National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Oceanography Centre
Cruise Report No. 59
RRS *James Cook* Cruise JC174

20 OCTOBER - 26 NOVEMBER 2018

Rapid Cruise Report for Cruise JC174

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DOCUMENT DATA SHEET

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PUBLICATION DATE 2019

TITLE

RRS *James Cook* Cruise JC174 20 October – 26 November 2018. Rapid cruise report for Cruise 174.

REFERENCE

Southampton, UK: National Oceanography Centre, Southampton, 185pp.
(National Oceanography Centre Cruise Report, No. 59)

ABSTRACT

The purpose of RRS James Cook cruise JC174 was to refurbish the RAPID 26°N array of moorings that span the Atlantic from the Bahamas to the Canary Islands. Las Palmas on Saturday 20th October 2018 and ended in the evening of Tuesday 26th November at Freeport, Bahamas. There was a port call at Nassau, Bahamas on 16th November to take on board additional equipment and one scientist.

The moorings are part of a purposeful Atlantic wide array that monitors the Atlantic Meridional Overturning Circulation and the associated heat transport. The RAPID-MOCHA-WBTS array is a joint UK- US programme.

During JC174 moorings were serviced at sites: EBH4, EBH4L, EBH3, EBH2, EBH1, EBH1L, EBHi, EB1, EB1L, MAR3, MAR3L, MAR2, MAR1, MAR1L, MAR0, WB6, WB4, WB4L, WBH2, WB2, WB2L, WB1, WBADCP and WBAL. Sites with suffix 'L' denote landers fitted with bottom pressure recorders.

Moorings were equipped with instruments to measure temperature, conductivity and pressure, and a number of moorings were also equipped with current meters and/or oxygen sensors. The ABC Fluxes project extends the measurements on the RAPID 26°N array to include biological and chemical measurements.

CTD stations were conducted throughout the cruise for purposes of providing pre- and post-deployment calibrations for mooring instrumentation (including oxygen and carbonate chemistry sampling) and for testing mooring releases prior to deployment.

The RAPID telemetry system was deployed adjacent to mooring WB2, and 24 temperature sensors and 2 75kHz ADCPs were recovered from mooring WB1 for the MerMEED project.

Shipboard underway measurements were systematically logged, processed and calibrated, including: surface meteorology, 5m depth sea temperatures and salinities, water depth, and navigation. Water velocity profiles from 15 m to approximately 800 m depth were obtained using two vessel mounted Acoustic Doppler Current Profilers (one 75 kHz and one 150 kHz)

KEYWORDS

Atlantic Meridional Overturning Circulation, AMOC, RAPID, moorings, mooring array, North Atlantic

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1 Scientific and Ship's Personnel

Name	Position	Affiliation
James Gwinnell	Master	
Robert Ovenden	Chief Officer (to 16th Nov)	
Evelyn Voaden	Chief Officer (from 16th Nov)	
Malcolm Graves	2nd Officer	
Ewan MacWilliam	3rd Officer	
Keith Sneddon	Chief Engineer	
Noel Doherty	2nd Engineer	
Alan MacNeil	3rd Engineer	
Edin Silajdzic	3rd Engineer	
Dave Hawksworth	ETO	
Paula McDougall	Purser	
John Hopley	CPOS	
Greg Lewis	CPOD	
Duncan Lawes	ERPO	
Will McLennan	PO	
Steve Day	SG1A	
Brian Ray	SG1A	
Jason Reynolds	SG1A	
Kevin Riley	SG1A	
Darren Caines	Head Chef	
Jacqueline Waterhouse	Chef	
Pete Robinson	Steward	
Kevin Mason	Steward	
Jack Bush	Cadet	
Andrea Dodd	Cadet	
John Soares	Cadet	
David Smeed	Chief Scientist	NOCS
Pete Brown	Scientist	NOCS
Lidia Carracedo	Scientist	NOCS
Ben Moat	Scientist	NOCS
Darren Rayner	Scientist	NOCS
Hannah Wright	Scientist	NOCS
Steve Mack (From 16 Nov)	Scientist	NOCL
Philip Leadbitter	PhD Student	Univ. East Anglia
Emma Worthington	PhD Student	NOCS
Paul Provost	Senior Technical Officer	NOCS/NMFSS
Jeff Benson	Technician (Moorings)	NOCS/NMFSS
Dean Cheeseman	Technician (Engineering)	NOCS/NMFSS
Dave Childs	Technician (Moorings)	NOCS/NMFSS
Chris Crowe	Technician (Moorings)	NOCS/NMFSS
Colin Hutton	Technician (Moorings)	NOCS/NMFSS
Mark Maltby	ITO	NOCS/NMFSS
Nick Rundle	Technician (Moorings)	NOCS/NMFSS
John Wynar	Technician (Moorings)	NOCS/NMFSS
Thomas Ballinger	Trainee	NOCS/NMFSS
Nick Harker	Trainee	NOCS/NMFSS
Tim Powell	Trainee	NOCS/NMFSS

Table 1.1 Cruise personnel.

2 Itinerary

Cruise JC174 aboard the RRS James Cook sailed from Las Palmas on Saturday 20th October 2018 and ended in the evening of Tuesday 26th November at Freeport, Bahamas. There was a port call at Nassau, Bahamas on 16th November to take on board additional equipment and one scientist.

Work on the eastern boundary array started on 20th October with a shallow test CTD followed by two calibration CTDs followed by the servicing of mooring EBH3 the following day. The eastern boundary array was completed on 29th October with the deployment of EB1. Unfortunately, mooring EBH4 could not be recovered. Both releases appeared to release ok but ranges indicated that they did not rise from the seafloor. A drag was undertaken, but without success

Work on the mid-Atlantic array, including the NOG sediment trap mooring was completed between 4th and 9th March. During the following transit to the western boundary array three deep Argo floats were and calibration CTDs were completed prior to each float deployment. After deployment of mooring WB6 at 70°31 W the ship proceeded to Nassau to complete clearance for work in Bahamian waters.

Following departure form Nassau work on the western boundary array was completed from 17th to 25th November. This included deployment of the MYRTLE telemetry lander at site WB2. The cruise concluded with an ADCP survey to the east and south of Abaco Island, before docking in Freeport in the evening of 26th November.

A full itinerary is given in Table 2.1 below.

Date	Operation	Start time	End time	Durat. (hrs)	Latitude (°N)	Long. (°W)	Notes
Sat 20 Oct	Depart Las Palmas	11:20					Depart delayed for electrical repair following rain
	Test CTD0	15:27	15:59	00:32	28°42.19	15°45.49	
	CTD1	16:50	20:55	04:05	28°42.19	15°45.49	8 releases, 24 microcats
	CTD2	22:29	03:22	04:51	28°42.19	15°45.49	6 releases, 24 microcats Extra time for ODOs adaptive sampling
Sun 21 Oct	Transit to EBH3						
	Recover EBH3	14:41	16:37	01:56			
Mon 22 Oct	Attempt recovery of EBH4	08:41	09:48	01:07			Good comms. and release ok but no movement
	Drag for EBH4	12:10	18:50	06:40	27°50.53	13°32.80	Recovered two old anchors and dragged releases c. 2 miles
Tue 23 Oct	Recover EBH4L6	06:51	08:00	01:09			
	Deploy EBHL8	08:32	08:39	00:07	27° 52.15	13° 30.65	
	Deploy EBH4	10:03	11:28	01:25	27° 51.40	13° 32.46	
	Deploy EBH3	13:32	16:10	01:38	27° 48.52	13° 44.79	
	CTD3	18:10	19:23	01:13	27°52.00	13°32.14	For calibration of deployed ODOs
	Trilateration of EBH4	19:36	21:02	01:26			
	CTD4	22:51	00:10	01:19	27°49.11	13°44.39	For calibration of deployed ODO
Wed 24 Oct	Trilateration of EBH3	00:25	02:23	01:58			
	Recover EBH2	06:52	08:24	01:32			
	Deploy EBH2	09:27	09:59	00:32	27° 36.90	14° 12.62	
	Transit to Las Palmas						
	Boat transfer	16:40	17:15				Collection of CTD swivel
Thu 25 Oct	Recover EBH1L	06:49	08:14	01:25			

	Recover EBH1	08:36	10:16	01:40			
	Deploy EBH1	11:44	12:17	00:33	27° 13.36	15° 25.33	
	Deploy EBHL8	13:06	13:11	00:05	27° 13.02	15° 25.97	
	Transit to EBHi						
Fri 26 Oct	CTD5	21:59	02:06	04:07	24°55.02	21°18.00	6 releases, 24 microcats
Sat 27 Oct	Recover EBHi	08:35	10:16	01:40			
	Deploy EBHi	10:46	11:22	00:36	24° 55.98	21° 15.93	
Sum 28 Oct	CTD6 - 5100m	04:58	09:43	04:45	23°46.50	24°09.40	8 releases, 24 microcats
	Recover EB1	10:18	15:18	05:00			
	Attempt recover EB1L11	15:50					Released ok but did not move
Mon 29 Oct	Deploy EB1L13	09:10	09:15	00:05	23° 47.91	24° 07.75	
	Deploy EB1	12:15	16:29	03:45	23° 44.14	24° 10.66	Deployed early to avoid long tow with the RAS
	Start trilateration	17:27	18:06				
	CTD7 - 400m	18:43	19:22	00:39	23°43.57	24°10.59	Sample same time as RAS
	CTD8 - 5100m	20:26	00:49	04:23	23°44.35	24°11.85	24 microcats. Post deploy ODO cal.
Tue 30 Oct	Trilaterate EB1L13	02:20	03:01				
	Transit to MAR3						
Thu 1 Nov	CTD9	14:06					Abandoned after pipe to O2 sensor separated
	CTD10 - 5600m	14:42	20:15	05:33	23°23.43	30°57.28	releases, microcats
Fri 2 Nov	Deploy Argo 7217	10:21			23°43.63	38°00.07	
Sat 3 Nov	Recover MAR3L10	08:08	10:52	02:44			Imploded glass resulted in slow rise
	Recover MAR3	11:35	16:25	04:50			
	Recover NOG	17:39	20:08	02:29			
	CTD11 - 3500m	21:00	00:40	03:40	23°45.64	41°05.27	For shallow rated microcats

Sun 4 Nov	Deploy MAR3	11:22	15:21	03:59	23° 52.15	41° 05.41	
	Deploy MAR3L12	16:16	16:21	00:05	23° 51.52	41° 05.36	
	Deploy NOG	17:56	19:46	01:50	23° 45.36	41° 05.77	
	Trilaterate moorings	20:37	00:07	03:30			
Mon 5 Nov	Deploy Argo 7216	12:36			23°52.28	43°30.03	
Tue 6 Nov	Deploy Argo 7215	14:13			24°07.69	49°00.12	
	Deploy MAR1L12	17:15		04:54			
	Recover MAR1L10	18:22					
	CTD12	21:13	01:52	04:39	24°11.77	49°44.42	Pre recovery O2 calibration
Wed 7 Nov	Recover MAR1	10:14	16:02	04:52			
	CTD13	18:58	23:52	04:54	24°11.03	49°44.97	microcats
	Deploy PIES	17:15	17:20	00:05	24° 10.92	49° 45.93	
Thu 8 Nov	Deploy MAR1	12:21	17:15	04:54	24° 09.97	49° 44.95	
	CTD14	19:12	20:02	00:50	24°10.96	49°45.02	To coincide with RAS sample
	CTD15	21:00	01:36	04:36	24°10.98	49°46.28	Post deploy O2 calibration
Fri 9 Nov	Attempt recovery of MAR0	14:18					Released ok but failed to rise.
	Deploy MAR0	18:41			25° 08.68	52° 01.26	Modified mooring design to use all syntactic. Moved deployment site.
	Triangulate	19:20	20:10				Two ranges
Sat 10 Nov	CTD16	11:24	15:49	04:25	25°21.83	55°00.07	Pre- Deep Argo deploy
	Deploy Deep Argo No 25	15:59			25°21.77	55°00.04	
Mon 12 Nov	CTD17	07:03	11:24	04:21	24°40.44	62°45.00	Pre- Deep Argo deploy
	Deploy Deep Argo No 22	11:37			24°40.43	62°44.75	
	Recover Deep Argo 6028		13:45		24°34.27	62°50.80	For Scripps
Tue 13 Nov	CTD18				25°52.45	68°04.90	Pre- Deep Argo deploy

	Deploy Deep Argo No 23	21:47			25°52.45	68°04.90	
Wed 14 Nov	Recover wb6	11:24	14:09	02:45			
	Deploy wb6	16:14	17:39	01:25	26° 29.73	70° 31.40	BPR swapped after damage during deployment
	CTD19						
	Complete triangulation		23:45				
Thu 15 Nov	Transit to Nassau						
Fri 16 Nov	Nassau port call	12:55	18:15				Take on equipment and personnel
Sat 17 Nov	CTD20	07:27	11:06	03:39	26°26.43	75°44.76	
	Recover wb4	11:50	17:04	05:14			
	Recover wb4l12	18:15	20:57	02:42			Recovered for inspection new design
Sun 18 Nov	Recover wb4l11	11:19	13:07	01:48			
	Deploy wb4	16:10	21:05	04:55	26° 27.10	75° 43.61	
	Deploy wbl13	21:41	21:46	00:05	26° 28.74	75° 43.58	New syntactic lander
	CTD21	23:21	03:42	04:21	26°28.50	75°44.00	
Mon 19 Nov	Boat transfer	13:00					Postponed
	Recover wbadcp	15:52	16:30	00:38			
	Deploy wbadcp	17:24			26° 31.89	76° 52.00	
	Deploy wbal8	18:21	18:25	00:04	26° 31.46	76° 52.00	
	Recover WBP1	18:56	19:59	01:03			
	Attempt recovery of wb2l11	21:12	22:06	00:54			Reply from releases ok but did not rise
	CTD22	23:22	03:02	03:40	26°30.00	76°37.00	
	CTD23	04:40	05:10	00:30	26°30.50	76°49.00	
Tue 20 Nov	Recover wbh2	11:54	15:36	03:42			
	Deploy wbh2	18:11	21:16	03:05	26° 28.79	76° 37.64	

	CTD24	22:14	02:36	04:22	26°30.00	76°37.00	Post deploy O2 calibration
Wed 21 Nov	CTD25	04:18	05:37	01:26	26°30.80	76°48.50	Pre-recovery of wb1
	Boat transfer						To recover
	Recover WB2	14:11	16:02	01:26			
	Recover WB1	19:11	21:29	02:18			
Thu 22 Nov	CTD26	00:04	03:54	03:50	26°30.90	76°44.42	
	Deploy MYRTLE lander	15:50	20:05	04:15	26°30.69	76°44.40	Released at 18:48:43
	Deploy wb2l13	20:45	20:49	00:04	26° 30.28	76° 44.77	
	CTD27	23:07	03:27	03:20	26°31.50	76°37.00	Deep nutrient samples
Fri 23 Nov	Deploy wb2	14:34	19:04	04:30	26° 31.00	76° 44.44	With telemetry buoy
	Trilaterate						wbh2, wb2, wb2l13
Sat 24 Nov	Trilaterate						wbadcp, wbal8
	Deploy wb1	16:56	19:22	02:24			Delayed start due to weather
	CTD28	20:51	23:45	02:57	26°30.11	76°48.50	Cal dip for RBRs and post deploy O2 cal + hi-res nutrient samples
Sun 25 Nov	CTD29	00:10	00:45	00:35	26°30.11	76°48.50	Timed for RAS sample at WB1
	ADCP survey						
	Myrtle pod recovery	11:00	13:15				On surface 11:05. Deployed boat to recover
	ADCP survey						
Mon 26 Nov	ADCP survey						
	Transit Freeport						
	Dock Freeport						

Table 2.1 Cruise itinerary.

3 Introduction

This cruise report is for cruise JC174 conducted aboard RRS *James Cook* in Autumn 2015. The primary purpose of the cruise was to service the UK contribution to the RAPID-MOC/MOCHA mooring array.

The RAPID-MOC/MOCHA array was first deployed in 2004 to measure the Atlantic Meridional Overturning Circulation (AMOC) at 26°N and has been maintained by regular service cruises since then. The array and associated observations are funded by NERC, NSF and NOAA. The NERC contribution to the first four years of measurements was funded under the directed programme "RAPID Climate Change". Following an international review NERC continued funding to 2014 under the programme "RAPID-WATCH". The servicing and redeployment of the UK moorings on this cruise are conducted under the "RAPID-AMOC" programme, which is funded until 2020. NSF and NOAA have also continued funding and commitments so that the system can continue operating at the same level of activity.

RAPID-AMOC continues the measurements at 26°N and extends these to include biological and chemical measurements in order to determine the variability of the AMOC and its links to climate and the ocean carbon sink on interannual-to-decadal time scales. The ABC Fluxes project is also funded under RAPID-AMOC and is adding biogeochemical samplers and sensors to the array.

Further information on the RAPID-MOC/MOCHA array please see previous cruise reports (detailed in Table 3.1)

As with previous RAPID cruises we also serviced the Northern Oligiotrophic Gyre (NOG) mooring, which is part of the FixO^3 network (more information at: http://noc.ac.uk/observatories/nog). Additional work was also conducted for the MeRMEED project: (http://gtr.rcuk.ac.uk/projects?ref=NE/N001745/1) which added 24 additional temperature sensors and two 75kHz ADCPs on the WB1 mooring.

As on previous cruises we deployed a number of Argo floats supplied by the UK Met Office. In addition, 3 Deep Argo floats were deployed. All Argo data is freely available online see http://www.argo.net/ for further details.

3.1 Results and Data Policy

All data and data products from RAPID 26°N project are freely available. The NERC data policy may be found at http://www.bodc.ac.uk/projects/uk/rapid/data policy/. Access to data and data products can be obtained via http://www.rapid.ac.uk/rapidmoc/ and http://www.rsmas.miami.edu/users/mocha/index.htm). Data may also be obtained directly from http://www.bodc.ac.uk/.

A full list of published papers is available on the programme website at http://www.rapid.ac.uk/publications.php.

3.2 Previous RAPID-MOC Cruises

Table 3.1 details the previous cruises completed as part of the RAPID-MOC project with information on the relevant cruise reports for reference, note this does not include all NOAA WBTS hydrography cruises.

Cruise	Vessel	Date	Objectives	Cruise Report
D277	RRS *Discovery*	Feb - Mar 2004	Initial Deployment of Eastern Boundary and Mid-Atlantic Ridge moorings	Southampton Oceanography Centre Cruise Report, No 53, 2005
D278	RRS *Discovery*	Mar 2004	Initial Deployment of UK and US Western Boundary Moorings	Southampton Oceanography Centre Cruise Report, No 53, 2005
D279	RRS *Discovery*	Apr –May 2004	Transatlantic hydrography (125 CTD stations)	Southampton Oceanography Centre, Cruise Report, No 54, 2005
P319	RV *Poseidon*	Dec 2004	Emergency deployment of replacement EB2 following loss	Appendix in National Oceanography Centre Southampton Cruise Report, No. 2, 2006
CD170	RRS *Charles Darwin*	Apr 2005	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings	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	National Oceanography Centre Southampton Cruise Report, No. 2, 2006
CD177	RRS *Charles Darwin*	Nov 2005	Service and redeployment of key Eastern Boundary moorings	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 Western Boundary moorings and WBTS hydrography section	National Oceanography Centre Southampton Cruise Report, No. 16, 2007
D304	RRS *Discovery*	May - Jun 2006	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings	National Oceanography Centre Southampton Cruise Report, No. 16, 2007
P343	RV *Poseidon*	Oct 2006	Service and redeployment of key Eastern Boundary moorings	National Oceanography Centre Southampton Cruise Report No. 28, 2008.
P345	RV *Poseidon*	Nov – Dec 2006	Emergency redeployment of EB1 and EB2 following problems on P343	National Oceanography Centre Southampton Cruise Report No. 28, 2008.
SJ-14-06	RV *Seward Johnson*	Sep – Oct 2006	Recovery and redeployment of WB2 and US Western Boundary moorings, and WBTS hydrography section	Appendix G in 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 WBTS hydrography section	National Oceanography Centre, Southampton Cruise Report, No 29
D324	RRS *Discovery*	Oct – Nov 2007	Service and redeployment of Eastern Boundary and Mid-Atlantic Ridge moorings	National Oceanography Centre, Southampton Cruise Report, No 34
SJ0803	RV *Seward Johnson*	Apr 2008	Service and redeployment of the Western Boundary moorings	National Oceanography Centre, Southampton Cruise Report, No 37
D334	RRS *Discovery*	Oct-Nov 2008	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	National Oceanography Centre, Southampton, Cruise Report No. 38, 2009
RB0901	RV *Ronald H. Brown*	Apr – May 2009	Service and redeployment of the UK and US Western Boundary moorings and the WBTS hydrography section	National Oceanography Centre, Southampton Cruise Report, No 39, 2009
D344	RRS *Discovery*	Oct – Nov 2009	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	National Oceanography Centre, Southampton, Cruise Report No. 51, 2010
D345	RRS *Discovery*	Nov – Dec 2009	Recovery and redeployment of US Western Boundary moorings, and WBTS hydrography section	RAPID/MOCHA Program Report (W. Johns, RSMAS).
D346	RRS *Discovery*	Jan – Feb 2010	Transatlantic hydrography (135 CTD stations)	National Oceanography Centre Cruise Report, No 16, 2012
OC459	RV *Oceanus*	Mar – Apr 2010	Service and redeployment of the Western Boundary moorings	National Oceanography Centre Cruise Report, No 01, 2010
RB1009	RV *Ronald H. Brown*	Nov – Dec 2010	Recovery of WB4 and WB3L3. Redeployment of WB4.	Appendix in: National Oceanography Centre Cruise Report, No -01, 2010
D359	RRS *Discovery*	Dec 2010 – Jan 2011	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	National Oceanography Centre Cruise Report, No. 09, 2011
KN200-4	RV *Knorr*	Apr – May 2011	Service and redeployment of Western Boundary Moorings and WBTS hydrography section	National Oceanography Centre Cruise Report, No 07, 2011
JC064	RRS *James Cook*	Sep – Oct 2011	Service and redeployment of the Eastern Boundary and Mid-Atlantic	National Oceanography Cruise Report, No. 14, 2012

			Ridge moorings	
RB1201	RV *Ronald H. Brown*	Feb – Mar 2012	Service and redeployment of Western Boundary Moorings and WBTS hydrography section	National Oceanography Centre, Cruise Report No. 19, 2012
EN517	RV *Endeavor*	Sep – Oct 2012	Service of US moorings in Western Boundary	RV Endeavor Cruise EN-517 Cruise Report
D382	RRS *Discovery*	Oct – Nov 2012	Service and redeployment of full UK RAPID array	National Oceanography Centre Cruise Report No. 21, 2012
AE1404	RV *Atlantic Explorer*	Mar 2014	Service of US moorings in Western Boundary	RV Atlantic Explorer Cruise AE-1404 Cruise Report
JC103	RRS *James Cook*	Apr – Jun 2014	Service and redeployment of full UK RAPID array	National Oceanography Centre Cruise Report No. 30, 2015
EN570	RV *Endeavor*	Oct 2015	Service of US moorings in Western Boundary	RV Endeavor Cruise EN-570 Cruise Report
DY039	RRS *Discovery*	Oct – Dec 2015	Service and redeployment of full UK RAPID array	National Oceanography Centre Cruise Report, 37
DY040	RRS *Discovery*	Dec -2015 – Jan 2016	Transatlantic hydrography	National Oceanography Centre Cruise Report, XX
EN598	RV *Endeavor*	May, 2017	Service of US moorings in Western Boundary	RV Endeavor Cruise EN-598 Cruise Report
JC145	*RRS James Cook*	Feb –Apr 2017	Service and redeployment of full UK RAPID array	National Oceanography Centre Cruise Report, 52
JC174	*RRS James Cook*		Service and redeployment of full UK RAPID array	This report

Table 3.1 Cruises conducted as part of the RAPID 26°N project

4 Scientific computing systems

David Smeed

The Linux workstations used for scientific processing of data were replaced prior to the cruise. The two new workstations, running Centos 7, taken to sea were:

- 'Koaekea' a Dell T5820, and,
- 'Akeake' a Dell T3420

All processing was done on 'Koaekea' and 'Akeake' was kept as a backup. A script 'keep_akeake_in_sync' was run every 6 hours (using cron) to keep the 'programs', 'cruise', 'rapid', and 'users' directories in sync. Both workstations were connected to one UPS which also powered one monitor that could be used if needed when turning the workstations on or off (it is not necessary to have a monitor and keyboard connected to each all of the time).

Mexec v3 software was used for most data processing, see data processing sections of the report for further details. Git was used to keep track of changes to the software. Matlab v2011b was used. This and some other software packages must be loaded using 'module'. It was found that putting module commands in the .cshrc file caused issues with some Matlab programs and it is better to keep these in the .login file.

5 NMFSS Ship Systems Computing and Underway Instruments

Mark Maltby, Nick Harker

5.1 Overview

The information in this section is been taken from the NMF Scientific Ship Systems Cruise Report where full details can be found.

The Ship-fitted instruments are listed in Table 5.1, the data were logged by the Techsas 5.11 data acquisition system. The system creates NetCDF and ASCII output

data files. Data were additionally logged into the legacy RVS Level-C format and raw NMEA strings from the instruments were also time stamped and logged.

Manufacturer	Model	Function/data types	Logged?
Steatite	MM3S	GPS network time server (NTP)	N
Applanix	POS MV	DGPS and attitude	Y
C-Nav	3050	DGPS and DGNSS	Y
Kongsberg Seatex	DPS116	Ship's DGPS	Y
Kongsberg Seatex	Seapath 330+	DGPS and attitude	Y
Sonardyne	Fusion USBL	USBL	Y
Sperry Marine		Ship gyrocompasses x 2	Y
Chernikeef Instruments	Aquaprobe Mk5	Electromagnetic speed log	Y
Kongsberg Maritime	Simrad EA640	Single beam echo sounder (hull)	Y
Kongsberg Maritime	Simrad EM122	Multibeam echo sounder (deep)	Y
Kongsberg Maritime	Simrad EM710	Multibeam echo sounder (shallow)	N
Kongsberg Maritime	Simrad SBP120	Sub bottom profiler	N
Kongsberg Maritime	Simrad EK60	Scientific echo sounder (fisheries)	N
NMFSS	CLAM	CLAM system winch log	Y
NMFSS	Surfmet	Meteorology suite	Y
NMFSS	Surfmet	Surface hydrography suite	Y
		Skipper log (ship's velocity)	Y
OceanWaveS GmbH	WaMoS II	Wave Radar	Y
Teledyne RD Instruments	Ocean Observer 75 kHz	VM-ADCP	Y
Teledyne RD Instruments	Ocean Observer 150 kHz	VM-ADCP	Y
DGS	AT1M	Gravity	Y

Table 5.1 Ship-fitted instruments

There was downtime with systems supplied by underway surface water for 18 hours from 11/11/18 17:43 to 12/11/18 11:40 due to repairs required to leaking pipe in the deck lab.

There are several gaps in data from EA640 and EM122 due to isolation of the systems during release and ranging of moorings.

5.2 Position and attitude

GPS and attitude measurement systems were run throughout the cruise.

The ***Applanix POSMV*** system is the vessel's primary GPS system, outputting the position of the ship's common reference point in the gravity meter room. The POSMV is available to be sent to all systems and is repeated around the vessel. The position fixes attitude and gyro data are logged to the Techsas system. True Heave is logged by the Kongsberg EM122 & EM710 systems.

The ***Kongsberg Seapath 330+*** system is the vessel's secondary GPS system. This was the position and attitude source that was used by the EM122 & EM710 due to its superior real-time heave data. Position fixes and attitude data are logged to the Techsas system.

The ***CNav 3050*** GPS system is the vessel's differential correction service. It provides the Applanix POSMV and Seapath330+ system with RTCM DGPS corrections (greater than 1m accuracy). The position fixes data are logged to the Techsas system.

5.3 Meteorology and sea surface monitoring package

The NMF Surfmet system was run throughout the cruise, excepting times for cleaning, entering and leaving port and whilst alongside (see Table 5.2).

The Surfmet system is comprised of:

- Hull water inlet temperature probe (SBE38).

- Sampling board conductivity, temperature salinity sensor (SBE45).
- Sampling board transmissometer (CST).
- Sampling board fluorometer (WS3S)
- Met platform temperature and humidity probe (HMP45).
- Met platform port and starboard ambient light sensors (PAR, TIR).
- Met platform atmospheric pressure sensor (PTB110).
- Met platform anemometer (Windsonic).

Date	Start Time	Stop Time	Cleaned	Transmissivity (v)	
				High	Low
Underway Water started on departing ESLPA					
20/10/2018	13:07	--	Yes	4.8007	0.0583
07/11/2018		18:20			
07/11/2018	18:29		Yes	4.7630	0.0586
11/11/2018		17:43		Stopped due to pipe leak	
12/11/2018	11:40				
Underway Water stopped and restarted due port call in Nassau					
16/11/2018		11:50		Port Call	
16/11/2018	19:45		Yes	4.7502	0.0584
26/11/2018		22:25	Yes	4.7360	0.0584
Underway Water stopped on arrival to Freeport					

Table 5.2 Underway water logging events

5.4 Hydro-acoustic systems

The EA640 single-beam echo-sounder was run throughout the cruise apart from during release and ranging of moorings when it was turned off to avoid interference. Both the 10 kHz and 12 kHz were run in active mode triggered by K-Sync. Pulse parameters were altered during the cruise in response to changing depth. It was used with a constant sound velocity of 1500 ms^{-1} throughout the water column to allow it to be corrected for sound velocity in post processing.

