20/2007	31/10/2008
	SBE 37	5485	500	Yes	18/10/2007	31/10/2008
	SBE 37	5486	700	Yes	18/10/2007	31/10/2008
	SBE 37	5487	900	Yes	18/10/2007	31/10/2008
	SBE 37	5488	1100	Yes	18/10/2007	31/10/2008
	SBE 37	3253	1400	Yes	18/10/2007	31/10/2008
	SBE 37	4472	1800	Yes	18/10/2007	31/10/2008
	SBE 37	4475	2500	Yes	18/10/2007	31/10/2008
	SBE 37	4718	3500	Yes	18/10/2007	31/10/2008
	SBE 37	4719	4500	Yes	18/10/2007	31/10/2008
EBL1	SBE 26	0420	5092	Yes	13/10/2006	30/10/2008
	SBE 26	0419	5092	Yes	13/10/2006	30/10/2008
EBHi	SBE 37	3479	3500	Yes	16/10/2007	29/10/2008
	SBE 37	3480	4000	Yes	16/10/2007	29/10/2008
	RBR	9656	4000	Yes	16/10/2007	29/10/2008
	SBE 37	3482	4500	Yes	16/10/2007	29/10/2008
EBP1	PIES	136	5094	Yes	25/11/2005	31/10/2008
MAR3	SBE 37	4720	2500	Yes	23/10/2007	4/11/2008
	SBE 37	4721	3000	Yes	23/10/2007	4/11/2008
	SBE 37	4722	3500	Yes	23/10/2007	4/11/2008
	SBE 37	4723	4000	Yes	23/10/2007	4/11/2008
	SBE 37	4178	4500	Yes	23/10/2007	4/11/2008
	SBE 37	4179	5000	Yes	23/10/2007	4/11/2008
	S4	35612571	5015	Yes	23/10/2007	4/11/2008
MARL4	BPR	0012	5045	Yes	28/05/2006	4/11/2008

NOG ST	SED T	12168-04	3000	Yes	Unknown	5/11/2008
	RCM 8	9450	3000	Yes	Unknown	5/11/2008
	SED T	12168-02	3000	Yes	Unknown	5/11/2008
	RCM8	9904	3000	Yes	Unknown	5/11/2008
MAR2	SBE 37	3918	1100	Yes	27/10/2007	7/11/2008
	SBE 37	3910	1400	Yes	27/10/2007	7/11/2008
	SBE 37	3282	1800	Yes	27/10/2007	7/11/2008
	SBE 37	4461	2250	Yes	27/10/2007	7/11/2008
	SBE 37	4462	2750	Yes	27/10/2007	7/11/2008
	SBE 37	4464	3250	Yes	27/10/2007	7/11/2008
	SBE 37	4714	3750	Yes	27/10/2007	7/11/2008
	SBE 37	4715	4250	Yes	27/10/2007	7/11/2008
	SBE 37	4717	4750	Yes	27/10/2007	7/11/2008
	S4	35612576	5150	Yes	27/10/2007	7/11/2008
	SBE 37	4468	5160	Yes	27/10/2007	7/11/2008
MAR1	SBE 37	3207	50	Yes	28/10/2007	7/11/2008
	SBE 37	3208	100	Yes	28/10/2007	7/11/2008
	SBE 37	3209	150	Yes	28/10/2007	7/11/2008
	SBE 37	3212	250	Yes	28/10/2007	7/11/2008
	SBE 37	3213	400	Yes	28/10/2007	7/11/2008
	SBE 37	3214	600	Yes	28/10/2007	7/11/2008
	SBE 37	3215	800	Yes	28/10/2007	7/11/2008
	SBE 37	3216	1000	Yes	28/10/2007	7/11/2008
	SBE 37	3217	1200	Yes	28/10/2007	7/11/2008
	SBE 37	3890	1600	Yes	28/10/2007	7/11/2008
	SBE 37	4708	2000	Yes	28/10/2007	7/11/2008
	SBE 37	4709	2500	Yes	28/10/2007	7/11/2008
	SBE 37	4710	3000	Yes	28/10/2007	7/11/2008
	SBE 37	4711	3500	Yes	28/10/2007	7/11/2008
	SBE 37	4712	4000	Yes	28/10/2007	7/11/2008
	SBE 37	4713	4500	Yes	28/10/2007	7/11/2008
	S4	35612577	5000	Yes	28/10/2007	7/11/2008
MARL3	SBE 53	0013	5218	Yes	25/05/2006	08/11/2008
	SBE 53	0014	5218	Yes	25/05/2006	08/11/2008
MAR0	SBE 37	4180	5100	Yes	28/10/2007	09/11/2008
	SBE 37	4181	5300	Flooded	-	-
	SBE 37	4183	5475	Flooded	-	-
	SBE 26	0389	5523	Yes	28/10/2007	09/11/2008
MAR3	SBE 37	2500	4720	Yes	23/10/2007	04/11/2008
	SBE 37	3000	4721	Yes	23/10/2007	04/11/2008
	SBE 37	3500	4722	Yes	23/10/2007	04/11/2008
	SBE 37	4000	4723	Yes	23/10/2007	04/11/2008
	SBE 37	4500	4178	Yes	23/10/2007	04/11/2008
	SBE 37	5000	4179	Yes	23/10/2007	04/11/2008
	S4	5015	35612571	Yes	23/10/2007	04/11/2008
EBP1	PIES	5094	136	Yes	25/11/2005	31/10/2008
EBH1	SBE 37	2500	3239	Yes	05/11/2007	18/11/2008
	SBE 37	3000	3284	Yes	05/11/2007	18/11/2008
EBL2	SBE 26	3000	400	Yes	16/10/2006	18/11/2008
EBH2	SBE 37	1600	3248	Yes	6/11/2007	19/11/2008
	SBE 37	1800	3249	Yes	6/11/2007	19/11/2008
	SBE 37	2000	4474	Yes	6/11/2007	19/11/2008

EBH3	SBE 37	900	3259	Yes	06/11/2007	19/11/2008
	SBE 37	1000	3264	Yes	06/11/2007	19/11/2008
	SBE 37	1100	3483	Yes	06/11/2007	19/11/2008
	SBE 37	1200	3486	Yes	06/11/2007	19/11/2008
	SBE 37	1400	3891	Yes	06/11/2007	19/11/2008
EBH4	SBE 37	325	3892	Yes	07/11/2007	19/11/2008
	SBE 37	400	3900	Yes	07/11/2007	19/11/2008
	SBE 37	500	3901	Yes	07/11/2007	19/11/2008
	SBE 37	600	3903	Yes	07/11/2007	19/11/2008
	SBE 37	700	3904	Yes	07/11/2007	19/11/2008
	SBE 37	800	3912	Yes	07/11/2007	19/11/2008
EBP2	PIES	1000	131	Yes	30/08/2006	18/11/2008
EBM1	SBE 37	420	3913	Yes	07/11/2007	20/11/2008
EBM4	SBE 37	275	3941	No	07/11/2007	--
EBM5	SBE 37	176	3115	No	07/11/2007	--
EBM6	SBE 37	95	3916	Yes	09/11/2007	20/11/2008

Table A1 *Mooring instrument record lengths*

Appendix B CTD Calibration Casts

Table B.1 *Details of instruments lowered on CTD calibration casts. Seabird SBE37 'MicroCAT' CTDs are indicated by 'm/c', with SMP for serial connection and IMP for inductive connection, and the shallow rated instruments noted in the comments. RBR XR-420 CTDs are indicated by 'RBR', acoustic releases by 'AR', and light release transponders by 'LRT'.*

Cast	Instrument Details			
	Type	s/n	Deployment	Comments
1	SMP m/c	3244	pre-deployment	
	SMP m/c	3258	pre-deployment	pressure is 15 dbar too low at all depths
	SMP m/c	3902	pre-deployment	
	SMP m/c	3905	pre-deployment	
	SMP m/c	3906	pre-deployment	
	SMP m/c	3907	pre-deployment	
	SMP m/c	3908	pre-deployment	
	SMP m/c	3919	pre-deployment	
	SMP m/c	3928	pre-deployment	
	SMP m/c	3930	pre-deployment	
	SMP m/c	3931	pre-deployment	
	SMP m/c	3932	pre-deployment	
	AR	928		
	AR	909		
	AR	908		
2	SMP m/c	3223	pre-deployment	3500 m pressure rating
	SMP m/c	3228	pre-deployment	3500 m pressure rating
	SMP m/c	3229	pre-deployment	3500 m pressure rating
	SMP m/c	3230	pre-deployment	3500 m pressure rating
	SMP m/c	3231	pre-deployment	3500 m pressure rating
	SMP m/c	3232	pre-deployment	3500 m pressure rating
	SMP m/c	3233	pre-deployment	3500 m pressure rating
	SMP m/c	3933	pre-deployment	
	SMP m/c	3934	pre-deployment	
	SMP m/c	4305	pre-deployment	
	SMP m/c	4306	pre-deployment	
	SMP m/c	4307	pre-deployment	
	AR	927		
	AR	929		
	AR	930		
3	SMP m/c	5238	pre-deployment	
	SMP m/c	5239	pre-deployment	
	SMP m/c	5240	pre-deployment	
	SMP m/c	6112	pre-deployment	
	SMP m/c	6113	pre-deployment	
	SMP m/c	6114	pre-deployment	
	SMP m/c	6115	pre-deployment	
	SMP m/c	6116	pre-deployment	
	SMP m/c	6117	pre-deployment	
	SMP m/c	6118	pre-deployment	
	SMP m/c	6119	pre-deployment	
	SMP m/c	6120	pre-deployment	

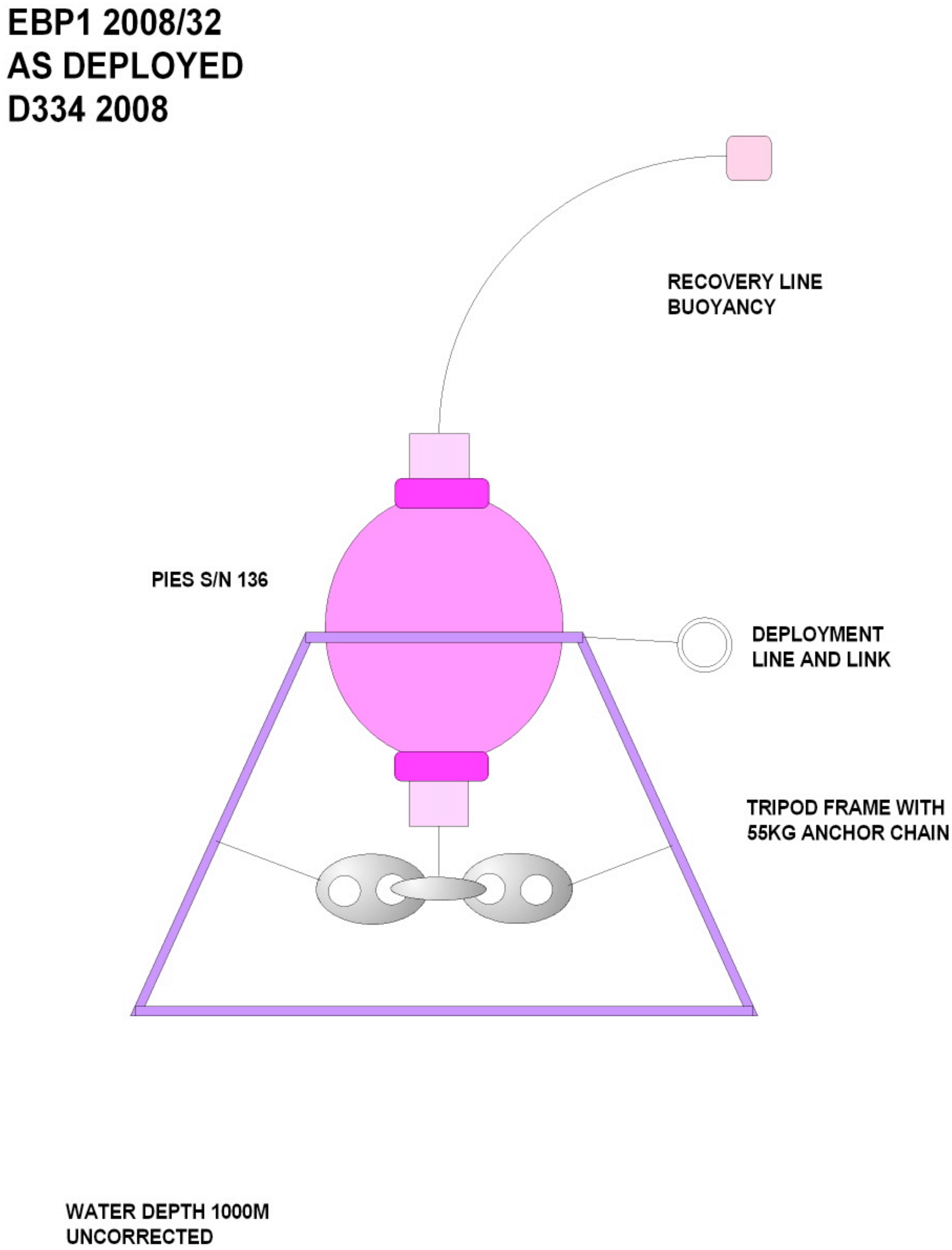
Cast	Instrument Details			
	Type	s/n	Deployment	Comments
4	SMP m/c	6122	pre-deployment	
	SMP m/c	6123	pre-deployment	
	SMP m/c	6124	pre-deployment	
	SMP m/c	6125	pre-deployment	
	SMP m/c	6126	pre-deployment	
	SMP m/c	6127	pre-deployment	
	SMP m/c	6128	pre-deployment	
	SMP m/c	6129	pre-deployment	
	SMP m/c	5241	pre-deployment	
	SMP m/c	5242	pre-deployment	
	SMP m/c	5243	pre-deployment	
5	SMP m/c	3265	post-deployment	
	SMP m/c	3266	post-deployment	
	SMP m/c	3269	post-deployment	pressure is 20 db low at bottom of upcast, OK at other depths
	SMP m/c	3270	post-deployment	clock is 30 minutes behind
	SMP m/c	3271	post-deployment	clock is 30 minutes behind
	SMP m/c	3274	post-deployment	
	SMP m/c	3277	post-deployment	
	SMP m/c	3251	post-deployment	conductivity has a pressure-dependent offset: it reads low by 0.03 mS/cm at ~5000 db, by 0.05 mS/cm at ~2500 db, and by 0.07 at ~500 db
	SMP m/c	3268	post-deployment	
	SMP m/c	3272	post-deployment	
	SMP m/c	3484	post-deployment	conductivity is bad, it responds with a large lag
	SMP m/c	5484	post-deployment	
	SMP m/c	5485	post-deployment	
	SMP m/c	5486	post-deployment	
	SMP m/c	5487	post-deployment	
	SMP m/c	5488	post-deployment	
	IMP m/c	3253	post-deployment	
	IMP m/c	4472	post-deployment	
	AR	912		
	AR	913		
	AR	922		

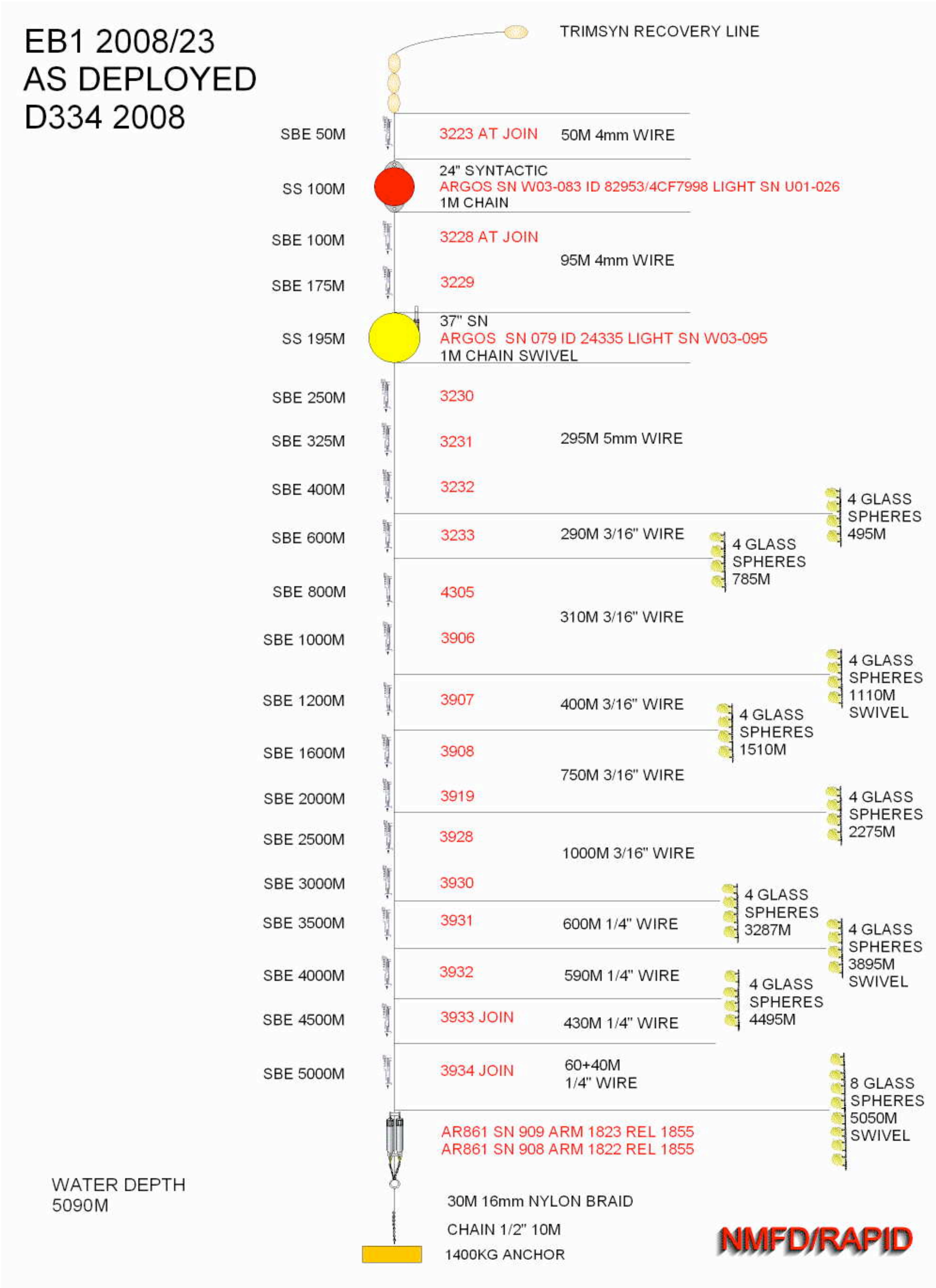
Cast	Instrument Details			
	Type	s/n	Deployment	Comments
6	SMP m/c	3479	post-deployment	
	SMP m/c	3480	post-deployment	
	SMP m/c	3482	post-deployment	
	SMP m/c	3225	post-deployment	3500 m pressure rating
	SMP m/c	3234	post-deployment	3500 m pressure rating
	SMP m/c	3224	post-deployment	3500 m pressure rating
	SMP m/c	3247	post-deployment	pressure is 10 db high at bottom of upcast, OK at other depths
	SMP m/c	3252	post-deployment	
	SMP m/c	3254	post-deployment	
	SMP m/c	3255	post-deployment	
	SMP m/c	3256	post-deployment	
	SMP m/c	3257	post-deployment	
	IMP m/c	4475	post-deployment	
	IMP m/c	4718	post-deployment	
	IMP m/c	4719	post-deployment	
	SMP m/c	5244	pre-deployment	
	RBR	9656	post-deployment	
	RBR	9657	post-deployment	
7	SMP m/c	6109	pre-deployment	
	SMP m/c	6110	pre-deployment	
	SMP m/c	6111	pre-deployment	pressure is slightly high at bottom of upcast, OK at other depths
	SMP m/c	6130	pre-deployment	
	SMP m/c	6131	pre-deployment	
	SMP m/c	6132	pre-deployment	
	SMP m/c	6133	pre-deployment	pressure is slightly low in bottom half of upcast
	SMP m/c	6134	pre-deployment	
	SMP m/c	6135	pre-deployment	
	SMP m/c	6136	pre-deployment	pressure is slightly low at bottom of upcast, OK at other depths
	SMP m/c	6137	pre-deployment	
	SMP m/c	6320	pre-deployment	
	SMP m/c	6321	pre-deployment	
	SMP m/c	6322	pre-deployment	
	SMP m/c	6323	pre-deployment	
	SMP m/c	6324	pre-deployment	pressure is slightly low at all depths
	SMP m/c	6325	pre-deployment	
	SMP m/c	6326	pre-deployment	
	AR	914		
	AR	915		
	AR	924		