The EM122 multibeam echo sounder was run throughout the cruise apart from during release and ranging of moorings triggered by K-sync. The position and attitude data was supplied from the Seapath 330+ due to its superior real-time heave. Applanix PosMV position and attitude data is also logged to the .all files as the secondary source and True Heave *.ath file are logged to allow for inclusion during reprocessing. Sound velocity profiles were derived from a statistical model using SHOM & Ifremer's DORIS programme, derived from CTD data and from the Valeport SV profiler.

The surface Sound Velocity (SV) sensor (AML SmartSV) mounted on the drop keel was used throughout providing SV data to the EM122. The port drop keel remained flush with the hull for the duration of the cruise.

EM122 data was post processed using CARIS HIPS&SIPS 10.4 data was relatively clean with little cleaning required for data up to 18:00 06/11/18 at this time the ship was trimmed from bow down to bow up to reduce the number of bilge alarms. This change had a detrimental effect on the data due to air bubble being sucked in by the bulbous bow.

Both the 75 and 150 kHz were run consistently during the cruise.

5.5 Other systems

The single axis bridge Skipper Log and the dual axis Chernikeef science log were logged throughout the cruise. The Chernikeef log was calibrated in December 2017 offshore of Tenerife with an additional adjustment on 21/03/2018.
The AT1M-U12 gravity meter was run throughout the cruise. Tie in at the beginning and end of the cruise were performed at absolute stations. QC was performed on the AT1M-U12 data and good comparison was found with the Sandwell Smith grid.
The Wamos wave radar was run throughout the cruise but the system is currently not calibrated and thought to be over-reading wave height.

6 UNDERWAY DATA AND PROCESSING

Philip Leadbitter, Emma Worthington

6.1 Navigation, surfmet, and bathymetry data processing

Below is an overview of the daily processing. The bold text refers to MatLab scripts in the Mexec Suite. A watch keeping log was filled out every 2 hours between 0800 and 2000 (ship time, noted down in UTC) checking a number of the underway systems were functioning as expected over the course of the day. Bottle samples from the underway system were taken every 4 hours.

6.1.1 Navigation

The data acquisition system was started whilst docked at Las Palmas during the mobilization. This allowed for three days of data to be collected whilst stationary. After the three days each of the four main navigation streams (POSMVPOS, SEAPATH, CNAV and DPS) were compared with the aim of deciding the best to use for the rest of the data. After comparison the POSMVPOS stream was used as this gave the most reliable navigation details. The SEAPOS gave good agreement as well but gave a less consistent spread over the 3 days. Both the CNAV and DPS were out by up to 0.5˚ latitude and longitude.

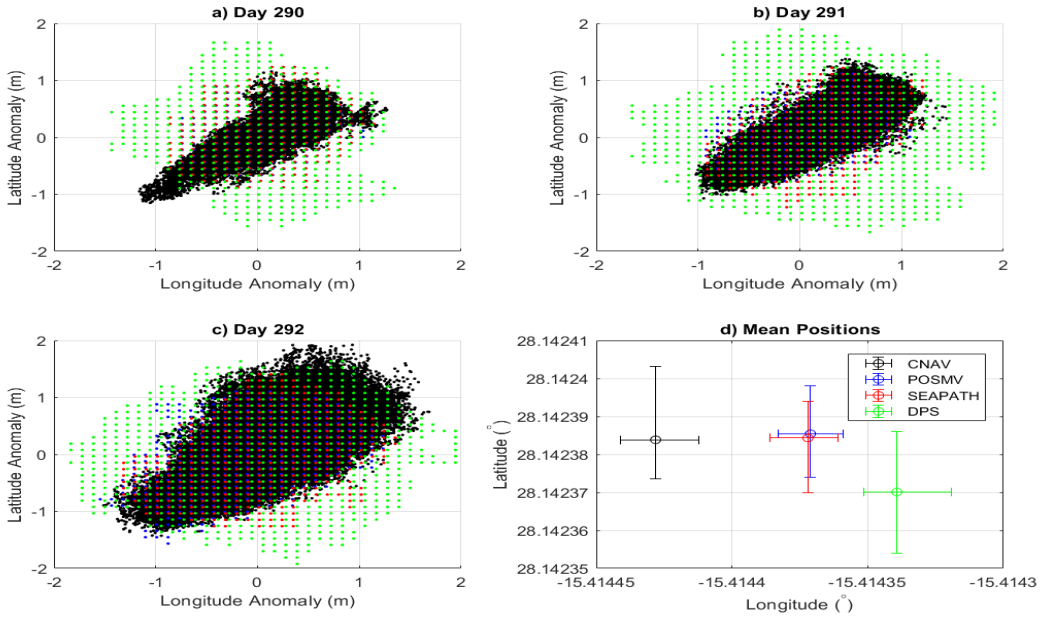

Figure 6.1 a) ,b) and c) show the latitude and longitude anomaly in meters of each navigation system d) shows the mean position of each navigation stream

and the maximum anomalies associated with them. CNAV has an offset of +0.27615 longitude and -0.0949 so that all the error bars show. When alongside the vessel was oriented from southwest (bow) to northeast (stern)
The main scientific heading was taken from the GYRO_S stream after comparing the headings or course over ground from the different navigational streams CNAV, POSMV, SEAPATH, GYROPMV and GYRO_S. This comparison was done on day 315 as there were no deployments with a general westward course. All of the data streams (other than the CNAV which was very noisy see figure 2) show very similar headings with all showing the same variation and changes over the course of the day.

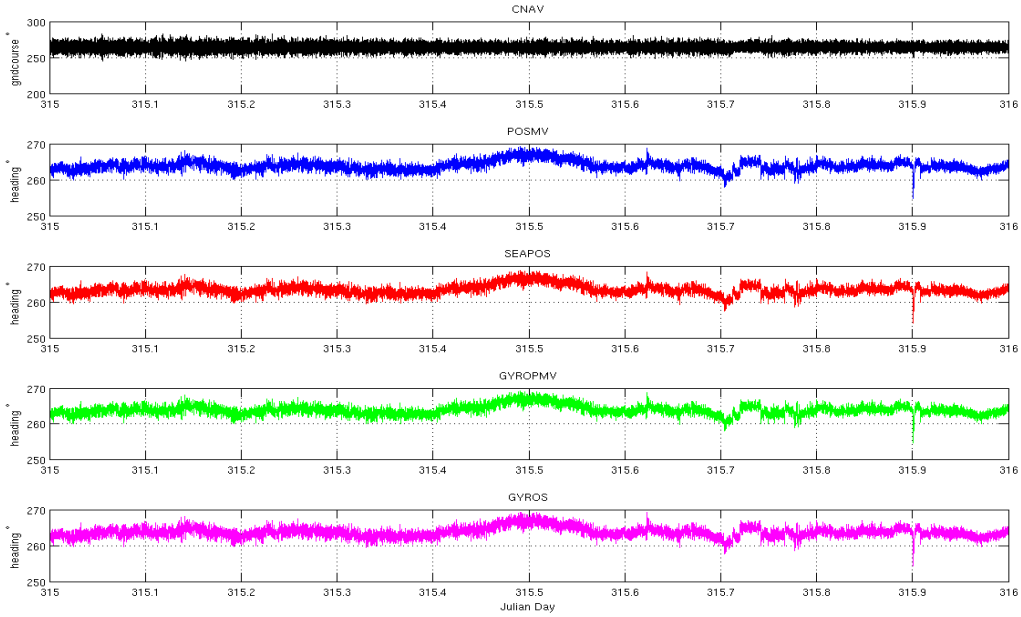

Figure 6.2 The five main gyro streams for Julian Day 315, the bottom panel for the GYRO_S was the final heading that was used.

6.1.2 Daily processing of underway data streams

Each day **techsas_linkscript** was run. This sorts all the Techsas files from the previous day. Following this **m_daily_proc** processes all the underway streams listed in mtnames. After applying preliminary quality control the day's data are appended to a file (following the convention *datastream_JC174_01.m*). Day 294 was appended twice between day 294 and 298. The append file was deleted and a new appended file was created by running using **m_daily_append_all**.
Once **m_daily_proc** has been run **mday_plots_all(*ddd*)** (where *ddd* refers to Julian day) is run. This creates plots for each of the streams of the underway data to check that the data are reasonable and highlight any issues. The following plots where created:
(1-4) The ship's path as seen by POSMVPOS, DPS, CNAV and SEAPOS. The main scientific stream that was being used was the POSMVPOS however each navigation stream was still checked on a daily basis so that if a backup was needed the other data streams showed a good match to the main stream
(5) The main scientific heading from the GYRO_S data stream
(6) The ships speed is plotted through the Chernikeef Log (CHF). The CHF has not been properly calibrated recently so doesn't give exact values of the ships speed. It does however give a good approximation and is useful for checking against other

varibles that may change if the ships speed changed such as heading, windspeed due to winds shadow etc. These changes line up well with changes in other data streams.
(7) The surfmet data shows wind speed, wind direction, humidity and air temperature.
(8) Shows true wind speed and true wind direction. Although mounted on the foremast the true wind speed and direction show some influence of being influenced by the vessel's superstructure when the predominant wind direction is from astern
(9-10) The underway water sampling split into **met_tsg** and **tsg** streams. On previous cruises these have been the same file but were separate files on JC174. These show transmission, fluorescence, conductivity, speed of sound through water and salinity (psu). This system was turned off between 1130 and 1945 JDate 320 (Nassau Port call), 1735 JDate 315 to 1135 JDate 316 for repairs to the pipes and 1800 to 1840 on JDate 313 for cleaning. Data from the JDate 302 to 311 for transmissometer (decreasing) and fluorometer (increasing) over this time due to organic build up in the system, salinity seems unaffected over this period.
The final processing was run at approximately 1430 UTC Julian day 330.

6.1.3 Bathymetry data

Bathymetry data were collected throughout the cruise, apart from when the ship was in port. For the most part, data from the two streams, EA600 and EM120, agreed well. In areas of rapidly changing bathymetry the single beam showed a lot of noise when the azimuth thruster was in use, mainly during deployment and recovery of moorings and CTD casts.
The first check of the bathymetry data involves bringing the EA600 single beam and EM120 swath streams together for comparison using **msim_02** and **mem120_02**. For this cruise no external bathymetry data were available to pull in. Quality control was based on the comparison between the two streams and an understanding of what caused noise in each stream. Suspect data from each stream were removed using **msim_plot** and **mem120_plot**.

6.2 TSG data and salinity calibration

Water samples were taken every 4 hours (0800, 1200, 1600 and 2000 ship's time) every day between days 293 to 327. A total of 133 bottle samples were taken. After being left in the temperature-controlled electronics workshop for a minimum of 24 hours the salinity from the bottles was measured using the same Autosal as the CTD samples and compiled in *sal_jc174_01.csv.* The times and dates of the samples were edited into this before using **mtsg_01** to load the bottle values. **mtsg_bottle_compare** was used to compare the salinity calculated from the bottles to the salinity from the TSG samples (see figure 6.3). Residuals are calculated and plotted against Julian day, sea surface temperature and sea surface salinity. A weak negative linear trend can be seen in all three variables. The TSG minus the sample salinity against time has a mean value of 0.0487 psu. After 4 outliers were removed a linear calibration (0.00089893/86400*time – 0.3278) was fitted to the TSG salinity values.

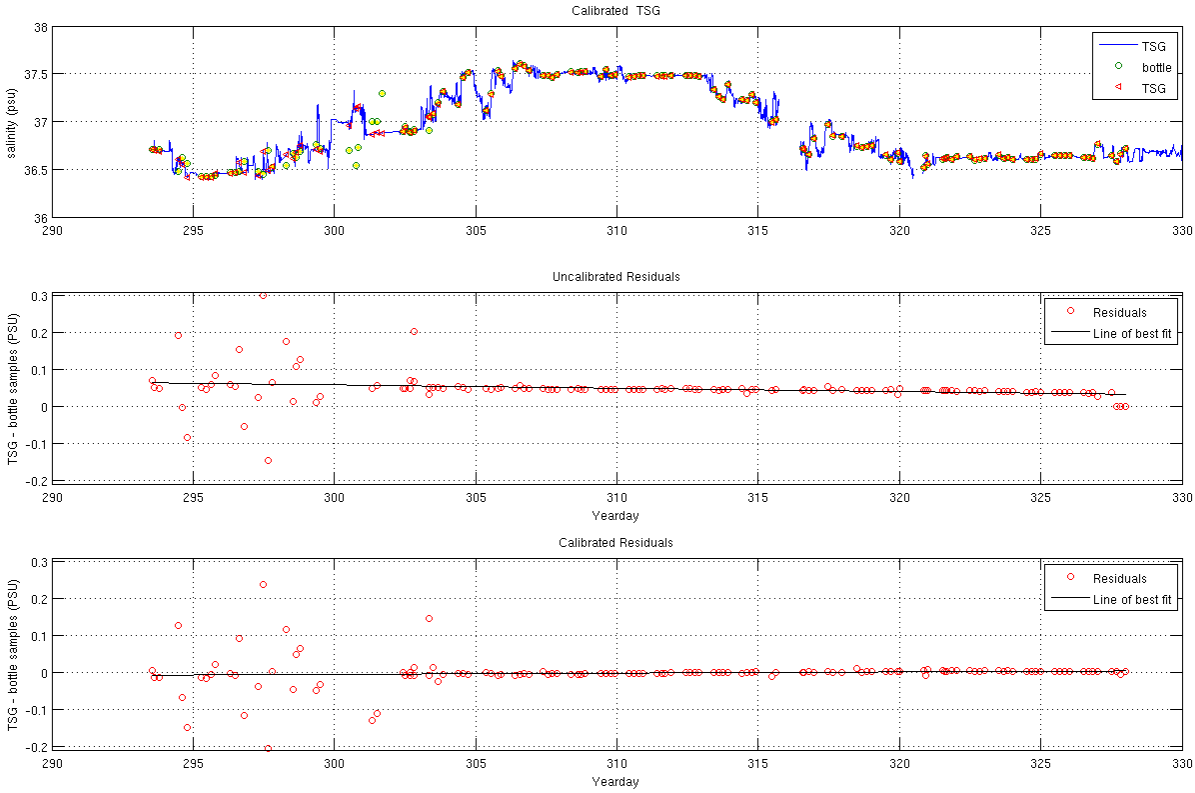

Figure 6.3 The top panel shows the TSG compared to the bottle samples. The second panel shows the uncalibrated residuals between TSG and bottles. The bottom panel shows the residuals of the TSG minus the bottles samples after the calibration has been applied

6.3 Vessel Mounted Acoustic Doppler Current Profiler (VMADCP)

The two vessel-mounted Acoustic Doppler Current Profiler (vmADCP) instruments were used throughout the cruise. They work at two different frequencies, 75 kHz, which penetrates deeper into the water column but has lower resolution; and 150 kHz, which has higher resolution but doesn't reach as deep. The two instruments are referenced in the text and within directory and filenames as os75 and os150.

Both instruments have transducers installed on the port-side keel. Although the keel can be dropped, for this cruise the retracted keel position was used, so the transducers were approximately 6.0 m below the waterline (compared with around 8.6 m in the dropped keel position).

Computer hardware and software

The instruments were controlled from the main lab, with a vmADCP designated computer for each of os75 and os150. There are three types of software installed on each computer: BBTalk, for communication with (and initialisation of) the vmADCP; VmDas, for data collection; and WinADCP, for data visualisation. VmDas is Windows-based software for data acquisition provided by TRDI. We will also use CODAS (Common Ocean Data Access System) processing software, which is a set of Python programs that operates on ADCP data and ancillary navigation data. CODAS can process UHDAS (University of Hawaii Data Acquisition System) data, and post-process VmDAS data.

Testing

Prior to the start of the cruise, the instruments were tested using the BBTalk software. The TestOS.rds script (found for each instrument locally at C:/Program Files (x86)/RD Instruments/RDI Tool/TestOS.rds) was run via BBTalk software, and the results saved as:

- OS75kHz/OS75_prechecks_20181020.txt
- OS150kHz/OS150_prechecks_20181020.txt

under the /jc174/Ship_Systems/Acoustics/ directory. All tests passed.

Configuration

For each of os75 and os150 two VmDas .ini configuration files were created with the commands shown in Table 6.1 with the only difference being whether the bottom tracking is on (BP100) or off (BP000), see Table 6.2. In the filenames NB indicates a 'narrowband'.

The plan was for bottom tracking to be on while we were in shallower water to allow calibration; otherwise it was to be off, as the data quality is affected, since every second ping is searching for the bottom rather than measuring water velocity.

OS75 Configuration code	OS150 (where different)	What it does
CR1		Restores the default configuration before doing any changes
CB411		Sets baud rate to 9600 bps, with no parity, one stop bit and 8 data bits
NN060	**NN040**	Sets number of bins to 60 (40) in narrowband mode.
NP00001		Ping in narrowband single-ping profile mode.
NS1600	**NS0800**	Bin size in cm
NF0800	**NF0400**	Data blanking distance below the instrument in cm.
BP001		Bottom track enabled (BP000 when disabled)
BX10000	**BX05000**	Maximum bottom depth search in decimetres
WD111100000		Output velocity configuration
TP000150	**TP000100**	Time in centi-seconds between bottom and water pings
TE00000200		Time between ensembles. However, a setting in vmDAS is used to tell the instruments to ping as fast as possible, and the output is single pings, so this has no effect.
EZ100001		Speed of sound calculated with the temperature sensor in the instrument
EX00000		Output beam coordinates
EA000900	**EA00000**	Transducer mis-alignment correction (in 1/100 degrees). This is only applied to average profiles displayed in vmDAS; the single-ping data are output in beam coordinates.
ED00060		Transducer depth in decimetres. This is 8.6 m for the keel down, 6.0 m for the keel up.
ES35		Salinity, for calculating the speed of sound. Set to 35 ppt.
CX 0, 1		ADCP triggers itself, rather than waiting for an external trigger.
CK		Store configuration to non-volatile ADCP memory, so that it remains there after launching.

Table 6.1 vmADCP configuration options for OS150 and OS75, set up using BBTalk software.

	Bottom tracking off	Bottom tracking on
os75	JC174_OS75NB_60bin_16m_BTOFF_nosync.ini	JC174_OS75NB_60bin_16m_BTON_nosync.ini
os150	JC174_OS150NB_40bin_8m_BTOFF_nosync.ini	JC174_OS150NB_40bin_8m_BTON_nosync.ini

Table 6.2 vmADCP configuration file names

6.3.1 Data acquisition

To allow easier handling of data, recording was stopped and restarted at around 11am each day. Data were collected using the VmDas software (version 1.48). This software uses the same vmADCP COM port as BBTalk, so only one can be run at once. VmDas collects and stores real-time single ping data, and produces both short- and long-term averages. Raw data are saved to 'JC174/Ship_Systems/Acoustics/OSxxxkHz/raw_data'.
The VmDas display was checked every 2 hours as part of the underway watchkeeping log.
The raw VmDas data files were regularly synchronised to the ship's networked data servers. It could take up to 30 minutes to synchronise once the data collection has been stopped, so it was important to allow that time to ensure all data files are complete.

6.3.2 Issues

The OS150 instrument stopped producing short-term averages on days 313 (9 Nov 2018) and 323 (19 Nov 2018). The reason was not known, and restarting the logging at 11am corrected the issue.

6.3.3 CODAS + UHDAS processing

To transfer the data for CODAS processing, the shell script **vmadcp_linkscript_jc** was run. This script copies the data from the ship's network servers to the processing directory on the mstar workstation.
Full documentation of the processing used can be found at https://currents.soest.hawaii.edu/docs/adcp_doc/index.html.
ENR data is the single-ping data recorded by VmDas. To process it using CODAS, we must convert it into the UHDAS format. The preliminary processing involves:

- Converting ENR and supporting (N1R, N2R) files as if they were logged by UHDAS
- Writing a control file for CODAS processing
- Processing from scratch as if it were UHDAS data

Before processing, a 'fake_uhdas_data' directory was created under jc174_os75 alongside the adcp_pyproc and vmdas_data directories. Under adpy_pyproc, a jc174_enrproc directory was created. The same was done for jc174_os150.
Multiple steps are required, so for ease and consistency of processing, a script **vmadcp_enr_proc** was created to process all the data between a start and end sequence for a given instrument. It is called with 3 arguments, with the first argument being the instrument frequency (75 or 150), and the second and third being the start and end sequences, e.g.,

```
>> vmadcp_enr_proc 75 004 006
```

For ease of editing, the cruise data was processed in chunks of 3 sequences at a time. The script shows the progress of the processing, and the user must press the space key when prompted to run scripts, or open GUIs to enter filenames and variables. Text output by the script informs the user what to do at each stage. When the script has run, the user needs to change directory to the processing directory that has been created for the sequence, e.g., os75_004_006/os75nb, and create a q_py.cnt control file. The easiest way is to copy and paste the text at the end of the script output, and then change the required parts in a text editor.

Once this has been done, the following command will do the processing (auto runs all the required steps).
>> quick_adcp.py --cntfile q_py.cnt --auto

6.3.4 Viewing processed data

The cruise track of the processed sequences can be viewed by running "plot_nav nav/a004006.gps" (the database name is set during the processing). The bottom track and watertrack outputs are found in cal/botmtrk/btcaluv.out and cal/watertrk/adcpcal.out respectively, and are used for calibrating the instrument output. The main way to view the processed data is using **dataviewer.py**.

Editing data

The UHDAS processing already has the default dataviewer.py editing parameters applied, and the processing guidelines recommend that **only egregiously bad data** is manually removed. The sequence data were examined visually using dataviewer, and any remaining bad data identified. These could then be removed by going to the edit directory within the appropriate processing directory, and running dataviewer.py with the -e edit option.

The editing mode allows changing of numerous thresholds, or manual removal of individual bins. Since there were only a small number of 'bad' bins, the default thresholds were not changed, and only manual editing was done, described in Table 6.3and Table 6.4.

Sequence numbers	Julian days	Reason for removing bad data
001 - 003	293.4 - 293.5	4 bins at top of section of automatically-removed section.
007 - 009	297.5 - 297.6	Bad profile while ship turning
019 - 021	311.0 - 311.1	Single bin within automatically-removed profile
028 - 030	319.5 - 319.6	Start of automatically-removed data when ship turning/stopping.
031 - 033	322.5 - 322.7	Several small groups of bins missed in large area of automatically-removed data
034 - 036	324.4 - 324.6	Ship turning
037 - 038	328.1 - 328.2	On edge of percent good, just missed by automatic threshold. Incongruously strong velocity.
039 - 039	328.8 329.2 - 329.3	Bad data bins near bottom. Bad data at edge of automatically-removed data while ship turning.

Table 6.3: Edits made to OS75 data.

Sequence numbers	Julian days	Reason for removing bad data
001 - 003	293.4 - 293.5	4 bins at top of section of automatically-removed section.
004 - 006	294.5 - 295.6	Single bin while ship turning
007 - 009	297.8	Bad bins at bottom while ship turning
016 - 018	306.55	2 bad bins while turning
019 - 021	307.8 - 308.0 ~310.5	Small number of bins at surface during changes in ship velocity
028 - 030	319.5 - 319.6	Start of automatically-removed data when ship turning/stopping.
031 - 033	320.5 - 320.6	Single bin at surface during change in ship velocity.
037 - 039	326.8 - 327.1 327.5 - 327.7 328.2 - 328.3	On edge of percent good, just missed by automatic threshold. Incongruously strong velocity.
040 - 040	329.2 - 329.3	Profile at end of automatically-removed data due to ship turning.

Table 6.4: Edits made to OS150 data.

Merging of data sequences
Processing of all sequences was done exactly as for the shorter sequence chunks. To apply the edits, the abadbin.asclog and abadprf.asclog files in the edit directory of each edited sequence needed to be copied to the full sequence edit directory as *.asc files. To prevent overwriting, each had the sequences appended, e.g. abadbin.asclog for sequences 004 to 006 becomes abadbin_004_006.asc. The edits were then applied by running
>> quick_adcp.py --steps2rerun apply_edit:navsteps:calib --auto

6.3.5 Final calibration and export

The bottom tracking outputs for the whole cruise are shown in Table 6.5. The phase correction had already been applied, but an amplitude correction of 1.006 was applied to the whole sequence. The post-calibration output is also shown in Table 6.5, with the amplitude now within 3% of 1, and the phase close to zero.

	Time range	Data points (unedited)	Parameter	Median	Mean	STD
Before calibration	292.46 - 322.91	322	Amplitude	1.0055	1.0064	0.0055
			Phase	-0.0494	0.0935	0.5174
After calibration			Amplitude	0.9996	1.0004	0.0054
			Phase	-0.0457	0.0928	0.5144

Table 6.5 Final pre- and post-calibration bottom tracking data for OS75

A phase correction had not been initially applied for OS150, but using the bottom track data for the whole cruise (Table 6.6), a phase correction of -0.16 and an amplitude correction of 1.004 were applied, with the post-calibration output also shown in Table 6.6.

	Time range	Data points (unedited)	Parameter	Median	Mean	STD
Before calibration	292.46 - 323.50	111	Amplitude	1.0032	1.0042	0.0060
			Phase	-0.1569	-0.1975	0.3520
After calibration			Amplitude	0.9995	1.0007	0.0050
			Phase	0.0050	-0.0284	0.3412

Table 6.6: Final pre- and post-calibration bottom tracking data for OS150

Finally, the data were exported as Matlab .mat files and NetCDF .nc files.

7 CTD operations

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7.1 CTD operation

CTD wire 2 (grease removed temporarily and streamed on JC170 passage, but not previously used for CTDs) was inspected before the start of the cruise and re-terminated at both the slip-ring junction box and the sea cable end. The sea cable end was terminated with the normal S&M CTD termination; it was load tested by following the standard procedure of being pulled at 0.5T, 1.0T, 1.5T and 2.0T. The termination assembly was held for 5 minutes at each and re-torqued between each. It had a 'megger' value of >1000 MOhms and internal resistance of 80.9 Ohms post-load test.
No problems were encountered on the test cast to 200m. During the down cast on the second deployment the secondary oxygen sensor exhibited a slow drift compared to the primary oxygen, and subsequently shifted to normal readings at approximately

2500m. The rest of the cast had normal values. The primary oxygen sensor was noisy for the last 500m of the down cast, and then became less noisy on the remaining 2000m of the upcast. Both sensors were cleaned according to SBE Application Notes after the third deployment. Casts 002 & 005 displayed some noise in both sensors at depths greater than 3000m, but profiles for down and up cast were acceptable. Similar noise was seen in secondary oxygen during casts 006 & 008. Step changes in both dissolved oxygen sensors at bottle stops for casts where CTD was stopped for 5 minute soaks or longer. Deployment 009 was aborted after a few hundred metres as the primary oxygen sensor exhaust tubing had come loose. The tubing was reaffixed and them immediately redeployed for cast 010.
As both the swivels used on this cruise were recently modified and repaired they were both trialled to prove their reliability. Refurbished MDS titanium CTD swivel s/n 1253-1 installed for deployments 005 - 013; no problems or oil leaks observed. After cast 013 the swivel was deemed to be sufficiently tested and working well. It was swapped with swivel s/n 1253-2 for casts 014-029; no oil leaks or other problems with the swivel were noted.
During cast 021 the termination failed, short circuit, at approximately 55m during the upcast. 50m of wire was chopped off and then re-terminated using polyurethane compound in a mould and left to cure for 24 hours. A final megger value of >1000 MOhms and internal resistance of 79.3 Ohms was measured. This remained for the duration of the cruise.
SBE 32 Carousel position 23 failed to release during two deployments; following on-deck testing the problem was determined to possibly be mechanical. The trigger assembly was found to be binding when under load, and a “block & tackle” loop was added to position 13 as well as to position 23, to reduce the load by 50%. At the end of the cruise, when the latch assembly was removed for routine maintenance, positions 6, 23 & 24 were found to have corrosion and leakage around the magnet/solenoid assembly.

7.2 Salinity measurement

A Guildline 8400B, s/n 72227, was installed in the Electronics Workshop as the main instrument for salinity analysis (the spare s/n 71126, was not installed). The Autosal set point was 24C, and samples were processed according to WOCE cruise guidelines: The salinometer was standardized at the beginning of the first set of samples, and checked with an additional standard analysed prior to setting the RS. Once standardized the Autosal was not adjusted for the duration of sampling.
A standard was analysed after each crate of samples to monitor & record drift, excepting the first crate of CTD samples (second standard analysed after sample 12, third standard analysed after sample 25).
Standards were labelled sequentially and increasing, beginning with number 9000. Standard deviation set to 0.00002. 18 crates of salinity samples were analysed, with 33 bottles of standard used to monitor the instrument drift. The electronic standby value after the standardisation was stable at 6065 to 6068 for the duration of the cruise. After standard 9014 the capillary tubing bung dislodged from the conductivity cell tubing, which resulted in the salinometer being powered down whilst the bung was reinserted. After turning the Autosal back on, the bath was left to stabilise overnight. The next SSW analysed (9015) showed no instrument drift, thus the standardisation of the salinometer was not adjusted. Problems with the dislodging of the capillary tube bung continued to occur periodically; the bung was reinserted without powering down the Autosal on each instance. The peri-pump 12V socket corroded during CTD crate

37, which resulted in the pump slowing considerably. The pump was replaced prior to the next crate of samples.

8 CTD Data

David Smeed

Most casts were for the purposes of calibration of the microcat CTDs, but some were completed before and after recovery of moorings with oxygen sensors to enable in-water calibration of oxygen, and others were completed before the deployment of Deep Argo floats. The shallow casts were to obtain samples for calibration of the SeapHOx and HydroC sensors.

There were 12 bottles on the frame and on most deep casts they were all used to obtain samples to calibrate oxygen and salinity. Bottle stops were all 5 minutes each when microcats were being calibrated, otherwise they were for 2 minutes.