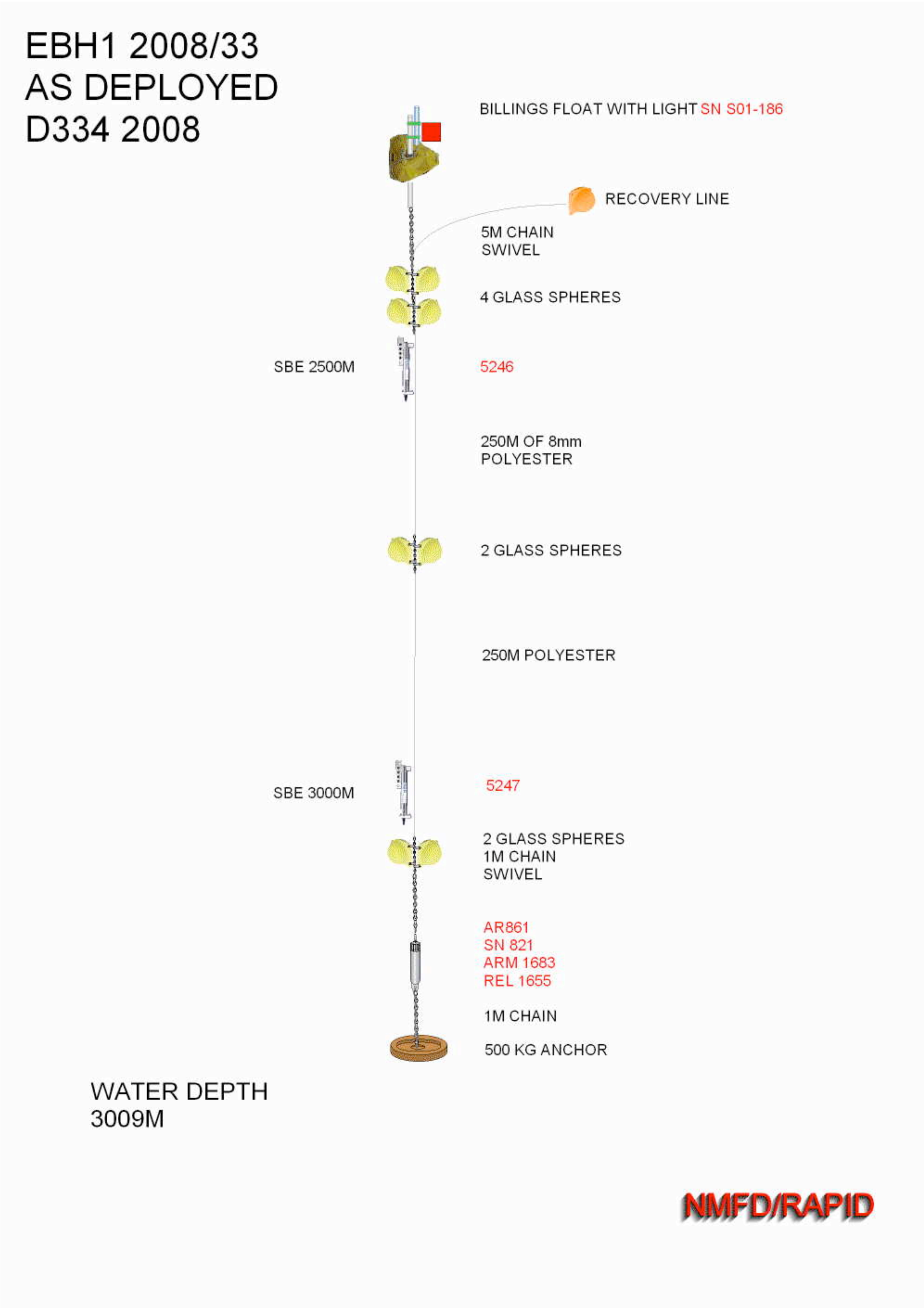
Cast	Instrument Details			
	Type	**s/n**	**Deployment**	**Comments**
8	SMP m/c	6327	pre-deployment	
	SMP m/c	6328	pre-deployment	
	SMP m/c	3258	pre-deployment	
	SMP m/c	6329	pre-deployment	
	SMP m/c	6330	pre-deployment	
	SMP m/c	6331	pre-deployment	
	SMP m/c	6332	pre-deployment	
	SMP m/c	6333	pre-deployment	
	SMP m/c	6334	pre-deployment	
	SMP m/c	5245	pre-deployment	
	SMP m/c	5246	pre-deployment	pressure is low in bottom half of upcast
	SMP m/c	5427	pre-deployment	
	IMP m/c	4720	post-deployment	
	IMP m/c	4721	post-deployment	
	IMP m/c	4722	post-deployment	
	IMP m/c	4723	post-deployment	
	IMP m/c	4178	post-deployment	
	IMP m/c	4179	post-deployment	
9	SMP m/c	3207	pre-deployment	3500 m pressure rating, conductivity is 0.02 mS/cm high over bottom half of upcast,
	SMP m/c	3208	pre-deployment	3500 m pressure rating
	SMP m/c	3209	pre-deployment	3500 m pressure rating
	SMP m/c	3212	pre-deployment	3500 m pressure rating
	SMP m/c	3213	pre-deployment	3500 m pressure rating
	SMP m/c	3214	pre-deployment	3500 m pressure rating
	SMP m/c	3215	pre-deployment	3500 m pressure rating
	SMP m/c	3216	pre-deployment	3500 m pressure rating
	SMP m/c	3217	pre-deployment	3500 m pressure rating
	SMP m/c	3890	pre-deployment	pressure is low in bottom half of upcast
	IMP m/c	3282	post-deployment	
	IMP m/c	4461	post-deployment	
	IMP m/c	4462	post-deployment	
	IMP m/c	4714	post-deployment	pressure is low in bottom half of upcast
	IMP m/c	4715	post-deployment	pressure is low in bottom half of upcast
	IMP m/c	4717	post-deployment	pressure is low in bottom half of upcast
	SMP m/c	3918	post-deployment	
	SMP m/c	3910	post-deployment	conductivity is 0.02 mS/cm high over bottom half of upcast,

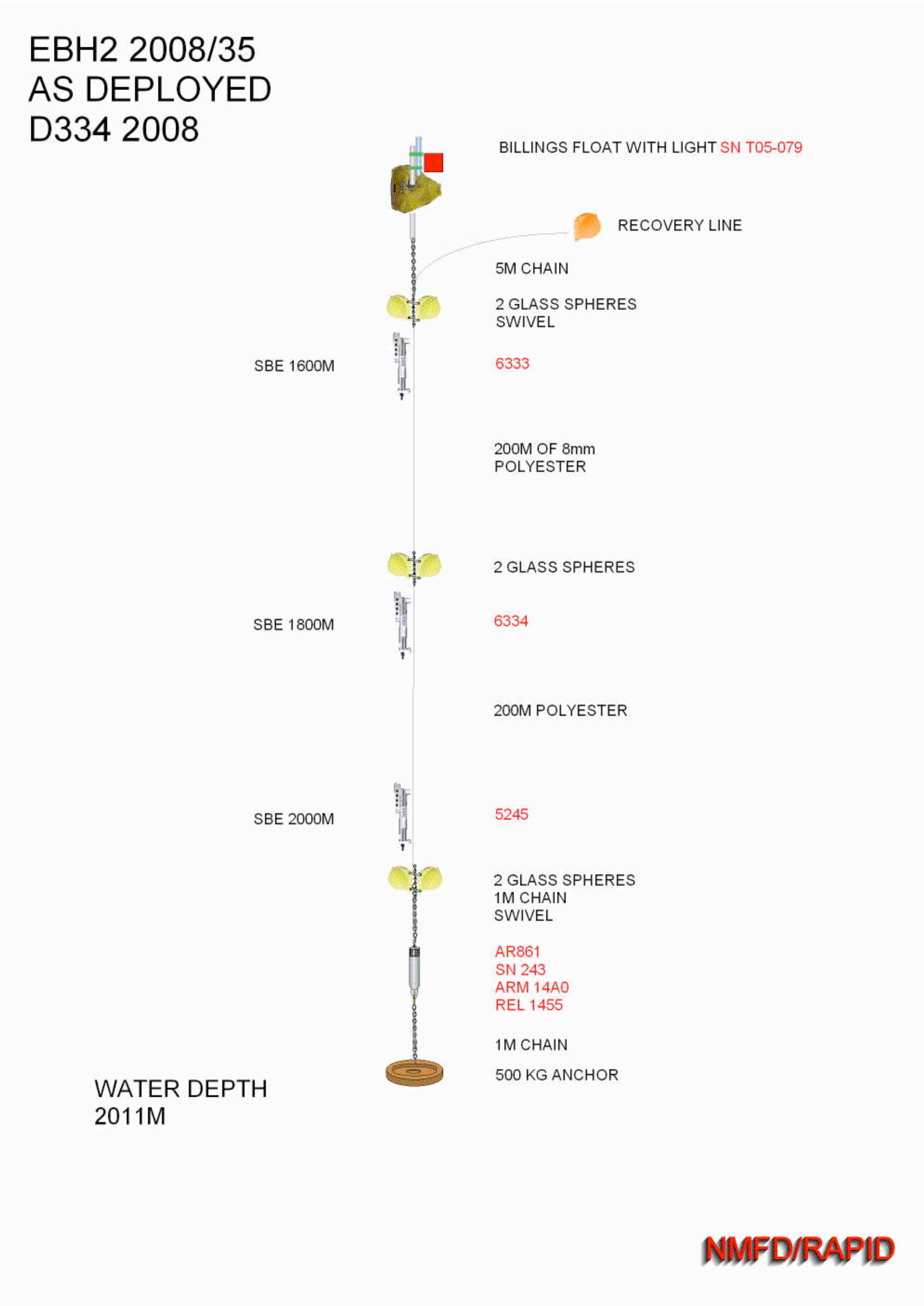
Cast	Instrument Details			
	Type	**s/n**	**Deployment**	**Comments**
11	IMP m/c	4464	post-deployment	conductivity is slightly low
	IMP m/c	4466	post-deployment	conductivity is slightly low
	IMP m/c	4708	post-deployment	depth-dependent pressure offset, conductivity is slightly low
	IMP m/c	4709	post-deployment	depth-dependent pressure offset, conductivity is slightly low
	IMP m/c	4710	post-deployment	depth-dependent pressure offset, conductivity is slightly low
	IMP m/c	4711	post-deployment	depth-dependent pressure offset, conductivity is slightly low
	IMP m/c	4712	post-deployment	depth-dependent pressure offset, conductivity is slightly low
	IMP m/c	4713	post-deployment	depth-dependent pressure offset, conductivity is slightly low
	IMP m/c	4180	post-deployment	
	AR	821		
	AR	252		
	AR	368		
	AR	243		
	AR	262		
12	LRT	ID #001		OK
	LRT	ID #002		Did not release
	LRT	ID #003		Did not release
	LRT	ID #004		Did not release
	LRT	ID #005		Did not release
	LRT	ID #006		OK
	LRT	ID #007		OK
13	LRT	ID #002		OK
	LRT	ID #003		OK
	LRT	ID #004		OK
	LRT	ID #005		OK
18	AR	370		OK
	AR	324		failed
24	SMP m/c	3239	post-deployment	3500 m pressure rating
	IMP m/c	3284	post-deployment	
	SMP m/c	3248	post-deployment	
	SMP m/c	3249	post-deployment	
	IMP m/c	4474	post-deployment	
	SMP m/c	3259	post-deployment	
	SMP m/c	3264	post-deployment	
	SMP m/c	3483	post-deployment	
	SMP m/c	3486	post-deployment	
	SMP m/c	3892	post-deployment	
	SMP m/c	3900	post-deployment	
	SMP m/c	3901	post-deployment	
	SMP m/c	3903	post-deployment	
	SMP m/c	3904	post-deployment	
	SMP m/c	3912	post-deployment	
	SMP m/c	3913	post-deployment	
	SMP m/c	3916	post-deployment	
	SMP m/c	3891	post-deployment	

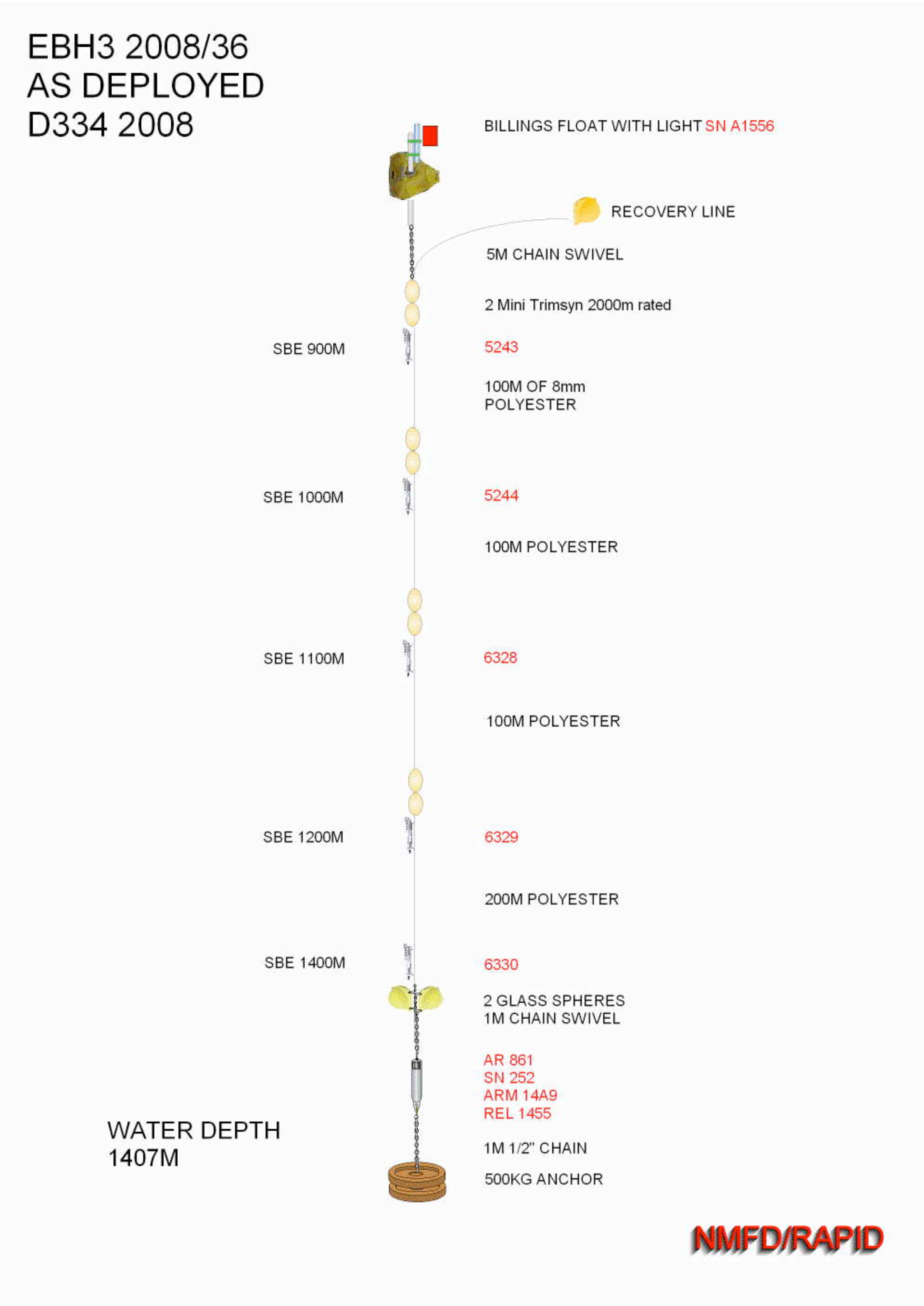
Appendix C Mooring Diagrams

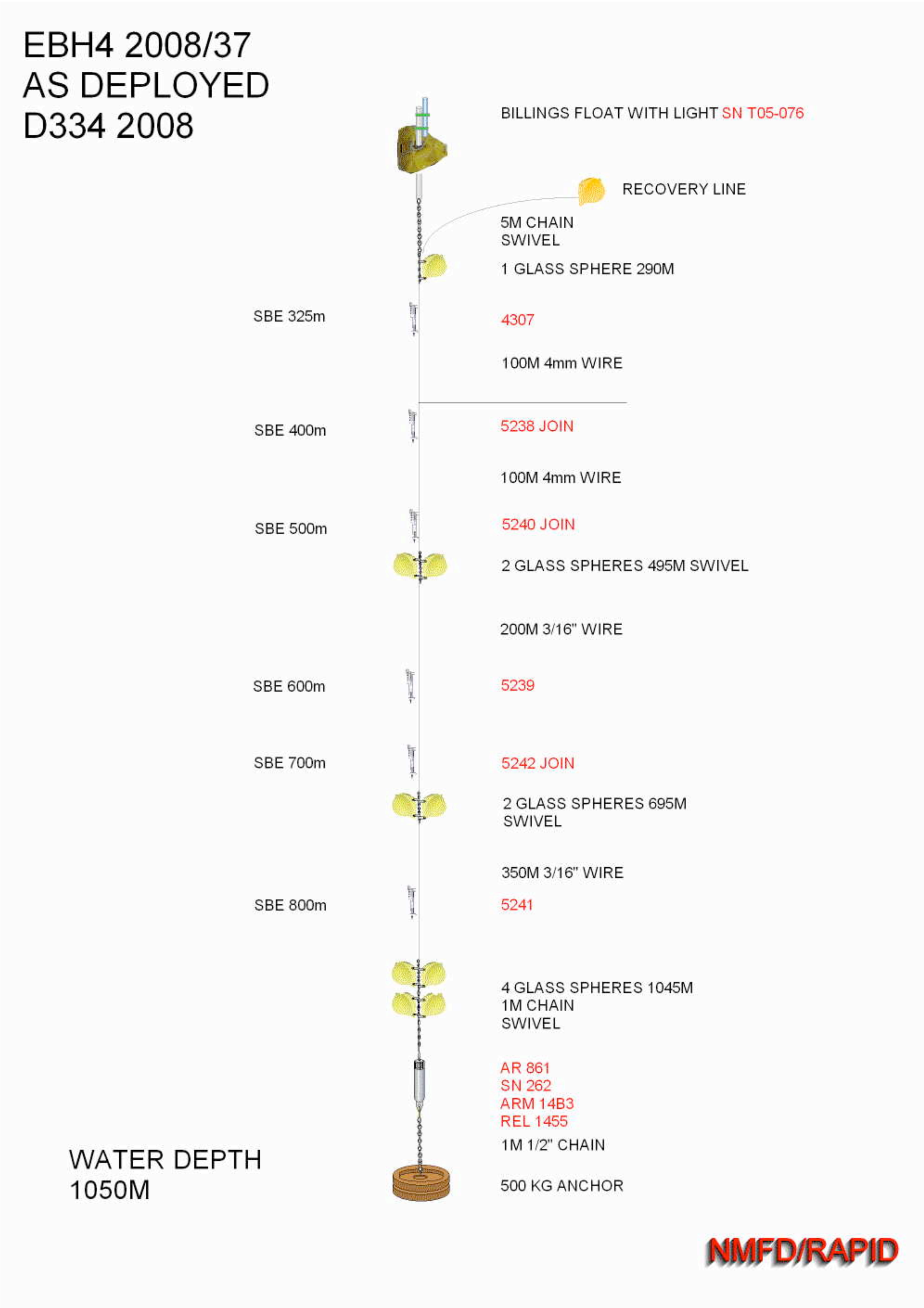


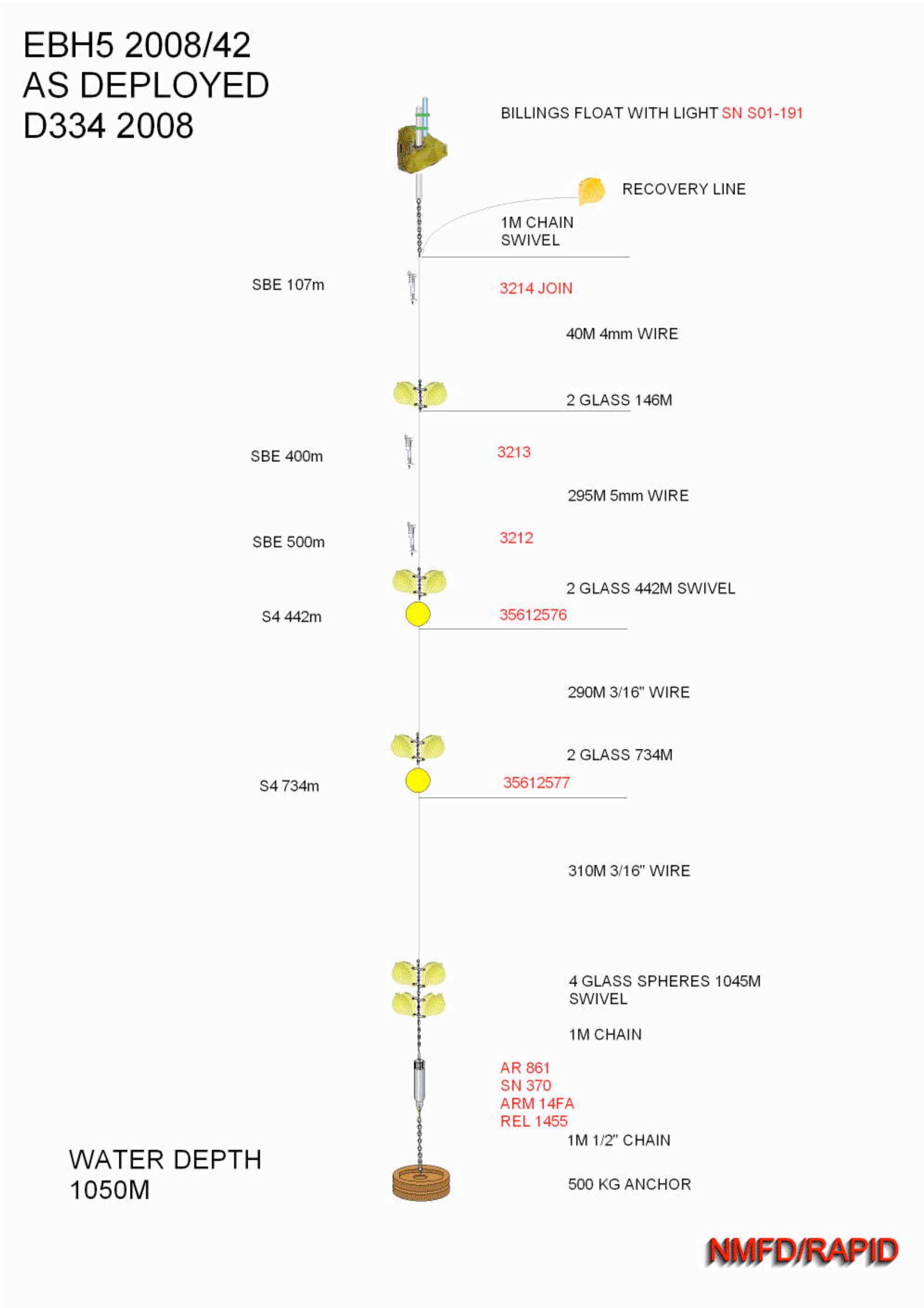

EB1 2008/23
AS DEPLOYED
D334 2008
TRIMSYN RECOVERY LINE
SBE 50M
3223 AT JOIN
50M 4mm WIRE
SS 100M
24" SYNTACTIC
ARGOS SN W03-083 ID 82953/4CF7998 LIGHT SN U01-026
1M CHAIN
SBE 100M
3228 AT JOIN
95M 4mm WIRE
SBE 175M
3229
SS 195M
37" SN
ARGOS SN 079 ID 24335 LIGHT SN W03-095
1M CHAIN SWIVEL
SBE 250M
3230
SBE 325M
3231
295M 5mm WIRE
SBE 400M
3232
4 GLASS SPHERES 495M
SBE 600M
3233
290M 3/16" WIRE
4 GLASS SPHERES 785M
SBE 800M
4305
310M 3/16" WIRE
SBE 1000M
3906
4 GLASS SPHERES 1110M SWIVEL
SBE 1200M
3907
400M 3/16" WIRE
4 GLASS SPHERES 1510M
SBE 1600M
3908
750M 3/16" WIRE
SBE 2000M
3919
4 GLASS SPHERES 2275M
SBE 2500M
3928
1000M 3/16" WIRE
SBE 3000M
3930
4 GLASS SPHERES 3287M
SBE 3500M
3931
600M 1/4" WIRE
4 GLASS SPHERES 3895M SWIVEL
SBE 4000M
3932
590M 1/4" WIRE
4 GLASS SPHERES 4495M
SBE 4500M
3933 JOIN
430M 1/4" WIRE
SBE 5000M
3934 JOIN
60+40M
1/4" WIRE
8 GLASS SPHERES 5050M SWIVEL
AR861 SN 909 ARM 1823 REL 1855
AR861 SN 908 ARM 1822 REL 1855
WATER DEPTH
5090M
30M 16mm NYLON BRAID
CHAIN 1/2" 10M
1400KG ANCHOR
NMFD/RAPID