A total of 28 CTD stations were completed during the cruise. These are numbered 1 to 8 and 10 to 29. Station 9 was abandoned, due to the tube connecting the oxygen sensor to the pump having a loose connection. After the connection was fixed a new profile was made as station 10.

Station	Start Date	Start Time	End time	Latitude	Longitude	Water depth (corr. m)	Profile depth (m)
1	20-Oct	16:50	20:55	28°42.19	15°45.49	3607	3596
2	20-Oct	22:29	03:22	28°42.19	15°45.49	3608	3598
3	23-Oct	18:10	19:23	27°52.00	13°32.29	1079	1069
4	23-Oct	22:51	00:10	27°49.11	13°44.39	1421	1409
5	26-Oct	21:59	04:07	24°55.02	21°18.01	4505	4490
6	28-Oct	04:58	09:45	23°46.5	24°09.60	5089	5075
7	29-Oct	18:43	19:22	23°43.57	24°10.59	5116	406
8	29-Oct	20:26	00:49	23°44.36	24°11.85	5125	5118
9	31-Oct	14:06	Abandoned				
10	31-Oct	14:42	05:33	23°23.43	30°57.28	5665	5628
11	03-Nov	21:10	00:40	23°45.64	41°05.27	4205	3500
12	06-Nov	21:13	01:52	24°11.77	49°44.42	5224	5124
13	07-Nov	18:58	23:52	24°11.00	49°44.97	5216	5127
14	08-Nov	19:12	20:02	24°10.96	49°45.02	5220	506
15	08-Nov	21:00	01:36	24°10.97	49°46.28	5094	5026
16	10-Nov	11:24	15:49	25°21.83	55°00.07	5954	5944
17	12-Nov	07:03	11:24	24°40.44	62°45.00	5804	5788
18	13-Nov	17:15	21:39	25°52.45	68°04.90	5412	5380
19	14-Nov	18:26	23:09	26°29.67	70°32.52	5496	5483
20	17-Nov	07:27	11:06	26°26.43	75°44.76	4698	4692
21	18-Nov	23:21	03:42	26°28.50	75°44.00	4706	4693
22	19-Niv	23:22	03:02	26°30.00	76°37.00	4723	4713
23	20-Nov	04:40	05:10	26°30.50	76°49.00	1368	103
24	20-Nov	22:14	02:36	26°30.00	76°37.00	4736	4721
25	21-Nov	04:18	05:37	26°30.80	76°48.50	1406	1394
26	22-Nov	00:04	03:54	26°30.90	76°44.42	3900	3891
27	22-Nov	23:07	03:27	26°31.50	76°37.00	4634	4643
28	24-Nov	20:51	23:45	26°30.11	76°48.50	1401	1392
29	25-Nov	00:10	00:45	26°30.11	76°48.50	1399	104

Table 8.1 List of CTD stations

8.1 Analysis of standard seawater samples and calibration of the salinometer

All standard seawater samples were from batch P161 with 2*K15 = 1.99974 (Practical salinity 34.9948). A standard was used before and after each crate of salinity samples, and one additional standard was used halfway through crate 1. A total of 34 standards were used. When the first standard was run it was found that an offset of 0.000003 was needed. From the offset and K15 value it can be deduced that the sample average was 1.999737. This deduced value was added as the first line of the sal_jc174_01.csv file and given sample number 999000. In this file following standard samples are indicated by sample numbers from 999001 to 999033.
The inferred offsets from the standard samples are shown as red and blue crosses in Figure 8.1, red denotes a sample at the start of a crate. From these the offsets applied to the salinometer readings for samples from the CTD and underway were determined by linear interpolation using MEXEC routine 'msal_standardise_avg' (called by msal_01). Note that the offset at the start of a crate was usually larger than at the end, typically by about 5e-5 but for crates 2 and 3 there were changes of over 10e-5. These changes are thought to be due to changes in the ambient temperature.

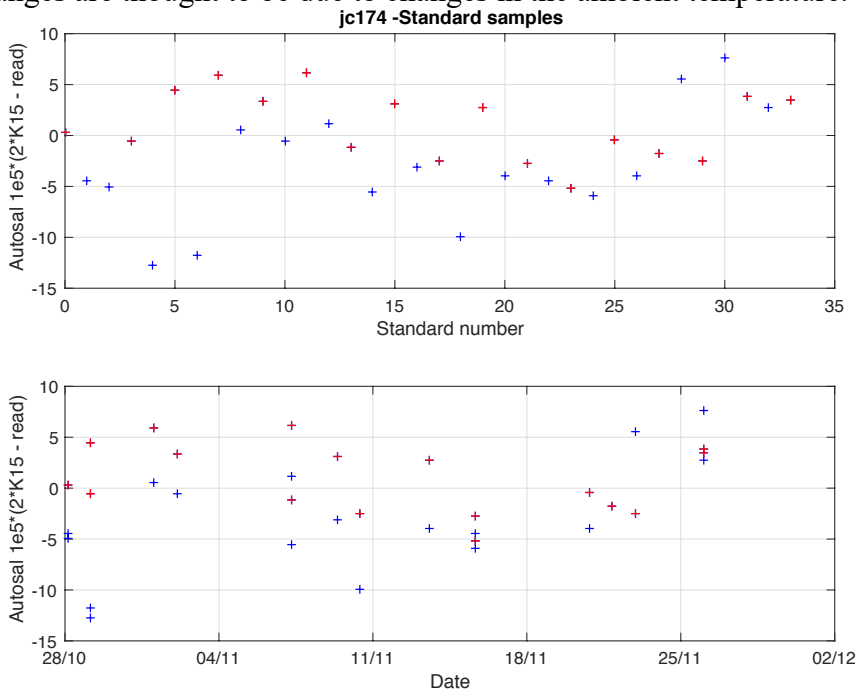

Figure 8.1 Inferred offset calculated as 2xK15 – salinometer average is shown a) as a function of the standard number and b) as a function of the date on which the samples were analysed. Red indicates a standard at the start of a new crate. Note a change of 5e-5 corresponds with a salinity difference of 0.001.

8.2 Calibration of conductivity

A comparison of the raw salinity data with the bottle samples is shown in Figure 8.2. A comparison of the two sensors suggest that on stations 1 and 2 conductivity values of sensor 2 were about 0.002 lower than on all following stations. An ad hoc correction was therefore made for these two stations for sensor 2. It is also evident that there is a slight linear time dependent offset for both sensors. Following this initial correction, a calibration for each conductivity sensor was derived in the following form

Cond_cor = Cond_raw*(1 + A + B*time + C*Press/1000 + D*Temp)/1000

The coefficients A, B, C and D were determined in parallel using least squares multiple linear regression (Matlab function 'regress') that minimised the sum of the squares of the residuals. Time was measured in days from the start of the first CTD. The residual was defined as:
Res = (Cond_sam / Cond_raw) – 1 – (A + B*time + C*Press/1000 + D*Temp)/1000
The coefficients of the calibration are shown in Table 8.2. Outliers further than 0.005 from the mean difference were excluded from the calculation.

Sensors	A	B (day^{-1})	C ($dbar^{-1}$)	D ($°C^{-1}$)	Mean sal. diff ($x10^3$) pre cal.	RMS sal diff ($x10^3$) post cal.	No. of samps.	No. of Out-liers
Sens 1	0.10388	0.00170	-0.00847	-0.00285	1.32	1.11	218	18
Sens 2	0.01252	0.00104	-0.00324	-0.00328	0.88	1.07	218	18

Table 8.2 Details of the conductivity calibrations. The mean salinity difference (x 10^3) between bottle sample and sensor is shown pre-calibration (after calibration the difference is identically zero). Also shown is the RMS difference post calibration (x 10^3) and the number of samples used.

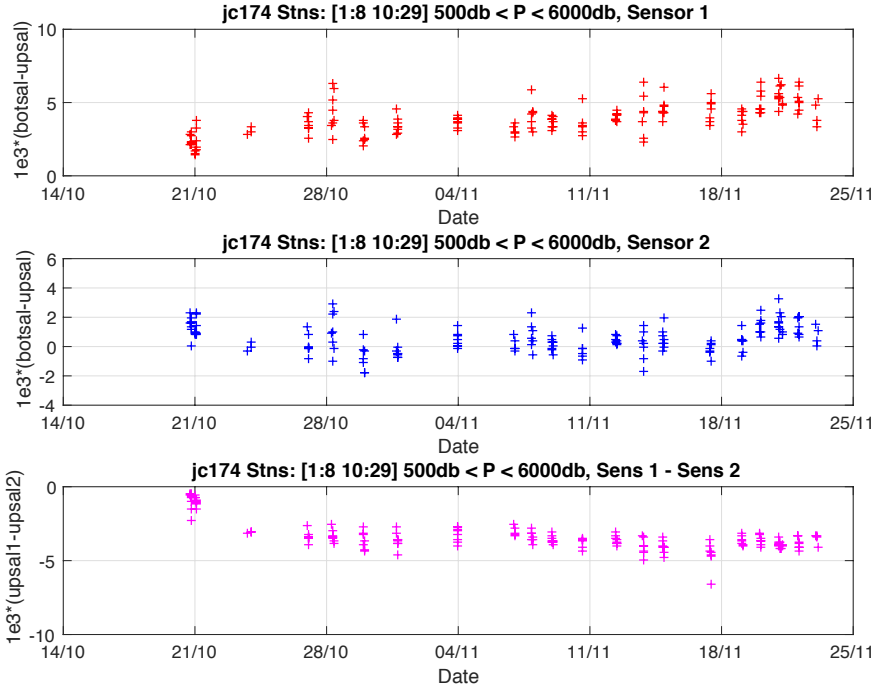

Figure 8.2 Comparison of salinity measurements at bottle stops before calibration. Upper panel, bottle minus sensor1; middle panel bottle minus sensor2; and lower panel sensor1 minus sensor2.

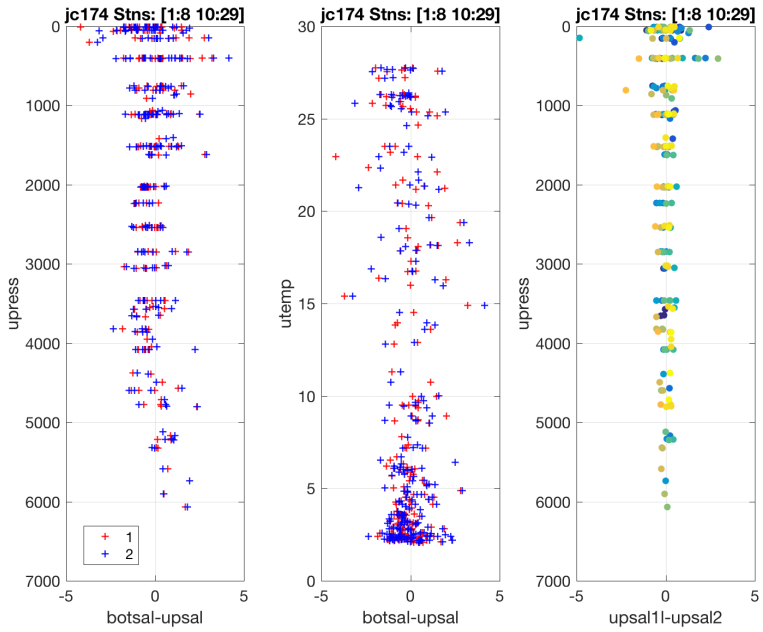

Figure 8.3 Comparison of salinity measurements at bottle stops after calibration. Red = bottle minus sensor 1, blue = bottle minus sensor 2. Left panel, as a function of pressure, middle panel as a function of temperature and right panel difference between the two sensors as a function of pressure.

8.3 Choice of primary sensors

There was a significant pressure dependent difference between the two temperature sensors with sensor 2 being about 0.002 warmer at a pressure of 5000 db. Comparison with CTDs from previous cruises close to the site EB1, in the deep eastern basin where properties are expected to be most stable, suggests that sensor 1 was most likely to be closest to the true value.

After calibration the RMS difference between the salinities at the bottle stops determined from the two sensors was about 0.56 and the difference between each sensor and the bottles was slightly more. We conclude that there was no significant difference in the accuracy of the conductivity measurements and so sensor 1 was chosen because, as noted above it is expected to have the most accurate temperature.

9 Argo float deployment

There were 6 Argo floats deployed during the cruise: 3 regular 2000db floats and 3 Deep Argo floats. CTD profiles were completed before the deployment of deep floats

Float number	Date	Time	Latitude (°N)	Longitude (°W)	Water depth (m)
7217	02 Nov 18	10:21	23°43.63	38°00.07	5728
7216	05 Nov 18	12:37	23°52.28	43°30.03	3940]
7215	06 Nov 18	14:13	24°07.69	49°00.12	4791
Deep 25	09 Nov 18	15:59	25°21.77	55°00.04	5410
Deep 22	12 Nov 18	11:37	24°40.43	62°44.75	5802
Deep 23	13 Nov 18	21:47	25°52.45	68°04.90	5390

Table 9.1 Argo float deployments.

10 Oxygen analysis

Pete Brown, Lidia Carracedo

The two oxygen sensors on the CTD were calibrated by means of an automatic Winkler titration of discrete water samples. Dissolved oxygen analyses of the water samples were performed with an automated Ti-touch Titrator, using amperometric endpoint detection.

10.1 CTD sampling

A total of 26 CTD casts were sampled for dissolved oxygen. All depths at which a Niskin bottle was fired (usually 12 depths for the deep casts, 6 depths for the shallow casts) were sampled. Duplicate samples were drawn at one/two depths on every cast. The Niskin bottles selected for the duplicates changed for each cast, except for the first CTD cast, for which all 12 depths were double-sampled in order to assess reproducibility of the sampling practise of both samplers in charge. The standard deviation of the first-cast duplicates ranged between 0.02 to 0.60 μmol L^{-1}. In total, 42 sets of duplicates were run during the cruise. In addition to the CTD-sampling, 14 underway samples were taken (underway system, chemistry lab) at station numbers 5, 10, 12, 13, 15, 16, 17, 18, 19, 21, 22, 24, 25 and 26.

The oxygen sampling was carried out according to the guidelines by Langdon (2010), analogously to the previous RAPID cruises (see RAPID cruise reports No. 30, 37, 52 for more details).

Some useful sampling tips:

- Prior to sampling each station, the reagent dispenser pipette tips (2-3 mL) were emptied and refilled to reduce the risk of injecting bubbles into the sample.
- Silicon Tygon tubing was attached to the Niskin spigot to transfer water to the flask. The tubing was kept wet (submerged in sea water) between stations to reduce the tendency of bubbles to form within it.
- While sampling, at least three flask volumes (approximately 15 seconds) were allowed to flow though the bottle.
- The bottles were held from the neck to minimise changes in water temperature.
- The fixing temperature was measured with a digital thermometer just before fixing the sample.
- After addition of the chemicals (1mL of manganese chloride, immediately followed by 1mL of alkaline iodide solution), the bottles were vigorously shaken for 15 seconds (twisted about 20 times) to facilitate the mixing and formation of the precipitate (manganese hydroxides). A second shake was performed after 30 min.
- The bottles (fixed samples) were submerged in a Milli-Q water bath (opaque tank). This sort of storage was chosen because *i)* a water seal around the lid was not possible due to the bottle's shape, and *ii)* the water tank ensured a more temperature-controlled environment.
- Sample storage varied between 3-4 days. Keeping the samples and analysing them every 3-4 days is more time efficient and accurate than immediate analysis by CTD station.
- Each stopper is unique to each flask. Regular checks were made to ensure each stopper/flask pair had the same number attached to them. Cracks and chips in both the bottles and stoppers were also regularly checked for.

10.2 Winkler titration

The Winkler method is an iodometric titration in which oxygen in the seawater sample quantitatively oxygenates iodide ions to form iodine. Manganese chloride ($MnCl_2.4H_2O$) and alkaline iodide (NaOH + NAI), once added to a water sample, create a white-brown precipitate of manganese hydroxides ($Mn(OH)_2$). When acidified to a pH of 1.0 to 2.5 after injection of sulphuric acid, the manganic hydroxide forms manganic sulphate, this releases iodine from the iodide. During titration, the endpoint occurs when the added thiosulphate ($S_2O_3Na_2$. $5H_2O$) balances the iodate equivalents, thus the oxygen concentration in the sample is calculated by proportion. The dissolved oxygen concentration of seawater is defined as the number of micromoles of oxygen gas per kilogram of seawater, which gives the units μmol kg^{-1}.

A Metrohm 916 Ti-Touch unit, with amperometric end point detection, was utilised to accurately perform titration on board the RSS James Cook during the JC174 cruise. The protocols followed during the analysis are the same as in the previous RAPID JC145 cruise (see RAPID cruise report No. 52 for more details). They include: blanks (*BKL protocol* on the Metrohm 916 Ti-Touch), thiosulphate standardization (*STD protocol* on the Metrohm 916 Ti-Touch), and the Winkler amperometric titration of the oxygen samples (*O2 protocol* on the Metrohm 916 Ti-Touch). Chemical reagents were pre-prepared offshore in accordance with procedures outlined by Dickson (1994).

Some useful analysis tips:

- Lab temperature was regularly checked during the analysis (it varied between 21.8-23.8°C).
- At the start of each set of analysis, reagent blanks and standardizations were performed (see sections 2.1 and 2.2).
- Prior to starting the analysis, the Metrohm Ti-Touch unit burettes were fully flushed out three or four times (*'Prepare' mode* on the Metrohm 916 Ti-Touch), or until the piston burettes were bubble free.
- The reagent dispensers (manganese chloride, iodide and sulphuric acid) were pumped 2-3 times to remove air bubbles.
- For every sample, the pipette tip of the Thiosulphate and the electrode were placed at the same level.
- Between samples, the pipette tip of the Thiosulphate and the electrode were rinsed with Milli-Q water and wiped.
- Pipette tips were placed so that they did not point to the electrode directly.
- The magnetic stirrer speed was held at a constant pace.

10.3 Blank

Before any samples are analyzed, “blank” (this section) samples and “standards” (section 10.4) were characterized at the beginning of every analytical session. Blank measurements were made using empty sample bottles, which were thoroughly washed in tap water three times, then washed again in distilled Milli-Q water before being filled to about the shoulder with distilled water. 1 mL of sulphuric acid was added before the bottle was placed on the stirrer (speed pace 4). Then 1 mL of alkaline iodide was added before stirring again. The solution was checked at this stage to ensure it was clear (otherwise being repeated) before adding 1 ml of manganous

chloride. If clear, 1 mL of the iodate standard was injected using the Dosimat before the mixture was titrated against sodium thiosulphate. Once the titration was finished the volume of titrant was recorded and another 1ml of iodate standard added to the same bottle. A total 4ml of iodate standard was added to the bottle in 1ml amounts and titrated each time. This whole procedure was repeated for a minimum of three times (3 blank samples), looking for a consistency between replicates of at least 0.002 mL. The average blank value per analysis set is summarized in Table 10.1. Blank time response is shown in Figure 10.1.

10.4 Standardisation of sodium thiosulphate

After the blanks were measured, the thiosulphate molarity was checked against an iodate certified iodate standard of known molarity (1.667 mM, OSIL Scientific). The procedure is similar to that of the Blank measurements except that exactly 10 mL of potassium iodate standard was added to a bottle in one injection and then titrated. Three repeats (or more if needed) were performed per standardization set, until replicates agreed by at least 0.5%. The average titre per analysis set is shown in Table 10.1. Time response of the standard measurements is shown in Figure 10.1

Analysis set	Date of analysis	CTD stations	Calibration	Volume (mL)
1	23/10/2018	1 -2	Blank Titre	0.004113
			Standard Vol	10
			Standard Titre	0.93605
2	25/10/2018	3 - 4	Blank Titre	0.0038
			Standard Vol	10
			Standard Titre	0.935
3	30/10/2018	5 - 8	Blank Titre	0.003943
			Standard Vol	10
			Standard Titre	0.9361
4	04/11/2018	10- 11	Blank Titre	0.0035
			Standard Vol	10
			Standard Titre	0.9358
5	09/11/2018	12 - 15	Blank Titre	0.0038
			Standard Vol	10
			Standard Titre	0.9349
6	15/11/2018	16 - 19	Blank Titre	0.0046
			Standard Vol	10
			Standard Titre	0.9366
7	20/11/2018	20 - 23	Blank Titre	0.004535
			Standard Vol	10
			Standard Titre	0.9364
8	25/11/2018	23 - 26	Blank Titre	0.0045
			Standard Vol	10
			Standard Titre	0.936

Table 10.1 Blank and standard average values per sampling set.

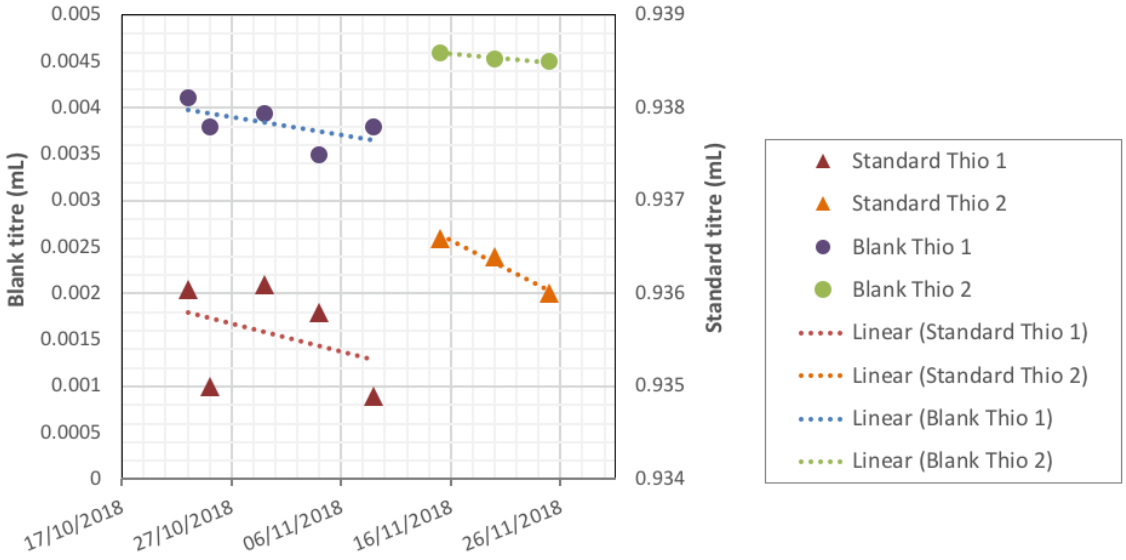

Figure 10.1 Blank and standard response versus time.

10.5 Sample analysis

The basic steps for the sample titration were as follows:
1) Take the sample from the deionized water storage-bath and wipe off the excess of water.
2) Remove the stopper carefully to avoid sample loss.
3) Add 1ml of sulphuric acid and carefully insert a magnetic stirrer into the sample
4) Stir the sample (stir vel. of 3.5) until it there is no precipitate remaining.
4) Titrate the liberated iodine against sodium thiosulphate to a dead stop (O_2 protocol) and record the volume of added thiosulphate.
5) Repeat procedure until all the stored samples have been analyzed (usually three to four stations).
A total of 291 CTD oxygen samples were analyzed, of which 42 pairs are duplicates (Table 10.2). After finishing the analysis, the corresponding oxygen concentrations were calculated in an Excel file, saved as *CalcSheet_JC174_StnNN.xlsx*, where NN denotes the station number. At each station the sample titration volumes (mL), calculated oxygen concentration values (µmol/L), fixing temperature values (ºC), station number and flask numbers were recorded. The calculation accounted for the volumes specific to each oxygen flask. Preliminary quality code flags were assigned to the data (2=Good, 3=Dubious, 6=Duplicate, 4=Bad, 9=Missing).
Reproducibility was checked, obtaining an average absolute difference between sets of duplicates (42 in total) of 0.5 µmol L^{-1} (and an average median of 0.3 µmol L^{-1}) (Figure 10.2).
Finally, the calculated oxygen concentrations (in µmol L^{-1}, Figure 10.3) were saved to a csv file (*oxy_jc174_0NN.cvs*, where NN denotes the station number). The file contains the bottle number, the station number, the sample number, the fixing temperature, the computed oxygen values, and the oxygen flags. Ultimately, the csv file was imported to MATLAB® and data incorporated to CTD NetCDF files to perform the CTD sensor calibration.

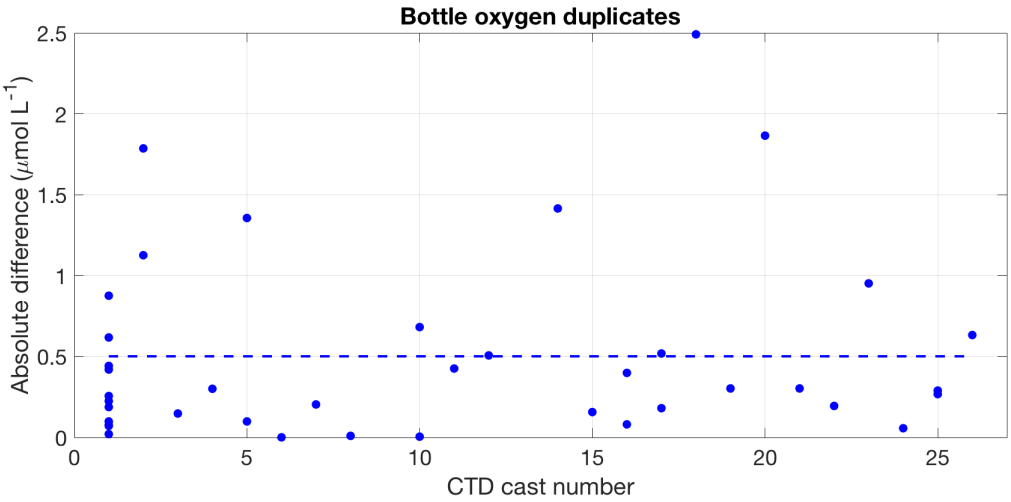

Figure 10.2 Absolute differences between duplicate oxygen samples.

CTD station	Description	Niskin bottles sampled	No. duplicates	Total No. samples
1	CTD-test1	12	12	24
2	CTD-test2	12	2	14
3	Post-EBH4	6	1	7
4	Post-EBH3	7	1	8
5	Pre-EBHi	11	2	13
6	Pre-RAS EB1 deep	12	1	13
7	Post-RAS EB1 shallow	6	1	7
8	Post-RAS EB1 deep	11	2	13
10	CTD-calibration	11	2	13
11	Post-MAR3	12	1	13
12	Pre-RAS MAR1 deep	12	1	13
13	Pre-RAS MAR1 deep	12	1	13
14	Post-RAS MAR1 shallow	5	1	6
15	Post-RAS MAR1 deep	12	1	13
16	Pre-Deep Argo-1	10	2	12
17	Pre-Deep Argo-2	12	2	14
18	Pre-Deep Argo-3	12	1	13
19	Post-WB6	12	1	13
20	Pre-WB4	9	1	10
21	Post-WB4	11	1	12
22	Pre-RAS WBH2 deep	11	1	12
23	Pre-RAS WBH2 shallow	5	1	6
24	Post-RAS WBH2 deep	10	1	11
25	Post-RAS WBH2 shallow	6	1	7
26	Pre-RAS WB1 deep	10	1	11
Total			42	291

Table 10.2 CTD oxygen sampling strategy followed in JC174.

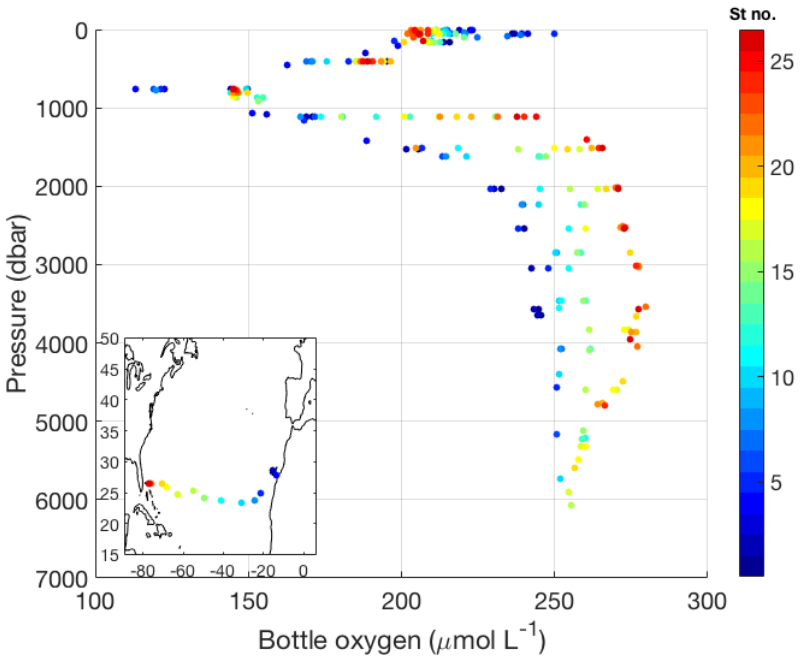

Figure 10.3. Oxygen bottle data (in µmol L^{-1}). Colour scale represent the number station (1 to 26).

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11 Discrete chemical sampling

Pete Brown, Lidia Carracedo

Discrete bottle samples were collected for the later analysis of dissolved inorganic carbon (DIC), total alkalinity, DI^{13}C (^{13}C/^{12}C carbon isotopes of DIC), inorganic nutrients and organic nitrogen on a number of CTD stations. Not all parameters were sampled for on all stations. A number of stations were not full depth, instead focussing on the location and / or timing of Remote Autonomous Sampler (RAS) sampling patterns.

A summary of the station locations and chemical parameters sampled for these is given in the Table below. In total, 21 stations were sampled for inorganic and organic nutrients, 14 for DIC and alkalinity, and 7 for DI13C. These comprised a total of 190 unique station-niskin pair samples for inorganic and organic nutrients, 110 for DIC and alkalinity, and 63 for DI^{13}C.

The methods followed for sample collection were as described in the DY039 cruise report. DIC, alkalinity and DI^{13}C samples were stored in a fridge at approximately 6°C until the end of the cruise. Nutrient samples were immediately frozen for storage.

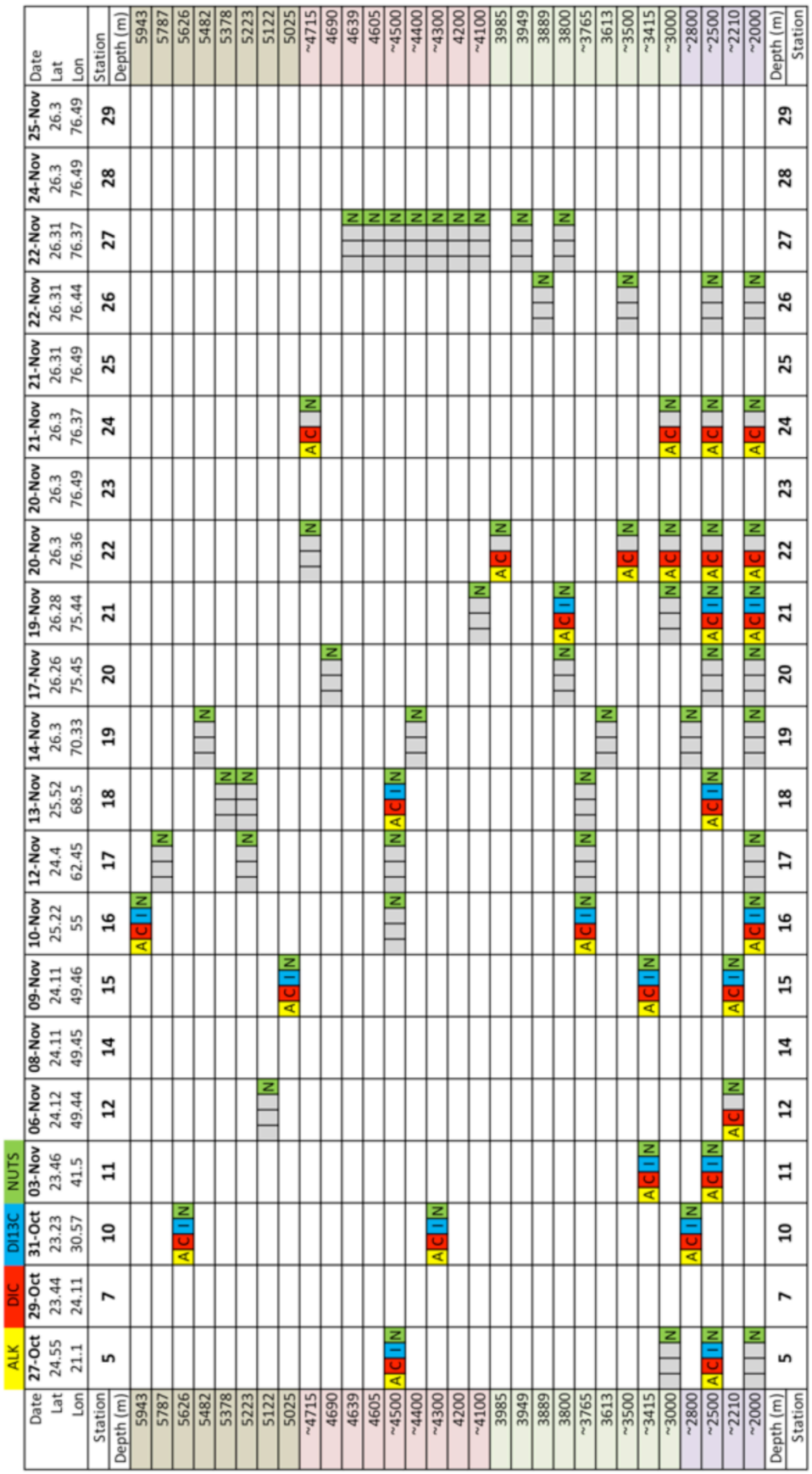


Table 11.1 Location of samples collected for chemical analysis below 2000 m during jC174. Key: A - alkalinity, C - DIC, I – $DI^{13}C$ isoptopes, N – inorganic and organic nutrients

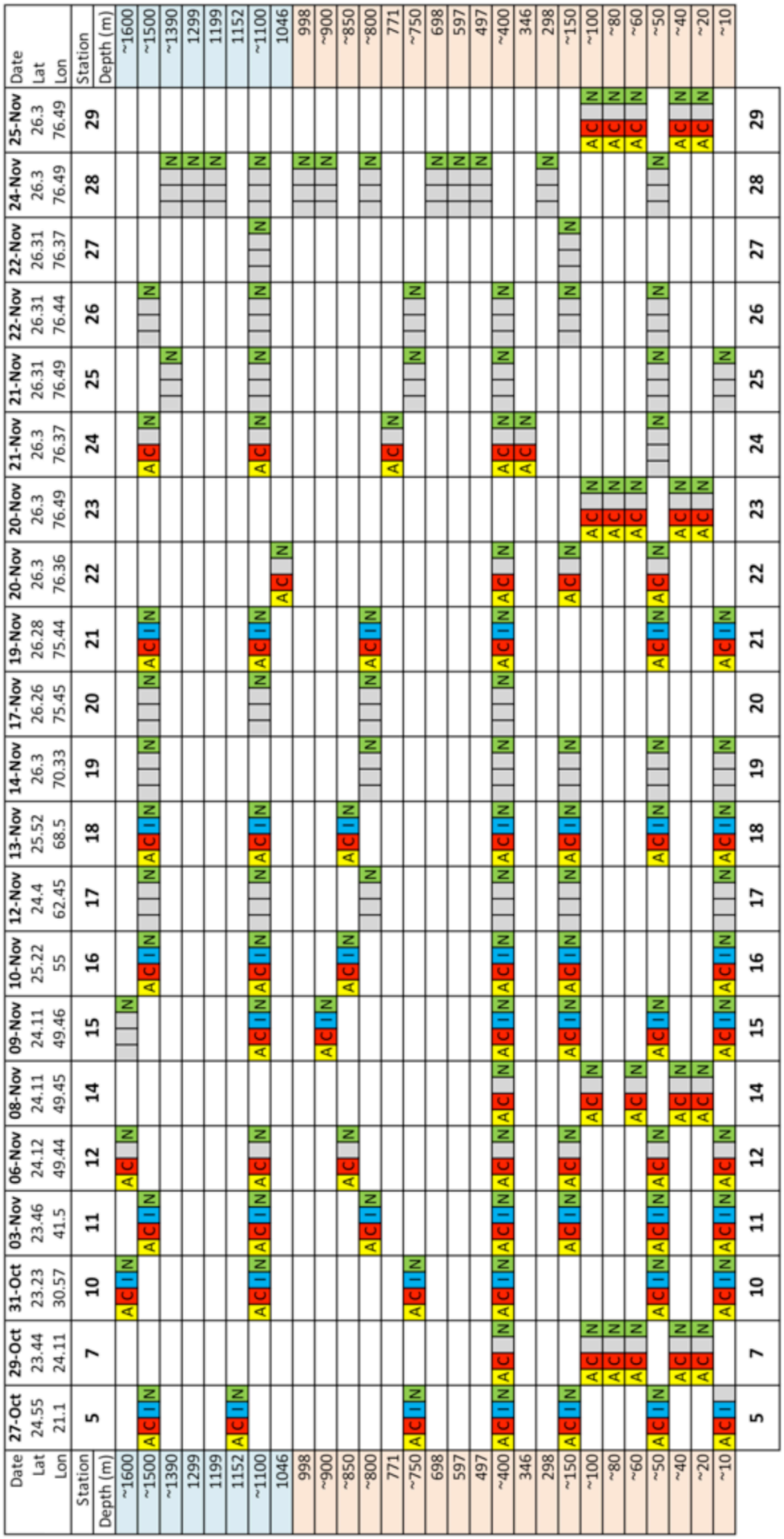


Table 11.2 Location of samples collected for chemical analysis above 2000 m during jC174. Key: A - alkalinity, C - DIC, I – DI^{13}C isotopes, N – inorganic and organic nutrients

12 Contros HydroC CO_2 sensors

Pete Brown, Lidia Carracedo, & Darren Rayner

12.1 Background

Contros HydroC pCO_2 sensors were deployed as on DY039 and JC145, namely at approximately 40-50 m depth and paired with Deep SeapHOx combined pH-oxygen-temperature-salinity-pressure sensors, both installed on a sensor frame attached to the bottom of a remote access sampler (RAS) with a further MicroCAT CTD installed for good measure. The Contros HydroC is capable of measurements at intervals of 1s to 1week for a period up to and including 18 months dependent on deployment conditions. Here they were deployed with HydroB battery packs (84 x Lithium D cells) and set to sample once per day. As before, the sensors were configured with flow-through head and pumps (in this instance low-power Seabird Electronics 5M pumps) that directly move seawater across the anti-fouling copper-protected membrane, speeding up the equilibration and response time.

12.2 Recovery of sensors deployed on JC145

EB1 (S/N CO2-0812-020):
This sensor was attached to the RAS frame that was on the upper part of the mooring lost in January 2018.
MAR1 (S/N CO2-0812-005):
The sensor was heavily fouled on retrieval. Communication with the sensor was immediately possible when connected to the mains, and a seemingly full dataset was downloaded. Further investigation revealed that no data had been collected for a 5-6 week period leading up to the end of December 2017, but no other data were missing up to and including the day before retrieval.
WB1 (S/N CO2-1114-002):
The sensor was heavily fouled on retrieval. Communication was not possible with the sensor when connected to the mains. Cleaning / removal of fouling did not reveal any obvious cause for this. On attempt to open the sensor in order to retrieve the microSD memory card from within it became immediately apparent that the sensor had flooded. This unit had been delivered directly from the manufacturer and had not been opened by any user prior to deployment. Once retrieved it was not possible to mount the microSD card. The unit will be returned to Germany for repair or replacement.

12.3 JC174 deployments

Two pumps and associated cables were missing from the boxes hand-carried to the cruise so two had to be turned around from those recovered. As the unit from EB1 was lost it meant we had to rely on recovery of both the remaining units to allow redeployment of the pCO_2 sensors – fortunately this was the case, though the pump cable used on WB1 had to be repaired first due to damage from fishbite.

Calibration

Two sensors (CO2-1114-003 and CO-1114-001) were specially calibrated in Kiel, Germany in August 2017. Only one new unit (CO2-0918-001) had not been used previously and this was supplied with a calibration from September 2018. Calibration conditions had been chosen to optimize performance in subtropical waters at ~50 m depth, but allowing for substantial knockdown (200 m+). Specifically, calibration was performed in waters of 15-30°C for a measuring range of 200-1000 µatm.

Mooring Location	Deployment date	Serial Number	Sampling time: local (UTC)	Logging Settings
EB1	29-10-2018	CO2-0918-001	23:03-00:00 (00:03-01:00)	Zero (Average 5s, Log 10s) Flush (Av. 5, Log 5) Measure (Av. 10, Log 10)
MAR1	08-11-2018	CO2-1114-001	23:03-00:00 (02:03-03:00)	Zero (Average 5s, Log 10s) Flush (Av. 5, Log 5) Measure (Av. 10, Log 10)
WB1	25-11-2018	CO2-1114-003	23:03-00:00 (03:03-04:00)	Zero (Average 5s, Log 10s) Flush (Av. 5, Log 5) Measure (Av. 10, Log 10)

Table 12.1 Sensor specific information.

12.3.1 Setup

As per DY039 & JC145, the sensors were set up using the Contros Detect software package (currently PC only), with planned daily measurements at midnight local time. Of the three systems to be used, one was a new unit, the other two had been used before.

CO2-0918-001 – new unit

Initial connection brought up an error message in Detect software 'Sensor not configured correctly: there is a mismatch between the communication of the sensor and the configuration in the driver file. Please contact support'. Kongsberg-Contros were contacted and we received an updated .XML file for use with the Detect software, but this was received the morning of the deployment of EB1 and we had already setup the instrument by this point. The .XML file has an entry for every serial number, which was missing for this unit from the copy of the file we had - hence the error message. The .XML file appears to only contain parameters used for displaying real-time data when connected to the instrument and shouldn't affect the operation of the instrument when in logging mode. The version of Detect was verified to be the latest version, with multiple versions all being 2.0.5.0 (on the CD supplied with the first batch of instruments in 2015, on the USB stick with the same units, on the USB stick supplied with instruments in 2018, and put on the Kongsberg-Contros FTP site during the cruise).

A test deployment was set up in 'daily mode', but after enabling the unit could not be reawakened. Only a complete power cycle enabled a successful connection to be established. Reconnection revealed that the sampling cycle that had been set had changed, to the extent that the 'Flush' cycle wasn't sufficiently long enough for the CO2 concentration to settle. Further 'daily mode' deployment tests were conducted and each time the instrument was reconnected the sleep/wake cycle had changed from that programmed.

Changing the test deployment to 'continuous' mode allowed a timetable to be remembered through using a repeating awake/sleep schedule rather than specific times of the day. The sensors were therefore setup using a 'continuous' schedule as detailed in Table 12.2.

A further complication with unit CO2-0918-001 was that it appeared to ignore the flush period setting. The flush runs before the actual sampling interval to run water over the membrane and provide equilibration time before the measurement is recorded. The difference between the 'flush' and 'measure' period is just a binary flag in the data toggled between 1 and 0 for when the instrument is flushing or measuring, with the sensor responses logged the same for both. To overcome the lack of a flush period being registered with this instrument we extended the measurement period to

include the intended 18-minute flush period, and this will then need separating out by sample timing during post-processing rather than the data flag.
For this instrument it also seemed that the 'awake' time setting was not really being used, as if it were longer than the measurement schedule the instrument would just go to sleep after the measurements. However, the opposite was found for the instruments deployed on MAR1 and WB1, with them repeating the measurement cycle until the 'awake' period had passed – this despite them all being upgraded to the same firmware. But notes written during the cruise on this subject are not clear when re-reading, so there is no definite answer to this at the moment but should be borne in mind in the future.
CO2-1114-001
Firmware was updated from 2015081101 to 2018042401. A 'daily mode' deployment test was conducted and as with the new unit running the new firmware, on reconnection the sampling schedule was incorrect compared to that set, and the data collected was not as expected. A subsequent test found the sensor had changed its mode from sleepmode to continuous sampling.
As with the sensor on EB1 we overcame this by setting the unit to run in 'continuous' mode with an appropriately long sleep time so that it sampled once per day. Unlike the instrument on EB1, this unit was performing a flush and flagging the data as expected so the measurement period did not have to be extended.
This unit also didn't just go to sleep once completing the measurement program, so with the 'awake' period being set to 2 minutes longer than the total measurement program and the 'zero' period also being 2 minutes it means that there should be an extra zero period after the measurement as well as before it.
CO2-1114-003
The firmware was also updated on this instrument before setup and deployment. Deployment parameters are given in Table 12.1.

Step	Action	EB1. CO2-0918-001		Time of day (local)	MAR1. CO2-1114-001		WB1. CO2-1114-003		Time of day (local)
		Durat-ion (mins)	Cum. time (mins)	For EB1 only	Durat-ion (mins)	Cum. time (mins)	Durat-ion (mins)	Cum. time (mins)	Same for MAR1 and WB1
1	Warm-up	35	35	23:00 – 23:35	35	35	35	35	23:00 – 23:35
2	Zero	2	37	23:35 – 23:37	2	37	2	37	23:35 – 23:37
3	Flush	1*	37*	n/a*	18	55	18	55	23:37 – 23:55
4	Measur e	20	57	23:37 – 23:57	2	57	2	57	23:55 – 23:57
5	Zero (if awake period longer than samplin g steps)	n/a‡	57	n/a‡	2	59	2	59	23:57 – 23:59
6	Sleep	1383	1440	23:57 – 23:00 (+1 day)	1381	1440	1381	1440	23:59 – 23:00 (+1 day)
	Awake	60‡			59		59		

Table 12.2. Process steps during single sample measurement for HydroC.

*This instrument was not registering a flush time, so this is effectively zero. Unless it starts including it during the deployment and then the regular sampling will progressively step 1 minute after the previous day's sampling
‡This instrument appeared not to use its awake time and so would sleep after the 5 measurement steps had finished. If it starts using it during the deployment then there will be an extra 2-minute flush and 1 minute of either zeroing or measuring before it goes to sleep and the regular sampling will step 3 minutes after the previous day's sampling.

13 Satlantic SeapHOx sensors

Pete Brown & Darren Rayner

The SeaBird Deep SeapHOx sensor combines a Deep SeaFET pH sensor with a SeaBird MicroCAT CTD and SBE63 oxygen optode (MicroCAT-ODO). Two of these sensors were recovered during JC174, and three deployed with details below.

13.1 Recovery of sensors deployed as part of JC145

EB1: SeaFET SN 103, MicroCAT-ODO SN 14152, Deployed 10 Mar 2017

Unfortunately, this sensor was attached to the RAS frame located at the top of the mooring at EB1 that became detached from the mooring line in January 2018. Although the beacon was initially communicating, its battery failed before it could be collected. Thus, the system is currently lost.

MAR1: SeaFET SN104, ODO SN 14150 – Deployed 19 Mar 2017, Recovered 07 Nov 2018

The system was recovered with heavy biofouling but communication was immediate when a connection was made. Daily data files were downloaded for the full deployment period.

WB1: SeaFET SN 105, ODO SN 14151 – Deployed 30 Mar 2017 Recovered 21 Nov 2018

The system was recovered with heavy biofouling. Communication was again immediate when a connection was made. Daily data files were downloaded for the full deployment period. In February 2018 pH data were observed to jump to ~23 caused by erratic electrode voltages. From May 2018 erratic data was also observed in salinity and oxygen. Inspection of the SeapHOX unit cables revealed that they had been the victim of repeat fish bites that had severed the external casing allowing water ingress. At first it was thought the cable damage may have been what affected the sensor output, but the manufacturer clarified that damage to this cable would more likely results in erroneous or missing CTD-O data, but this is unaffected. Instead it is likely that the ISFET chip has failed, possibly due to increasing humidity in the pressure case.

13.2 Sensor setup for deployment on JC174

All sensors were placed in a seawater reservoir set up in the chemical lab a minimum of 5 days before deployment to allow the electrode to acclimatise and condition to surface seawater conditions. At least 24 hours before deployment, new batteries were installed, the instrument powered on and a lab test conducted to ensure that pH values were being produced. One new unit was delivered to the ship for its Nassau port call on 16th November. Initial testing on this unit found the MicroCAT-ODO had no communication with the Deep SeaFET. This was rectified through the system settings: 'power CTD and pump' was selected and data subsequently came through.

The V2 sensors were set up using UCI software according to the following settings:
• Autonomous sampling scheme
• No real-time data transmission
• External pump not enabled
• Minimum deployment temperature 15°C
• Sample interval 14400 seconds

Mooring	SeaFET S/N	MicroCAT-ODO S/N	Deployment date	Frequency
EB1	721-0004	12906	29-11-2018	Every 4 hours starting 00:00 local (00:00 UTC)
MAR1	721-2002	12903	08-11-2018	Every 4 hours starting 00:00 local (02:00 UTC)
WB1	721-2006	20312	25-11-2018	Every 1 hour starting 00:00 local (04:00 UTC)

Table 13.1 Sensor specific information

Following the identification of fish bites on the cables of the sensor recovered at WB1, copper tape was applied to the cables of the sensor deployed there subsequently. No tape was applied to the sensors at EB1 and MAR1 as these were deployed before WB1 was recovered and the damage identified.

14 Remote Access Samplers (RAS)

Pete Brown & Darren Rayner

The McLane Research Laboratories Inc. (www.mclane.com) Remote Access Sampler (RAS) 3-48-500 is an instrument for the autonomous collection of seawater samples. It works by pumping water out of the bottom of an acrylic sample cylinder in which an evacuated sample bag is installed. A pressure gradient is created, and the removed volume is replaced by local seawater being pushed into the sample inlet, through a multi-position valve and into the bag. A movement of the valve back to its home position isolates the sample collected until recovery. Pre-injection of a sample preservative into the bag can mean the sample can be stored safely on the instrument indefinitely without compromising sample integrity. The sampler is capable of collecting 48 samples, from a frequency of 3 samples an hour to a deployment period of 18 months.

Four RAS were deployed during JC145 across the subtropical North Atlantic as part of the NERC-funded Atlantic BiogeoChemical (ABC) Fluxes program. This looks to extend the capabilities of the successful RAPID mooring array into a biogeochemical sphere by the use of both autonomous samplers and carbon system sensors (pH, pCO_2).

14.1 Recovery of RAS systems deployed as part of JC145

EB1 – Sampler S/N 14082-1 Deployed 10-03-2017 Not Recovered

Unfortunately, the top of the mooring at EB1 had become detached from that below in January 2018, and although the beacon was communicative, its battery failed before it could be collected, and thus the system is currently lost.

MAR1 – Sampler S/N 13278-01 Deployed 19-03-2017 Recovered 07-11-2018

The system was recovered prior to its sampling event for sample 45. It was in a fouled condition and had sustained some damage: a number of tubing fittings to the bottom

of the sample bottles had become detached, indicating single or multiple events of large energy of some sort - these were for bottles 13, 23, 25, 27, 35 and 41, of which only one had a sample (35), indicating that the tubing had become detached before their respective sampling events; on the top of the unit, the compensation tube to bottle 13 was broken, the valve fitting for the acid/water wash position was snapped but still in place, and the bottle fitting for position 11 was equally snapped but still in place. Inspection of the bottom sensor frame revealed substantial crevice corrosion beneath electrical tape, which will render the frame unusable until repaired.

Samples had been collected by the RAS between positions 1 and 44 with the exception of 13, 23, 25, 27 and 41 (due to detached bottom tubing), and position 3 (due to the sample bag on/off fitting not being opened prior to deployment). Samples removed were labelled and stored upright in a cool box for shipping back to the UK for analysis.

On initial viewing, sample volumes appeared anomalously low (150-250 mL instead of an expected 500 mL) with sample volumes generally appearing to decrease the later they were collected. A number of causes were postulated to have possibly been linked to this and investigated during post-recovery lab testing:

- the use of a copper-nickel ‘banjo bolt’ at the sample inlet, with the theory being that the bore of the sample inlet was reduced by using the bolt
- a blockage within the valve itself
- the use of novel bags with an on/off valve fitting; as with the banjo bolt, a smaller bore of the tubing could have restricted water movement, or the valve not being opened sufficiently
- pump not performing optimally
- other

Data downloaded from the system suggested that it had pumped 500 mL for each sample event, and pump and valve information appeared normal. The valve and pump were removed from the RAS frame and installed in a lab sink. It was noticed that the top fitting of the pump (that holds it in place and connects it to the RAS frame) was cracked, possibly due to the removal of the corrosion-prone spacers installed by the manufacturer, and subsequent overtightening of the replacement screws. A ‘pump volume test’ was first run with water just being run through the valve – this gave a volume of 415 mL without a banjo bolt and 413 mL with it installed. Six bottle positions were then set up as in a normal deployment, using bags of a mixture of quality, composition (Aclar & Tedlar), and the on/off valves open to various degrees. Volumes collected ranged from 135-200 mL during the first test, and 155-192 mL during the second when the test was rerun without the banjo bolt installed. These results thus rule out the banjo bolt as the cause of the problem, and also the type of bag used. The test was then rerun after loosening of the top pump fitting, and results obtained were between 155-195 mL.

The pump was removed and disassembled for cleaning. It was postulated that the cracked fitting caused an imperfect seal with the pump, allowing it to pump water through the poor seal rather than through the tubing, with the relative resistances being: valve resistance>seal>pump tubing to bulk. After cleaning and reinstallation, a further test gave similar volumes as to before.

A new pump delivered with system 14520-02 was installed in the test system with the recovered valve (13278-01). Volumes obtained during the test ranged from 120-270 mL, large than before but still below expected. Valve 14520-02 was then used with pump 14520-02 and volumes obtained this time were 428-525 mL, as would be expected, leading us to suspect valve 13278-01 was problematic.

WBH2 – Sampler S/N 13278-04 Deployed 01-04-2017 Recovered 20-11-2018
All sample bags were empty on the system. Communication could not be made with the electronics controller unit. Unfortunately, further investigation revealed that the controller module had flooded, and given the empty bags it was expected that this happened on deployment.
The RAS frame was in a very heavily corroded condition, caused by crevice corrosion to the stainless steel located beneath the main plastic bottle frame. It is so bad that substantial repair will be required before it is reusable. Substantial corrosion was also revealed below some electrical tape on the sensor frame. The entire bar will need replacing before redeployment would be possible.
It was hoped that the pump and valve could be redeployed later in the cruise. However, the pump appeared slightly corroded, particularly around the bottom screw fitting and further investigation suggested this might have spread to the electronics inside. The valve looked fine for reuse.
Using valve 13278-04 recovered from WBH2 with pump 13278-01 recovered from MAR 1 a lab test was conducted. Water volumes collected ranged from 50-165 mL. Replacing the pump with that recovered from WBH2 gave volumes of 140-245mL.
A number of further tests were conducted:

- Manual pump test (13278-04) bypassing sample bag through port 1 (same as normal deployment but without bag or sample tube installed: 515 mL
- Manual pump test (13278-04) bypassing sample bag through port 1 (same as normal deployment but without bag installed: 515 mL
- Manual pump test (13278-04) through port 1 (same as normal deployment, with Tedlar bag installed): 235 mL
- Manual pump test (13278-04) through port 1 (same as normal deployment, with Tedlar bag installed, NOC-made compensation tube replaced with McLane one): no bag installed – 515 mL; bag installed - 245 mL
- Same as above but with compensation tube replaced with plug: no bag installed – 515 mL; bag installed - 250 mL

WB1 – Sampler S/N 13278-05 Deployed 30-03-2017 Recovered 21-11-2018
The system was recovered in a heavily fouled condition, 2 days after its final sample collection event. On the top side, practically all sample tubing was still attached (sample 5 tubing the only one to have become detached) but a number of compensation tubes had been lost (samples 4, 5, 8, 12, 16, 38, 41, 45, 46 and 47). Bottom tubing was found to be detached from positions 19, 21 and 26; however, this must have occurred after their respective sampling events as samples were collected from these positions. Samples were collected from all bottles, with the exceptions of 37 and 41 (sample bag on/off fitting not opened) and 47 (no known cause). As for MAR1, sample volumes were substantially lower than expected (~150-300 mL). Communication with the control module was successful and outputs suggested all sampling events were completed successfully. Samples removed were labelled and stored upright in a cool box for shipping back to the UK for analysis.

14.1.1 Cable damage

Post-recovery inspections of the individual valves and pumps revealed a significant amount of damage to the power cables, whereby assumed fish bites had cut through to the inner cabling, allowing ingress of water into the sheath. This occurred on:

- Valve 13728-04 (recovered from WBH2)
- Pump 13728-01 (recovered from MAR1)

- Valve 13728-01 (recovered from MAR1)
- Pump 13728-05 (recovered from WB1)

14.2 Deployment of replacement RAS systems

Four Remote Access Samplers were deployed during JC174. These are listed in Table 14.1

Mooring	Sampler S/N	Colour code	Deployment date	Last sample to be collected
EB1	14520-01	Green	29-11-2018	05-04-2020
MAR1	13278-02	Blue	08-11-2018	14-05-2020
WB1	13278-01	Red	25-11-2018	30-05-2020
WBH2	14520-02	Yellow-black	21-11-2018	26-05-2020

Table 14.1 List of Remote Access Samplers deployed on JC174

14.2.1 Instrument preparation

The NOC Standard Operating Procedure for RAS deployment [*Brown and Rayner*, 2015] was followed during the instrumental setup for all four RAS deployed.

EB1 – deployed 29/11/2018

RAS unit 14520-02 was initially set up for deployment at EB1. However, during the filling of the bottom tubing with milli-Q water (by sequential changes in port position and a short period of reverse pumping) communication was lost with the instrument as the valve was moving between positions 27 and 28. Separate communications cables, USB-RS232 adaptors and an alternative PC were tested to rule these out as causes. When the electronics control module was removed from its housing, it was found to be very hot, with some battery casings having melted, and a burnt odour emanating. Closer inspection found that one component on the electronics board had failed and burnt out. Communications with the supplier McLane indicated that this kind of component failure was very rare, and a replacement electronics control module would be sent to Nassau, Bahamas for the port call, thereby enabling deployment of the instrument in the western boundary. In lieu of this instrument failure, RAS 14520-01 was instead readied for action.