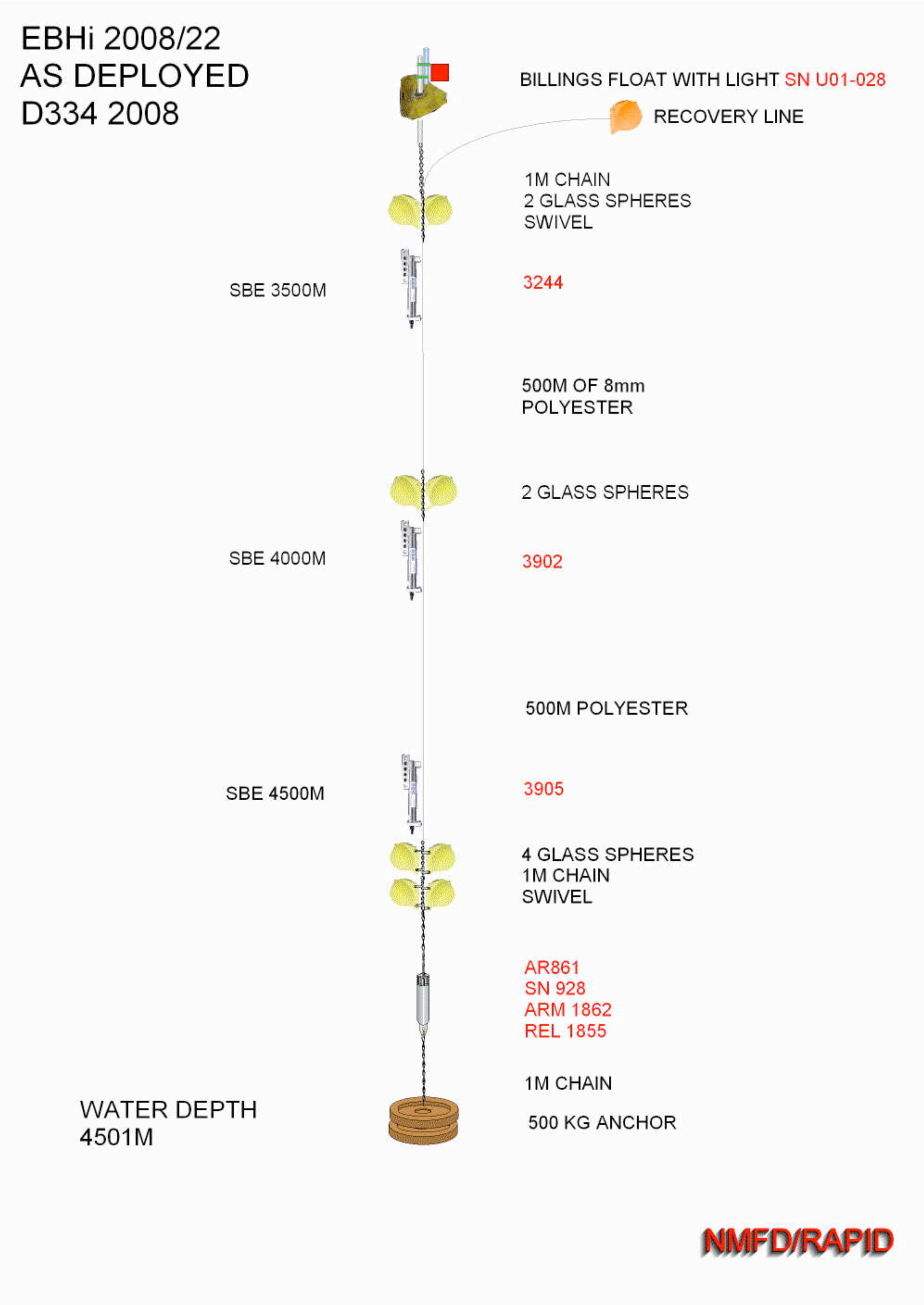

EBH1 2008/33
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH LIGHT SN S01-186
RECOVERY LINE
5M CHAIN
SWIVEL
4 GLASS SPHERES
SBE 2500M
5246
250M OF 8mm
POLYESTER
2 GLASS SPHERES
250M POLYESTER
SBE 3000M
5247
2 GLASS SPHERES
1M CHAIN
SWIVEL
AR861
SN 821
ARM 1683
REL 1655
1M CHAIN
500 KG ANCHOR
WATER DEPTH
3009M
NMFD/RAPID

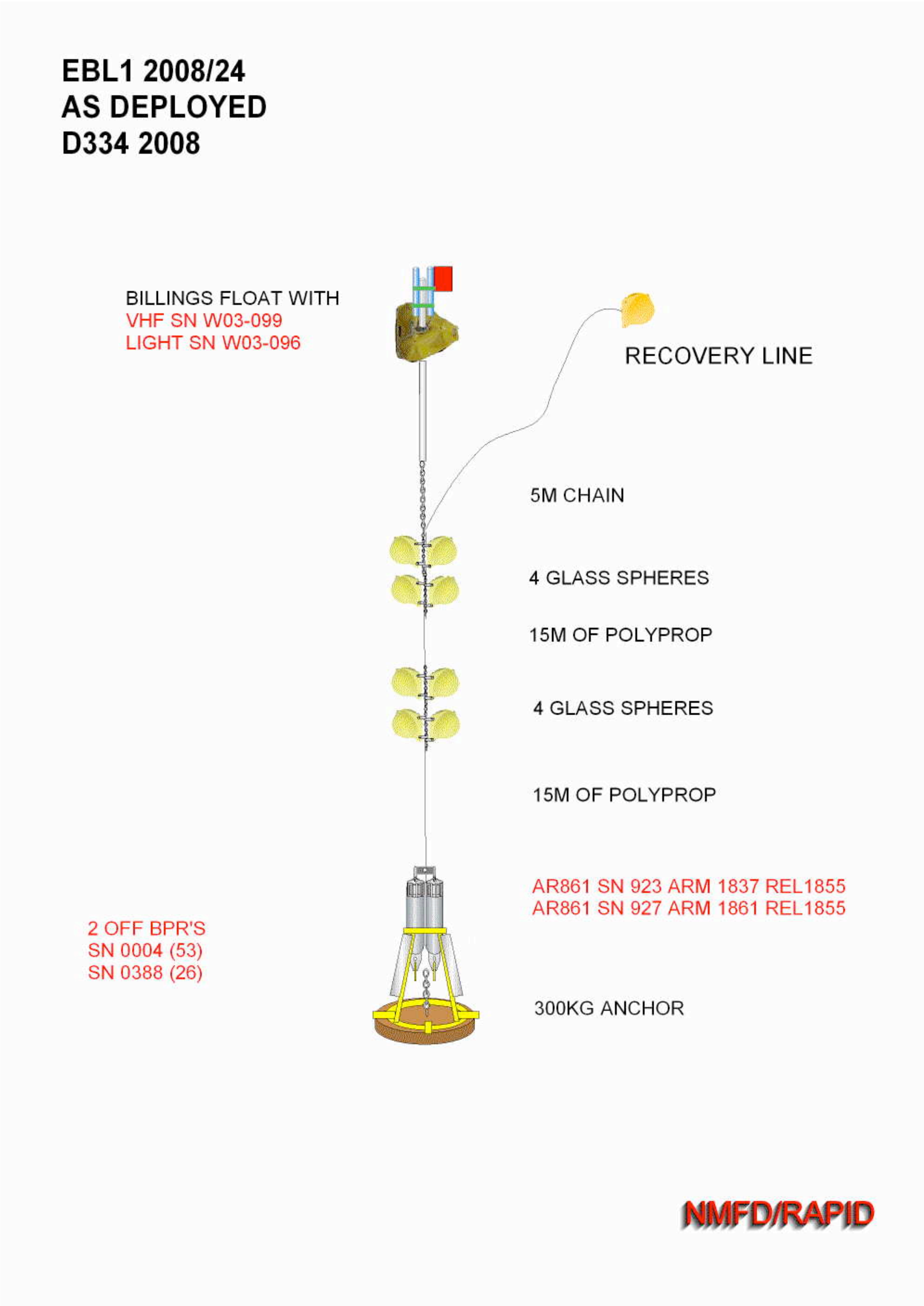

EBH2 2008/35
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH LIGHT SN T05-079
RECOVERY LINE
5M CHAIN
2 GLASS SPHERES
SWIVEL
SBE 1600M
6333
200M OF 8mm
POLYESTER
2 GLASS SPHERES
SBE 1800M
6334
200M POLYESTER
SBE 2000M
5245
2 GLASS SPHERES
1M CHAIN
SWIVEL
AR861
SN 243
ARM 14A0
REL 1455
1M CHAIN
500 KG ANCHOR
WATER DEPTH
2011M
NMFD/RAPID

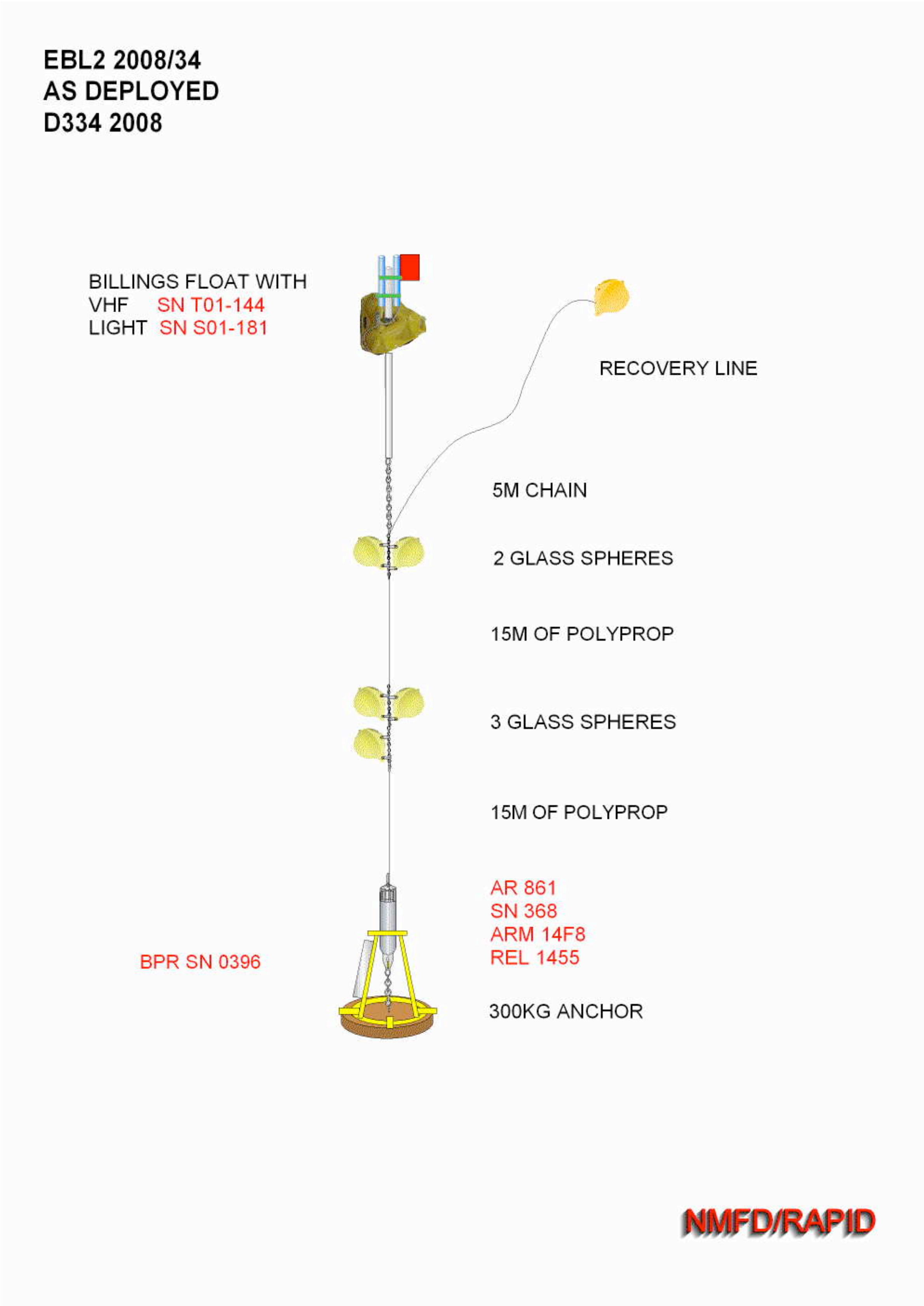

EBH3 2008/36
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH LIGHT SN A1556
RECOVERY LINE
5M CHAIN SWIVEL
2 Mini Trimsyn 2000m rated
SBE 900M
5243
100M OF 8mm
POLYESTER
SBE 1000M
5244
100M POLYESTER
SBE 1100M
6328
100M POLYESTER
SBE 1200M
6329
200M POLYESTER
SBE 1400M
6330
2 GLASS SPHERES
1M CHAIN SWIVEL
AR 861
SN 252
ARM 14A9
REL 1455
WATER DEPTH
1407M
1M 1/2" CHAIN
500KG ANCHOR
NMFD/RAPID

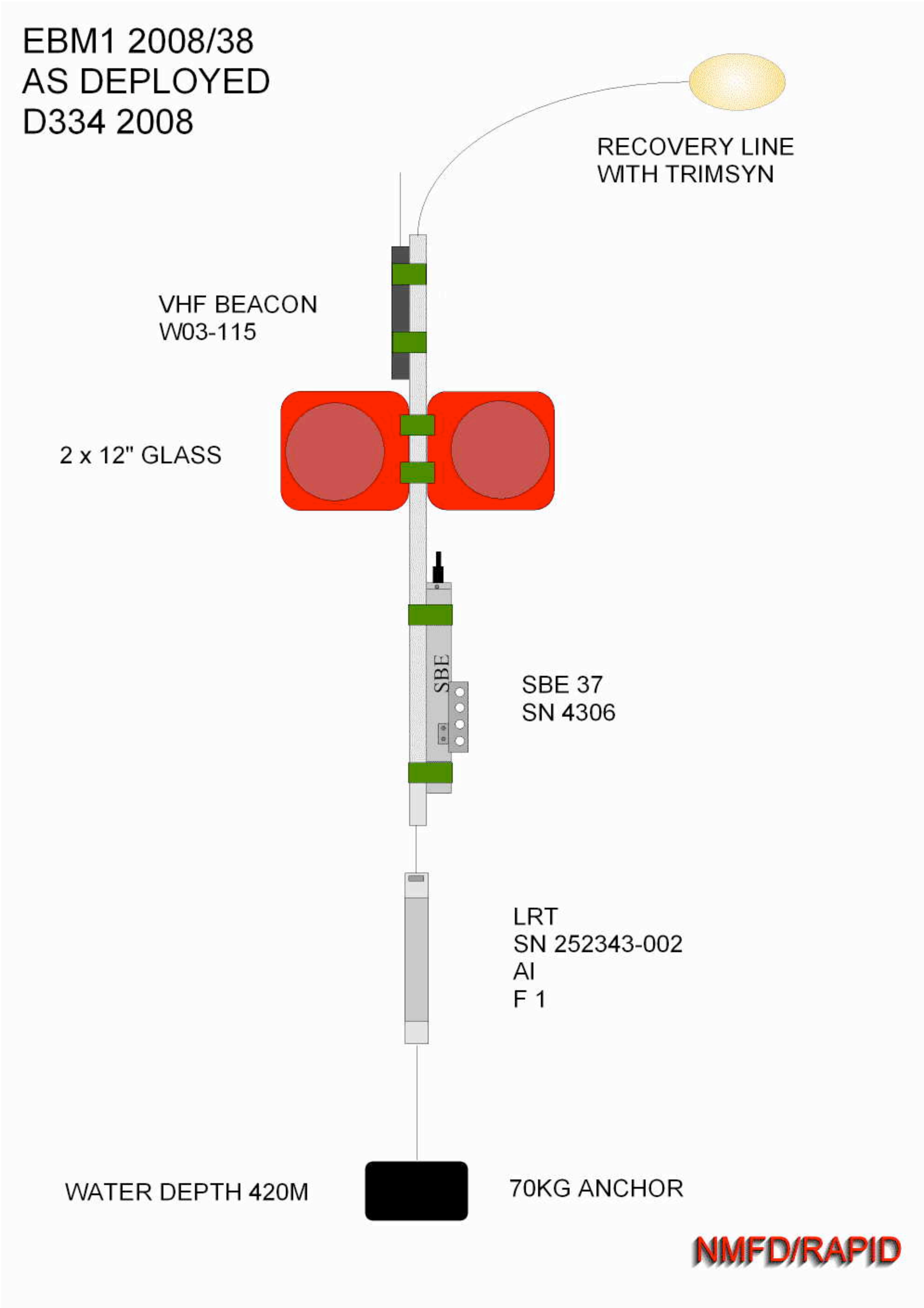

EBH4 2008/37
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH LIGHT SN T05-076
RECOVERY LINE
5M CHAIN
SWIVEL
1 GLASS SPHERE 290M
SBE 325m
4307
100M 4mm WIRE
SBE 400m
5238 JOIN
100M 4mm WIRE
SBE 500m
5240 JOIN
2 GLASS SPHERES 495M SWIVEL
200M 3/16" WIRE
SBE 600m
5239
SBE 700m
5242 JOIN
2 GLASS SPHERES 695M
SWIVEL
350M 3/16" WIRE
SBE 800m
5241
4 GLASS SPHERES 1045M
1M CHAIN
SWIVEL
AR 861
SN 262
ARM 14B3
REL 1455
1M 1/2" CHAIN
WATER DEPTH
1050M
500 KG ANCHOR
NMFD/RAPID