- RAS time and date was set to UTC. Local time was UTC.
- Due to the 'Acid wash' blue tubing becoming detached during a previous deployment, the position of this bottle was switched with that of bottle 48. This was to give it more protection towards the centre of the RAS.
- A stainless steel mesh was added to the top of the RAS with cable ties. This was to protect somewhat the sample inlet and tubing below from the chain.
- Where possible, fittings on RAS were removed, checked for corrosion and replaced with new (metric) versions. Stainless steel spacers were introduced between the bottle frame and main frame, and between the controller housing fitting and main frame.
- During instrumental setup (pump primed, top line filled, bottom lines prefilled, bags added, mercuric chloride added to sample lines, bags opened, acrylic cylinders filled), some air managed to get into the sample lines / push the sample preservative bag. An assessment of the quantity of air in the lines is made below:

EB1 Pre-deployment sample line assessment: location of preservative					
Port	Notes	Port	Notes	Port	Notes
1	5 bubbles	18	3 bubbles	35	No air in line
2	2 small bubbles	19	~15 cm air in total	36	~4 cm air in total
3	3 bubbles	20	No air in line	37	~10 cm air in total
4	~5 cm air in total	21	No air in line	38	No air in line
5	~12 cm air in total	22	6 bubbles	39	1 bubble
6	~3 cm air in total	23	16 bubbles	40	~1 cm air in total
7	5 bubbles	24	8 bubbles	41	~0.5 cm air in total
8	1 bubble	25	~2 cm air in total	42	No air in line
9	8 small bubble	26	~3 cm air in total	43	~0.5 cm air in total
10	3 bubbles	27	~4 cm air in total	44	~4 cm air in total
11	2 bubbles	28	~6 cm air in total	45	1 bubble
12	5 bubbles	29	~1 cm air in total	46	1 bubble
13	4 bubbles	30	~1 cm air in total	47	1 bubble
14	2 bubbles	31	5 bubbles	48	1 bubble
15	8 bubbles	32	Lots of tiny bubbles	49	-
16	5 bubbles	33	4 bubbles		
17	10 bubbles	34	4 bubbles		

- As a modification to previous deployments, opaque sleeving was added to the sample line tubing following assessment of gas volume. After previous recoveries significant discolouration / greying / clouding of the plastic was noted on the sample bag fitting and tubing between this and the sample cap. It was hypothesised that this was caused by mercuric chloride in the sample lines dissociating to mercury and chlorine in the continued presence of sunlight before migration to the top of the sample bag. Addition of the sleeving was to offer additional protection for the contents of the sample lines whilst awaiting sampling to occur.

Sampling schedule for EB1:
First sample on deployment for calibration. Second sample at midnight so that offset can be compared to deployment sample. Further 46 samples at 12-day interval. Therefore, 553 days plus 12 days for replacement RAS to be deployed to continue timeseries frequency.

EB1							
Port	Date	Time		Port	Date	Time	
		Local	UTC			Local	UTC
1	29/10/18	19:00:00	19:00:00	25	02/08/19	00:00:01	00:00:01
2	30/10/18	00:00:01	00:00:01	26	14/08/19	00:00:01	00:00:01
3	11/11/18	00:00:01	00:00:01	27	26/08/19	00:00:01	00:00:01
4	23/11/18	00:00:01	00:00:01	28	07/09/19	00:00:01	00:00:01
5	05/12/18	00:00:01	00:00:01	29	19/09/19	00:00:01	00:00:01
6	17/12/18	00:00:01	00:00:01	30	01/10/19	00:00:01	00:00:01
7	29/12/18	00:00:01	00:00:01	31	13/10/19	00:00:01	00:00:01
8	10/01/19	00:00:01	00:00:01	32	25/10/19	00:00:01	00:00:01
9	22/01/19	00:00:01	00:00:01	33	06/11/19	00:00:01	00:00:01
10	03/02/19	00:00:01	00:00:01	34	18/11/19	00:00:01	00:00:01
11	15/02/19	00:00:01	00:00:01	35	30/11/19	00:00:01	00:00:01
12	27/02/19	00:00:01	00:00:01	36	12/12/19	00:00:01	00:00:01
13	11/03/19	00:00:01	00:00:01	37	24/12/19	00:00:01	00:00:01
14	23/03/19	00:00:01	00:00:01	38	05/01/20	00:00:01	00:00:01
15	04/04/19	00:00:01	00:00:01	39	17/01/20	00:00:01	00:00:01
16	16/04/19	00:00:01	00:00:01	40	29/01/20	00:00:01	00:00:01
17	28/04/19	00:00:01	00:00:01	41	10/02/20	00:00:01	00:00:01
18	10/05/19	00:00:01	00:00:01	42	22/02/20	00:00:01	00:00:01

19	22/05/19	00:00:01	00:00:01	43	05/03/20	00:00:01	00:00:01
20	03/06/19	00:00:01	00:00:01	44	17/03/20	00:00:01	00:00:01
21	15/06/19	00:00:01	00:00:01	45	29/03/20	00:00:01	00:00:01
22	27/06/19	00:00:01	00:00:01	46	10/04/20	00:00:01	00:00:01
23	09/07/19	00:00:01	00:00:01	47	22/04/20	00:00:01	00:00:01
24	21/07/19	00:00:01	00:00:01	48	04/05/20	00:00:01	00:00:01

At time of deployment, final readout of RAS was:

Date	Time	Battery	Temp	Port
10/29/18	09:40:34	37.9 Vb	24.2C	00 (home)

MAR1 – deployed 08 Nov 2018

- RAS system 13278-02 was prepared for deployment, a unit that had previously been deployed at WBH2 between Nov 2015 and Mar 2017. Inspection of the stainless-steel frame revealed substantial crevice corrosion that had not been remedied during the gap between cruises. The top frame was deemed repairable on board that would allow it to be reused, but not in time for deployment at MAR1. It was decided that the frame from the new RAS unit 14520-02 would be used with all RAS parts removed (including valve, controller, pump, and both top and bottom bottle frames). These would be replaced with the components from 13278-02.
- RAS time and date was set to UTC. Local time was UTC -2.
- Valve 'Acid wash' bottle switch with sample position 48.
- A stainless-steel mesh was added to the top of the RAS with cable ties. This was to protect somewhat the sample inlet and tubing below from the chain.
- Where possible, fittings on RAS were removed, checked for corrosion and replaced with new (metric) versions. Stainless steel spacers were introduced between the bottle frame and main frame, and between the controller housing fitting and main frame.
- Air managed to get into the sample lines / push the sample preservative into the bag during instrumental setup, sometime between initial system preparation the day before deployment, and the morning of deployment. An assessment of the quantity of air in the lines is made below:

MAR1 Pre-deployment sample line assessment: location of preservative			
Sample line	Notes	Sample line	Notes
1	~ 15 cm	26	1 bubble
2	3 bubbles	27	3 bubbles
3	~ 2 cm	28	3 bubbles
4	~ 20 cm	29	No air in line
5	~ 1 cm	30	3 bubbles
6	~ 25 cm	31	~ 10 cm
7	~ 1 cm	32	~ 3 cm
8	~ 1 cm	33	~ 10 cm
9	4 bubbles	34	1 bubble
10	~ 7 cm	35	~ 2 cm
11	~ 15 cm	36	~ 1 cm
12	~ 15 cm	37	~ 1 cm
13	~ 4 cm	38	~ 3 cm
14	~ 3 cm	39	~ 3 cm
15	1 bubble	40	~ 2 cm
16	~ 4 cm	41	~ 5 cm
17	No air in line	42	~ 4 cm

18	~ 2 cm	43	~ 3 cm
19	9 bubbles	44	1 bubble
20	~ 1 cm	45	~ 7 cm
21	~ 1 cm	46	2 bubbles
22	1 bubble	47	No air in line
23	~ 5 cm	48	~ 10 cm
24	~ 3 cm	49	Air in line
25	~ 3 cm		

- As for EB1, opaque sleeving was added to the sample line tubing following the assessment of gas volumes.

Sampling schedule for MAR1:
First sample on deployment for calibration. Second sample at 0000 local so that offset can be compared to deployment sample. Further 46 samples at 12-day interval. Therefore, 553 days plus 12 days for replacement RAS to be deployed to continue roughly two-week timeseries.

MAR1							
Port	Date	Time		Port	Date	Time	
		Local	UTC			Local	UTC
1	08/11/2018	17:10:00	19:10:00	25	12/08/2019	00:00:01	02:00:01
2	09/11/2018	00:00:01	02:00:01	26	24/08/2019	00:00:01	02:00:01
3	21/11/2018	00:00:01	02:00:01	27	05/09/2019	00:00:01	02:00:01
4	03/12/2018	00:00:01	02:00:01	28	17/09/2019	00:00:01	02:00:01
5	15/12/2018	00:00:01	02:00:01	29	29/09/2019	00:00:01	02:00:01
6	27/12/2018	00:00:01	02:00:01	30	11/10/2019	00:00:01	02:00:01
7	08/01/2019	00:00:01	02:00:01	31	23/10/2019	00:00:01	02:00:01
8	20/01/2019	00:00:01	02:00:01	32	04/11/2019	00:00:01	02:00:01
9	01/02/2019	00:00:01	02:00:01	33	16/11/2019	00:00:01	02:00:01
10	13/02/2019	00:00:01	02:00:01	34	28/11/2019	00:00:01	02:00:01
11	25/02/2019	00:00:01	02:00:01	35	10/12/2019	00:00:01	02:00:01
12	09/03/2019	00:00:01	02:00:01	36	22/12/2019	00:00:01	02:00:01
13	21/03/2019	00:00:01	02:00:01	37	03/01/2020	00:00:01	02:00:01
14	02/04/2019	00:00:01	02:00:01	38	15/01/2020	00:00:01	02:00:01
15	14/04/2019	00:00:01	02:00:01	39	27/01/2020	00:00:01	02:00:01
16	26/04/2019	00:00:01	02:00:01	40	08/02/2020	00:00:01	02:00:01
17	08/05/2019	00:00:01	02:00:01	41	20/02/2020	00:00:01	02:00:01
18	20/05/2019	00:00:01	02:00:01	42	03/03/2020	00:00:01	02:00:01
19	01/06/2019	00:00:01	02:00:01	43	15/03/2020	00:00:01	02:00:01
20	13/06/2019	00:00:01	02:00:01	44	27/03/2020	00:00:01	02:00:01
21	25/06/2019	00:00:01	02:00:01	45	08/04/2020	00:00:01	02:00:01
22	07/07/2019	00:00:01	02:00:01	46	12/08/2019	00:00:01	02:00:01
23	19/07/2019	00:00:01	02:00:01	47	24/08/2019	00:00:01	02:00:01
24	31/07/2019	00:00:01	02:00:01	48	05/09/2019	00:00:01	02:00:01

At time of deployment, final readout of RAS was:

Date	Time	Battery	Temp	Port
11/08/18	10:38:54	33.7 Vb	25.9°C	00 (home)

WBH2 – 13278-01 deployed 20 Nov 2018
Following the failure of the control module electronics during setup of RAS 14520-02 for deployment at EB1, the manufacturer McLane sent out a replacement unit to Nassau that was collected during the port call on 16 Nov 2018. This new unit was

installed in the control module housing ready for installation along with the valve, pump and sample bottle frames, installed onto the RAS frame.
The stainless-steel frame supplied with 14520-02 had already been used for the MAR1 deployment when the original frame intended for this location (for 13278-02) was found to have not been repaired, and thus too corroded for immediate use. Instead, the crevice corrosion identified on the 13278-02 frame was ground down and smoothed on passage westwards from MAR1, with stainless steel washers added to raise the plastic bottle matrix off the frame bars, allowing for its subsequent reuse. RAS 14520-02 components were thus installed in this repaired top frame. This process however identified an unforeseen problem, namely that the electronics controller module for the new system (with its redesigned battery bay) was of a different (larger) size than the old design. Unfortunately, the plastic spacers and retaining bolts intended for this larger module had been used on the MAR1 deployment, and the remaining pieces were now too small to accommodate the module, the curved bolts in particular markedly too short to attach the module to the frame. Four straight bolts were instead removed from the MAR1 recovered frame, and cut to size. Plastic spacers were then put both above and below the controller module to attach it to the frame, the uppermost one reinforced with a section of stainless steel frame (5 cm x 20 cm x 0.5 cm).

- RAS time and date was set to UTC. Local time was UTC -4.
- Valve 'Acid wash' bottle switch with sample position 48.
- A stainless steel mesh was added to the top of the RAS with cable ties. This was to protect somewhat the sample inlet and tubing below from the chain.
- Where possible, fittings on RAS were removed, checked for corrosion and replaced with new (metric) versions. Stainless steel spacers were introduced between the bottle frame and main frame, and between the controller housing fitting and main frame. The position of the pump tubing was checked following final setup and it could be seen that it was correctly located
- During instrumental setup (pump primed, top and bottom lines prefilled, acrylic cylinders 100% filled – no backwards pumping / valve turning), some air managed to get into the sample lines / push the sample preservative bag. An assessment of the quantity of air in the lines is made below:

WBH2 Pre-deployment sample line assessment: location of preservative					
Port	Notes	Port	Notes	Port	Notes
1	5 bubbles	18	No air in line	35	No air in line
2	2 bubbles	19	~ 4 cm	36	~ 1 cm
3	~ 1 cm	20	~ 2 cm	37	~ 2 cm
4	3 bubbles	21	~ 18 cm	38	3 bubbles
5	2 bubbles	22	~ 5 cm	39	~ 1 cm
6	4 bubbles	23	~ 10 cm	40	1 bubble
7	~ 1cm	24	~ 4 cm	41	~ 1 cm
8	2 bubbles	25	No air in line	42	No air in line
9	No air in line	26	~ 10 cm	43	5 bubbles
10	7 bubbles	27	~ 13 cm	44	3 bubbles
11	~ 0.5 cm	28	~ 2 cm	45	4 bubbles
12	~ 1 cm	29	~ 1 cm	46	1 bubble
13	~ 1 cm	30	1 bubble	47	~ 1 cm
14	~ 4 cm	31	~ 1 cm	48	2 bubbles
15	~ 2 cm	32	2 bubbles	49	Air in line
16	~ 1 cm	33	No air in line		
17	~ 1 cm	34	5 bubbles		

Sampling schedule for WBH2:
First sample on deployment for calibration. Second sample at 0000 local so that offset can be compared to deployment sample. Further 46 samples at 11-day interval. Therefore, 507 days plus 11 days for replacement RAS to be deployed to continue roughly two-weekly timeseries.

WBH2							
Port	Date	Time		Port	Date	Time	
		Local	UTC			Local	UTC
1	20/11/2018	21:30:00	01:30:00	25	11/08/2019	00:00:01	04:00:01
2	01/12/2018	00:00:01	04:00:01	26	22/08/2019	00:00:01	04:00:01
3	12/12/2018	00:00:01	04:00:01	27	02/09/2019	00:00:01	04:00:01
4	23/12/2018	00:00:01	04:00:01	28	13/09/2019	00:00:01	04:00:01
5	03/01/2019	00:00:01	04:00:01	29	24/09/2019	00:00:01	04:00:01
6	14/01/2019	00:00:01	04:00:01	30	05/10/2019	00:00:01	04:00:01
7	25/01/2019	00:00:01	04:00:01	31	16/10/2019	00:00:01	04:00:01
8	05/02/2019	00:00:01	04:00:01	32	27/10/2019	00:00:01	04:00:01
9	16/02/2019	00:00:01	04:00:01	33	07/11/2019	00:00:01	04:00:01
10	27/02/2019	00:00:01	04:00:01	34	18/11/2019	00:00:01	04:00:01
11	10/03/2019	00:00:01	04:00:01	35	29/11/2019	00:00:01	04:00:01
12	21/03/2019	00:00:01	04:00:01	36	10/12/2019	00:00:01	04:00:01
13	01/04/2019	00:00:01	04:00:01	37	21/12/2019	00:00:01	04:00:01
14	12/04/2019	00:00:01	04:00:01	38	01/01/2020	00:00:01	04:00:01
15	23/04/2019	00:00:01	04:00:01	39	12/01/2020	00:00:01	04:00:01
16	04/05/2019	00:00:01	04:00:01	40	23/01/2020	00:00:01	04:00:01
17	15/05/2019	00:00:01	04:00:01	41	03/02/2020	00:00:01	04:00:01
18	26/05/2019	00:00:01	04:00:01	42	14/02/2020	00:00:01	04:00:01
19	06/06/2019	00:00:01	04:00:01	43	25/02/2020	00:00:01	04:00:01
20	17/06/2019	00:00:01	04:00:01	44	07/03/2020	00:00:01	04:00:01
21	28/06/2019	00:00:01	04:00:01	45	18/03/2020	00:00:01	04:00:01
22	09/07/2019	00:00:01	04:00:01	46	29/03/2020	00:00:01	04:00:01
23	20/07/2019	00:00:01	04:00:01	47	09/04/2020	00:00:01	04:00:01
24	31/07/2019	00:00:01	04:00:01	48	20/04/2020	00:00:01	04:00:01

At time of deployment, final readout of RAS was:

Date	Time	Battery	Temp	Port
11/20/18	12:31:11	35.0 Vb	30.3°C	00 (home)

WB1 – deployed 25 Nov 2018
The last of the four RAS deployments, the system to be deployed at WB1 had to be one that had been 'turned around' from a system recovered during JC174, namely either 13278-01 from MAR1, 13278-04 from WBH2, or 13278-05 from WB1. Of these three, both 13278-01 and 13278-05 had successfully collected water samples, albeit at volumes substantially lower than expected indicating possible performance issues with the valves/pump. As noted above, post-recovery inspections of the individual valves and pumps revealed a significant amount of damage to the power cables, specifically caused by fish bites allowing ingress of water into the sheath. This initially discounted the use of valve 13728-04 (recovered from WBH2), pump 13728-01 (recovered from MAR1), valve 13728-01 (recovered from MAR1) and pump 13728-05 (recovered from WB1). Closer inspection revealed that the cable from pump 13278-01 was not as damaged as the others, and water had not apparently managed to ingress into the centre of the cable. This cable was repaired on ship (h/t S. Mack) by removing the connectors and replacing the cable linking them, enabling the pump to be reused. For valve 13278-01 the cable was unrepairable, so valve 13278-05

was used instead. The pump recovered from MAR1 looked to be low on oil (though no leak was obvious) so some was siphoned from the corroded pump from WBH2 to top up the level. In future spare oil will need to be sourced and the state of the pump electronics from WBH2 verified if they are to be used again.
Overview of WB1 2-18-2020 components:

- Pump 13278-01, Valve 13278-05, Electronics Controller 13278-01

Following the deployment of RAS systems

- RAS time and date was set to UTC. Local time was UTC -4.
- RAS time and date was set to UTC. Local time was UTC -4.
- Valve 'Acid wash' bottle switch with sample position 48.
- A stainless steel mesh was added to the top of the RAS with cable ties. This was to protect somewhat the sample inlet and tubing below from the chain.
- The position of the pump tubing was checked following final setup and it could be seen that it was correctly located
- Where possible, fittings on RAS were removed, checked for corrosion and replaced with new (metric). Stainless steel spacers were introduced between the bottle frame and main frame, and between the controller housing fitting and main frame.
- During instrumental setup (pump primed, top and bottom lines prefilled, acrylic cylinders 100% filled – no backwards pumping / valve turning), some air managed to get into the sample lines / push the sample preservative bag. An assessment of the quantity of air in the lines is made below:

WB1 Pre-deployment sample line assessment: location of preservative					
Port	Notes	Port	Notes	Port	Notes
1	~ 5 cm	18	~ 1 cm	35	~ 4 cm
2	~ 5 cm	19	~ 6 cm	36	~ 3 cm
3	~ 6 cm	20	~ 11 cm	37	~ 4 cm
4	~ 15 cm	21	~ 15 cm	38	~ 1 cm
5	~ 11 cm	22	~ 8 cm	39	~ 3 cm
6	~ 20 cm	23	~ 6 cm	40	~ 1 cm
7	~ 8 cm	24	~ 4 cm	41	~ 1 cm
8	~ 11 cm	25	~ 2 cm	42	~ 4 cm
9	~ 8 cm	26	~ 23 cm	43	~ 1 cm
10	~ 15 cm	27	~ 15 cm	44	~ 5 cm
11	~ 4 cm	28	~ 21 cm	45	~ 1 cm
12	~ 15 cm	29	~ 11 cm	46	~ 11 cm
13	~ 4 cm	30	~ 15 cm	47	~ 11 cm
14	~ 1 cm	31	~ 3 cm	48	~ 6 cm
15	~ 8 cm	32	~ 1 cm	49	Air in line
16	~ 2 cm	33	~ 3 cm		
17	~ 2 cm	34	~ 2 cm		

Sampling schedule for WB1:
First sample on deployment for calibration. Second sample at 0000 local so that offset can be compared to deployment sample. Further 46 samples at 12-day interval. Therefore, 553 days plus 12 days for replacement RAS to be deployed to continue roughly two weekly timeseries.

WB1							
Port	Date	Time		Port	Date	Time	
		Local	UTC			Local	UTC
1	23/11/2018	21:30:00	01:30:00	25	27/08/2019	00:00:01	04:00:01
2	24/11/2018	00:00:01	04:00:01	26	08/09/2019	00:00:01	04:00:01
3	06/12/2018	00:00:01	04:00:01	27	20/09/2019	00:00:01	04:00:01
4	18/12/2018	00:00:01	04:00:01	28	02/10/2019	00:00:01	04:00:01
5	30/12/2018	00:00:01	04:00:01	29	14/10/2019	00:00:01	04:00:01
6	11/01/2019	00:00:01	04:00:01	30	26/10/2019	00:00:01	04:00:01
7	23/01/2019	00:00:01	04:00:01	31	07/11/2019	00:00:01	04:00:01
8	04/02/2019	00:00:01	04:00:01	32	19/11/2019	00:00:01	04:00:01
9	16/02/2019	00:00:01	04:00:01	33	01/12/2019	00:00:01	04:00:01
10	28/02/2019	00:00:01	04:00:01	34	13/12/2019	00:00:01	04:00:01
11	12/03/2019	00:00:01	04:00:01	35	25/12/2019	00:00:01	04:00:01
12	24/03/2019	00:00:01	04:00:01	36	06/01/2020	00:00:01	04:00:01
13	05/04/2019	00:00:01	04:00:01	37	18/01/2020	00:00:01	04:00:01
14	17/04/2019	00:00:01	04:00:01	38	30/01/2020	00:00:01	04:00:01
15	29/04/2019	00:00:01	04:00:01	39	11/02/2020	00:00:01	04:00:01
16	11/05/2019	00:00:01	04:00:01	40	23/02/2020	00:00:01	04:00:01
17	23/05/2019	00:00:01	04:00:01	41	06/03/2020	00:00:01	04:00:01
18	04/06/2019	00:00:01	04:00:01	42	18/03/2020	00:00:01	04:00:01
19	16/06/2019	00:00:01	04:00:01	43	30/03/2020	00:00:01	04:00:01
20	28/06/2019	00:00:01	04:00:01	44	11/04/2020	00:00:01	04:00:01
21	10/07/2019	00:00:01	04:00:01	45	23/04/2020	00:00:01	04:00:01
22	22/07/2019	00:00:01	04:00:01	46	05/05/2020	00:00:01	04:00:01
23	03/08/2019	00:00:01	04:00:01	47	17/05/2020	00:00:01	04:00:01
24	15/08/2019	00:00:01	04:00:01	48	29/05/2020	00:00:01	04:00:01

At time of deployment, final readout of RAS was:

Date	Time	Battery	Temp	Port
11/24/18	14:17:39	33.1 Vb	25.9°C	00 (home)

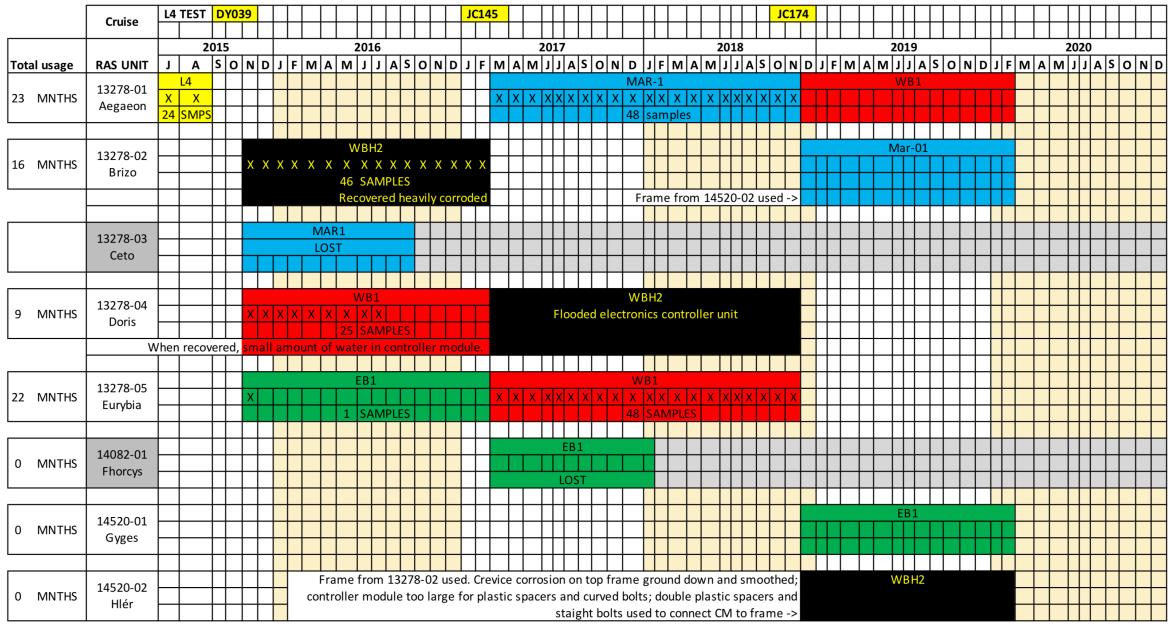


Table 14.2 Usage of the different RAS systems

References
Brown, P. J., and D. Rayner (2015), Standard operating procedure for the pre-deployment setup of the McLane Remote Access Sampler (RAS)Rep., National Oceanography Centre, Southampton, UK.

15 Trial underway CO_2 system

Hannah Wright, Nick Rundle

The CO_2 underway system comparison experiment belonging to Sue Hartman, Jon Campbell and Nick Rundle aimed to compare readings of the Pro-Oceanus CO_2 sensor when fully submerged and when partly submerged. The purpose of this experiment was to determine if an alternative sensor container which exposes most of the pCO_2 sensor housing could be used without affecting sensor results. The new sensor container could then be smaller and more suitable for installing into a ship's engine room, therefore broadening the possibilities of vessels that can carry the CO_2 underway system for the Ships of Opportunity programme. As ships' engine rooms are generally very warm this experiment aimed to test how high environmental temperatures impact sensor readings.

Two underway systems were to be run on the cruise. One of which was the standard tank in which the sensors were placed inside and fully submerged in the seawater – this is known as the 'loft' system. The other was a standing tank system with a door in which the sensors were attached. The CO_2 sensor housing is partly external to this tank and is known as the 'bender' system. The sensors contained in both systems are as in Table 15.1.

Sensor Type	**Location**
Anderraa 4319 Conductivity	Loft and Bender
Anderraa 4050 Temperature	Loft and Bender
Anderraa 4330 Oxygen Optode x 2 [one old and one new]	Loft and Bender
Pro-Oceanus Co2-ProCV	Loft and Bender
Pro-Oceanus GTD-Pro Gas tension	Loft only

Table 15.1 Instruments used in the underway CO2 equipment

The flow rate was also measured for each tank. Each required a minimum flow of 10 l/min. They were originally set up in the Controlled Environment Lab, 226. The idea was to turn off the air conditioning to this lab on certain days to let the temperature increase. The data output as well as air temperature data was being managed by a laptop running Jon's 'NOC Underway CO2 Sensor Logger' software.

The experiment was started on 25/10/2018. It was brought up by the Chief Engineer the next morning that the output of the two systems of 20 l/min was too much for the grey water tank capacity. Therefore, the experiment was moved so that the output could be drained overboard. It was found that the CTD lab was the best solution and the output could be guided to the scuppers via hoses. However, having the hoses exposed in the lab space led to the 'bender' output being stepped on and the increase in pressure caused the seal of the tank to crack. Due to required repairs to the 'bender' system the actual experiment start date was extended to 31/10/2018.

With the experiment moved to a semi-outside environment it was not possible to control the temperature which should have been an important aspect of this

experiment. However, as the cruise was in the sub-tropics the temperature was mainly in the mid to high 20's.
DIC and nutrient samples were taken daily from the supply to the systems to be analysed after the cruise. Oxygen samples were taken from the supply and analysed along with the CTD oxygen samples. As there were not enough chemicals to run the O_2 analyser for the whole cruise it was not possible to obtain O_2 samples every day. Nutrients samples were kept in the freezer.
Underway flow interruptions and notes:

- 03/11/2018 17:00 – 18:00 Both systems were flushed with fresh water
- 08/11/2018 DIC sample taken at pCO_2 sensor AZPC time and so invalid
- 09/11/2018 17:30 – 18:30 Both systems were flushed with fresh water
- 11/11/2018 17:40 - 12/11/2018 11:00 Underway system switched off for engineering works to a leaky pipe. The daily samples had not been taken before this point.
- 12/11/2018 18:00 – 13/11/2018 13:00 Systems emptied, tanks and sensors rinsed out, pCO_2 and new O_2 optodes were switched over for the second half of the comparison experiment. Some issues with leaking from lid o-rings when rebuilt but were fixed the next morning.
- 16/11/2018 12:00 – 19:00 underway system switched off for port call in Nassau
- 17/11/2018 19:30 – 20:30 Both systems were flushed with fresh water
- 18/11/2018 12:45 discovered that flow serial input had been knocked out so some flow data will be missing.
- 23/11/2018 13:00 – 14:20 systems were flushed with fresh water. 00:26 Loft tank found fallen off into sink, was upright but optodes not fully submerged.
- 26/11/2018 13:30 the system was stopped and turned off

16 Data telemetry systems

Steve Mack, Darren Rayner and Hannah Wright

16.1 Telemetry buoy controllers

Two telemetry systems were deployed on moorings EBH3 and WB2 in order to receive data back from these moorings remotely. The telemetry systems include a buoy controller with power supply that controls inductive communications to all sensors on the mooring to poll for data. The data is averaged periodically into records which are transferred to an acoustic modem with an external battery supply. Each record will contain the averages for every sensor on the mooring as well as compass data from within the buoy controller housing and supply voltage, temperature and humidity values from the buoy controller circuit board itself. The records can be retrieved acoustically by a using a Teledyne Benthos ATM900 series Acoustic Modem and utilising the 'datalogger commands'. A different data retrieval technique is to be used for each telemetry system deployment. On the EBH3 mooring a Wave Glider surface vehicle will retrieve the data by positioning at the mooring site and polling the mooring acoustic modem for the records. The records can then be sent to

base over Iridium. On the WB2 mooring a MYRTLE lander is to be placed at the mooring site and will poll the mooring acoustic modem for records. These records will be uploaded to pop-up pods that can be periodically released to float to the surface and deliver the data over Iridium. All times are set to GMT.
Equipment for each buoy controller system is as follows:

- A7334 RAPID Buoy Controller v2.0a inside a Develogic battery housing
- Teledyne Benthos Acoustic Modem, ATM964 Low Frequency and external transducer
- Seabird Inductive Cable Coupler, ICC 100 turns
- Seabird Inductive Modem Module, IMM RS232/LLS
- Compass model
- Modem External battery pack: Develogic battery housing 7s7p SAFT 33600 lithium metal cells.

Benthos modem configuration parameters are below. All other parameters should remain as default settings.

@TxRate=5 (800) @TxPower=8 @WakeTones=Ena @P1Baud=9600 @P1EchoChar=Dis @P1FlowCtl=0 (None) @P1Mode=0 (Cooked)	@P1Protocol=0 (RS232)@P1StripB7=Dis @P1NoSleep=Dis @IdleTimer=00:03:00 @Prompt=1 (Arrow) @Verbose=0 or 1 @RingBuf=Ena	@Logmode=1 (Sentinel) @Sentinel=10 @OpMode=1 (Online) *these parameters are controlled in the Buoy Controller firmware

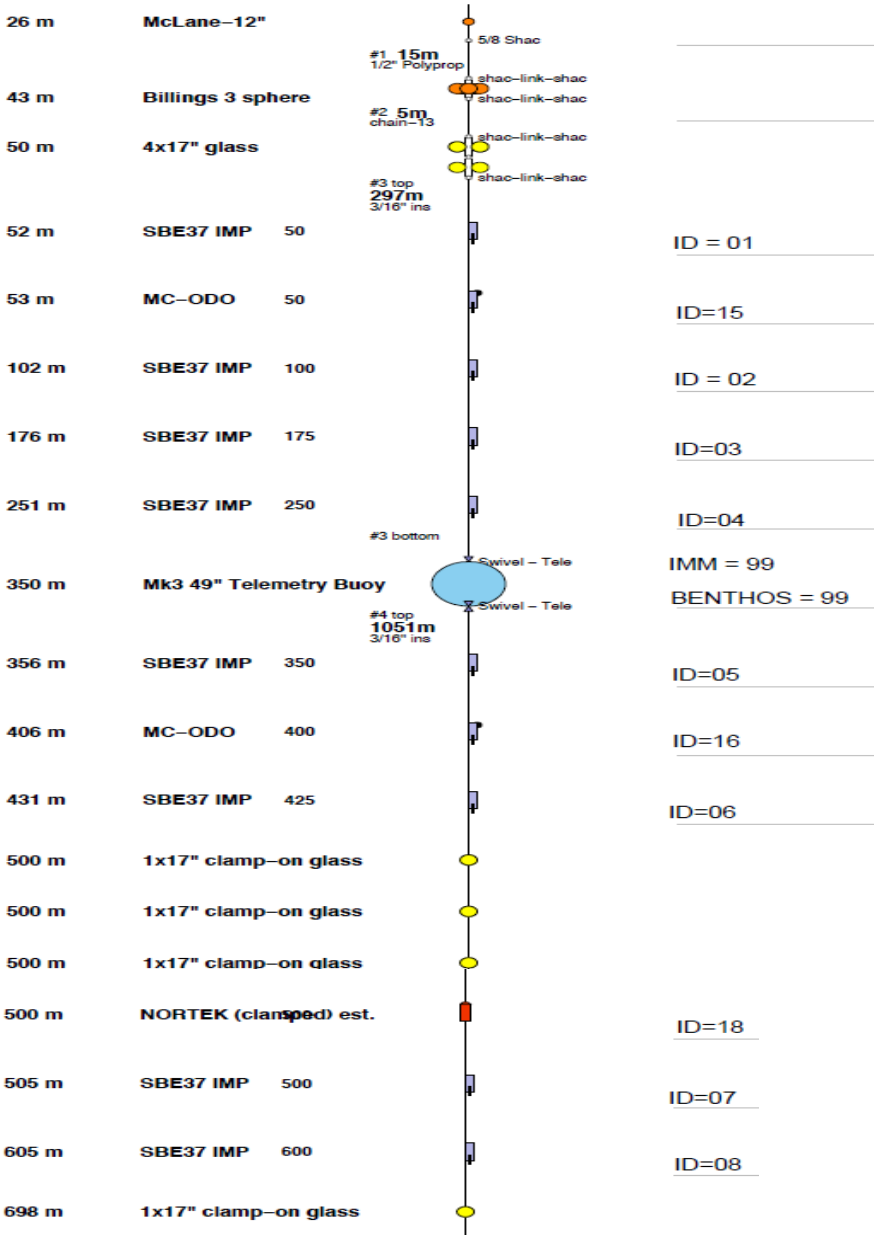
Recovery and deployment documentation has been produced for the safe recovery and redeployment of the systems. Specific settings for each telemetry system are as follows.

EBH3, Wave Glider telemetry System

Modem to be pointing towards the surface to communicate with the surface vehicle so placed at the top of the telemetry buoy.
Buoy controller Develogic housing: titanium containing 7s7p SAFT 33600 lithium metal cells
RECORDING SCHEDULE CONFIGURATION:

Schedule start time: 22/10/2018 17:00:00
Schedule sampling interval: 60 minutes
Schedule averaging interval: 12 samples (12.00 hours)
Schedule stop time: 21/10/2025 12:53:10

BENTHOS MODEM CONFIGURATION: @LocalAddr = 99
The instrument IDs are shown in Figure 16.1


26 m
McLane–12"
5/8 Shac
#1 15m
1/2" Polyprop
shac–link–shac
43 m
Billings 3 sphere
shac–link–shac
#2 5m
chain–13
50 m
4x17" glass
shac–link–shac
shac–link–shac
#3 top
297m
3/16" ins
52 m
SBE37 IMP
50
ID = 01
53 m
MC–ODO
50
ID=15
102 m
SBE37 IMP
100
ID = 02
176 m
SBE37 IMP
175
ID=03
251 m
SBE37 IMP
250
ID=04
#3 bottom
Swivel – Tele
350 m
Mk3 49" Telemetry Buoy
IMM = 99
BENTHOS = 99
Swivel – Tele
#4 top
1051m
3/16" ins
356 m
SBE37 IMP
350
ID=05
406 m
MC–ODO
400
ID=16
431 m
SBE37 IMP
425
ID=06
500 m
1x17" clamp–on glass
500 m
1x17" clamp–on glass
500 m
1x17" clamp–on glass
500 m
NORTEK (clamped) est.
ID=18
505 m
SBE37 IMP
500
ID=07
605 m
SBE37 IMP
600
ID=08
698 m
1x17" clamp–on glass

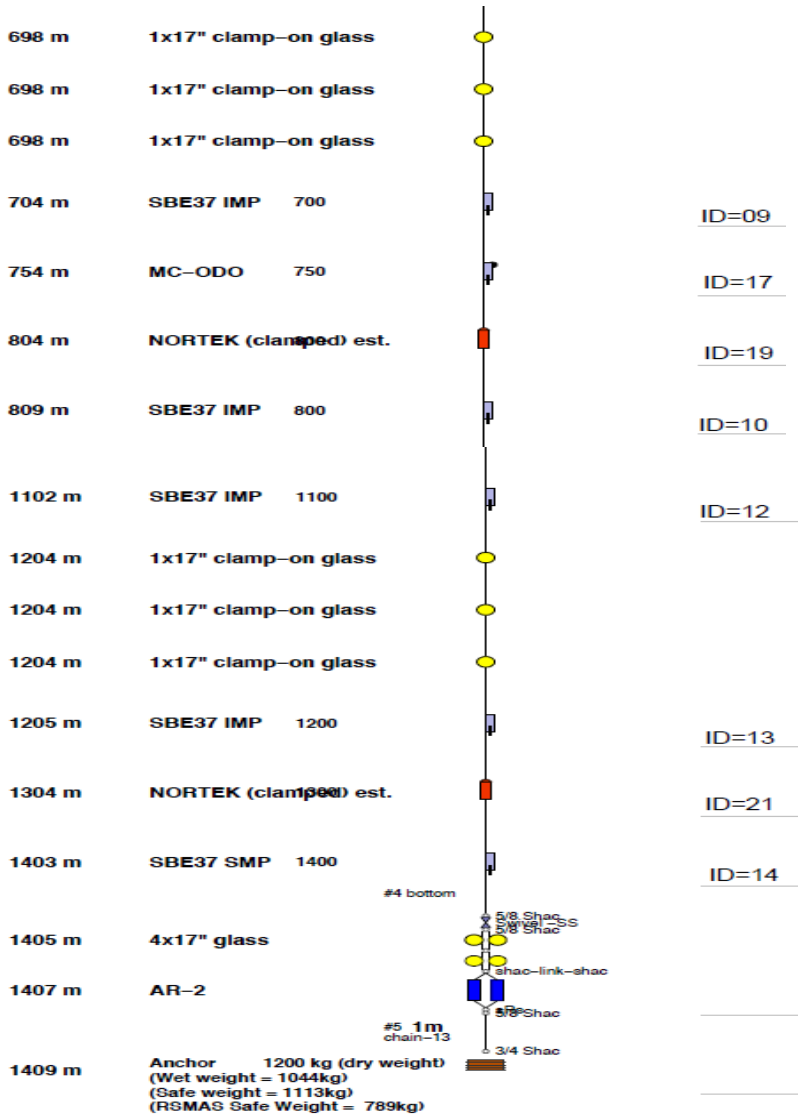


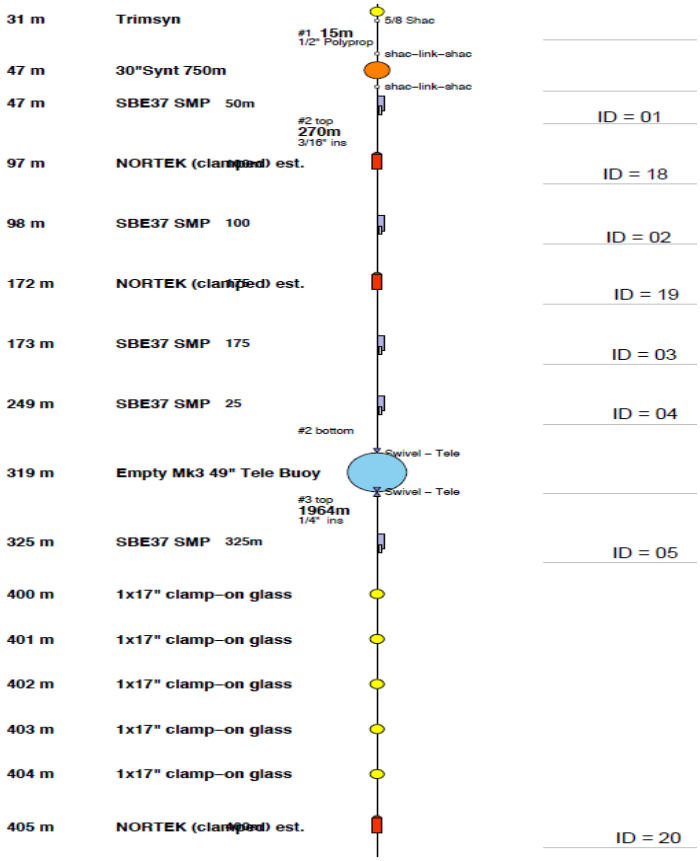
Figure 16.1 Telemetry instrument IDs for buoy controller on mooring EBH3

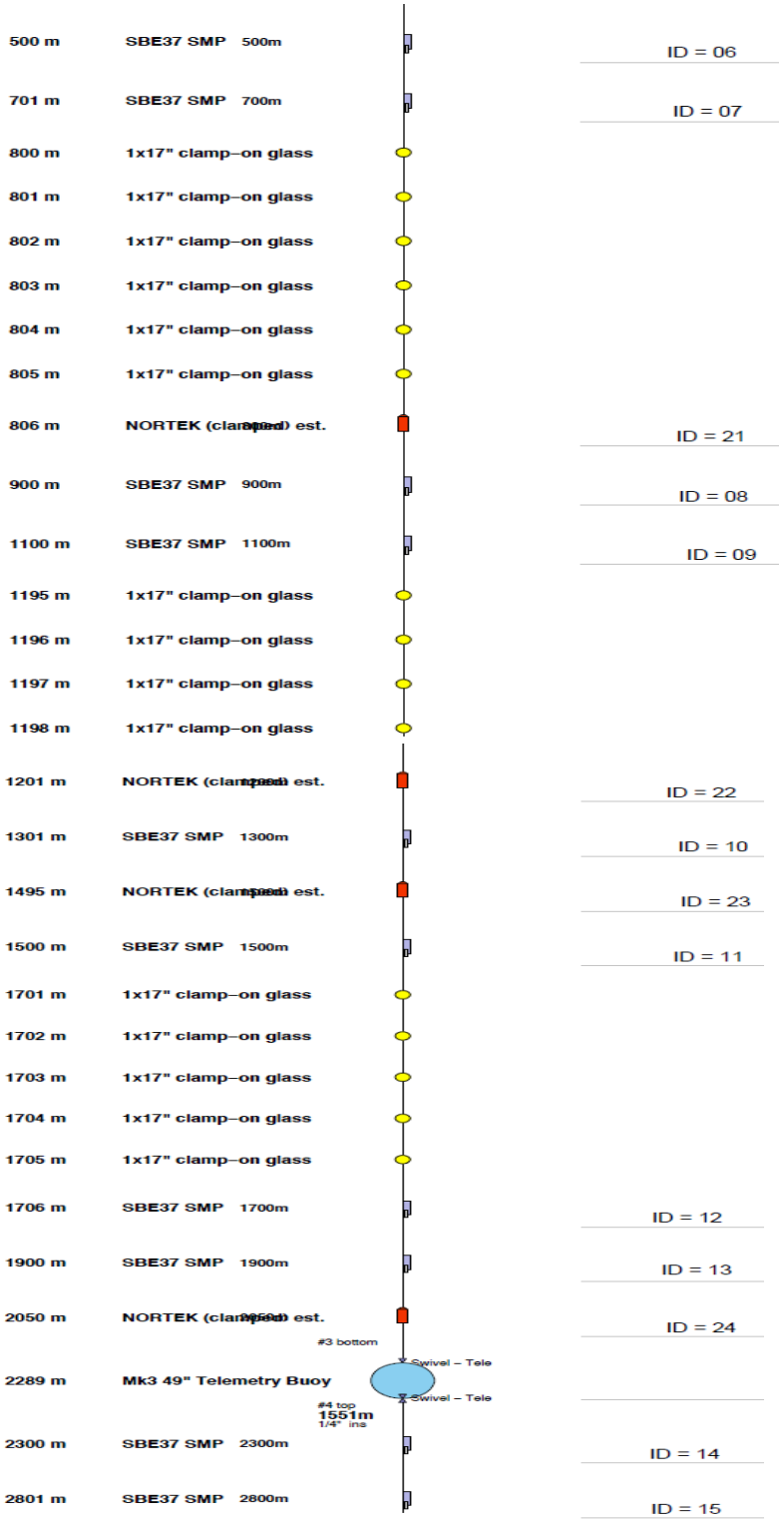
The EHB3 telemetry mooring was deployed 23/10/2018. It was discovered after the deployment that the Benthos modem had been connected to the wrong serial port of the buoy controller and so will not be collecting the new data from the mooring. In testing prior to the deployment the Benthos modem in datalogger mode was picking up noise from the other port on the transceiver as signal and saving that as a record. In future the contents of the records created in testing should be checked before deployment rather than just their presence or absence. Due to this error the Wave Glider deployment was cancelled as there would be no data to collect from EBH3 and nothing to gain from acoustic transfer of older stored data as the acoustic communications distance is the same as the previous trials. On recovery the inductive data storage should be checked against the sensor stored data.

WB2, Myrtle system

The mooring consists of two syntactic telemetry buoys, one of which was populated with the telemetry system, the second just for buoyancy but allowing an unbroken inductive link. The modem transducer was fixed to the bottom of the lower telemetry buoy, facing down to communicate with the lander.

The bottom telemetry buoy containing the telemetry system has inductive swivels either side. The top telemetry buoy has an inductive swivel beneath and a plate configuration on top – the same as the Wave Glider telemetry buoy set up.
Buoy controller Develogic housing: composite containing 6s7p SAFT 33600 lithium metal cells
BUOY CONTROLLER RECORDING SCHEDULE CONFIGURATION:
Schedule start time: 22/11/2018 01:20:00
Schedule sampling interval: 60 minutes
Schedule averaging interval: 12 samples (12.00 hours)
Schedule stop time: 31/10/2027 00:00:00
i.e. records will be created at 00:20 and 12:20 hours.
BUOY CONTROLLER BENTHOS MODEM CONFIGURATION: @LocalAddr = 98
MYRTLE CONTROLLER DOWNLOAD SCHEDULE CONFIGURATION:
First Download Date & Time: 22/11/2018 00:40:00
Download Interval: 1440 minutes
MYRTLE BENTHOS MODEM CONFIGURATION:
@LocalAddr = 98
The instrument IDs are shown in Figure 16.2




500 m SBE37 SMP 500m
ID = 06
701 m SBE37 SMP 700m
ID = 07
800 m 1x17" clamp–on glass
801 m 1x17" clamp–on glass
802 m 1x17" clamp–on glass
803 m 1x17" clamp–on glass
804 m 1x17" clamp–on glass
805 m 1x17" clamp–on glass
806 m NORTEK (clamped) est.
ID = 21
900 m SBE37 SMP 900m
ID = 08
1100 m SBE37 SMP 1100m
ID = 09
1195 m 1x17" clamp–on glass
1196 m 1x17" clamp–on glass
1197 m 1x17" clamp–on glass
1198 m 1x17" clamp–on glass
1201 m NORTEK (clamped) est.
ID = 22
1301 m SBE37 SMP 1300m
ID = 10
1495 m NORTEK (clamped) est.
ID = 23
1500 m SBE37 SMP 1500m
ID = 11
1701 m 1x17" clamp–on glass
1702 m 1x17" clamp–on glass
1703 m 1x17" clamp–on glass
1704 m 1x17" clamp–on glass
1705 m 1x17" clamp–on glass
1706 m SBE37 SMP 1700m
ID = 12
1900 m SBE37 SMP 1900m
ID = 13
2050 m NORTEK (clamped) est.
ID = 24
#3 bottom
Swivel – Tele
2289 m Mk3 49" Telemetry Buoy
Swivel – Tele
#4 top
1551m
1/4" ins
2300 m SBE37 SMP 2300m
ID = 14
2801 m SBE37 SMP 2800m
ID = 15

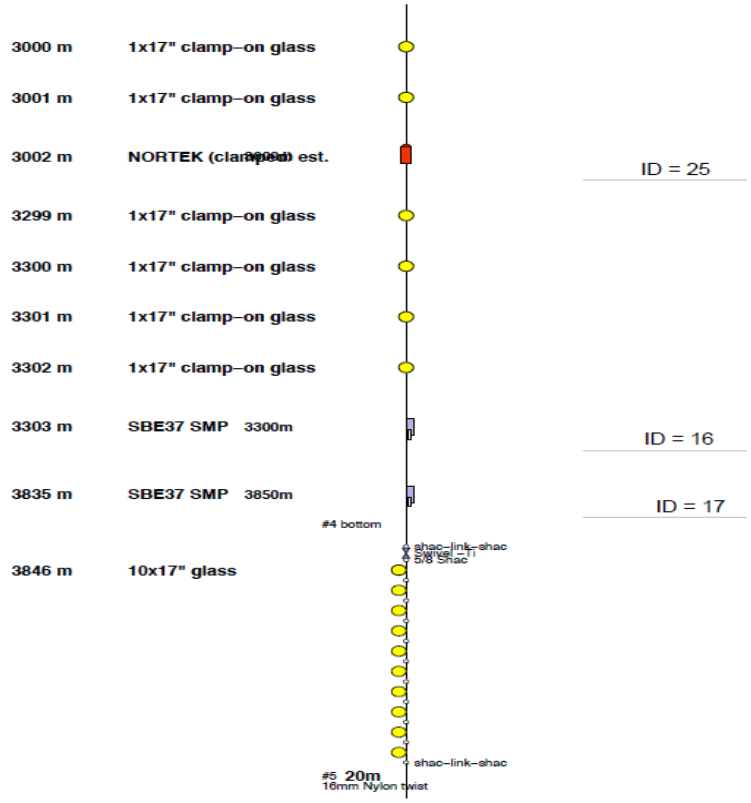


Figure 16.2 Telemetry instrument IDs for buoy controller on mooring WB2

16.2 MyrtleX telemetry lander

MyrtleX is a Lander frame on which are mounted releasable data capsules. Data is received from the mooring via a Benthos acoustic modem link. The acoustic modem is linked to the Lander Controller (SAM4L) which processes and stores the data. The data received are also passed through an InfraRed transmitter system, passing the data to each of the remaining capsules simultaneously. The capsules receive the data and store it on an SD card.

A 'timed release' system is employed to release the capsules at set times (Table 16.1). These times are based on 'hours' from timer setting. The timer wakes up every hour to check the hour counts against the set count. When a capsule is due for release a relay is fired and the motor drive relating to that capsule is activated, which will release the holding bar of the capsule. The pods are expected to rise at about 1 ms^{-1}. When a capsule is due for release an Infra-Red command is sent to all pods. This command is specific to one pod only and will be ignored by the others. On receipt of the correct command the data capsule will switch into 'Iridium mode' there will be a delay while the capsule is allowed to surface. The first message sent is a "POD X on SURFACE" followed by the data in 256 byte packets. This process is repeated until all data is transmitted. Data is received by email at various accounts. Each Iridium SBD unit has a unique IMEI identifier.

Note that the Iridum 256 byte data packet transmissions are checked to ensure the transmission was successful. If the transmission was not successful that packet will be re-transmitted until a successful transmission is achieved. However, the wakeup 'POD ON SURFACE' message is NOT checked for successful transmission. Therefore, due to satellites not being in view or sea surface conditions this may not always be received.

A nominal frame recovery date of 05/04/20 was used to calculate the spread in time of the pod releases, and details are given in Table 16.2

POD NUMBER	IMEI NUMBER	RELEASE TIME (HOURS)	RELEASE DATE (ALL at 1100Z)
1	300234063449070	72	25/11/18
2	300234063348920	1008	03/01/19
4	300234063448050	2856	21/03/19
5	300234063348920	4704	06/06/19
6	300234063442070	6552	22/08/19
7	300234063447010	8400	07/11/19
8	300234063347700	10248	23/01/20
9	300234063443040	11950	SECURED TO FRAME

Table 16.1 Programmed releases of the data pods.

Benthos XT6001. SN 70772. 12V Motor Drive	Benthos XT6000. 28V Burnwire
Receive: 10kHz Transmit: 12.0kHz	Receive: 14.5kHz Transmit: 12.0kHz
Enable 'F' Release 'D'	Release 'A'

Table 16.2 MyrtleX main frame acoustic releases

The lander was attached to the trawl cable equipped with a release and a USBL so that the frame could be accurately positioned on the seafloor. During the first attempt at deployment POD 5 came away from frame due to faulty fixing nut. The pod was recovered (albeit dropped back into the sea on recovery) and secured to the frame. Following this the lander was successfully lowered to 3872 m, and was on the bottom at 1900Z .

The first pod release was timed to occur when the ship was on station on 25th November. The pod was spotted on the surface at about 1100Z. This is one hour earlier than expected. It is likely to have been released on initial power up and that other pods will also release at 1000Z rather than 1100Z.

The pod was left in the water for several hours to allow time for transmissions and after recovery was left on deck to allow further time for transmission. However, no Iridium transmissions were received from the pod. It is possible that the wakeup message was missed by the satellite, and that there were no data on pod.

Investigation of the pod post-recovery revealed that it had switched to Iridium mode, acquired satellites, and attempted transmission. Battery voltages were all ok, but there were no data on the SD card.

17 Moorings

Darren Rayner

All mooring operations were conducted on the aft deck using the NMF double barrel winch and reelers with mooring lines passing through a block suspended on the end of a stern crane. Problems with the dropkeel transducer meant that it was not possible to communicate to the acoustic releases whilst underway and instead a handheld (or "superducer") transducer had to be used with the ship stationary every time.

Releases were tested on the CTD frame to at least their deployment depth prior to use, and moored CTDs were checked before deployment and after recovery to provide functionality checks and end-point reference calibrations.
Summaries of the deployment and recovery times are given in Table 17.1 and 17.2, with details of instruments lowered on CTD calibration dips given in Table 17.3. Table 17.4 summarises the instrument record lengths (NB: this is from initial inspection on the cruise, and not fully QC'd data, so there may be erroneous data included in the totals).

17.1 Mooring issues

EBH4 would not surface when the releases were fired. Both releases confirmed they had released but no change in the range was detected. Dragging was attempted and despite hooking the mooring and lifting the releases they fell from the grapnel to end up approximately 1300m from the initial position. They were fired again in case something had been disturbed during the drag, but they still would not rise. During the drag operation a section of polyester rope was brought to the surface on a grapnel which was at first thought to be the target mooring because it had some tension on it, but as it was hauled further it was found to be a short section attached to an old anchor from a previous deployment.
The top of EB1 came adrift and sent Iridium alerts on 31st December 2017. Unfortunately, transmissions stopped before it could be recovered. On this cruise we recovered what was left of the mooring and found that all was still present up to the 100m MicroCAT (though this had collapsed to a lower depth with the loss of the buoyancy above it). The RAS and sensors mounted in the frame beneath it were lost along with 8 glass and a 24" syntactic with beacons. The end of the recovered wire showed evidence of scratching and cutting of the plastic jacket with corrosion of the galvanised wire rope core leading it parting. It is believed the wire jacket was compromised by drifting longline and then the wire rusted through.
The lander at EB1 (EB1L11) would not rise despite both releases being fired. The reason for this is not certain, but glass implosions are suspected. No dragging was attempted for this small target in deep water and all instrumentation and buoyancy is considered lost.
MAR3L suffered implosion of the Billings float and four glass. The beacons were lost with the top of the Billings. There was sufficient buoyancy remaining in the 2 unaffected packs of glass (4 spheres each) to lift the lander so the BPRs and releases were recovered safely.
The NOG mooring was recovered with 6 imploded glass spheres from the 4000m 10-pack. These had been deployed in a string of 5 pairs so the replacement was changed to spread the 10 spheres out in a single string to reduce the risk of sympathetic implosions.
When attempting recovery of MAR0, the first release fired correctly and the mooring started to rise (as measured by the range responses from the deck unit), but it stopped after moving about 15-20m. The second release was also fired but there was no further change in the range. The assumption is that imploded glass is responsible for this. The design used glass at 4780m with a deep-rated syntactic just above the releases, which would have been sufficient to lift the mooring if the wire had parted beneath the glass. But if the glass imploded instead of breaking loose then there would be the additional weight of the chain which the glass was attached to, and it would then be marginal as to whether the deep syntactic could alone lift the whole mooring. This would be confounded if all 4 of the glass (plus the Billings float)

imploded. The replacement mooring used 5 CF-16 deep rated syntactic "rugby ball" floats in place of the glass to mitigate implosion of glass on this mooring.
WB4 surfaced approximately 400m west of where we were expecting it, which could have caused a problem with the vessel positioning. The trilaterated seabed position was checked and confirmed to be correct meaning either the mooring anchor had moved or the mooring was leaning over in strong currents. The vessel mounted ADCP didn't show anything unusual in the upper 1000m, but looking at the recovered current meter data there is a strong westerly current at all depths from 1200m down. The horizontal deflection of the mooring is plotted in Figure 17.1 using the change in pressure records and assuming a uni-directional flow. This slightly over-estimates the deflection we saw, but this wasn't the strongest period of knockdown during the deployment. If we repeat the plot for that time (Figure 17.1 lower panel) then the top of the mooring could have been 2km away from the anchor position. This will need to be considered when setting up for recoveries in the future, or some means of locating the top of the mooring before recovery should be included in the design.
In addition to surfacing away from where expected, the top section of wire on WB4 parted during recovery when hauling aboard under low tension. The mooring was hooked onto again and recovered without further incident. Inspection of the section afterwards showed that there was damage to the plastic jacket exposing the galvanised metal wire, which then corroded weakening it. The scrapes on the wire are consistent with those seen on EB1 and are thought to be caused by longline fishing gear. The top of this mooring would have surfaced by itself if left much longer in the water.
The bespoke syntactic lander recovered from WB4L worked very well. The surfacing rate was slightly quicker than predicted by models (possibly due to the slight streamlining of the lander legs on ascent compared to descent). The simple flag was very effective for spotting the lander on the surface, which was especially useful as there were no messages received from the Iridium beacon (including once on deck) and the main body of the lander sits fairly low in the water. There was significant crevice corrosion of the stainless bolt inserts and these will need to be replaced for future deployments. These bolts will not affect the security of the instruments and releases as they are also clamped by plastic collars, but the replacement landers deployed on this cruise were liberally coated with water-repellent grease under the stainless-steel plates where the inserts are located.
The top of WB2 broke loose and surfaced on 2nd September 2018 shortly before this cruise. It was rescued by a small boat out of Abaco and towed to Marsh Harbour. Inspection of the recovered kit showed that the mooring had parted on the section between the 175m syntactic and the 400m glass. The recovered floats and instruments were collected from Marsh Harbour and transferred to the James Cook during this cruise with the remaining mooring being recovered except for the MicroCAT at 325m. It is thought the mooring parted either due to drifting longline fishing gear or active small-boat sport fishing gear damaging the wire and exposing the galvanised core as per WB4 and EB1, and it's probable that the MicroCAT was scraped from the mooring by the same line that damaged the wire rope jacket.
WB2L11 was not recovered. Both releases were fired and confirmed they had released, but there was no change in the range to the lander despite repeated release attempts. The reason for this is unknown but given the relatively large amount of glass implosions seen on this cruise, this seems the most likely cause for the lander too.