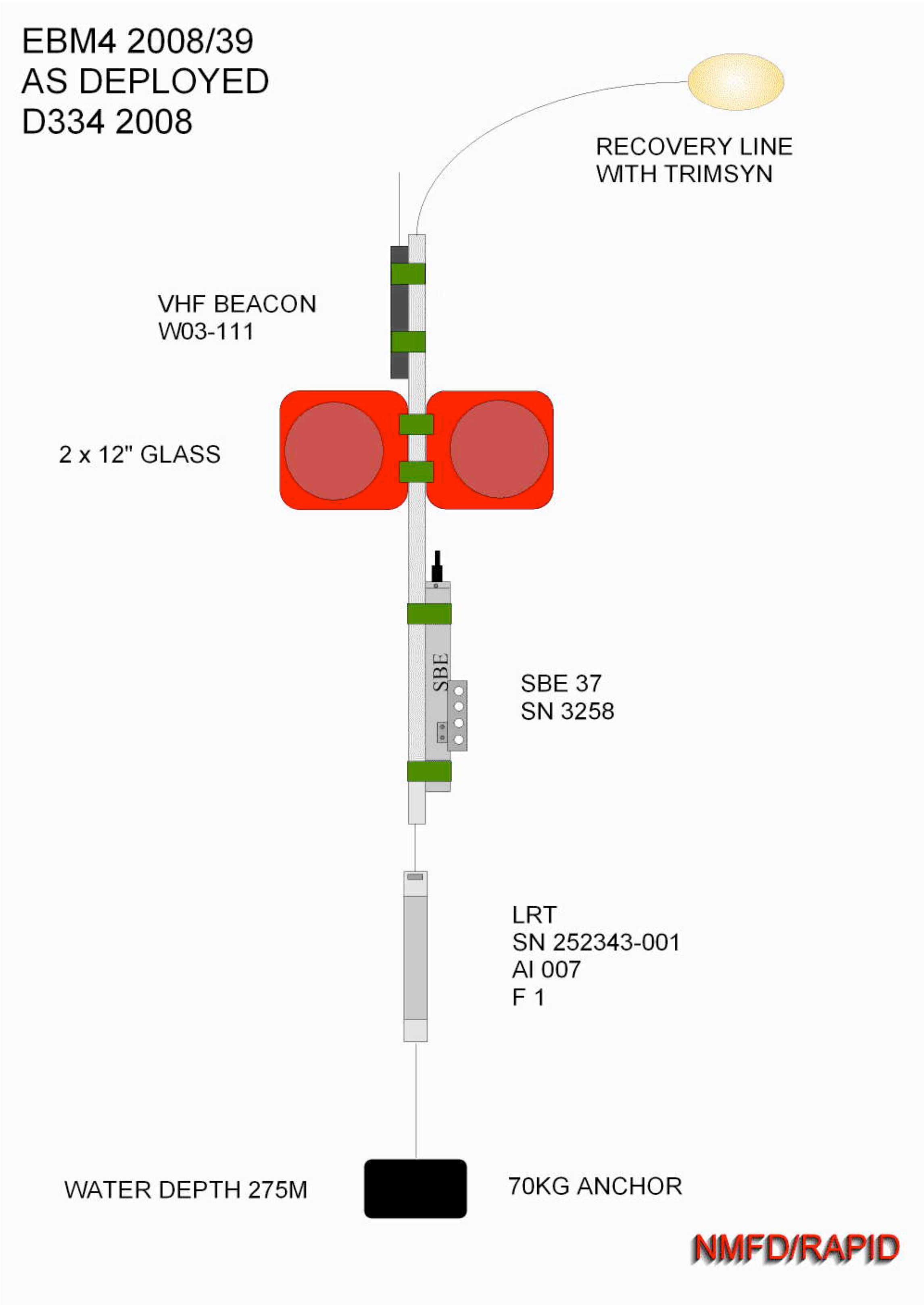

EBH5 2008/42
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH LIGHT SN S01-191
RECOVERY LINE
1M CHAIN
SWIVEL
SBE 107m
3214 JOIN
40M 4mm WIRE
2 GLASS 146M
SBE 400m
3213
295M 5mm WIRE
SBE 500m
3212
2 GLASS 442M SWIVEL
S4 442m
35612576
290M 3/16" WIRE
2 GLASS 734M
S4 734m
35612577
310M 3/16" WIRE
4 GLASS SPHERES 1045M
SWIVEL
1M CHAIN
AR 861
SN 370
ARM 14FA
REL 1455
1M 1/2" CHAIN
WATER DEPTH
1050M
500 KG ANCHOR
NMFD/RAPID

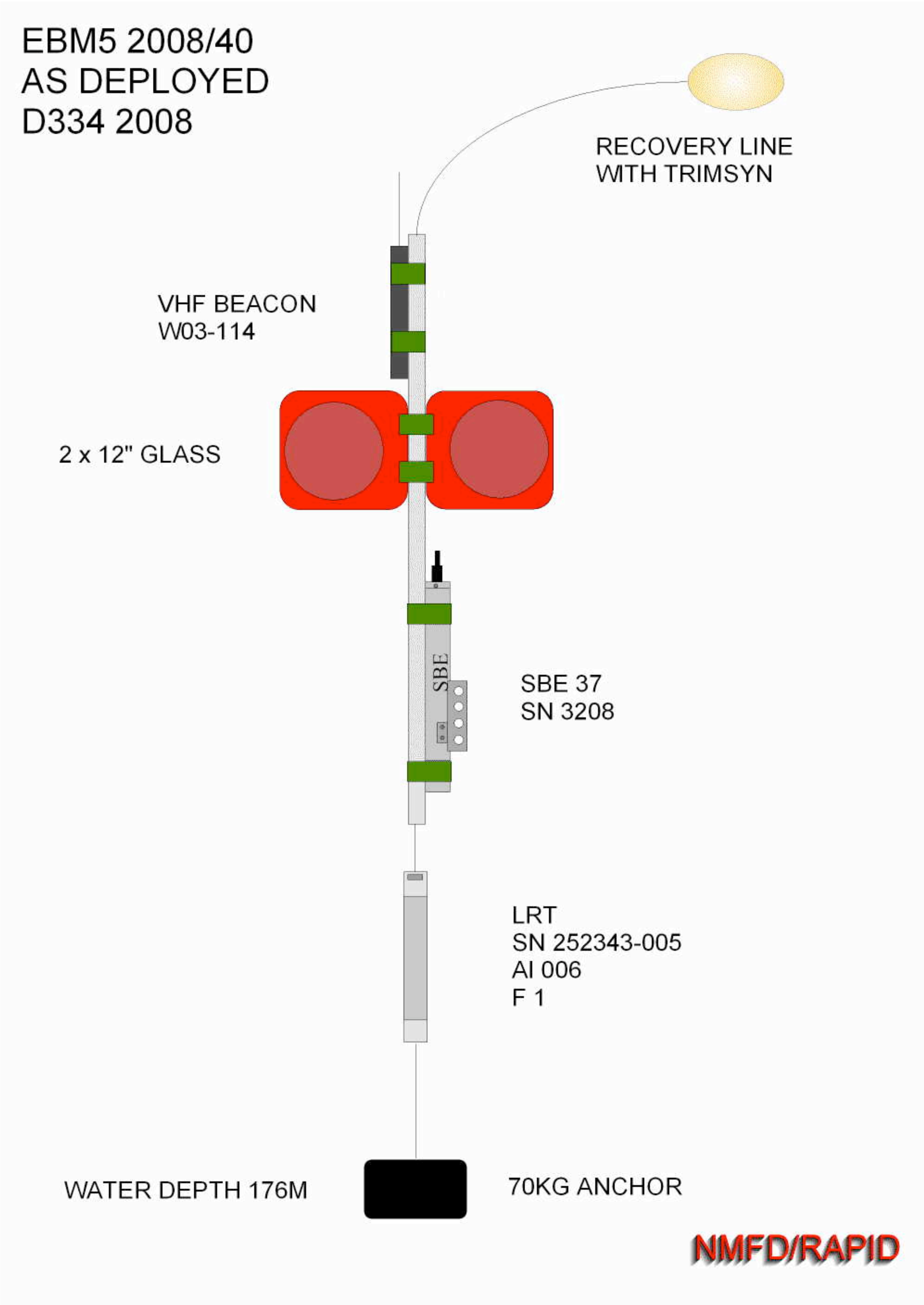

EBHi 2008/22
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH LIGHT SN U01-028
RECOVERY LINE
1M CHAIN
2 GLASS SPHERES
SWIVEL
SBE 3500M
3244
500M OF 8mm
POLYESTER
2 GLASS SPHERES
SBE 4000M
3902
500M POLYESTER
SBE 4500M
3905
4 GLASS SPHERES
1M CHAIN
SWIVEL
AR861
SN 928
ARM 1862
REL 1855
1M CHAIN
WATER DEPTH
4501M
500 KG ANCHOR
NMFD/RAPID

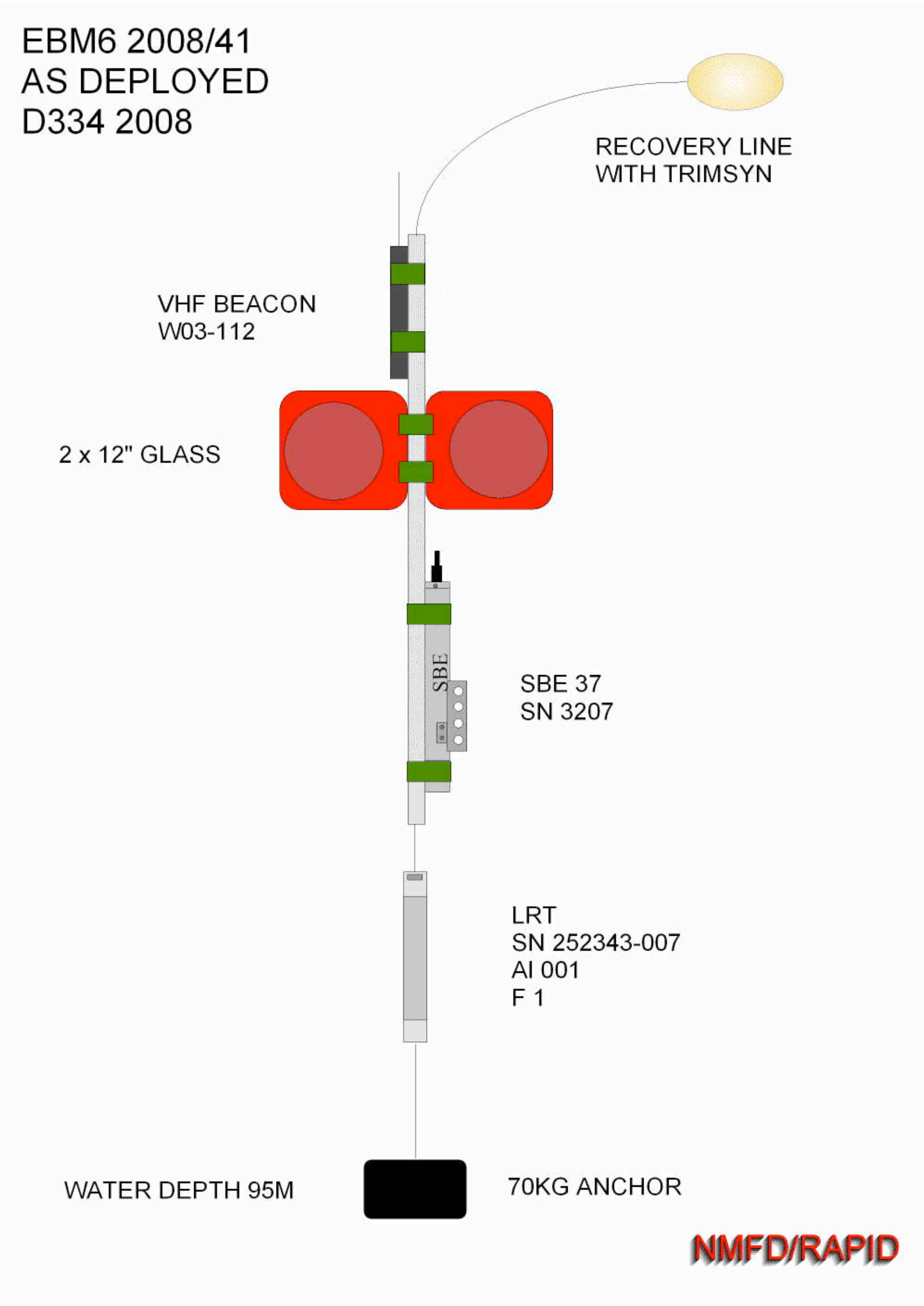

EBL1 2008/24
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH
VHF SN W03-099
LIGHT SN W03-096
RECOVERY LINE
5M CHAIN
4 GLASS SPHERES
15M OF POLYPROP
4 GLASS SPHERES
15M OF POLYPROP
AR861 SN 923 ARM 1837 REL1855
AR861 SN 927 ARM 1861 REL1855
2 OFF BPR'S
SN 0004 (53)
SN 0388 (26)
300KG ANCHOR
NMFD/RAPID

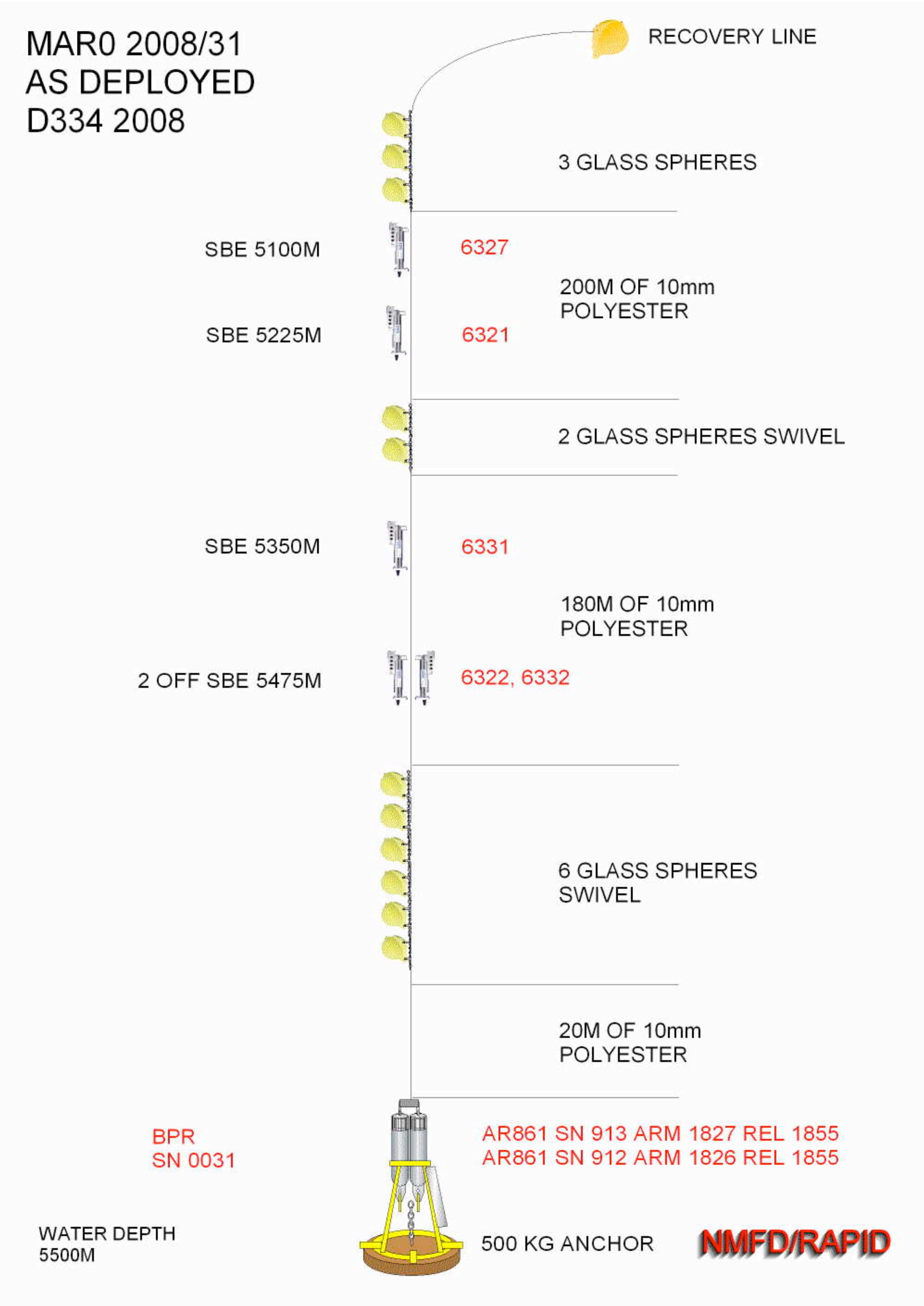

EBL2 2008/34
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH
VHF SN T01-144
LIGHT SN S01-181
RECOVERY LINE
5M CHAIN
2 GLASS SPHERES
15M OF POLYPROP
3 GLASS SPHERES
15M OF POLYPROP
AR 861
SN 368
ARM 14F8
REL 1455
BPR SN 0396
300KG ANCHOR
NMFD/RAPID

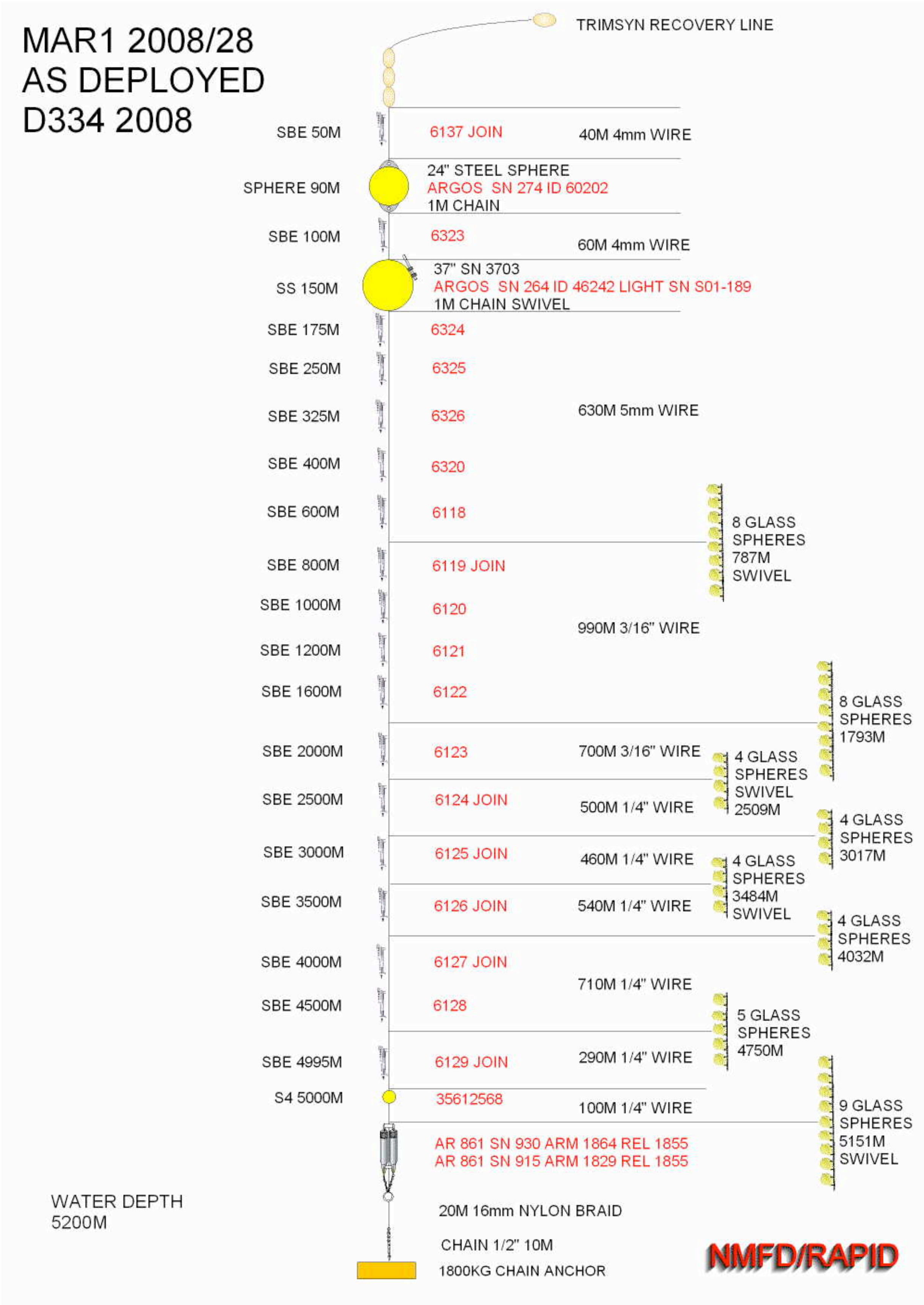

EBM1 2008/38
AS DEPLOYED
D334 2008
RECOVERY LINE
WITH TRIMSYN
VHF BEACON
W03-115
2 x 12" GLASS
SBE
SBE 37
SN 4306
LRT
SN 252343-002
AI
F 1
WATER DEPTH 420M
70KG ANCHOR
NMFD/RAPID


EBM4 2008/39
AS DEPLOYED
D334 2008
RECOVERY LINE
WITH TRIMSYN
VHF BEACON
W03-111
2 x 12" GLASS
SBE
SBE 37
SN 3258
LRT
SN 252343-001
AI 007
F 1
WATER DEPTH 275M
70KG ANCHOR
NMFD/RAPID


EBM5 2008/40
AS DEPLOYED
D334 2008
RECOVERY LINE
WITH TRIMSYN
VHF BEACON
W03-114
2 x 12" GLASS
SBE
SBE 37
SN 3208
LRT
SN 252343-005
AI 006
F 1
WATER DEPTH 176M
70KG ANCHOR
NMFD/RAPID