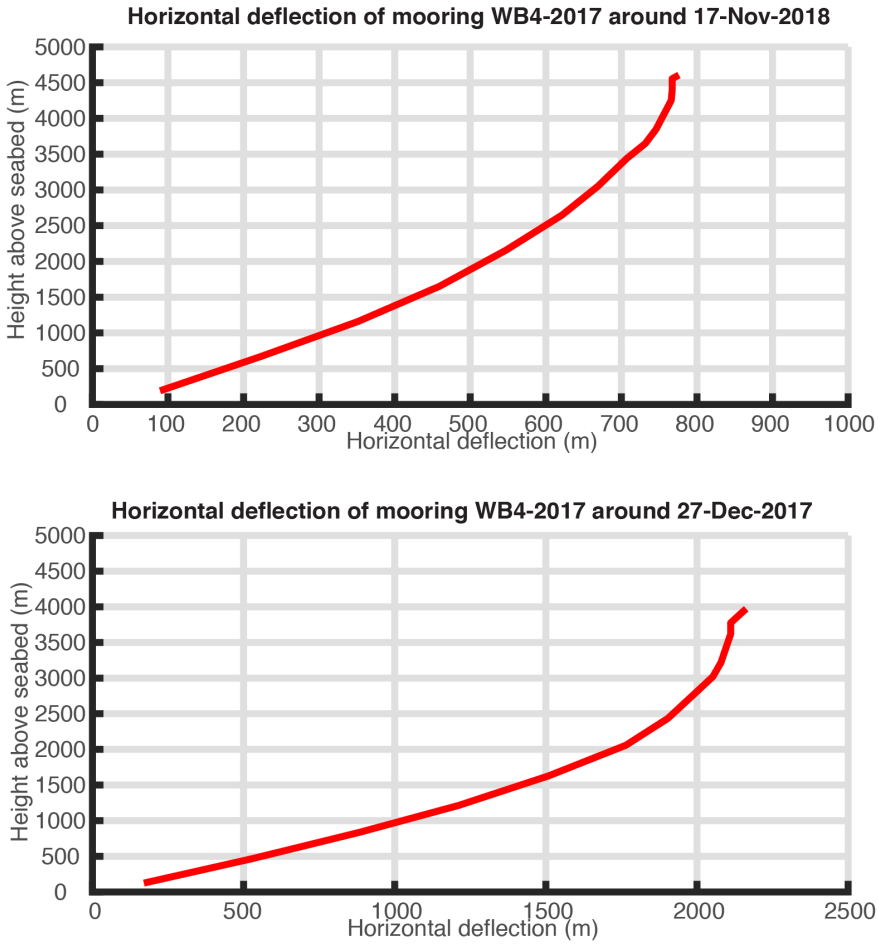


Figure 17.1 Estimated knockdown of mooring WB4. Upper panel – showing horizontal deflection of mooring WB4 at the time of recovery using a simple linear calculation from the change in pressure record from the minimum value, assuming a uni-directional flow so that all deflection is in the same direction. Lower panel – the same but for the time of maximum knockdown experienced during the 18-month deployed

17.2 Instrument problems

17.2.1 ABC Fluxes instruments

For problems with the Contros Hydro-C pCO_2, SeaBird Deep SeapHOx and McLane RAS instruments please refer to the individual sections (12, 13 and 14) on these instruments.

SeaBird MicroCAT-ODOs

Some MicroCAT-ODOs were found to have adaptive sampling turned off, but this wasn't spotted until after deployment of EBH4 and EBH3.

Another problem was also found with some of the ODO settings for the recovered instruments with some set to have the OxNTau = 1 and OxTau20 = 20. This is not the default settings of new instruments where OxNTau is 7 and OxTau20 is 5.5. The first 12 ODOs we purchased in 2013 were mistakenly supplied with OxNTau set to 4 and SeaBird acknowledged this in Field Service Bulletin 27 stating that it may cause the instruments to not pump for long enough.

Our newer instruments were supplied with the default value of 7, but also the setting hidden. OxTau20 is displayed in the DC response (as TAU_20), but the OxNTau setting is not readily visible. The only way to see it appears to be turning off the adaptive sampling so that in the DS response there is a line similar to: "adaptive pump control disabled, pump on time 7.0 * 5.5 = 38.5 sec"
Where the first number is OxNTau and the second is OxTau20. If adaptive sampling is on this line does not show and instead the instrument returns: "adaptive pump control enabled" without any numbers.
Searching through previous capture files and recovered data files from CTDs and moorings I put together a table of all the settings and what the pump time will be using these settings comparing it to what it should be with adaptive sampling on, OxNTau=7 and OxTau20=5.5.
One instrument recovered from EB1_2017, two instruments on WB4_2017 and those deployed on this cruise on EBH4_2018 and EB1_2018 will not be pumping for very long (15s or less compared to 50-110s if the setting had been correct) and as such the oxygen measurements may be compromised. The required pumping duration is generally longer for deeper deployed instruments so these may be the most affected. EBH4_2018 is further complicated by having adaptive sampling turned off, so it runs for even less time than intended.
The EBH3 instruments all had adaptive sampling turned off too, but the effect is less severe (38s pumping time instead of the intended 38-72s for the 3 instruments) as the OxNTau and OxTau20 values were what they should have been (7 and 5.5).
For the instruments that have the wrong settings it appears that they were changed during calibration at SeaBird and not changed back. To mitigate this happening again in the future the moor.cfg files used with *autosbe* were updated to include commands for correctly setting the OxNTau, OxTau20 and Adaptive Sampling parameters. The instructions for setting up the ODOs if not using *autosbe* were also updated.
In addition to the changes to the *autosbe* mooring config file, the caldip config file was also changed so that adaptive sampling was turned off and OxNTau was reduced to 1 so that these can sample faster during the cal dip when we are interested primarily in T, C and P rather than oxygen data (shown to not be worthwhile calibrating by cal dip). Otherwise there are only a few samples per 5 minute bottle stop (samples at about 40 second intervals with OxNTau=7 and OxTau20). This risks the setting not being turned back on if there is a computer used during setup without an updated *autosbe* moor.cfg file, so care needs to be taken in the future to check these settings.
MicroCAT-ODO sn 10542 recovered from WB4 had a short record with a flat battery message. However, it was noted that the battery pack was loose and this could have caused the loss of power. This would also explain why there are data gaps in the middle of the timeseries. A repeated attempt at downloading confirmed that it wasn’t just a problem with the download and the instrument did actually stop logging during the gaps.

17.2.2 RAPID instruments

There was a short record on BPR sn 0399 from EBH1L due to a depleted battery. It was therefore not possible to correct the rest of data for any clock drift as the timing offset cannot be checked as this gets changed when repowered.
RCM11 305 from EBH1 wasn't downloading correctly so it was tried with a manual terminal dump (CTRL-Q) to start the download (9600/8/N/2 port settings), but no additional data were successfully downloaded through the terminal application. It had

a very short record (only 3 months) despite 2-hourly sampling. Some further investigation was planned to see if the fault could be narrowed down to either the instrument itself or the DSU, but it's likely this instrument needs to be retired.
RCM11 448 from MAR3 also had a short record (220 days).
MicroCAT 4710 from MAR3 had no data as it was incorrectly setup and not programmed to start. Improvements to the setup checking procedures are planned for the future.
SBE53 sn53 from MAR3L10 has a jump to shallower pressure that is not present in paired BPR. This needs further investigation.
The S4s are no longer useable. We only have one useable system that isn't heavily corroded around the battery compartment. SN 35612568 recovered from MAR3 also had no data. These instruments are to be retired.
SBE53 sn 0040 was slightly damaged when deploying WB6 on this cruise. When deploying one of the floats the wire caught on the BPR in the frame breaking the plastic guard around the pressure sensor. It was switched out with a replacement instrument from the planned WB4 lander, and then subsequently repaired and deployed on WB4L13.
MicroCAT sn 6838 from WB4 was flooded with the end cap ripped off and the battery pack missing. The extent of the corrosion suggests this happened some time before recovery.
The ADCP recovered from WB4 had a short record (only 3 months) that didn't cover any period of significant knockdown. The short record has been put down to a power failure, but this will need checking if it's actually a fault with the type of Flash card present. The instrument was also incorrectly setup to measure 1.6m bins instead of 16m bins and so if it had been measuring during a knockdown event the data would not have been useful anyway. With the wrong bin size setting of 1.6m, the instrument should still have only used 0.6 out of 4 battery packs, so this doesn't explain the short record.
The ADCP from WBADCP was also incorrectly set to measure 1.6m bins, so the data collected is of minimal use for the intended purpose.
SBE53 sn 0429 had a P sensor failure part way through the deployment.
The PIES recovered from WBAP1 gave no sensible communications when talking to it acoustically. XPND just triggered a 4-second pulsing rather than allowing range commands to be sent. Recovery was successful but serial communications could not be established. The sphere was opened and the flash card removed, but there was only 1 record on it before it failed. It appears that after passing pre-deployment checks (on the Spring 2016 NOAA WBTS Cruise) the unit stopped as soon as it entered the water. The unit was not flooded and the vacuum was intact.
MicroCAT sn 6816 recovered from WB1 was flooded but this was not realised until after the unit was download (on external power) and then opened to change the batteries. It appears the flood was confined to the battery area without affecting the main electronics. This flood also must have happened a significant time before recovery because of the extent of corrosion in the battery compartment, but it did not affect the instrument operation as it collected a full data set and was still logging when recovered. It's possible there was a small amount of water that when tipped during recovery caused the battery to short so that it would not download on internal power, but not sufficient to damage the battery during the deployment and stop the instrument.
MicroCAT sn 6833, also from WB1 had a short record due to a depleted battery.
MicroCAT sn 3916, also from WB1 had no data. The instrument prompt said the

batteries were flat, but I cannot find any capture file for the setup of this instrument on the previous cruise, so it's possible that it was never started before deployment. Again, this means we need to improve our deployment protocol checks for the future.
After a couple of weeks MicroCAT sn 5766 on WB2 slipped down the mooring wire from 2350m to 2850m where it was stopped by another MicroCAT.

17.2.3 MerMEED instruments

4 RBR-Solos would not download. The download process would hang for an unknown reason. Data were eventually downloaded from 2 of these units after repeated attempts, but sn 100274 would not communicate at all and when connecting to a PC this message was shown: "USB device not recognised". Several other units had short records due to battery depletion, which after discussion with the manufacturer has been attributed to condensation in the housing causing high current drains. The desiccant packs need to be replaced if these instruments are used again – they appear to have become saturated simply to being exposed to the lab humidity on board the previous cruise when downloading and changing batteries.
The ADCPs on WB1 were affected by the incorrect setup mentioned previously, with bin sizes of 1.6m meaning the data collected are not any use for what they were intended.

Mooring	Deployment cruise	Deployment data	Recovery date	Recovery start time (UTC)	Recovery duration
ebh4	jc145	2017-03-01	Not recovered		
ebh4L6	dy039	2015-10-28	2018-10-23	06:51	01:09
ebh3	jc145	2017-03-02	2018-10-21	14:41	01:56
ebh2	jc145	2017-03-02	2018-10-24	06:52	01:32
ebh1	jc145	2017-03-03	2018-10-25	08:36	01:40
ebh1L11	dy039	2015-10-29	2018-10-25	06:49	01:25
ebhi	jc145	2017-03-05	2018-10-27	07:27	01:40
eb1	jc145	2017-03-10	2018-10-28	10:18	05:00
eb1L10	dy039	2015-11-03	Not recovered		
nog	jc145	2017-03-14	2018-11-03	17:39	02:59
mar3	jc145	2017-03-15	2018-11-03	11:36	04:57
mar3L10	dy039	2015-11-08	2018-11-03	08:08	02:44
mar1	jc145	2017-03-19	2018-11-07	10:14	04:52
mar1L10	jc145	2015-11-12	2018-11-06	18:22	01:49
mar0	jc145	2017-03-20	Not recovered		
wb6	jc145	2017-04-06	2018-11-14	11:24	02:45
wb4	jc145	2017-04-03	2018-11-17	11:50	05:14
wb4L11	dy039	2015-11-23	2018-11-18	11:19	01:48
wb4L12	jc145	2017-04-02	2018-11-17	18:19	01:38
wbh2	jc145	2017-04-01	2018-11-20	11:54	03:42
wb2	jc145	2017-03-30	2018-11-21	14:11	04:04
wb2L11	dy039	2015-11-24	Not recovered		
wb1	jc145	2017-03-30	2018-11-21	19:11	02:28
wbadcp	jc145	2017-03-28	2018-11-19	15:52	00:38
wbap1	EN574	2016-02-16	2018-11-19	18:56	00:03

Table 17.1 Mooring recovery table.

Mooring	Latitude	Longitude	Depth (m)	Fallback (m)	Date	Time anchor drop	Deploy-ment duration
ebh4	27° 51.39	13° 32.45	1064	220	2018-10-23	11:28	01:25
ebh4L8	27° 52.67	13° 30.73	1025	371	2018-10-23	08:39	00:07
ebh3	27° 48.52	13° 44.79	1420	184	2018-10-23	16:10	01:38
ebh2	27° 36.90	14° 12.62	2019	No tri.	2018-10-24	09:59	00:32
ebh1	27° 13.36	15° 25.33	3046	No tri.	2018-10-25	12:17	00:33
ebh1L13	27° 13.02	15° 25.97	3052	No tri.	2018-10-25	13:11	00:05
ebhi	24° 55.98	21° 15.93	4499	No tri.	2018-10-27	11:22	00:36
eb1	23° 44.15	24° 10.66	5123	412	2018-10-29	16:29	03:45
eb1L13	23° 47.92	24° 07.74	5093	164	2018-10-29	09:15	00:05
nog	23° 45.30	41° 05.77	4251	153	2018-11-04	19:40	01:46
mar3	23° 52.14	41° 05.41	5058	399	2018-11-04	15:21	03:59
mar3L12	23° 51.54	41° 05.36	5072	491	2018-11-04	16:20	00:04
mar1	24° 09.96	49° 44.96	5214	383	2018-11-08	17:15	04:54
mar1L12	24° 10.97	49° 43.97	5215	79	2018-11-06	18:11	04:54
marP1	24° 10.92	49° 45.93	5199	No tri.	2018-11-07	17:15	00:05
mar0	25° 08.68	52° 01.26	5459	79	2018-11-09	18:41	00:58
wb6	26° 29.73	70° 31.40	5495	133	2018-11-14	17:39	01:25
wb4	26° 27.10	75° 43.61	4692	534	2018-11-18	21:05	04:55
wb4L13	26° 28.75	75° 43.54	4704	990	2018-11-18	21:46	00:05
wbh2	26° 28.79	76° 37.64	4748	665	2018-11-20	21:16	03:05
wb2	26° 31.01	76° 44.46	3916	367	2018-11-23	19:04	04:30
wb2L13	26° 30.26	76° 44.72	3885	329	2018-11-22	20:49	00:01
wb1	26° 30.02	76° 48.88	1395	124	2018-11-24	19:22	02:24
wbadcp	26° 31.89	76° 52.00	610	26	2018-11-19	17:24	00:07
wbaL8	26° 31.46	76° 52.00	625	123	2018-11-19	18:21	18:25
wbM	26° 30.69	76° 44.40	3899	Lowered	2019-11-22	18:49	04:15

Table 17.2 Mooring deployment table.

CAST NO.	Allocated	MICROCAT S/N	COMMENT
CAST 1		5242	over-reading C by 0.05mS/cm - have to deploy anyway
		5775	under-reading C by 0.05mS/cm - have to deploy anyway
		3904	under-reading P by 2000dbar, over-reading C by 0.05mS/cm
		3905	over-reading C by 0.03mS/cm - have to deploy anyway
		3270	ok
		7468	under-reading C by 0.04mS/cm - have to deploy anyway
		3269	over-reading C by 0.35mS/cm, under-reading P by 8 dbar at 400m
		6836	under-reading P by 10dbar at 750m - have to deploy anyway
		6800	ok
		3228	ok
		3239	ok
		4723	ok
		4471	ok
		5981	ok
		5982	ok
		4464	ok
		4462	under-reading by 0.1mS/cm
CAST 2		*5983*	ok
		4180	over-reading C by 0.05mS/cm - have to deploy anyway
		4072	over-reading C by 0.03mS/cm - have to deploy anyway
		4071	ok
		4470	Over-reading by 0.05mS/cm - have to deploy anyway. Shouldn't have been dipped as out of spec last year and not calibrated - was mistakenly put on this cast instead of sn:4070
		4068	ok
		3282	ok
		20253	ok
		20254	ok
		20255	ok
		5784	ok
		5767	ok
		6808	ok
		3223	over-reading C by 0.09mS/cm
		3220	ok
		4724	ok shallower than 1000m
		3219	ok
		5781	over-reading P at all depths (1100dbar at 3500m)
		6112	under-reading C by 0.06mS/cm - but got to deploy as no others dipped
		6826	ok
		12962	ok

CAST 5		5770	ok shallower than 3000m, but deployed at 3500m on EBHi as only slightly out for P
		3932	under-reading C by 0.13mS/cm
		3225	ok
		12963	ok
		12964	ok
		12965	ok
		12966	ok
		12967	ok
		12968	ok
		12998	ok shallower than 3000m
		12833	ok
		6824	ok
		6801	ok shallower than 3000m
		6335	ok shallower than 3000m
		5789	ok shallower than 2500m
		6126	ok
		6814	ok
		5782	ok shallower than 3000m
		6120	ok shallower than 3800m
		6804	ok
		5239	ok
		6117	ok
		5243	ok
		3913	didn't log any data - incorrectly setup
CAST 6		3913	ok
		3215	ok shallower than 3500m
		6810	ok
		6821	ok
		4719	ok
		11744	ok
		6127	ok
		11424	ok
		6830	ok deeper than 3000m
		6822	ok
		6798	ok
		6121	ok
		6326	ok
		5978	ok shallower than 1600m
		3248	ok shallower than 1600m
		6321	over-reading C by **14mS/cm**
		6323	ok

		7363	ok
		5989	ok
		5763	ok shallower than 3500m
		5991	ok
		5993	ok shallower than 4000m
		7361	ok
		5992	ok
CAST 8		6805	ok
		6840	ok
		6815	under-reading P at all levels
		6125	over-reading C by 0.035mS/cm
		4549	ok shallower than 2800m
		5246	ok shallower than 1600m
		6819	ok shallower than 2200m
		6828	ok
		10519	ok
		10547	ok
		10517	ok
		10545	ok
		10546	ok
		3928	ok shallower than 2800m
		4305	ok
		3910	ok shallower than 1100m
		3934	ok
		5773	ok shallower than 2800m
		3271	ok shallower than 2800m
		3265	ok
		5768	ok
		3251	ok
		4799	ok
		5762	ok shallower than 2200m
CAST 10		12908	ok
		12911	ok
		12902	ok
		12901	ok
		13000	ok
		12835	ok
		12834	ok
		12910	ok
		12999	ok
		6325	ok
		6322	ok

		6137	ok
		6128	ok
		6123	over-reading C by 0.025mS/cm
		4797	ok shallower than 2200m
		3486	over-reading C by 0.025mS/cm. P ok shallower than 1100m
		4800	ok shallower than 1100m
		3264	over-reading C by 0.03mS/cm, P ok shallower than 750m
		3911	just ok (C slightly high, but ok for now)
		3483	ok shallower than 1100m
CAST 11		*4070*	
		4062	P ok shallower than 2000m
		4060	over-reading C by 0.025mS/cm. P ok shallower than 3000m
		4066	over-reading C by 0.035mS/cm
		3254	over-reading C by 0.03mS/cm
		6818	over-reading C by 0.045mS/cm. P ok shallower than 2000m
		6115	over-reading C by 0.035mS/cm
		3257	over-reading C by 0.025mS/cm. P ok shallower than 2000m
		4307	P ok shallower than 2000m
		5779	
		4710	
		3214	ok shallower than 3000m
		5484	over-reading C by 0.025mS/cm. P ok shallower than 2000m
CAST 12	WB6	3268	ok
	WB4	3893	ok shallower than 500m
	WB6	4306	ok
	WB4	3230	Slightly over-reading C, but within specs compared to one CTD sensor
	WB6	3209	ok
	WB4	5485	ok shallower than 1600m
	WB2	*7470*	ok
	WB2	*7362*	ok
	WB6	3280	ok
		6817	Over-reading C by 0.045mS/cm. P ok shallower than 1100m
CAST 13		3890	Over-reading C by 0.085mS/cm. P ok shallower than 400m
		3912	Redipping as didn't log correctly - possibly flat battery
	WB4	3249	Over-reading C by 0.025mS/cm. P ok shallower than 1100m
		5765	Slow irregular sampling - Flat battery? Re-dip
		3207	Over-reading C by 0.05mS/cm. P ok shallower than 2200m
	WB4	5780	over-reading C by 0.025mS/cm. P ok at all depths
		6827	Over-reading C by 0.04mS/cm. P ok shallower than 1100m
	WB4	3244	ok shallower than 1600m
	WB4	3216	ok shallower than 1600m
	WB4	3213	ok shallower than 1600m

	WB4	3252	OK shallower than 2200m, but deeper than 700m
	n/a	5785	Ok shallower than 2800m. Mistakenly re-dipped and was then ok.
CAST 15		5765	Over-reading C by 0.04mS/cm. P ok shallower than 1100m
	WB4	5785	ok
	WB4	6825	ok
	WB4	6820	ok
	WB2	*4178*	ok
	WB6	6333	ok
	WB4	3933	ok
	WB4	3277	ok
		10518	Over-reading P by 1500dbar - affects oxygen measurement
		14114	ok
		14115	ok
		14148	ok
	WBH2	10520	ok
		3912	Over-reading C by 0.04mS/cm. P ok shallower than 1100m
CAST 19	WB1	6332	ok
		5245	over-reading P by approx 6bar at all depths
		5238	ok shallower than 3500m
	WB1	3907	ok
		6113	ok
CAST21	WBH2	12832	ok
	WBH2	12907	ok
		14116	ok
		4474	under-reading C by 1.5mS/cm. P ok shallower than 3000m
	WB2	*4461*	ok
		10542	over-reading C by 0.045mS/cm
		10543	ok
		10544	ok
		10555	ok
		14117	ok
		10556	ok
		6839	over-reading C by 0.045mS/cm. P ok shallower than 1100m
	WBH2	6802	ok
	WB1	6841	ok shallower than 3000m
	WBH2	7681	ok
	WB2	*4475*	ok
	WBH2	3255	ok shallower than 3800m
	WBH2	3900	ok shallower than 3800m
	WBH2	6799	ok
	WB1	3484	ok
		5979	ok

	WB1	5776	ok shallower than 1100m
CAST24		3233	over-reading C by 0.06mS/cm. P ok shallower than 750m
		3901	ok shallower than 2000m
		3247	ok
		6118	ok shallower than 3000m
		6811	ok
		5984	ok
		6122	ok
		4468	ok
		14147	ok shallower than 3000m
		12900	ok
		14149	ok
CAST26		*4795*	over-reading C by 0.025mS/cm. P ok shallower than 2500m
		3221	over-reading C by 0.035mS/cm. P ok shallower than 2500m
		6829	ok
		4714	ok
		3253	ok shallower than 2000m
		5783	over-reading C by 0.025mS/cm. P ok shallower than 2000m
		3234	ok shallower than 3000m
		3222	ok
		5777	ok shallower than 3500m
		3206	over-reading C by 0.025mS/cm
		5766	ok shallower than 3000m
		3256	ok
		3229	ok
		3224	ok
		6833	ok shallower than 2000m
		3916	over-reading C by 0.035mS/cm. P ok shallower than 2000m
		6831	over-reading C by 0.025mS/cm. P ok shallower than 1000m
		5772	over-reading C by 0.025mS/cm. P ok shallower than 1500m
		14145	Bad conductivity sensor. Very slow T response. P ok shallower than 3000m
CAST27		6834	ok
		14151	ok shallower than 2000m
		14146	ok shallower than 3000m
		14150	over-reading C by 0.03mS/cm

Table 17.3 Details of instruments calibrated on the CTD casts

Mooring	Nominal depth (m)	Inst. code	Serial number	Mean pressure (dbar)	Start date	End date	No. records	Comments
ebh4_13_2017	100	337	5980				0	Mooring Lost
	175	337	5986				0	Mooring Lost
	250	337	5786				0	Mooring Lost
	325	337	5787				0	Mooring Lost
	400	337	6124				0	Mooring Lost
	500	337	5990				0	Mooring Lost
	600	337	6320				0	Mooring Lost
	700	337	6331				0	Mooring Lost
	800	310	395				0	Mooring Lost
	800	337	6806				0	Mooring Lost
	1000	337	5988				0	Mooring Lost
ebh4l6_6_2015	1000	465	0396	1066.7	28/10/2015	22/10/2018	26145	
	1000	465	0397	1066.8	28/10/2015	22/10/2018	26145	
ebh3_12_2017	50	337	5978	56.1	02/03/2017	21/10/2018	14354	
	100	337	3248	101.2	02/03/2017	21/10/2018	14354	
	175	337	6321	177.0	02/03/2017	21/10/2018	14354	
	250	337	6323	250.0	02/03/2017	21/10/2018	14349	Stops 5 hours early. Reason unknown.
	325	337	7363	254.5	02/03/2017	21/10/2018	14354	
	400	337	5989	429.7	02/03/2017	21/10/2018	14354	
	500	337	5763	505.4	02/03/2017	21/10/2018	14354	
	500	370	8465	506.3	02/03/2017	21/10/2018	28708	
	600	337	4062	609.5	02/03/2017	21/10/2018	14354	
	700	337	5991	707.9	02/03/2017	21/10/2018	14354	
	800	337	5993	813.2	02/03/2017	21/10/2018	14354	

	800	370	11846	808.2	02/03/2017	21/10/2018	28708	
	950	337	4060	962.1	02/03/2017	21/10/2018	14354	
	1000	370	11855	999.0	02/03/2017	21/10/2018	28708	
	1100	337	7361	1114.5	02/03/2017	21/10/2018	14354	
	1200	337	5992	1219.9	02/03/2017	21/10/2018	14354	
	1300	370	12701	1302.6	02/03/2017	21/10/2018	28708	
	1400	337	6805	1425.9	02/03/2017	21/10/2018	14354	
ebh2_12_2017	1600	337	6840	1608.4	02/03/2017	24/10/2018	14412	
	1800	337	4066	1818.3	02/03/2017	24/10/2018	14412	
	1900	310	383	1932.0	02/03/2017	24/10/2018	7206	
	2000	337	6815	2027.0	02/03/2017	24/10/2018	14412	
ebh1l11_11_2015	3030	465	398	3097.1	30/10/2015	25/10/2018	26185	
	3030	465	399	3098.0	29/10/2015	24/02/2018	20364	Flat battery
ebh1_11_2015	2500	337	6125	2536.1	03/03/2017	25/10/2018	14418	
	2900	310	305	2956.8	03/03/2017	10/08/2017	1284	Battery ok, but data not written after 10/8/2017. Unknown if instrument itself or DSU causing the problem.
	3000	337	4549	3079.6	03/03/2017	25/10/2018	14418	
ebhi_12_2017	3500	337	5246	3491.9	05/03/2017	27/10/2018	14416	
	4000	337	6819	4034.4	05/03/2017	27/10/2018	14416	
	4400	310	303	4484.9	05/03/2017	27/10/2018	7207	
	4500	337	6828	4574.3	05/03/2017	27/10/2018	14416	
eb1l11_11_2015	5087	465	0058				0	Mooring lost
	5087	465	0394				0	Mooring lost
eb1_14_2017	50	383	14082-01				0	Instrument lost
	50	348	0812-020				0	Instrument lost
	50	375	103				0	Instrument lost

	50	337	3902				0	Instrument lost
	100	337	4797	155.0	10/03/2017	28/10/2018	14320	
	175	337	3486	160.9	10/03/2017	28/10/2018	14320	
	250	337	4800	237.7	10/03/2017	28/10/2018	14320	
	325	337	3264	312.4	10/03/2017	28/10/2018	14320	
	400	337	3911	393.0	10/03/2017	28/10/2018	14320	
	400	335	10519	390.6	10/03/2017	28/10/2018	3579	
	600	337	3483	589.9	10/03/2017	28/10/2018	14320	
	800	337	3928	796.5	10/03/2017	28/10/2018	14320	
	800	335	10547	795.7	10/03/2017	28/10/2018	3579	
	1000	337	4305	999.7	10/03/2017	28/10/2018	14320	
	1200	337	3910	1198.2	10/03/2017	28/10/2018	14320	
	1500	335	10517	1508.4	10/03/2017	28/10/2018	3580	
	1500	310	451	1514.8	10/03/2017	28/10/2018	7151	
	1600	337	3934	1610.9	10/03/2017	28/10/2018	14320	
	2000	337	5773	2017.7	10/03/2017	28/10/2018	14320	
	2000	335	10545	2018.5	10/03/2017	27/10/2018	3577	Last couple of records not downloaded
	2500	337	3271	2530.2	10/03/2017	28/10/2018	14320	
	3000	337	3265	3042.1	10/03/2017	28/10/2018	14320	
	3500	337	5768	3554.8	10/03/2017	28/10/2018	14320	
	3500	335	10546	3555.4	10/03/2017	28/10/2018	3580	
	4000	337	3251	4071.4	10/03/2017	28/10/2018	14320	
	4500	337	4799	4580.4	10/03/2017	28/10/2018	14320	
	4990	337	5762	5110.6	10/03/2017	28/10/2018	14320	
	5000	310	450	5088.3	10/03/2017	28/10/2018	7159	
mar3_12_2017	50	337	3254	31.7	15/03/2017	03/11/2018	14341	
	100	337	6818	74.8	15/03/2017	03/11/2018	14341	