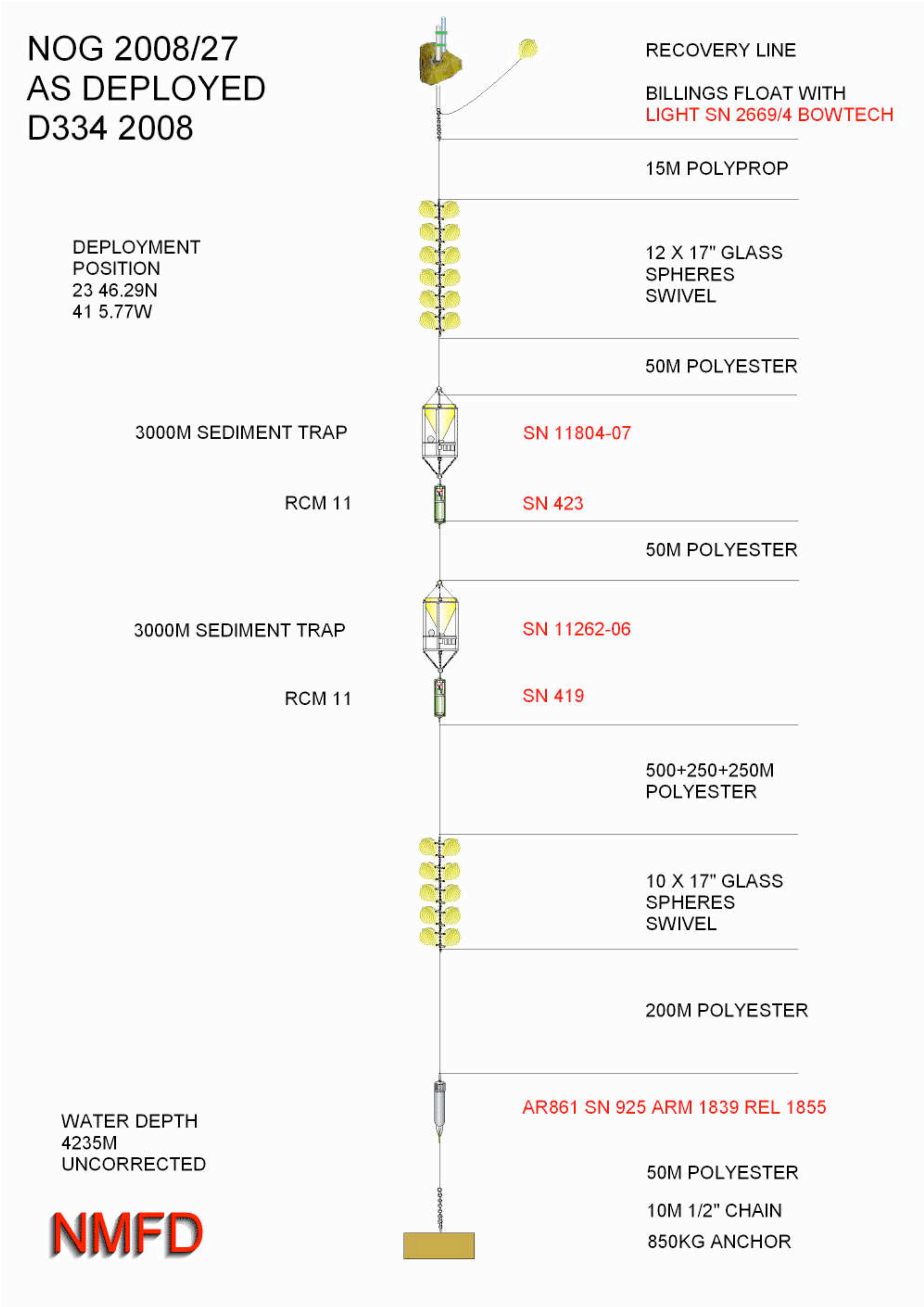

EBM6 2008/41
AS DEPLOYED
D334 2008
RECOVERY LINE
WITH TRIMSYN
VHF BEACON
W03-112
2 x 12" GLASS
SBE
SBE 37
SN 3207
LRT
SN 252343-007
AI 001
F 1
WATER DEPTH 95M
70KG ANCHOR
NMFD/RAPID

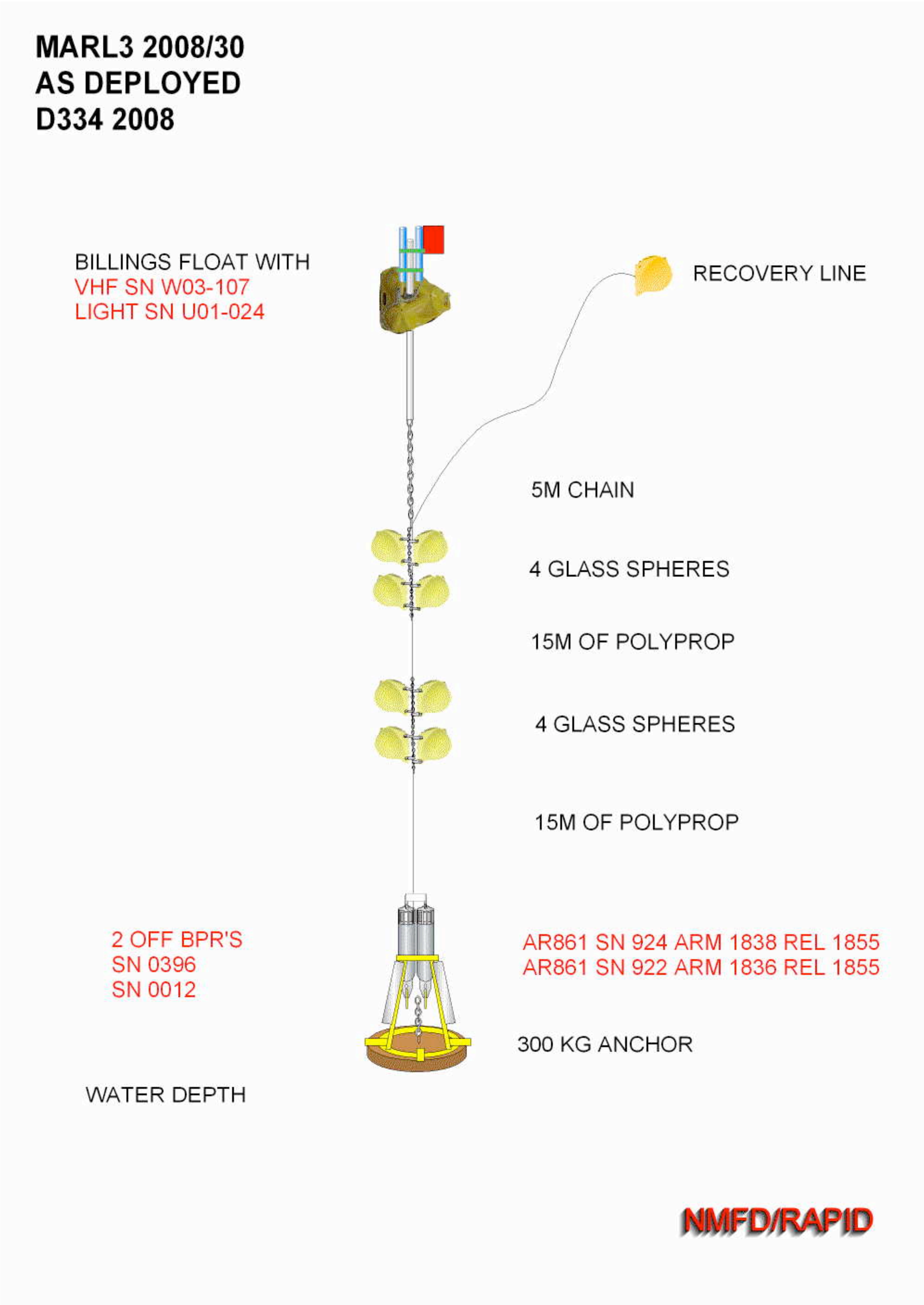

MAR0 2008/31
AS DEPLOYED
D334 2008
RECOVERY LINE
3 GLASS SPHERES
SBE 5100M
6327
200M OF 10mm
POLYESTER
SBE 5225M
6321
2 GLASS SPHERES SWIVEL
SBE 5350M
6331
180M OF 10mm
POLYESTER
2 OFF SBE 5475M
6322, 6332
6 GLASS SPHERES
SWIVEL
20M OF 10mm
POLYESTER
BPR
SN 0031
AR861 SN 913 ARM 1827 REL 1855
AR861 SN 912 ARM 1826 REL 1855
WATER DEPTH
5500M
500 KG ANCHOR
NMFD/RAPID

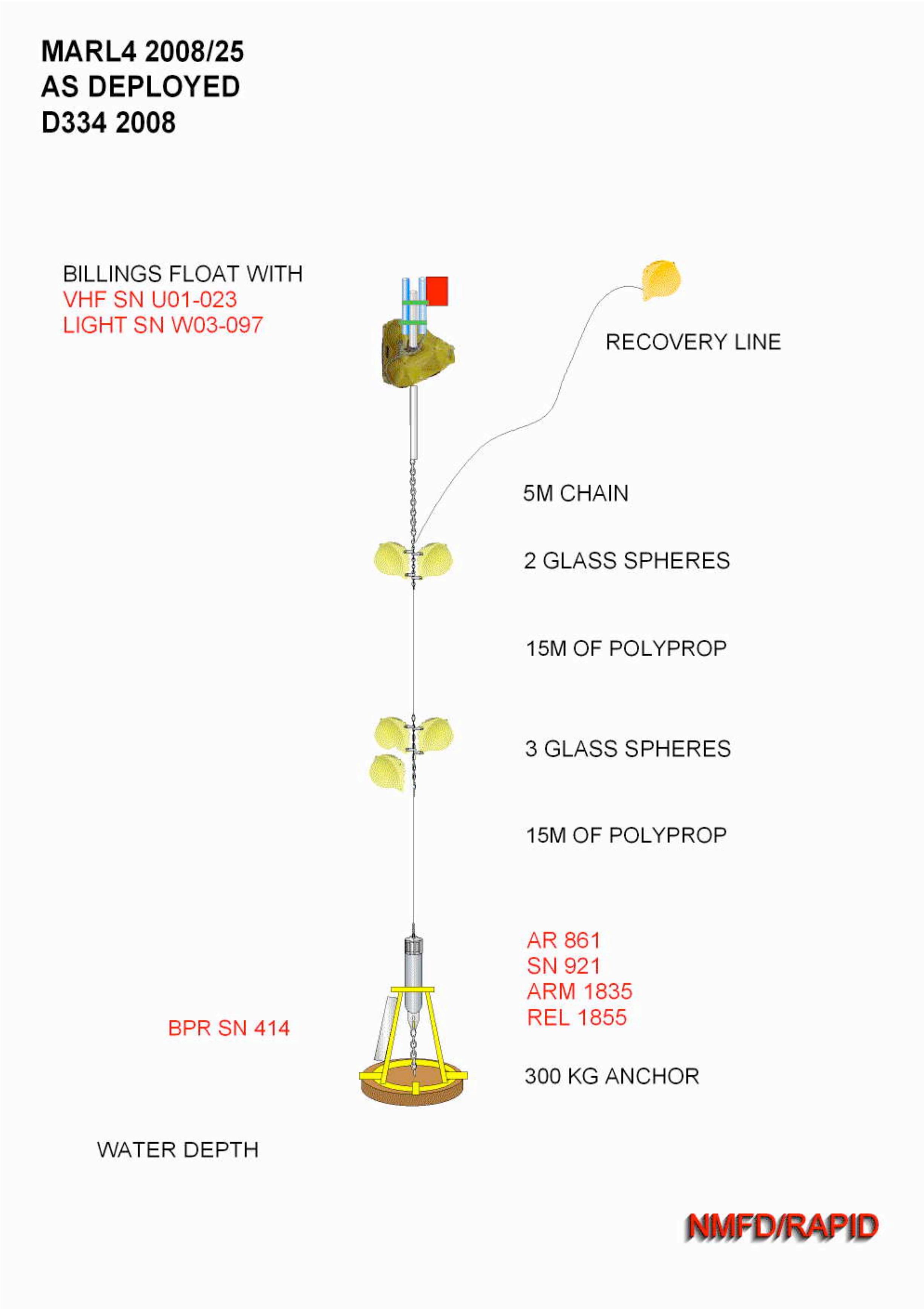

MAR1 2008/28
AS DEPLOYED
D334 2008
TRIMSYN RECOVERY LINE
SBE 50M
6137 JOIN
40M 4mm WIRE
SPHERE 90M
24" STEEL SPHERE
ARGOS SN 274 ID 60202
1M CHAIN
SBE 100M
6323
60M 4mm WIRE
SS 150M
37" SN 3703
ARGOS SN 264 ID 46242 LIGHT SN S01-189
1M CHAIN SWIVEL
SBE 175M
6324
SBE 250M
6325
SBE 325M
6326
630M 5mm WIRE
SBE 400M
6320
SBE 600M
6118
8 GLASS SPHERES 787M SWIVEL
SBE 800M
6119 JOIN
SBE 1000M
6120
990M 3/16" WIRE
SBE 1200M
6121
SBE 1600M
6122
8 GLASS SPHERES 1793M
SBE 2000M
6123
700M 3/16" WIRE
4 GLASS SPHERES SWIVEL 2509M
SBE 2500M
6124 JOIN
500M 1/4" WIRE
4 GLASS SPHERES 3017M
SBE 3000M
6125 JOIN
460M 1/4" WIRE
4 GLASS SPHERES 3484M SWIVEL
SBE 3500M
6126 JOIN
540M 1/4" WIRE
4 GLASS SPHERES 4032M
SBE 4000M
6127 JOIN
710M 1/4" WIRE
SBE 4500M
6128
5 GLASS SPHERES 4750M
SBE 4995M
6129 JOIN
290M 1/4" WIRE
S4 5000M
35612568
100M 1/4" WIRE
9 GLASS SPHERES 5151M SWIVEL
AR 861 SN 930 ARM 1864 REL 1855
AR 861 SN 915 ARM 1829 REL 1855
WATER DEPTH 5200M
20M 16mm NYLON BRAID
CHAIN 1/2" 10M
1800KG CHAIN ANCHOR
NMFD/RAPID


MAR2 2008/29
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH
LIGHT SN H01-008
5M CHAIN
RECOVERY LINE
4 GLASS
SPHERES
SWIVEL
SBE 1100M
6130 JOIN
700M
3/16" WIRE
SBE 1400M
6131
4 GLASS
SPHERES
1787M
SWIVEL
SBE 1800M
6132 JOIN
450M
3/16" WIRE
3 GLASS
SPHERES
2244M
SBE 2250M
6133 JOIN
495M
3/16" WIRE
3 GLASS
SPHERES
2745M
SWIVEL
SBE 2750M
6134 JOIN
990M
3/16" WIRE
SBE 3250M
6135
3 GLASS
SPHERES
3741M
SWIVEL
SBE 3750M
6136 JOIN
500M
3/16" WIRE
3 GLASS
SPHERES
4246M
SWIVEL
SBE 4250M
6109 JOIN
890M
3/16" WIRE
SBE 4750M
6110
4 GLASS
SPHERES
5142M
SWIVEL
S4 5150M
35612567
20M 3/16"
WIRE
SBE 5160M
6111
5 GLASS
SPHERES
5170M
SWIVEL
10M 3/16"
WIRE
AR 861 SN 914 ARM 1828 REL 1855
CHAIN 1/2" 10M
WATER DEPTH
5200M
1000KG ANCHOR
NMFD/RAPID


MAR3 2008/26
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH
LIGHT SN S01-187
5M CHAIN
RECOVERY LINE
2 GLASS SPHERES
SWIVEL 2500M
SBE 2500M
6112
500M
3/16" WIRE
3 GLASS SPHERES
2958M
SBE 3000M
6113
500M
3/16" WIRE
3 GLASS SPHERES
3461M
SBE 3500M
6114
500M
3/16" WIRE
3 GLASS SPHERES
SWIVEL 3965M
SBE 4000M
6115
500M
3/16" WIRE
3 GLASS SPHERES
4470M
SBE 4500M
6116
540M
3/16" WIRE
SBE 5000M
6117
S4 5015M
35612565
7 GLASS
SPHERES
SWIVEL
5017M
10M
3/16" WIRE
AR861 SN 929 ARM 1863 REL 1855
CHAIN 1/2" 10M
WATER DEPTH
5050M
1000KG CHAIN ANCHOR
NMFD/RAPID


NOG 2008/27
AS DEPLOYED
D334 2008
RECOVERY LINE
BILLINGS FLOAT WITH
LIGHT SN 2669/4 BOWTECH
15M POLYPROP
DEPLOYMENT
POSITION
23 46.29N
41 5.77W
12 X 17" GLASS
SPHERES
SWIVEL
50M POLYESTER
3000M SEDIMENT TRAP
SN 11804-07
RCM 11
SN 423
50M POLYESTER
3000M SEDIMENT TRAP
SN 11262-06
RCM 11
SN 419
500+250+250M
POLYESTER
10 X 17" GLASS
SPHERES
SWIVEL
200M POLYESTER
AR861 SN 925 ARM 1839 REL 1855
WATER DEPTH
4235M
UNCORRECTED
50M POLYESTER
10M 1/2" CHAIN
850KG ANCHOR
NMFD


MARL3 2008/30
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH
VHF SN W03-107
LIGHT SN U01-024
RECOVERY LINE
5M CHAIN
4 GLASS SPHERES
15M OF POLYPROP
4 GLASS SPHERES
15M OF POLYPROP
2 OFF BPR'S
SN 0396
SN 0012
AR861 SN 924 ARM 1838 REL 1855
AR861 SN 922 ARM 1836 REL 1855
300 KG ANCHOR
WATER DEPTH
NMFD/RAPID


MARL4 2008/25
AS DEPLOYED
D334 2008
BILLINGS FLOAT WITH
VHF SN U01-023
LIGHT SN W03-097
RECOVERY LINE
5M CHAIN
2 GLASS SPHERES
15M OF POLYPROP
3 GLASS SPHERES
15M OF POLYPROP
AR 861
SN 921
ARM 1835
REL 1855
BPR SN 414
300 KG ANCHOR
WATER DEPTH
NMFD/RAPID

Appendix D Mooring Log Sheets

RAPID MOORINGS CRUISE D334

		MRG ID:	EB1
Eastern Atlantic 26N	DEPLOYMENT	NMFSS ID	2008/23
LATITUDE	23 45.4417N	DATE	30/10/2008
LONGITUDE	24 07.6922W	DAY	304

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 1300

COMMENCE TIME	1339
COMPLETION TIME	1746
WATER DEPTH	5044

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1339
RECOVERY LINE			1339
TRIMSYN X 3			1339
SBE37	3223	1m above steel	1339
24" STEEL SPHERE and ARGos BEACON			1339
SBE 37	3228		1339
SBE 37	3229		1339
ARGOS BEACON	W03 095		1339
37" McLa STEEL SPHERE			1339
1M CHAIN SWIVEL			1339
SBE 37	3230		1355
SBE37	3231		1400
SBE37	3232		1404
4 X 17" GLASS FLOAT			1411
SBE37	3233		1415
4 X 17" GLASS FLOAT			1424
SBE37	4305		1428
SBE37	3906		1435
4 X 17" GLASS FLOAT			1441
SBE37	3907		1445
4 X 17" GLASS FLOAT			1456
SBE37	3908		1501
SBE37	3919		1515
4 X 17" GLASS FLOAT			1525
SBE37	3928		1531
SBE37	3930		1544
4 X 17" GLASS FLOAT			1552
SBE37	3931		1558
4 X 17" GLASS FLOAT			1609
SBE37	3932		1620
4 X 17" GLASS FLOAT			1625
SBE37	3933		1631
8 X GLASS FLOAT			1656
SBE37	3934		1656
SWIVEL			1656

ACOUSTIC RELEASE 1	909	ARM 1823 REL 1855	1656
ACOUSTIC RELEASE 2	908	ARM 1822 REL 1855	1656
30M NYLON BRAID			1746
10M CHAIN			1746
1500 KG ANCHOR			1746

MOORING METHOD

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID:	EBH1
Eastern Atlantic 26N	DEPLOYMENT
NMFSS ID	2008/33
LATITUDE	27 16.90550'N
LONGITUDE	15 25.71120'W
DATE	18/11/08
DAY	323

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 0945

COMMENCE TIME 1035

COMPLETION TIME 1103

WATER DEPTH 3006m u/c 3009m corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1036
RECOVERY LINE			1036
LIGHT		No vhf	1036
BILLINGS FLOAT			1036
5 m CHAIN SWIVEL			1036
4 X 17" GLASS			1036
SBE37	5246		1036
2 X 17" GLASS			1041
SBE 37	5247		1045
2 X 17" GLASS			1045
1M CHAIN SWIVEL			1045
ACOUSTIC RELEASE	821	ARM 1683 REL 1655	1045
1M CHAIN			1045
ANCHOR 500KG			1103

MOORING METHOD

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID: EBH2

Eastern Atlantic 26N

DEPLOYMENT

NMFSS ID 2008/35

LATITUDE 27° 36.73 N

DATE 19/11/2008

LONGITUDE 14° 12.7 W

DAY 324

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL TIME 0912

COMMENCE TIME 0913

COMPLETION TIME 0928

WATER DEPTH 2017 m u/u 2017 corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			0913
RECOVERY LINE			0913
LIGHT BEACON	T05-079	Checked	0913
BILLINGS FLOAT			0913
1M CHAIN			0913
2 GLASS SPHERES			0913
SWIVEL			0913
SBE 37	6333		0913
2 GLASS SPHERES			0920
SBE 37	6334		0920
SBE 37	5245		0927
2 GLASS SPHERES			0927
1M CHAIN SWIVEL			0927
ACOUSTIC RELEASE	243	ARM 14A0 REL 1455	0927
1M CHAIN			0927
500KG ANCHOR			0928

MOORING METHOD

Basket

COMMENTS

Lat and long deduced from GPS4k.

RAPID MOORINGS **CRUISE D334** **MRG ID:** EBH3

Eastern Atlantic 26N **DEPLOYMENT** **NMFSS ID** 2008/36

LATITUDE 27 48.78524'N **DATE** 19/11/2008

LONGITUDE 13 44.47947'W **DAY** 324

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 1435

COMMENCE TIME 1435

COMPLETION TIME 1451

WATER DEPTH 1410m
1412 corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT	AI556		1436
RECOVERY LINE			1435
LIGHT BEACON			1435
BILLINGS FLOAT			1436
1M CHAIN			1436
2 MINI TRIMSYN			1436
SBE37	5243		1436
2 MINI TRIMSYN			1439
SBE37	5244		1439
2 MINI TRIMSYN			1442
SBE37	6328		1442
2 MINI TRIMSYN			1444
SBE37	6329		1445
SBE 37	6330		1449
2 GLASS SPHERES			1449
1M 1/2'' CHAIN			1449
ACOUSTIC RELEASE	252	ARM 14A9 REL 1455	1450
CHAIN			1450
500KG ANCHOR			1450

MOORING METHOD

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID: EBH4

Eastern Atlantic
26N

DEPLOYMENT

NMFSS ID 2008/37

LATITUDE 27 50.998'N

DATE 19/11/08

LONGITUDE 13 32.393'W

DAY 324

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME

SITE ARRIVAL TIME

COMPLETION TIME 1841

WATER DEPTH 1048m u/c
1052 corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1750
RECOVERY LINE			1750
LIGHT			1750
BILLINGS FLOAT			1750
1M CHAIN SWIVEL			1750
1 GLASS SPHERE			1750
SBE37	4307		1750
SBE37	5238		1757
SBE37	5240		1806
2 GLASS SPHERES			1806
SBE37	5239		1811
SBE37	5242		1817
2 GLASS SPHERES			1817
SWIVEL			1817
SBE37	5241		1823
4 GLASS SPHERES			1823
1M CHAIN SWIVEL			1823
ACOUSTIC RELEASE	s/n 262	ARM 14B3 REL 1455	1841
1M 1/2'' CHAIN			1841
500KG ANCHOR			1841

MOORING METHOD

COMMENTS

Wd=1047

RAPID MOORINGS **CRUISE D334** **MRG ID:** EBH5

Eastern Atlantic 26N **DEPLOYMENT** **NMFSS ID** 2008/42

DATE 21/11/2008

DAY 326

LATITUDE 27°50.36 N

LONGITUDE 13°32.81 W

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 0600

COMMENCE TIME 0944

COMPLETION TIME 110027

WATER DEPTH 1050 uncorr
1054 corr

ITEM	SER NO	COMMENT	TIME
LIGHT BEACON	S01 - 191		0945
BILLINGS FLOAT			0945
1M CHAIN SWIVEL			0945
RECOVERY FLOAT			0945
RECOVERY LINE			0945
SBE37	3214		0945
2 GLASS SPHERES			0952
SBE37	3213		0955
SBE37	3212		1004
2 GLASS SPHERES			1011
S4	35612576		1011
2 GLASS SPHERES			1022
S4	35612577		1022
4 GLASS SPHERES			1100
SWIVEL			1100
1M CHAIN			1100
ACOUSTIC RELEASE	370	ARM 14FA REL 1455	1100
1M 1/2“ CHAIN			1100
500KG ANCHOR			110027

MOORING METHOD

COMMENTS

RAPID MOORINGS

CRUISE D334

MRG ID: EBHi

Eastern Atlantic
26N

DEPLOYMENT

NMFSS ID 2008/22

LATITUDE 24 57.12310 N

DATE 29/10/2008

LONGITUDE 21 16.08686 W

DAY 303

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 0936

SITE ARRIVAL

COMPLETION TIME 1000

TIME

WATER DEPTH 4472 u/c
4499 corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			0936
RECOVERY LINE			0936
LIGHT	ST – 400 A++	Light confirmed on	0936
BILLINGS FLOAT			0936
5M CHAIN		replaced 1m with a 5m length	0936
2 X GLASS SPHERES			0936
SWIVEL			0936
SBE37	3244		0937
2 X GLASS SPHERES			0946
SBE37	3902		0946
SBE37	3905		1000
4 X GLASS SPHERES			1000
1M CHAIN			1000
SWIVEL			1000
ACOUSTIC RELEASE	928	ARM 1862 REL 1855	1000
1M CHAIN			1000
500 KG ANCHOR			1000

MOORING METHOD

COMMENTS

Full serial number on light not readable

RAPID MOORINGS **CRUISE D334** **MRG ID:** EBL1

Eastern Atlantic 26N **DEPLOYMENT** **NMFSS ID** 2008/24

LATITUDE	23 48.133'N	**DATE**	31/10/2008
LONGITUDE	24 06.822''W	**DAY**	305

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 1818

COMMENCE TIME 1825

COMPLETION TIME 183044

WATER DEPTH 5050 +\- 25 m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1825
RECOVERY LINE			1825
LIGHT			1825
VHF SN			1825
BILLINGS FLOAT			1825
CHAIN SWIVEL			1825
4 X 17" GLASS			1828
4 X 17" GLASS			1829
ACOUSTIC RELEASE	923		1829
ACOUSTIC RELEASE	927		1829
2 OFF BPR'S	0388 & 0004		1829
ANCHOR			183044

MOORING METHOD

COMMENTS

Water depth was missing and has been deduced from bathymetry charts.

RAPID MOORINGS

CRUISE D334

MRG ID: EBL2

Eastern Atlantic 26N

DEPLOYMENT

NMFSS ID 2008/34

LATITUDE 27 17.148'N

DATE 18/11/08

LONGITUDE 15 25.692" W

DAY 323

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 1124

COMMENCE TIME 1125

COMPLETION TIME 1127

WATER DEPTH 3002m u/c
3005m corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1125
RECOVERY LINE			1125
LIGHT	SO1 – 181	Light on	1125
VHF SN	TO1 – 144		1125
BILLINGS FLOAT			1125
1M CHAIN SWIVEL			1125
2 X 17" GLASS			1125
3 X 17" GLASS			1125
ACOUSTIC RELEASE	368	Label had disintegrated ARM 14F8 REL 1455	1125
BPR	0396		1125
ANCHOR 300KG			1127

MOORING METHOD

COMMENTS

RAPID MOORINGS — CRUISE D334

MRG ID: EBM1

Eastern Atlantic
26N

DEPLOYMENT

NMFSS ID **2008/38**

LATITUDE 27 53.66'

DATE 20/11/08

LONGITUDE 13. 24.34'W

DAY 325

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1842

SITE ARRIVAL TIME 1842

COMPLETION TIME 1844

WATER DEPTH 495m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1842
RECOVERY LINE			1842
VHF BEACON	W03 – 115		1842
2 X 12" GLASS SPHERE			1842
SBE37	4306		1842
SONARDYNE LRT RELEASE	ID002 252343 - 003		1843
ANCHOR 70kg			1844

MOORING METHOD

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID: EBM4

Eastern Atlantic
26N

DEPLOYMENT

NMFSS ID
2008/39

LATITUDE 27 54.45'N

DATE 20/11/08

LONGITUDE 13 22.09'W

DAY

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1919

SITE ARRIVAL

TIME 1918

COMPLETION TIME 1921

WATER DEPTH 283m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1919
RECOVERY LINE			1919
VHF BEACON	W03-111		1919
2 X 12" GLASS SPHERE			1919
SBE37	3258		1919
SONARDYNE LRT RELEASE	ID007 252 343-001		1920
ANCHOR 70kg			1921

MOORING METHOD

COMMENTS

RAPID MOORINGS **CRUISE D334** **MRG ID:** EBM5

Eastern Atlantic
26N

DEPLOYMENT

NMFSS ID
2008/40

LATITUDE 27 54.603'N

DATE 20/11/08

LONGITUDE 13 21.61'W

DAY325

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1934

SITE ARRIVAL

TIME 1934

COMPLETION TIME 1935

WATER DEPTH

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			193420
RECOVERY LINE			193420
VHF BEACON	W03 – 114		193450
2 X 12"GLASS SPHERE			193450
SBE37	3208		193450
SONARDYNE LRT RELEASE	ID006 252 343-005		193450
ANCHOR 70kg			193520

MOORING METHOD

COMMENTS

RAPID MOORINGS	**CRUISE D334**	**MRG ID:** EBM6
Eastern Atlantic 26N	**DEPLOYMENT**	**NMFSS ID 2008/41**

LATITUDE 27 55.21’N — **DATE 20/11/08**

LONGITUDE 13 19.89’W — ***DAY 325***

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1952

SITE ARRIVAL TIME

COMPLETION TIME 1953

WATER DEPTH 100m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1952
RECOVERY LINE			1952
VHF BEACON	W03 -112		1952
2 X GLASS SPHERE			1952
SBE37	3207		1952
SONARDYNE LRT RELEASE	ID001 S/N 252343-007		1952
ANCHOR 70kg			1953

MOORING METHOD

COMMENTS

RAPID MOORINGS — CRUISE D334

MRG ID: EBP1

Eastern Atlantic
26N

DEPLOYMENT

NMFSS ID 2008/32

LATITUDE 23°49.38'N

DATE 15/11/08

LONGITUDE 24°05.98'W

DAY 320

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1957

SITE ARRIVAL TIME 1957

COMPLETION TIME1959

WATER DEPTH 5050 m (u/c)

ITEM	SER NO	COMMENT	TIME
RECOVERY LINE			1957
RECOVERY FLOAT			1957
PIES	136		1959
DEPLOYEMENT LINE			1959
TRIPOD FRAME			1959
55KG ANCHOR			1959

MOORING METHOD

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID: MAR0

DEPLOYMENT

Eastern Atlantic 26N

NMFSS ID 2008/31

LATITUDE 25 06.35' N

DATE 9/11/2008

LONGITUDE 52 00.62' W

DAY 314

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1632

COMPLETION TIME 1719

SITE ARRIVAL TIME 1600

WATER DEPTH 5483 m u/c
5544 m corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1632
RECOVERY LINE			1632
3 X GLASS SPHERES			1632
SBE37	6322		1632
SBE37	6332		1637
2 X GLASS SPHERES			1637
SBE37	6331		1646
SBE37	6327		1651
SBE37	6321		1651
6 X GLASS SPHERES			1651
ACOUSTIC RELEASE	913	ARM 1827 REL 1855	1651
ACOUSTIC RELEASE	912	ARM 1826 REL 1855	1651
BPR	0031		1651
TRIPOD ASSEMBLY			1651
ANCHOR 500 KG			1718

DEPLOYMENT METHOD

COMMENTS

RAPID MOORINGS CRUISE D324

MRG ID: MAR1

DEPLOYMENT

Eastern Atlantic 26N

NMFSS ID 2008/28

LATITUDE 24 10.72'N

DATE 08/11/2008

LONGITUDE 49 43.47'W

DAY 313

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1221

COMPLETION TIME 1637

SITE ARRIVAL TIME 1205

WATER DEPTH 5166m u/c
5216m corr

ITEM	SER NO	COMMENT	TIME
TRIMSYN FLOAT		Reused from MAR1 recoverd	1221
RECOVERY LINE			
3 X TRIMSYN			
SBE37	6137		
24" STEEL SPHERE	274	PTT-1D 60202 no light	1225
SBE37	6323		1230
ARGOS BEACON	264	PTT-1D 46242/S01-189	1236
37" STEEL SPHERE			1236
1M CHAIN SWIVEL			1236
SBE37	6325		1239
SBE37	6324		1243
SBE37	6320		1247
SBE37	6326		1250
SBE37	6118		1256
8 X GLASS SPHERES			1305
SBE37	6119	Attached a few metres behind mark	1309
SBE37	6121		1315
SBE37	6120		1324
SBE37	6122		1338
8 X GLASS SPHERES			1346
SBE37	6123		1353
4X GLASS SPHERES			1419
SWIVEL			1419
SBE37	6124		1419
4 X GLASS SPHERES			1435
SBE37	6125		1437
4 X GLASS SPHERES		+ swivel	1454
SBE37	6126		1454
4 X GLASS SPHERES			1515
SBE37	6128		1515
SBE37	6129		1534

5 X GLASS SPHERES			1546
SBE37	6127		1606
S4	35612568		1606
9 X GLASS SPHERES			1619
SWIVEL			1619
ACOUSTIC RELEASE	930	ARM: 1864 REL: 1855	1619
ACOUSTIC RELEASE	915	ARM: 1829 REL: 1855	1619
20M NYLON BRAID			1629
10M CHAIN			1629
CHAIN ANCHOR 1800 KG			1637

DEPLOYMENT METHOD

COMMENTS

Monday 10/11: Revisited and steamed slowly along the deployment track looking for any surface expression.

RAPID MOORINGS CRUISE D334

MRG ID: MAR2

Eastern Atlantic 26N

DEPLOYMENT

NMFSS ID 2008/29

LATITUDE 24’ 10.58616

LONGITUDE 49’ 45.35294

DATE 08/11/2008

DAY 313

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 17:49

COMPLETION TIME 20:43

SITE ARRIVAL TIME 17:39

WATER DEPTH 5164 u/c
5214 corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1751
RECOVERY LINE			1752
LIGHT			1751
BILLINGS FLOAT			1752
4 X GLASS SPHERES			1752
SWIVEL			1752
SBE37	6130		1754
SBE37	6131		1804
4 X GLASS SPHERES			1819
SBE37	6132		1821
3 X GLASS SPHERES			1837
SBE37	6133		1837
3 X GLASS SPHERES			1852
SBE37	6134		1852
SBE37	6136		1904
3 X GLASS SPHERES			1922
SBE37	6109		1922
SWIVEL			1940
3 X GLASS SPHERES			1940
SBE37	6135		1940
SBE37	6110		1955
4 X GLASSS SPHERES			2014
S4	35612567		2014
SBE37	6111		2015
5 X GLASS SPHERES			2020
SWIVEL			2020
ACOUSTIC RELEASE	914	ARM 1828 REL 1855	2041
10M CHAIN			2041
ANCHOR 1000 KG			2043

RAPID MOORINGS **CRUISE D334** **MRG ID:** MAR3

Eastern Atlantic 26N ***DEPLOYMENT*** **NMFSS ID** 2008/26

LATITUDE	23 52.24'N	**DATE**	1/11/2008
LONGITUDE	41 05.31'W	**DAY**	309

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME	1817	**SITE ARRIVAL TIME**	1800
COMPLETION TIME	2022		
WATER DEPTH	5007m u/c 5046m corr		

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1817
RECOVERY LINE			1817
LIGHT			1817
BILLINGS FLOAT			1817
2 X GLASS SPHERES			1817
SWIVEL			1817
SBE37	6112		1817
3 X GLASS SPHERES			1846
SBE37	6113		11846
SBE37	6114		1901
3X GLASS SPHERES			1903
3 X GLASS SPHERES			1920
SWIVEL			1920
SBE37	6115		1922
3 X GLASS SPHERES			1938
SBE37	6116		1941
SBE37	6117		1955
S4	35612565		1958
7 X GLASS SPHERES			1958
SWIVEL			
ACOUSTIC RELEASE		SN 929 ARM 1863 Release 1855	
10M CHAIN			2022
CHAIN ANCHOR 1000 KG			

DEPLOYMENT METHOD

COMMENTS

Target: 23 52.27'N
41 04.79'W
wd 5027m corr Area 19 [4986 u/c]

NOG Sediment Trap

RAPID MOORINGS CRUISE D334

MRG ID:

NMFSS ID 2008/27

Eastern Atlantic 26N **DEPLOYMENT**

DATE 5/11/2008

LATITUDE 23°46.29'N

LONGITUDE 41°05.77'W

DAY 310

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 12:42

COMPLETION TIME 14:38

WATER DEPTH 4256 corr

ITEM	SER NO	COMMENT	TIME
Recovery line			12:42
Billings			12:43
Light		Same as recovered mooring (SN 2669/4)	12:43
12x17' glass			12:47
SED trap	11804-07		12:57
RCM11	423		12:57
SED trap	11262-06		13:03
RCM11	419		13:03
10x17' glass		Glass tangled whilst deploying. Then untangled.	13:46
AR	925	Trouble releasing anchor took about 20 minutes to resolve this	13:56
Anchor		Towed onto deployment position	14:37:29

MOORING METHOD

Freefall Deployment

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID: MARL3

Eastern Atlantic 26N

DEPLOYMENT

NMFSS ID 2008/30

LATITUDE 24° 12.23'N

DATE 10/11/2008

LONGITUDE 49° 43.70'W

DAY 315

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 0500

COMMENCE TIME 0845

COMPLETION TIME 0903

WATER DEPTH 5173m u/c 5224m corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			0859
RECOVERY LINE			0859
LIGHT			0859
VHF SN	W03-107	Ch 72	0859
BILLINGS FLOAT			0900
1M CHAIN SWIVEL			0900
4 X 17" GLASS			0901
4 X 17" GLASS			0901
ACOUSTIC RELEASE	924	ARM: 1858 REL: 1855	DIAG 1849
ACOUSTIC RELEASE	922	ARM: 1836 REL: 1855	DIAG 1849
2 OFF BPR'S	0012 & 0035		0902
ANCHOR 300KG			0902

MOORING METHOD

Release 040243

COMMENTS

RAPID MOORINGS　CRUISE D334

MRG ID: MARL4

Eastern Atlantic 26N　**DEPLOYMENT**

NMFSS ID 2008/25

LATITUDE 27 16.93'N　**DATE** 4/11/2008

LONGITUDE 15 25.65'W　**DAY** 309

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME

COMMENCE TIME 1714

COMPLETION TIME 171615

WATER DEPTH 5040m u/c

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1714
RECOVERY LINE			1714
LIGHT	W03-097		1714
VHF SN	U01-023	Ch 72	1714
BILLINGS FLOAT+5m chain			1714
2 X GLASS SPERES			1715
1M CHAIN SWIVEL			1715
3 X 17" GLASS			1716
ACOUSTIC RELEASE	921	ARM 1849 REL 1855	1716
ACOUSTIC RELEASE	414		1716
BPR			1716
ANCHOR 300KG			171615

MOORING METHOD

COMMENTS

Appendix E Acoustic Release Record

Serial No	Type	Previous Location	Current Location	Date Deployed	Position		Water Depth	Serviced	Batts	Bench tested	Wire tested	Depth tested
					Lat	Long						
824	AR861	EB1	ON BOARD									
823	AR861	EB1	ON BOARD									
822	AR861	NEW	MARL2	23/10/2007	23 51.95	41 05.54	5041	AS NEW	YES	YES	YES	5000
821	AR861	MAR3	EBH1	18/11/2008	27 16.90550	15 25.71120	3009	YES	YES	YES	YES	4500
819	AR861	EB2	ON BOARD									
820	AR861	EB2	ON BOARD									
818	AR861	NEW	MARL1	26/10/2005	24 11.68	49 42.64		AS NEW	YES	YES	YES	5500
252	AR861	NOG	EBH3	19/11/2008	27 48.7852	13 44.47947	1412	YES	YES	YES	YES	4500
826	AR861	NEW	EBL4	5/11/2007				AS NEW	YES	YES	YES	4500
354	AR861	EBHI	ON BOARD									
928	AR861	NEW UNIT	EBHI	29/10/2008	24 57.12310	21 16.08686	4499	NEW UNIT	YES	YES	YES	4500
827	AR861	NEW	EBL3	3/11/2007				AS NEW	YES	YES	YES	4500
825	AR861	MAR1	ON BOARD									
244	AR861	IXSEA SERVICE	MARL1	26/10/2007	24 11.68	49 42.64		IXSEA SERVICE	YES	YES	YES	5500
260	AR861	MAR1	ON BOARD									
262	AR861	MAR0	EBH4	19/11/2008	27 05.998	13 32.393	1052	YES	YES	YES	YES	4500
909	AR861	NEW UNIT	EB1	30/10/2008	23 45.4417	24 07.6922	5090	NEW UNIT	YES	YES	YES	4500
908	AR861	NEW UNIT	EB1	30/10/2008	23 45.4417	24 07.6922	5090	NEW UNIT	YES	YES	YES	4500
927	AR861	NEW UNIT	EBL1	31/10/2008	23 48.133	24 06.822	5050	NEW UNIT	YES	YES	YES	4500
930	AR861	ON BOARD	MAR1	8/11/2008	24 10.72	49 43.47	5216	NEW UNIT	YES	YES	YES	4500
929	AR861	ON BOARD	MAR3	4/11/2008	23 52.24	41 05.31	5046	NEW UNIT	YES	YES	YES	4500
320	AR861	MAR0	ON BOARD									
368	AR861	MAR2	EBL2	18/11/2008	27 17.148	15 25.692	3005	YES	YES	YES	YES	4500
370	AR861	EBH4	EBH5	21/11/2008	27 50.36	13 32.81	1054	YES	YES	YES	YES	1000
495	AR861	EBH3	ON BOARD									
921	AR861	ON BOARD	MARL4	4/11/2008	23 51.57	41 06.0		NEW UNIT	YES	YES	YES	4500
923	AR861	NEW UNIT	EBL1	31/10/2008	23 48.133	24 06.822	5050	NEW UNIT	YES	YES	YES	4500
282	AR861	EBH2	ON BOARD									
358	AR861	EBH1	ON BOARD									
925	AR861	ON BOARD	NOG	6/11/2008				NEW UNIT	YES	YES	YES	4500
359	AR861	EBL1	ON BOARD									
361	AR861	EB2	EBL3	3/11/2007				YES	YES	YES	YES	5500
912	AR861	ON BOARD	MAR0	9/11/2008	25 06.35	52 00.62	5544	NEW UNIT	YES	YES	YES	4500
913	AR861	ON BOARD	MAR0	9/11/2008	25 06.35	52 00.62	5544	NEW UNIT	YES	YES	YES	4500

243	AR861	MARL4	EBH2	19/11/2008	27 36.73	14 12.7	2011	YES	YES	YES	YES	4500
367	AR861	MARL3	ON BOARD	2006								
324	AR861	EBL2	ON BOARD	2006				YES	YES	YES	YES	FAIL
914	AR861	ON BOARD	MAR2	8/11/2008	24 10.58616	49 45.35294	5214	NEW UNIT	YES	YES	YES	4500
915	AR861	ON BOARD	MAR1	8/11/2008	24 10.72	49 43.47	5216	NEW UNIT	YES	YES	YES	4500
924	AR861	ON BOARD	MARL3	10/11/2008	24 12.23	49 43.70	5173	NEW UNIT	YES	YES	YES	4500
256	AR861	MARL3	ON BOARD									
922	AR861	ON BOARD	MARL3	10/11/2008	24 12.23	49 43.70	5173	NEW UNIT	YES	YES	YES	4500
162	RT661	EBL1	ON BOARD									

Appendix F Mooring Recovery Logsheets

RAPID MOORINGS	**CRUISE D334**	**MRG ID:**	EB1
Eastern Atlantic 26N	RECOVERY	**NMFSS ID**	2007/22
LATITUDE	23 50.63N	**DATE**	31/10/2008
LONGITUDE	24 05.14W	**DAY**	305

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

COMMENCE TIME	0730	**TIME**	0500
COMPLETION TIME			

WATER DEPTH

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		Biofouling	0819
RECOVERY LINE		Biofouling	0819
TRIMSYN X 3			0828
SBE37	3224	Biofouling	0828
24” STEEL SPHERE and ARGOS BEACON	√		0833
SBE 37	3251		0833
SBE 37	3268		0838
ARGOS BEACON	√		0840
37” McLa STEEL SPHERE	√		0840
1M CHAIN SWIVEL	√		0840
SBE 37	3272		0844
SBE37	3484		0847
SBE37	5484		0850
4 X 17” GLASS FLOAT	√		0854
SBE37	5485		0854
SBE37	5486		0904
4 X 17” GLASS FLOAT	√		0908
SBE37	5487		0914
4 X 17” GLASS FLOAT	√		0919
SBE37	5488		0919
SBE37	3253		0928
4 X 17” GLASS FLOAT	√		0932
SBE37	4472		0943
4 X 17” GLASS FLOAT	√		0955
SBE37	4475		1009
4 X 17” GLASS FLOAT	√		1026
SBE37	4718		1041
4 X 17” GLASS FLOAT	√		1050
4 X 17” GLASS FLOAT	√	Wire tangled;	1106
SBE37	4719	Microcta stuck inside the wrapped up wirre	1106

8 X GLASS FLOAT	√	Glass pack chain tangled	1128
SWIVEL	√		1128
ACOUSTIC RELEASE 1	SN. ARM REL		1128
ACOUSTIC RELEASE 2	SN. ARM REL		1128

MOORING METHOD

COMMENTS

1000: change of drum
1026: wire tangled up around glass floats ~3m in tangle

RAPID MOORINGS		CRUISE D334	MRG ID:	EB2
Eastern Atlantic 26N		RECOVERY	NMFSS ID	2007/21
LATITUDE	23 56.127N		DATE	3/10/2008
LONGITUDE	24 03.344W		DAY	305

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME	1330	SITE ARRIVAL TIME	1246
COMPLETION TIME	1626		
WATER DEPTH	5089m	RELEASE	125445

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		TRIMSYN	1330
RECOVERY LINE			1330
TRIMSYN X 3			1337
SBE37	3225	Heavy biofouling	1337
24” STEEL SPHERE		Argos T04-044 ID 46243	1343
SBE 37	3234	Biofouling	1345
SBE 37	3247		1350
ARGOS BEACON		254 TD 42746 light U01-024	1354
37” McLa STEEL SPHERE			1354
1M CHAIN SWIVEL			1354
SBE37	3252 + 009657	Plus RBR also 250m	1400
SBE37	3254		1405
SBE37	3255		1410
4 X 17” GLASS FLOAT			1413
SBE37	3256		1420
4 X 17” GLASS FLOAT			1425
SBE37	3257		1425
SBE37	3265		1433
4 X 17” GLASS FLOAT			1438
SBE37	3266		1441
4 X 17” GLASS FLOAT			1448
SBE37	3269		1453
SBE37	3270		1502
4 X 17” GLASS FLOAT			1508
SBE37	3271		1524
4 X 17” GLASS FLOAT			1536
4 X 17” GLASS FLOAT			1548
SBE37	3274		1553
4 X 17” GLASS FLOAT			1603
SBE37	3277		1622
8 X GLASS FLOAT		Glass floats mixed up (bottom glass); 1 float imploded	1626
SWIVEL			1626
ACOUSTIC RELEASE 1	SN. ARM REL	819 Ar 1681 Rel 1655	1626
ACOUSTIC RELEASE 2	SN. ARM REL	820 Ar 1682 Rel 1655	1626

MOORING METHOD

Total time: 3:26

COMMENTS	1517: switched the drum 1603: messed up wire around it; some 15m doubled; glass floats ok; ~15 min to unwrap cable (not cut); beginning of cable after glasses quite filted.

RAPID MOORINGS	**CRUISE D334**	**MRG ID:**	EBH1
Eastern Atlantic 26N	RECOVERY	**NMFSS ID**	2007/30
LATITUDE	27 16.93'N	**DATE**	18/11/08
LONGITUDE	15 25.65'W	**DAY**	323

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 0600

COMMENCE TIME 0713 (release time)

COMPLETION TIME 0836

WATER DEPTH 3001m u/c 3009m corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			0804
RECOVERY LINE			0804
LIGHT			0813
BILLINGS FLOAT			0813
1M CHAIN SWIVEL			0813
4 X 17" GLASS			0813
SBE37	3239	yes	0813
2 X 17" GLASS			0827
SBE 37	3284		0836
2 X 17" GLASS			0836
1M CHAIN SWIVEL			0836
ACOUSTIC RELEASE	SN. ARM REL	s/n 358 ARM14EE 1455	0836

MOORING METHOD

Release

COMMENTS

RAPID MOORINGS **CRUISE D334** **MRG ID:** EBH2

Eastern Atlantic 26N **RECOVERY** **NMFSS ID** 2007/31

LATITUDE 27 36.71'N **DATE** 19/11/08

LONGITUDE 14 12.75'W **DAY** 324

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME overnight

COMMENCE TIME 0802

COMPLETION TIME 0825

WATER DEPTH 2011m u/c 2011 corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			0802
RECOVERY LINE			0802
LIGHT BEACON		yes	0807
BILLINGS FLOAT			0807
1M CHAIN			0807
2 GLASS SPHERES			0808
SWIVEL		?	0808
SBE 37	3248		0808
2 GLASS SPHERES			0816
SBE 37	3249		0816
SBE 37	4474	Wrong clamp, Stopped to change	0825
2 GLASS SPHERES			0825
1M CHAIN SWIVEL		Yes	0825
ACOUSTIC RELEASE	SN. ARM REL	282 ARM 14BA REL 1455	0825

MOORING METHOD

Basket

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID: EBH3

Eastern Atlantic 26N

RECOVERY

NMFSS ID 2007/32

LATITUDE 27 48.845621'N

DATE 19/11/08

LONGITUDE 13 44.45031'W

DAY 324

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 1236

COMMENCE TIME 1238

COMPLETION TIME 1345

WATER DEPTH 1405m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1309
RECOVERY LINE			1309
LIGHT BEACON	501-191		1317
BILLINGS FLOAT			1317
1M CHAIN		+ Swivel	1317
2 MINI TRIMSYN			1317
SBE37	3259		1317
2 MINI TRIMSYN			1317
SBE37	3264		1326
2 MINI TRIMSYN			1326
SBE37	3483		1331
2 MINI TRIMSYN			1336
SBE37	3486		1345
SBE 37	3891	Slight biofouling	1345
2 GLASS SPHERES			1345
1M CHAIN		+ Swivel	1345
ACOUSTIC RELEASE	SN. ARM REL	495/15A4/1555	1345

MOORING METHOD

COMMENTS

RAPID MOORINGS **CRUISE D334**

MRG ID: EBH4

Eastern Atlantic
26N

RECOVERY

NMFSS ID 2007/33

LATITUDE 27 15.014'N

DATE 19/11/08

LONGITUDE 13 32.380'W

DAY 324

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1602

SITE ARRIVAL

TIME 1600

COMPLETION TIME 1708

WATER DEPTH 1041m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT	√	40m +60m 4mm red	1626
RECOVERY LINE	√		1626
LIGHT	√		1633
BILLINGS FLOAT	√		1633
1M CHAIN SWIVEL	√		1633
2 MINI TRIMSYN	√		1633
SBE37	3892		1640
2 MINI TRIMSYN		100m of 4mm red	1644
SBE37	3900	tangled – SBE slammed into ship	1644
2 MINI TRIMSYN			1653
SBE37	3901		1653
2 MINI TRIMSYN			1658
SBE37	3903		1658
2 MINI TRIMSYN			1703
SBE37	3904		1703
SBE37	3912		1708
2 GLASS SPHERES			1708
1M CHAIN SWIVEL			1708
ACOUSTIC RELEASE	SN. ARM REL	370 14FA 1455 AR861	1708

MOORING METHOD

COMMENTS

Target 27 51.03'N
13 32.37'W

Wd=1047

RAPID MOORINGS | CRUISE D334

MRG ID: EBHi

Eastern Atlantic
26N

RECOVERY

NMFSS ID 2007/20

LATITUDE 24 57.14N

DATE 29/10/08

LONGITUDE 21 15.92W

DAY 303

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME

SITE ARRIVAL

TIME 0500

COMPLETION TIME

WATER DEPTH 4501m corr

Waiting for dawn

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		Yellow	0757
RECOVERY LINE		Yellow/black shackled to billings	0757
LIGHT		Novatech	0804
BILLINGS FLOAT		No flag	0804
1M CHAIN		Needs to be 10m	0804
2 X GLASS SPHERES		Orange hats	0804
SWIVEL			0804
SBE37	3479* cell up		0804
2 X GLASS SPHERES			0817
SBE37	3480* cell up		0817
RBR		BR s/n 009656 20cm below 3480	0817
SBE37	3482 cell down		0825
4 X GLASS SPHERES			0825
1M CHAIN			0825
SWIVEL		Elkins EEI (Marked Rapid)	0825
ACOUSTIC RELEASE	SN. ARM REL	861 AR s/n 354 with stainless link insolated to ARM 14EA REL 1445	0825

MOORING METHOD

COMMENTS

0618: first release command sent - inconsistent ranges after release.
But many still glum range as was on seabed
Actual first release sent : 063930

RAPID MOORINGS	**CRUISE D334**	**MRG ID:** EBL1_2006
Eastern Atlantic 26N	RECOVERY	**NMFSS ID 2006/45**

LATITUDE N 23 53.49 | **DATE 31/10/08**

LONGITUDE W 24 5.14 | **DAY 305**

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1025

COMPLETION TIME 1040

ITEM	SER NO	COMMENT	TIME
Billing float 3 sphere type with VHF and light	SN 408-009 vhf SN H01-008 light		1032
Recovery line			1032
4x17' Spheres			1036
4x17' Spheres			1038
DUAL RELEASES	861 SN 359 661 SN 162	Hit the stern being brought aboard No label	1040
Tripod assembly	2xSBE26	0419 AND 0420 6885M RATED	1040

MOORING METHOD

COMMENTS

RAPID MOORINGS — CRUISE D334

MRG ID: EBL2_2006

Eastern Atlantic
26N

RECOVERY

NMFSS ID
2006/46

LATITUDE N 27 16 79

DATE 18/11/08

LONGITUDE W 15 25 21

DAY 323

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME release at 083945

COMPLETION TIME 0936

ITEM	SER NO	COMMENT	TIME
Billing float 3 sphere type with VHF and light	SN S01-181 LIGHT SN T01-144 VHF	No flag	0929
Recovery line			0924
2x17' Spheres			0929
4x17' Spheres			0933
ACOUSTIC RELEASE	SN 324	ARM 14D4 REL 1455	0933
Tripod assembly	SN 400	SBE 26 4127M RATED	0936

MOORING METHOD

COMMENTS

RAPID MOORINGS **CRUISE D334** **MRG ID:** EBM1

Eastern Atlantic
26N

RECOVERY

NMFSS ID **2007/36**

LATITUDE 27 53.68'

DATE 20/11/08

LONGITUDE 13. 24.33'W

DAY 325

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 0826

SITE ARRIVAL

TIME

COMPLETION TIME 0829

WATER DEPTH 420m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			0826
RECOVERY LINE			0826
VHF BEACON			0829
2 X GLASS SPHERE			0829
SBE37	3913		0829
SONARDYNE LRT RELEASE	240841-009	1D 001 F1	0829

MOORING METHOD

Chilli mix appears to have kept fouling clear of bottom of release

COMMENTS
Wd=500

No VHF signal received

RAPID MOORINGS | CRUISE D334

MRG ID: EBM4

Eastern Atlantic
26N

RECOVERY

NMFSS ID
2007/37

LATITUDE 27 54.46'N

DATE

LONGITUDE 13 22.08'W

DAY

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME

SITE ARRIVAL

TIME

COMPLETION TIME

WATER DEPTH 275m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			
RECOVERY LINE			
VHF BEACON			
2 X GLASS SPHERE			
SBE37	3941		
SONARDYNE LRT RELEASE	200-003	1D 004 F1	

MOORING METHOD

NOT RECOVERED

COMMENTS
Wd=250

Target 27 54.50'N
13 21.97'W

RAPID MOORINGS **CRUISE D334** **MRG ID:** EBM5

Eastern Atlantic
26N

RECOVERY

NMFSS ID 2007/38

LATITUDE 27 54.6'N

DATE

LONGITUDE 13 21.6'W

DAY

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME

SITE ARRIVAL

TIME

COMPLETION TIME

WATER DEPTH 176

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			
RECOVERY LINE			
VHF BEACON			
2 X GLASS SPHERE			
SBE37	3115		
SONARDYNE LRT RELEASE	245 718-003	1D 009, F1	

MOORING METHOD

NOT RECOVERED

COMMENTS
Wd =175

Target 27 54.63'N
13 21.57'W

RAPID MOORINGS

CRUISE D334

MRG ID:
EBM6

Eastern Atlantic
26N

RECOVERY

NMFSS ID
2007/39

LATITUDE

DATE 20/11/08

LONGITUDE

DAY 325

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1210

SITE ARRIVAL

COMPLETION TIME 1215

TIME 1144

WATER DEPTH 95m

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		Heavy fouling	1210
RECOVERY LINE			1210
VHF BEACON			1214
2 X GLASS SPHERE			1214
SBE37	3916		1214
SONARDYNE LRT RELEASE	841010	1D 006, F1	1214

MOORING METHOD

COMMENTS
Wd = 100

All SBE tied to release with blue rope, then to mast and through buoyancy.
Chris's 'special' chilli paste smeared around the release end.

M6 to M5 1.6
M5 to M4 0.4
M4 to M1 2.5

RAPID MOORINGS | CRUISE D334

MRG ID: EBP1

Eastern Atlantic 26N

RECOVERY

NMFSS ID 2005/64

LATITUDE 23°48.52' N

LONGITUDE 24°06.50'W

DATE 31/10/2008

DAY 305

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME 1750

COMMENCE TIME 1800

COMPLETION TIME 2000

WATER DEPTH 5094 corr

RELEASE TIME

ITEM	SER NO	COMMENT	TIME
Plastic pickup float	n/a		1802
PIES unit	136		1949 (on surface)
			2000

COMMENTS

Engines + bow chruster off. Setting 1.5 cables downwind of site.

1756: Transpond [XPND]

RAPID MOORINGS CRUISE D334

MRG ID: MAR0

RECOVERY

Eastern Atlantic 26N

NMFSS ID 2007/27

LATITUDE 25 06.35'N

DATE 9/11/2008

LONGITUDE 52 00.60'W

DAY 314

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 0921 (release time)

SITE ARRIVAL TIME 0920

COMPLETION TIME

WATER DEPTH 5523m corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1044
RECOVERY LINE			1044
3 X GLASS SPHERES			1049
SBE37	4180		1049
2 X GLASS SPHERES			1059
SBE37	4181		1059
SBE37	4183		1106
6 X GLASS SPHERES			1106
ACOUSTIC RELEASE	SN. ARM REL	320	1111
ACOUSTIC RELEASE	SN. ARM REL	262	1111
BPR	SBE 26 389		1111

DEPLOYMENT METHOD

COMMENTS

RAPID MOORINGS CRUISE D334

MRG ID: MAR1

RECOVERY

Eastern Atlantic 26N

NMFSS ID 2007/28

LATITUDE 24 10.744'N

LONGITUDE 49 43.474

Positions from bridge due to loss of GP4 and GP12 during deployment

DATE 7/11/2008

DAY 312

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1457 ?

COMPLETION TIME 1856

SITE ARRIVAL TIME 1545

WATER DEPTH 5162m u/c 5212m corr

ITEM	SER NO	COMMENT	TIME
TRIMSYN FLOAT			1605
RECOVERY LINE			1605
3 X TRIMSYN			1609
SBE37	3207	Heavy fooling	1609
24" STEEL SPHERE		+ Argos beacon sn 274 ID 620202	1615
SBE37	3208	Heavy fooling	1615
ARGOS BEACON	264	PTT-ID46242 Bowtech (no sn)	1628
37" STEEL SPHERE			1628
1M CHAIN SWIVEL			1628
SBE37	3209		1628
SBE37	3212		1633
SBE37	3213		1637
8 X GLASS SPHERES		Some tangling	1641
SBE37	3214		1641
SBE37	3215		1649
SBE37	3216		1654
SBE37	3217		1703
8 X GLASS SPHERES			1709
SBE37	3890		1717
4X GLASS SPHERES		Some tangling	1729
SWIVEL			1729
SBE37	4708		1730
4 X GLASS SPHERES		Tangled	1730
SBE37	4709		1747
4 X GLASS SPHERES			1800
SBE37	4710		1802
4 X GLASS SPHERES			1819
SBE37	4711	4000m after glass of 4032!!	1820
SBE37	4712		1833
5 X GLASS SPHERES		Sphere broken	1838
SBE37	4713		1848
94X GLASS SPHERES	35612577		1858

SWIVEL			1854
ACOUSTIC RELEASE	SN. ARM REL	Sn: 260 AR: 861 REL:1455 arm:1455	1855
ACOUSTIC RELEASE	SN. ARM REL	Sn:825 ARM 1687 Rel 1655 AR: 861	1856

DEPLOYMENT METHOD

COMMENTS

Ranging whilst recovering MAR2

RAPID MOORINGS CRUISE D334

MRG ID: MAR2

Eastern Atlantic 26N

RECOVERY

NMFSS ID 2007/29

LATITUDE 24 10.938'N

LONGITUDE 49 45.008'W

DATE 7/11/2008

DAY

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1136

COMPLETION TIME 1451

SITE ARRIVAL TIME 1136

WATER DEPTH

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1230
RECOVERY LINE			1230
LIGHT		No light! VHF beacon s/n U11-015	1244
BILLINGS FLOAT			1244
4 X GLASS SPHERES			1244
SWIVEL			1244
SBE37	3918		1247
SBE37	3910		1256
4 X GLASS SPHERES		Wire tangled but equipment intact	1305
SBE37	3282		1305
3 X GLASS SPHERES		Wire snagging also	1317
SBE37	4461		1317
3 X GLASS SPHERES			1330
SBE37	4462		1330
SBE37	4464	Snagging	1345
3 X GLASS SPHERES		Tangle – had t cut wire	1358
SWIVEL			1358
3 X GLASS SPHERES		Small tangle – had to cut wire	1358
SBE37	4714		1415
SBE37	4715		1415
3 X GLASSS SPHERES		All tangled – had to cut wire.	1433
S4			1443
SBE37			1443
5 X GLASS SPHERES			1443
SWIVEL			1443
ACOUSTIC RELEASE	SN. ARM REL	Sn 368 AR14F8, Rel 1455	1451

RECOVERY METHOD

RAPID MOORINGS CRUISE D334

MRG ID: MAR3

RECOVERY

Eastern Atlantic 26N

NMFSS ID 2007/24

LATITUDE 23 52.27'N

DATE 4/11/2008

LONGITUDE 41 04.79'W

DAY 309

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 1334

COMPLETION TIME 1459

SITE ARRIVAL TIME 1105

WATER DEPTH 4986m u/c 5027m corr

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1334
RECOVERY LINE			1334
LIGHT			1334
BILLINGS FLOAT			1334
2 X GLASS SPHERES			1334
SWIVEL	C307		1334
SBE37	4720		1334
2 X GLASS SPHERES			1350
SBE37	4721		1350
2 X GLASS SPHERES			1404
SBE37	4722		1404
3 X GLASS SPHERES		Some tangling – wire cut and re-tied before recommencing hauling	1419
SWIVEL	C305		1419
SBE37	4723		1419
3 X GLASS SPHERES		1 glass imploded – some tangling – wire cut	1436
SBE37	4178		1436
SBE37	4179		1449
S4	35612571	S4 banged into stern	1455
7 X GLASS SPHERES			1455
SWIVEL			1455
ACOUSTIC RELEASE	SN. ARM REL	s/n 821 ARM 1683 Rel 1655	1459

DEPLOYMENT METHOD

COMMENTS

RAPID MOORINGS **CRUISE D334** **MRG ID:** MARL3

Mid Atlantic 26N RECOVERY **UKORS ID** 2006/24

LATITUDE 24 12.62 **DATE** 8/11/08

LONGITUDE 49 43.64 **DAY** 313

NOTE ALL TIMES RECORDED IN GMT

COMMENCE TIME 0954

COMPLETION TIME 1008

ITEM	SER NO	COMMENT	TIME
17" glass pickup float	n/a		0954
Billings float	n/a		1001
Radio beacon on float			1001
Light on float			1001
4 x 17" glass	n/a		1001
4 x 17" glass	n/a		1005
1st SBE53	0013		1008
2nd SBE53	0014		1008
1st Acoustic release		367 AR861	1008
2nd Acoustic release		256 AR861	1008

DEPLOYMENT METHOD

COMMENTS

Release 0830
On surface 0932

RAPID MOORINGS	CRUISE D334	MRG ID:	MARL4
Eastern Atlantic 26N	RECOVERY	NMFSS ID	2006/25
LATITUDE 27 16.93'N		DATE	4/11/2008
LONGITUDE 15 25.65'W		DAY	309

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL

TIME

COMMENCE TIME 1634

COMPLETION TIME 1643

WATER DEPTH

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1634
LIGHT	SO1-187		1638
VHF SN	U01- 020		1638
BILLINGS FLOAT			1638
2 X 17" GLASS SPERES			1638
4 X 17" GLASS			1641
BPR	0012		1643
ACOUSTIC RELEASE		AR861 SN: 243 ARM 14A0 REL: 1455	1643

MOORING METHOD

COMMENTS

NOG Sediment Trap

RAPID MOORINGS CRUISE D334

MRG ID: NOG
NMFSS ID 2007/33
DATE 5/11/2008
DAY 310

Eastern Atlantic 26N **RECOVERY**

LATITUDE 23°45.93'N
LONGITUDE 41°6.07'W

NOTE ALL TIMES RECORDED IN GMT

SITE ARRIVAL TIME

0630 (waiting for light)

COMMENCE TIME 0830

COMPLETION TIME

WATER DEPTH 4254 corr

ITEM	SER NO	COMMENT	TIME
Recovery line			0940
Billings			0950
12x17' glass			0952
SED trap			1000
RCM8	9450		1000
SED trap			1010
RCM8	9904		1010
10x17' glass		4 glasses tangled on chain; polyester slighty wrapped around; cleared with shaking glasses with crane end manually.	1044
AR			1056

MOORING METHOD

Freefall Deployment
Deployed at 23°46.2' N 41°05.7'W

COMMENTS

Light flashing in sunlight. Design feature – Pswitch

1020: about 10m of rope tangled
1026: about 10m of badly tangled rope, continued 1032

Appendix G Instrument Setup Details

EBL1

Seabird SBE26 BPR — serial number 0388

Tide interval	30 min
Wave burst after every N tide measurements	9999
Wave samples per burst	68
No. of 0.25 s periods to integrate waves	33
Start date	31/10/2008
Start time	17:30:00

Seabird SBE53 BPR — serial number 0004

Header	EBL1_2008_D334
Tide interval	30 (min)
Tide measurements duration	30 (min)
Frequency of reference measurement	every 96 samples
Start date	31/10/2008
Start time	18:00:00

EBHi

Seabird SBE37 SMP CTD — serial number 3244

Sample interval	1800 s
Start date	29/10/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 3902

Sample interval	1800 s
Start date	29/10/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 3905

Sample interval	1800 s
Start date	29/10/2008
Start time	09:00:00

EB1

Seabird SBE37 SMP CTD — serial number 3223

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3228

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3229

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3230

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3231

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3232

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3233

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 4305

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3906

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3907

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3908

Sample interval	1800 s
Start date	30/10/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 3919

Sample interval	1800 s
Start date	30/10/2008
Start time	12:00:00

Seabird SBE37 SMP CTD — serial number 3928	
Sample interval	1800 s
Start date	30/10/2008
Start time	12:00:00
Seabird SBE37 SMP CTD — serial number 3930	
Sample interval	1800 s
Start date	30/10/2008
Start time	12:00:00
Seabird SBE37 SMP CTD — serial number 3931	
Sample interval	1800 s
Start date	30/10/2008
Start time	12:00:00
Seabird SBE37 SMP CTD — serial number 3932	
Sample interval	1800 s
Start date	30/10/2008
Start time	12:00:00
Seabird SBE37 SMP CTD — serial number 3933	
Sample interval	1800 s
Start date	30/10/2008
Start time	12:00:00
Seabird SBE37 SMP CTD — serial number 3934	
Sample interval	1800 s
Start date	30/10/2008
Start time	12:00:00

<u>EBP1</u>

University of Rhode Island PIES model 6.1E —	serial number 136
Mission statement	(none)
Travel time measurements	4 pings every 10 minutes
Pressure and temperature sampling	every 10 minutes
Pressure and temperature frequency file	disabled
Telemetry data file	enabled
PopUp write	disabled
Estimated water depth	5050 m
Acoustic lockout	6.06 s
Acoustic output level	195 dB
Release date	30/06/2015
Release time	20:15
Days until release	2418 days
Start date	15/11/2008
Start time	14:55:56

MAR0

Seabird SBE37 SMP CTD — serial number 6322

Sample interval	1800 s
Start date	09/11/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 6321

Sample interval	1800 s
Start date	09/11/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 6327

Sample interval	1800 s
Start date	09/11/2008
Start time	11:30:00

Seabird SBE37 SMP CTD — serial number 6331

Sample interval	1800 s
Start date	09/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6332

Sample interval	1800 s
Start date	09/11/2008
Start time	16:00:00

Seabird SBE53 BPR — serial number 0031

Header	MARL3_2008 [sic]
Tide interval	30 min
Tide measurements duration	30 min
Frequency of reference measurement	every 96 samples
Start date	08/11/2008
Start time	19:00:00

[NB: THE HEADER FIELD IS COPIED DIRECTLY FROM THE INSTRUMENT SETUP LOGSHEET AND IS INCORRECTLY ENTERED FOR THIS MOORING. Z SZUTS]

MAR1

Seabird SBE37 SMP CTD — serial number 6137

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6323

Sample interval	1800 s
Start date	08/11/208
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6324

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6325

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6326

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6320

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6118

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6119

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6120

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6121

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6122

Sample interval	1800 s
Start date	08/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6123

Sample interval	1800 s
Start date	08/11/2008
Start time	10:00:00

Seabird SBE37 SMP CTD — serial number 6124

Sample interval	1800 s
Start date	08/11/2008
Start time	10:00:00

Seabird SBE37 SMP CTD — serial number 6125

Sample interval	1800 s
Start date	08/11/2008
Start time	10:00:00

Seabird SBE37 SMP CTD — serial number 6126

Sample interval	1800 s
Start date	08/11/2008
Start time	10:00:00

Seabird SBE37 SMP CTD — serial number 6127

Sample interval	1800 s
Start date	08/11/2008
Start time	10:00:00

Seabird SBE37 SMP CTD — serial number 6128

Sample interval	1800 s
Start date	08/11/2008
Start time	10:00:00

Seabird SBE37 SMP CTD — serial number 6129

Sample interval	1800 s
Start date	08/11/2008
Start time	10:00:00

InterOcean S4A — serial number 35612568

Header	MAR1_2008
On time	1 min
Cycle time	30 min
Average count	120
Channels at average depth	Hx, Hx, cond., temp.,
Special Record Block count	48
Channels at SRB depth	Hx, Hx, cond., temp.,
Start date	08/11/2008
Start time	13:30:00

<u>MAR2</u>

Seabird SBE37 SMP CTD — serial number 6111

Sample interval	1800 s
Start date	08/11/2008

Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6109

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6130

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6131

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6132

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6136

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6110

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6133

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6134

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

Seabird SBE37 SMP CTD — serial number 6135

Sample interval	1800 s
Start date	08/11/2008
Start time	16:00:00

InterOcean S4A — serial number 35612567

Header	MAR2_2008
On time	1 min

Cycle time	30 min
Average count	120
Channels at average depth	Hx, Hx, cond., temp.,
Special Record Block count	48
Channels at SRB depth	Hx, Hx, cond., temp.,
Start date	08/11/2008
Start time	14:00:00

<u>MAR3</u>

Seabird SBE37 SMP CTD — serial number 6112

Sample interval	1800 s
Start date	04/11/2008
Start time	17:00:00

Seabird SBE37 SMP CTD — serial number 6113

Sample interval	1800 s
Start date	04/11/2008
Start time	17:00:00

Seabird SBE37 SMP CTD — serial number 6114

Sample interval	1800 s
Start date	04/11/2008
Start time	17:00:00

Seabird SBE37 SMP CTD — serial number 6115

Sample interval	1800 s
Start date	04/11/2008
Start time	17:00:00

Seabird SBE37 SMP CTD — serial number 6116

Sample interval	1800 s
Start date	04/11/2008
Start time	17:00:00

Seabird SBE37 SMP CTD — serial number 6117

Sample interval	1800 s
Start date	04/11/2008
Start time	17:00:00

InterOcean S4A — serial number 35612565

Header	MAR3_2008
On time	1 min
Cycle time	30 min
Average count	120
Channels at average depth	Hx, Hx, cond., temp.,

Special Record Block count	48
Channels at SRB	Hx, Hx, cond., temp.,
depth	
Start date	04/11/2008
Start time	18:30:00

MARL4

Seabird SBE26 BPR — serial number 0414

Tide interval	30 min
Wave burst after every N tide measurements	9999
Wave samples per burst	68
No. of 0.25 s periods to integrate waves	33
Start date	04/11/2008
Start time	16:00:00

MARL3

Seabird SBE53 BPR — serial number 0012

Header	MARL3_2008
Tide interval	30 min
Tide measurements duration	30 min
Frequency of reference measurement	every 96 samples
Start date	09/11/2008
Start time	16:00:00

Seabird SBE53 BPR — serial number 0035

Header	MARL3_2008
Tide interval	30 min
Tide measurements duration	30 min
Frequency of reference measurement	every 96 samples
Start date	08/11/2008
Start time	19:00

EBH1

Seabird SBE37 SMP CTD — serial number 5246

Sample interval	1800 s
Start date	18/11/2008
Start time	10:30:00

Seabird SBE37 SMP CTD — serial number 5247

Sample interval	1800 s
Start date	18/11/2008
Start time	10:30:00

<u>EBL2</u>

Seabird SBE26 BPR — serial number 0396

Tide interval	30 min
Wave burst after every N tide measurements	9999
Wave samples per burst	68
No. of 0.25 s periods to integrate waves	33
Start date	18/11/2008
Start time	10:30:00

<u>EBH2</u>

Seabird SBE37 SMP CTD — serial number 6333

Sample interval	1800 s
Start date	19/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 6334

Sample interval	1800 s
Start date	19/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 5245

Sample interval	1800 s
Start date	19/11/2008
Start time	09:00:00

<u>EBH3</u>

Seabird SBE37 SMP CTD — serial number 5243

Sample interval	1800 s
Start date	19/11/2008
Start time	13:30:00

Seabird SBE37 SMP CTD — serial number 5244

Sample interval	1800 s
Start date	19/11/2008
Start time	13:30:00

Seabird SBE37 SMP CTD — serial number 6328

Sample interval	1800 s
Start date	19/11/2008
Start time	13:30:00

Seabird SBE37 SMP CTD — serial number 6329

Sample interval	1800 s
Start date	19/11/2008
Start time	13:30:00

Seabird SBE37 SMP CTD — serial number 6330

Sample interval	1800 s
Start date	19/11/2008
Start time	13:30:00

<u>EBH4</u>

Seabird SBE37 SMP CTD — serial number 4307

Sample interval	1800 s
Start date	19/11/2008
Start time	16:30:00

Seabird SBE37 SMP CTD — serial number 5238

Sample interval	1800 s
Start date	19/11/2008
Start time	16:30:00

Seabird SBE37 SMP CTD — serial number 5239

Sample interval	1800 s
Start date	19/11/2008
Start time	16:30:00

Seabird SBE37 SMP CTD — serial number 5240

Sample interval	1800 s
Start date	19/11/2008
Start time	16:30:00

Seabird SBE37 SMP CTD — serial number 5241

Sample interval	1800 s
Start date	19/11/2008
Start time	16:30:00

Seabird SBE37 SMP CTD — serial number 5242

Sample interval	1800 s
Start date	19/11/2008
Start time	16:30:00

<u>EBM1</u>

Seabird SBE37 SMP CTD — serial number 4306

Sample interval	1800 s
Start date	20/11/2008
Start time	18:30:00

<u>EBM4</u>

Seabird SBE37 SMP CTD — serial number 3258

Sample interval	1800 s
Start date	20/11/2008
Start time	18:30:00

EBM5

Seabird SBE37 SMP CTD — serial number 3208

Sample interval	1800 s
Start date	20/11/2008
Start time	18:30:00

EBM6

Seabird SBE37 SMP CTD — serial number 3207

Sample interval	1800 s
Start date	20/11/2008
Start time	18:30:00

EBH5

Seabird SBE37 SMP CTD — serial number 3212

Sample interval	1800 s
Start date	21/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 3213

Sample interval	1800 s
Start date	21/11/2008
Start time	09:00:00

Seabird SBE37 SMP CTD — serial number 3214

Sample interval	1800 s
Start date	21/11/2008
Start time	09:00:00

InterOcean S4A — serial number 35612576

Header	EBH5 2008
On time	1 min
Cycle time	30 min
Average count	120
Channels at average depth	Hx, Hx, cond., temp.,
Special Record Block count	48
Channels at SRB depth	Hx, Hx, cond., temp.,
Start date	21/11/2008

Start time	09:30:00

InterOcean S4A — serial number 35612577

Header	EBH5 2008
On time	1 min
Cycle time	30 min
Average count	120
Channels at average depth	Hx, Hx, cond., temp.,
Special Record Block count	48
Channels at SRB depth	Hx, Hx, cond., temp.,
Start date	21/11/2008
Start time	09:30:00

Appendix H Charts and Diagrams

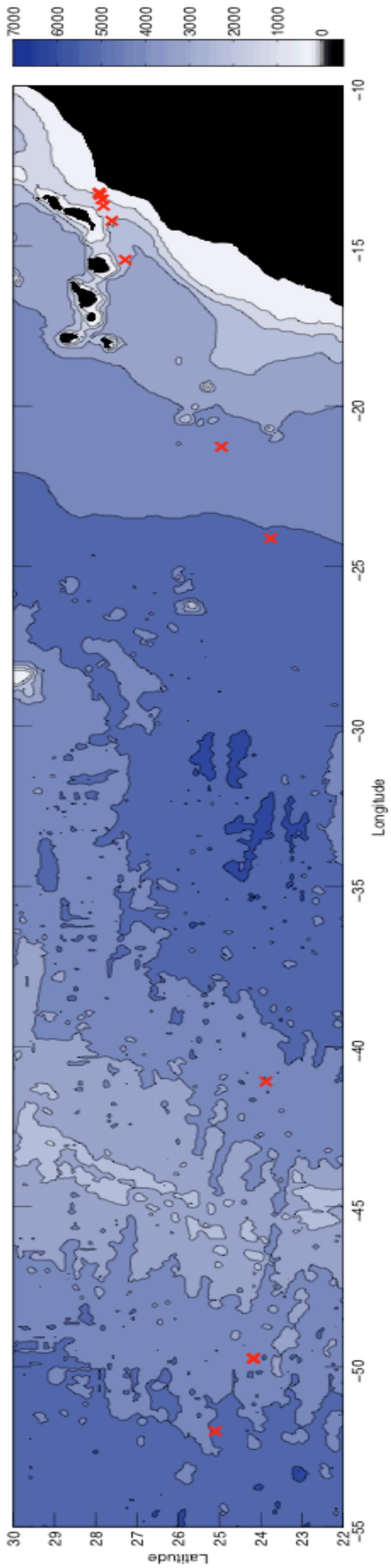


Figure H.1 *Chart of the mooring deployment locations during D334.*

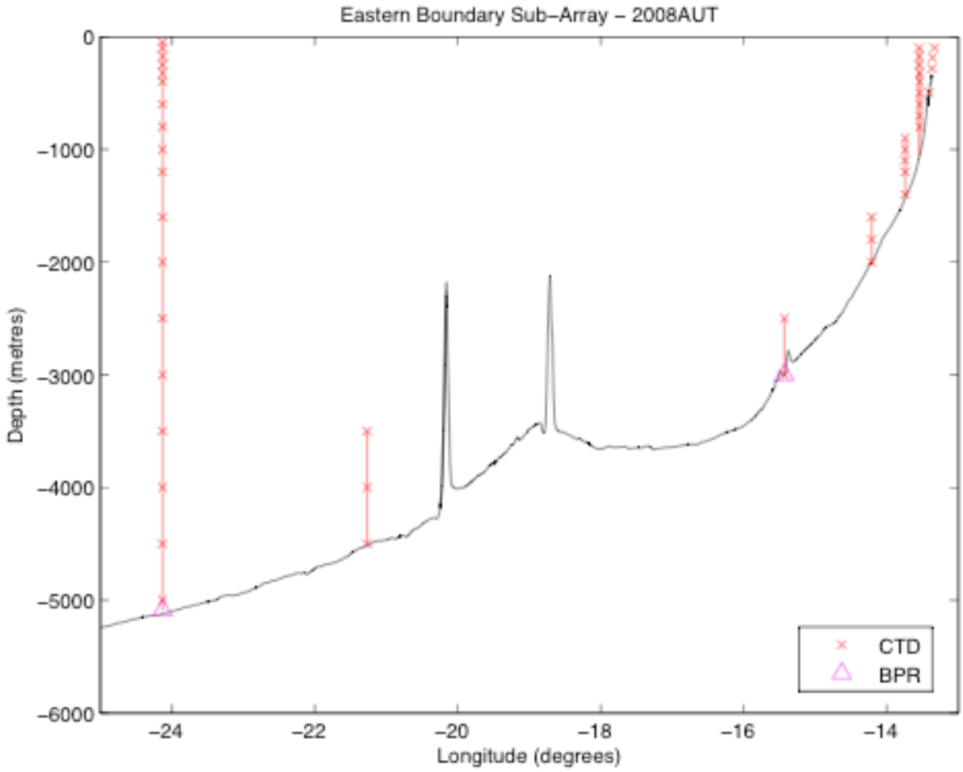


Figure H.2 *Schematic of the Eastern Boundary Sub-Array as deployed on D334*

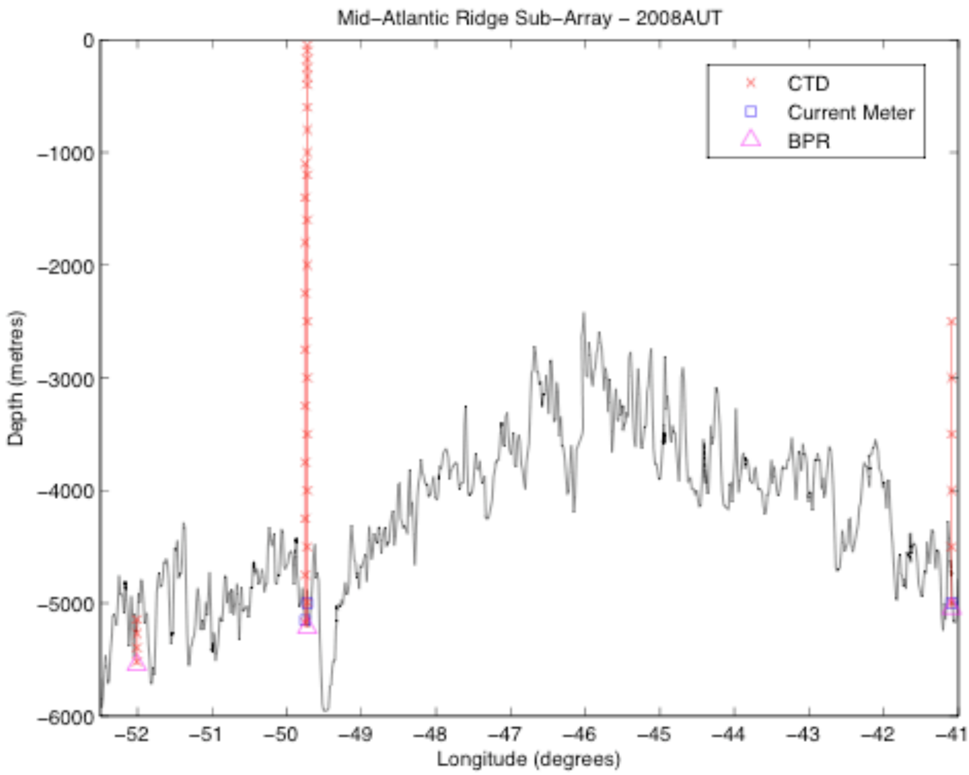


Figure H.3 *Schematic of the Mid-Atlantic Ridge Sub-Array as deployed on D334*