	180	337	3817	158.7	15/03/2017	03/11/2018	14341	
	225	337	6115	235.3	15/03/2017	03/11/2018	14341	
	330	337	3257	315.6	15/03/2017	03/11/2018	14341	
	405	337	4307	389.8	15/03/2017	03/11/2018	14341	
	600	337	5779	585.5	15/03/2017	03/11/2018	14341	
	800	337	3214	997.8	15/03/2017	03/11/2018	14341	
	1000	337	5484	1206.2	15/03/2017	03/11/2018	14341	
	1200	337	4710				0	Incorrectly setup. No data logged.
	1500	310	448	1514.4	15/03/2017	20/03/2018	2613	Short record despite 2-hourly sampling rate
	1600	337	3268	1612.2	15/03/2017	03/11/2018	14341	
	2000	337	3893	2024.3	15/03/2017	03/11/2018	14341	
	2500	337	4306	2526.6	15/03/2017	03/11/2018	14341	
	3000	337	3230	3042.4	15/03/2017	03/11/2018	14341	
	3500	337	3209	3545.8	15/03/2017	03/11/2018	14341	
	4000	337	5485	4078.2	15/03/2017	03/11/2018	14341	
	4500	337	7470	4580.7	15/03/2017	03/11/2018	14341	
	5000	337	7362	5097.0	15/03/2017	03/11/2018	14341	
	5000	302	35612568				0	Data corrupt, nothing recovered.
mar3l10_10_2015	5038	465	0053	5278.5	09/11/2015	03/11/2018	26156	Jump in P record after about 2 years
	5038	465	0036	5279.3	09/11/2015	03/11/2018	26156	
mar1l10_10_2015	5100	465	0012	5324.7	24/11/2015	06/11/2018	25883	Strong drift at start cutoff during processing
	5100	465	0037	5326.7	13/11/2015	06/11/2018	26145	
mar1_12_2017	50	337	3890	39.3	19/03/2017	07/11/2018	14345	
	50	348	0812-005	n/a	19/03/2017	06/11/2018	6660	43 days gap in record (12 sample burst once per day)
	50	375	104	38.9	19/03/2017	07/11/2018	3586	
	50	383	13278-01					Samples discussed in section 14

	100	337	3912	82.0	19/03/2017	07/11/2018	14345	
	175	337	3249	156.4	19/03/2017	07/11/2018	14345	
	250	337	5765	232.5	19/03/2017	07/11/2018	14345	
	325	337	3207	307.4	19/03/2017	07/11/2018	14345	
	400	337	5780	383.2	19/03/2017	07/11/2018	14345	
	400	335	10518	384.6	19/03/2017	07/11/2018	3586	
	600	337	6827	590.9	19/03/2017	07/11/2018	14345	
	800	337	3244	795.7	19/03/2017	07/11/2018	14345	
	800	335	14114	792.6	19/03/2017	07/11/2018	3586	
	1000	337	3216	1000.4	19/03/2017	07/11/2018	14345	
	1200	337	3213	1206.0	19/03/2017	07/11/2018	14345	
	1500	335	14115	1508.1	19/03/2017	07/11/2018	3586	
	1500	310	445	1503.8	19/03/2017	07/11/2018	7173	
	1600	337	3252	1616.7	19/03/2017	07/11/2018	14345	
	2000	337	5785	2019.8	19/03/2017	07/11/2018	14345	
	2000	335	14148	2020.4	19/03/2017	07/11/2018	3586	
	2500	337	6825	2530.9	19/03/2017	07/11/2018	14345	
	3000	337	6820	3043.2	19/03/2017	07/11/2018	14345	
	3500	337	4178	3555.2	19/03/2017	07/11/2018	14345	
	3500	335	10520	3554.6	19/03/2017	07/11/2018	3586	
	4000	337	6333	4072.6	19/03/2017	07/11/2018	14345	
	4500	337	3933	4579.7	19/03/2017	07/11/2018	14345	
	5000	337	3277	5101.3	19/03/2017	07/11/2018	14345	
	5100	302	35612572	5200.4	19/03/2017	07/11/2018	28691	
mar0_9_2017	4780	337	6823				0	Mooring lost
	4960	337	3266				0	Mooring lost
	5141	337	6832				0	Mooring lost

	5320	337	6327				0	Mooring lost
	5440	302	35612571				0	Mooring lost
	5513	337	4179				0	Mooring lost
wb1_13_2017	50	337	6833	94.9	30/03/2017	18/01/2018	6990	Short record
	50	348	1114-002	n/a			0	Instrument flooded
	50	375	105	87.0	31/03/2017	21/11/2018	3605	pH data questionable after 9 months
	50	383	13278-05	n/a				Samples discussed in section 14
	100	370	5590	137.7	30/03/2017	21/11/2018	28844	
	100	337	3916				0	No data. Either incorrectly setup or battery short.
	400	337	6831	434.3	30/03/2017	21/11/2018	14422	
	400	370	14145	432.7	30/03/2017	21/11/2018	3605	
	400	335	5885	497.1	30/03/2017	21/11/2018	28844	
	800	337	6816	828.6	30/03/2017	21/11/2018	14422	
	800	335	14146	827.3	30/03/2017	21/11/2018	3605	
	800	370	5890	854.5	30/03/2017	21/11/2018	28844	
	1200	337	5772	1227.8	30/03/2017	21/11/2018	14422	
	1200	370	12722	1207.9	30/03/2017	21/11/2018	28844	
wb2_14_2017	50	337	4795		30/03/2017	02/09/2018	12491	Top of mooring broke loose
	100	337	3221		30/03/2017	02/09/2018	12491	Top of mooring broke loose
	100	370	6516		30/03/2017	02/09/2018	24983	Top of mooring broke loose
	175	337	6834		30/03/2017	02/09/2018	12491	Top of mooring broke loose
	180	370	5899		30/03/2017	02/09/2018	24983	Top of mooring broke loose
	325	337	4721				0	Lost when mooring parted
	400	370	5967	458.6	30/03/2017	21/11/2018	28841	Fell to deeper depth after top of mooring lost
	500	337	6829	555.0	30/03/2017	21/11/2018	14419	Fell to deeper depth after top of mooring lost
	700	337	4714	755.5	30/03/2017	21/11/2018	14419	Fell to deeper depth after top of mooring lost

	800	370	6049	848.0	30/03/2017	21/11/2018	28841	Fell to deeper depth after top of mooring lost
	900	337	3253	944.2	30/03/2017	21/11/2018	14419	Fell to deeper depth after top of mooring lost
	1100	337	5783	1145.8	30/03/2017	21/11/2018	14419	Fell to deeper depth after top of mooring lost
	1200	370	6083	1566.5	30/03/2017	21/11/2018	28841	
	1300	337	3234	1335.4	30/03/2017	21/11/2018	14419	
	1500	370	3222	1541.0	30/03/2017	21/11/2018	28841	
	1500	337	6119	1566.5	30/03/2017	21/11/2018	14419	
	1700	337	5777	1742.0	30/03/2017	21/11/2018	14419	
	1900	337	3206	1942.1	30/03/2017	21/11/2018	14419	
	2050	370	6132	2122.5	30/03/2017	21/11/2018	28841	
	2300	337	5766	2846.4	30/03/2017	21/11/2018	14419	
	2800	337	3256	2861.9	30/03/2017	21/11/2018	14419	
	3000	370	6176	3106.4	30/03/2017	21/11/2018	28841	
	3300	337	3229	3353.6	30/03/2017	21/11/2018	14419	
	3850	337	3224	3905.9	30/03/2017	21/11/2018	14419	
wbadcp_13_2017	590	324	23643				0	Bin sizes set incorrectly so data unusable.
wbh2_10_2017	1500	383	13278-04				0	Instrument flooded
	1500	335	14147	1602.7	01/04/2017	20/11/2018	3586	
	1500	370	6751	1603.9	01/04/2017	20/11/2018	28695	
	2000	335	12900	2098.6	01/04/2017	20/11/2018	3586	
	2200	337	6118	2306.8	01/04/2017	20/11/2018	14347	
	2200	370	6753	2313.7	01/04/2017	20/11/2018	28695	
	3000	337	6811	3114.1	01/04/2017	20/11/2018	14347	
	3000	370	9266	3132.7	01/04/2017	20/11/2018	28695	
	3500	335	14149	3607.1	01/04/2017	20/11/2018	3586	
	3800	337	5984	3911.1	01/04/2017	20/11/2018	14347	
	3805	370	9402	3912.0	01/04/2017	20/11/2018	28695	

	4300	337	6122	4400.0	01/04/2017	20/11/2018	14347	
	4600	370	9406	4708.0	01/04/2017	20/11/2018	28695	
	4690	337	4468	4775.5	01/04/2017	20/11/2018	14347	
wb2l11_11_2015	3800	465	0055				0	Mooring lost
	3800	465	430				0	Mooring lost
wb4l11_11_2015	4800	465	0029	4782.7	01/12/2015	18/11/2018	26001	First few days cut off due to strong drift
	4800	465	429	4681.3	28/11/2015	18/11/2018	26064	
wb4l12_12_2017	4800	465	389	4785.4	04/04/2017	17/11/2018	14224	Recovered after 18-month deployment instead of 3 years
	4800	465	431	4784.9	04/04/2017	17/11/2018	14223	Recovered after 18-month deployment instead of 3 years
wb4_12_2015	50	337	3223	81.4	03/04/2017	17/11/2018	14225	
	50	335	10542	38.8	03/04/2017	09/08/2017	731	Suspected loose connection of battery
	100	337	6839	127.9	03/04/2017	17/11/2018	14225	
	100	370	6805	122.5	03/04/2017	17/11/2018	28452	
	200	324	10584				0	Bin sizes set incorrectly so data unusable.
	250	337	3901	278.8	03/04/2017	17/11/2018	14225	
	400	337	3247	431.6	03/04/2017	17/11/2018	14225	
	400	335	10543	433.6	03/04/2017	17/11/2018	3556	
	400	370	8502	430.9	03/04/2017	17/11/2018	28452	
	600	337	6838					Flooded
	800	337	6802	836.2	03/04/2017	17/11/2018	14225	
	800	335	10544	837.7	03/04/2017	17/11/2018	3556	
	805	370	9210	830.7	03/04/2017	17/11/2018	28452	
	1000	337	6841	1036.1	03/04/2017	17/11/2018	14225	
	1200	337	7681	1246.3	03/04/2017	17/11/2018	14225	
	1200	370	9409	1245.4	03/04/2017	17/11/2018	28452	
	1500	335	10555	1540.2	03/04/2017	17/11/2018	3556	

	1500	370	9433	1559.0	03/04/2017	17/11/2018	28452	
	1600	337	4475	1641.6	03/04/2017	17/11/2018	14225	
	2000	337	3255	2047.4	03/04/2017	17/11/2018	14225	
	2000	335	14117	2046.6	03/04/2017	17/11/2018	3556	
	2000	370	9439	2053.3	03/04/2017	17/11/2018	28452	
	2500	337	3900	2548.7	03/04/2017	17/11/2018	14225	
	3000	337	6799	3062.0	03/04/2017	17/11/2018	14225	
	3000	370	9444	3061.6	03/04/2017	17/11/2018	28452	
	3500	337	3484	3566.9	03/04/2017	17/11/2018	14225	
	3500	335	10556	3574.2	03/04/2017	17/11/2018	3556	
	4000	337	5979	4077.6	03/04/2017	17/11/2018	14225	
	4000	370	13482	4111.9	03/04/2017	17/11/2018	28452	
	4500	337	5776	4579.8	03/04/2017	17/11/2018	14225	
	4600	370	13588	4703.1	03/04/2017	17/11/2018	28452	
wb6_9_2015	4800	337	6332	4847.8	06/04/2017	14/11/2018	14083	
	4975	337	5245	5033.4	06/04/2017	14/11/2018	14083	
	5150	337	5238	5223.4	06/04/2017	14/11/2018	14083	
	5320	337	3907	5404.6	06/04/2017	14/11/2018	28167	
	5440	370	6088	5504.9	06/04/2017	14/11/2018	14083	
	5491	337	6113	5581.3	06/04/2017	14/11/2018	14083	
	5499	465	0060	5608.9	06/04/2017	14/11/2018	14081	
	5499	465	0081	5608.9	07/04/2017	14/11/2018	14069	First day cutoff due to strong drift

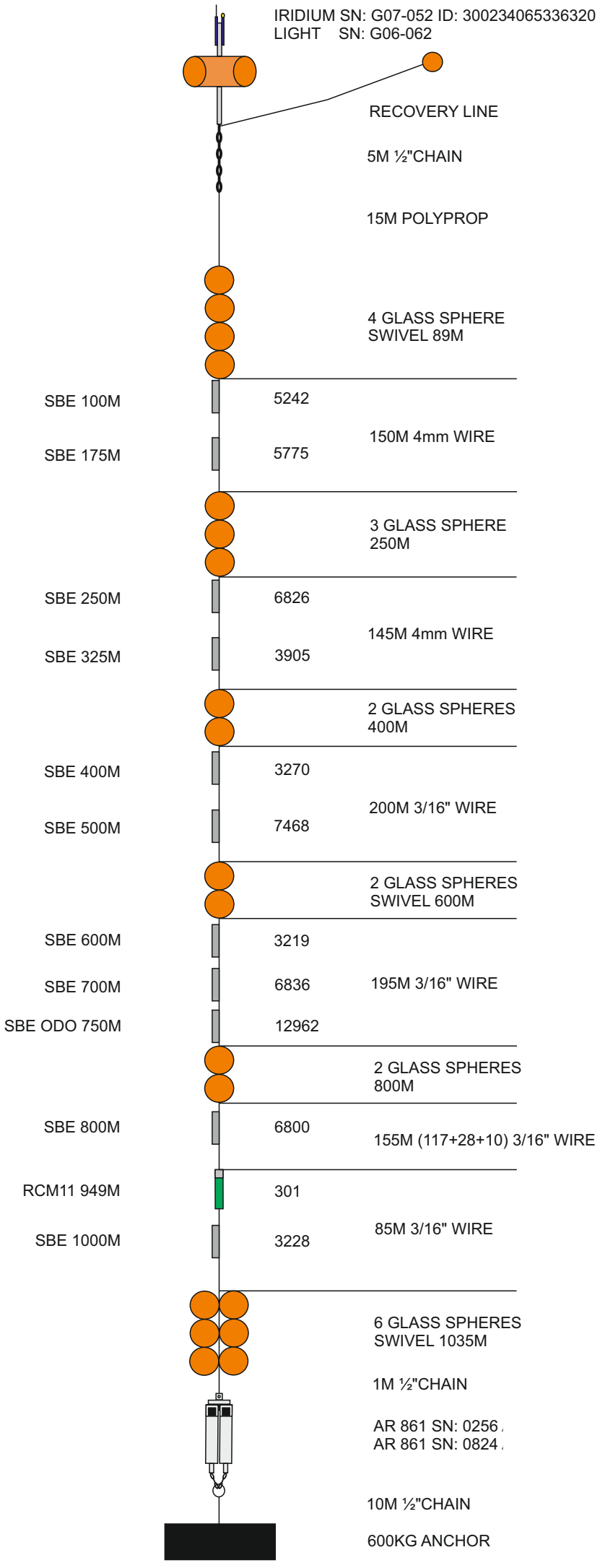
Table 17.4 Mooring instrument record lengths

Appendix A: Diagrams of deployed moorings

28 pages

EBH4 DEPLOYED 2018

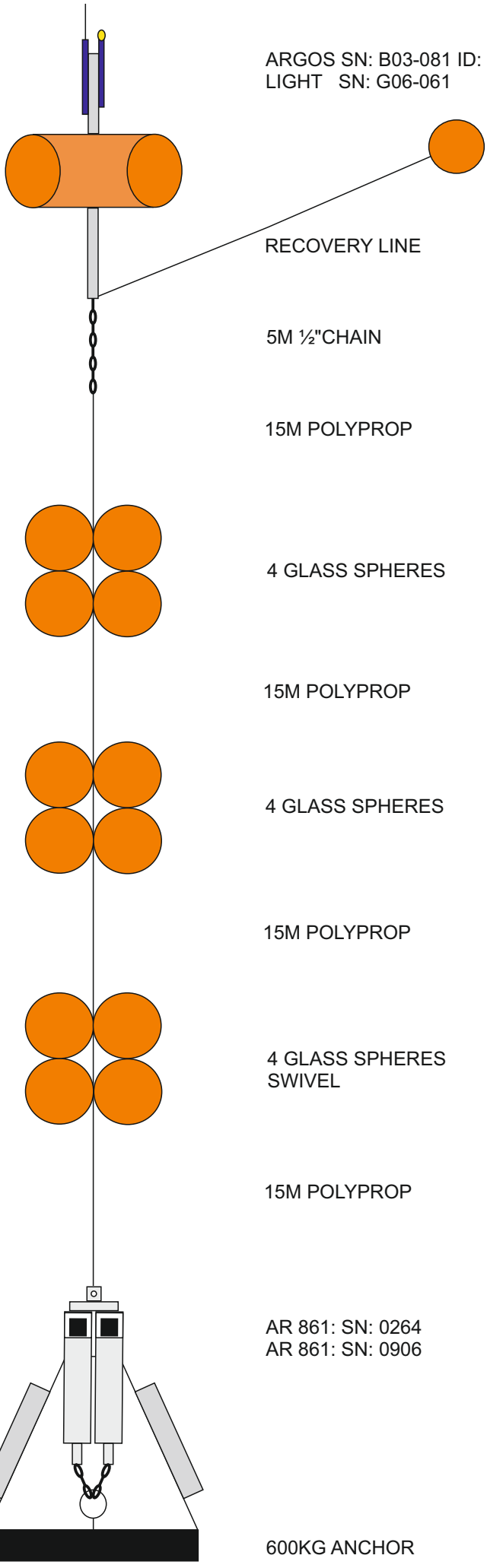
DATE: 23/10/2018
POSN: 27° 51.39'N
13° 32.45'W
DEPTH: 1064m



RAPID WATCH

EBH4L8
DEPLOYED

DATE: 23/10/2018
POSN: 27° 52.67'N
13° 30.73'W
DEPTH: 1025m



ARGOS SN: B03-081 ID: 129574/C02346A
LIGHT SN: G06-061

RECOVERY LINE

5M ½"CHAIN

15M POLYPROP

4 GLASS SPHERES

15M POLYPROP

4 GLASS SPHERES

15M POLYPROP

4 GLASS SPHERES
SWIVEL

15M POLYPROP

AR 861: SN: 0264
AR 861: SN: 0906

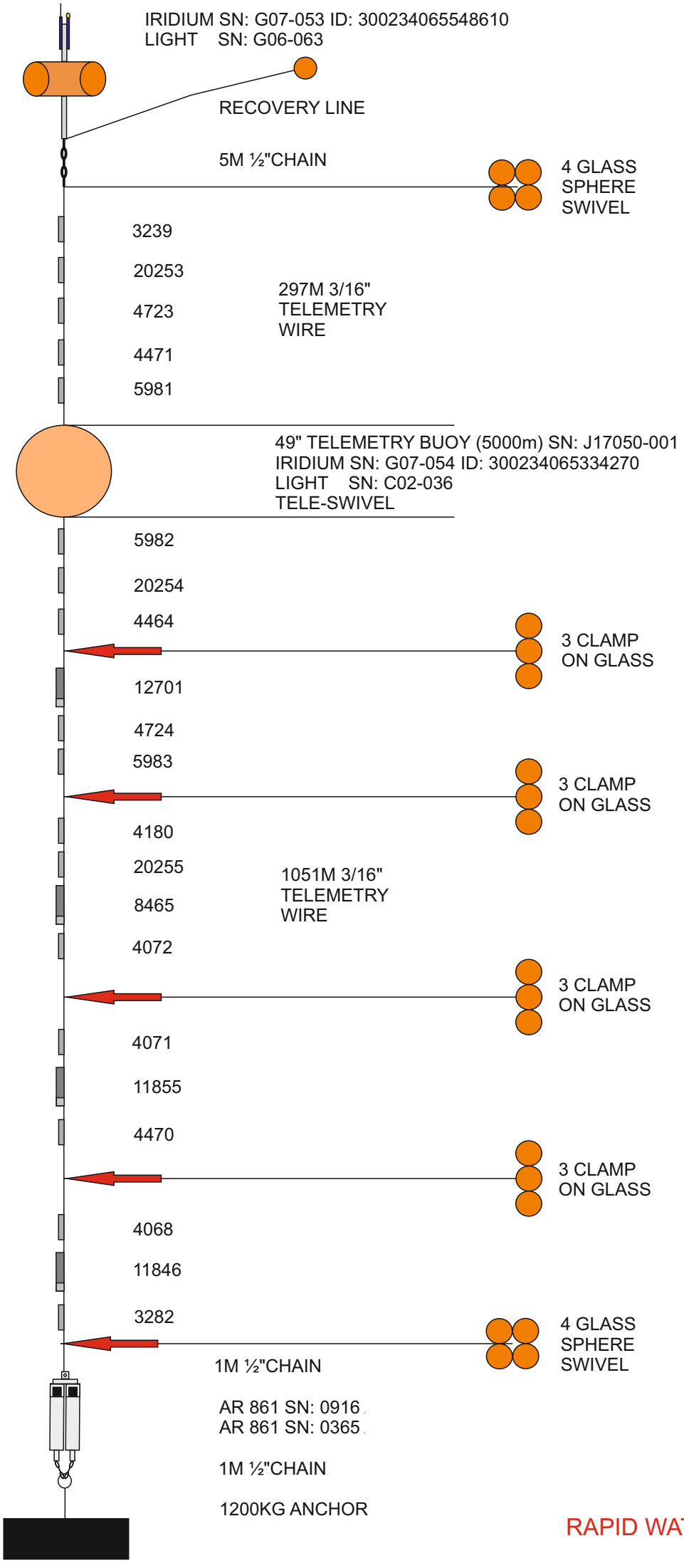
STAINLESS FRAME
2 OFF BPR'S
SN: 53-0030
SN: 26-0395

600KG ANCHOR

RAPID WATCH

EBH3 DEPLOYED 2018

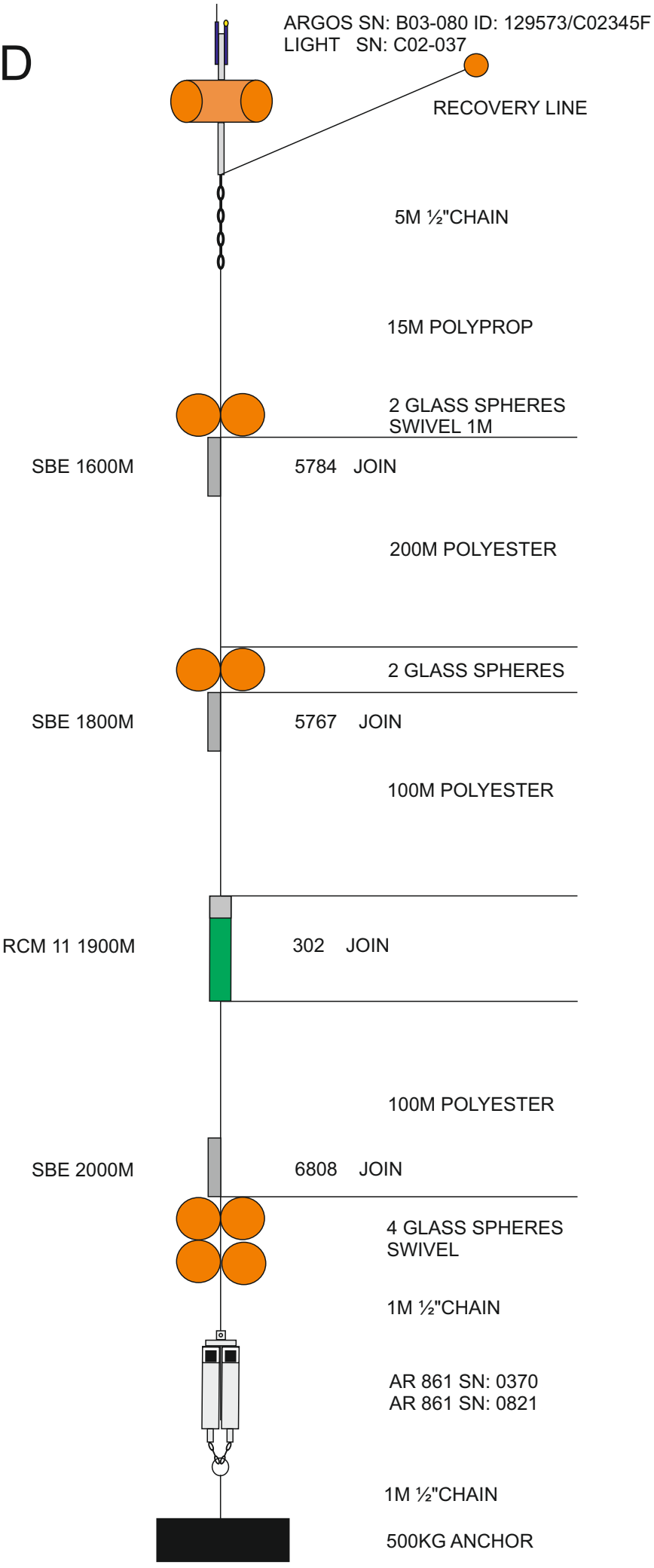
DATE: 23/10/2018
POSN: 27° 48.52'N
13° 44.79'W
DEPTH: 1420m



RAPID WATCH

EBH2 DEPLOYED 2018

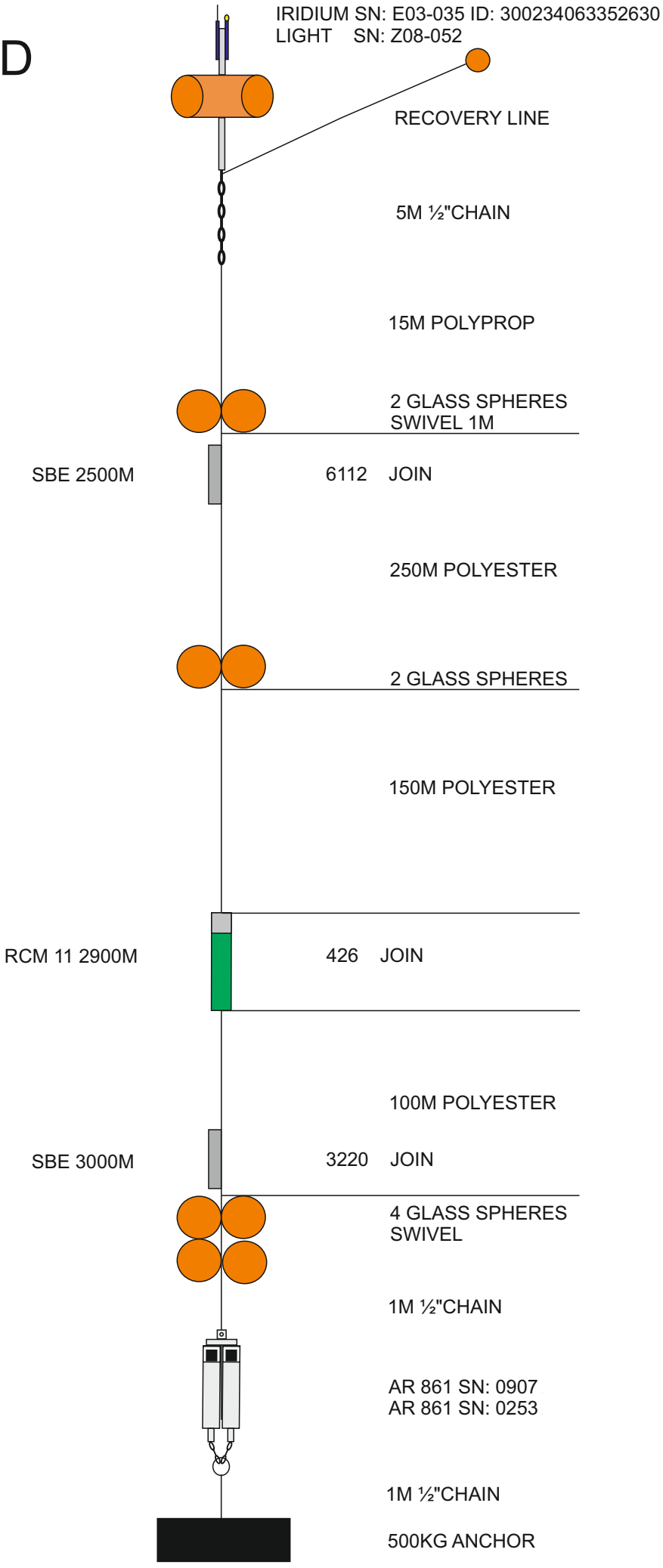
DATE: 24/10/2018
POSN: 27° 36.90'N
14° 12.62'W
DEPTH: 2019m



RAPID WATCH

EBH1 DEPLOYED 2018

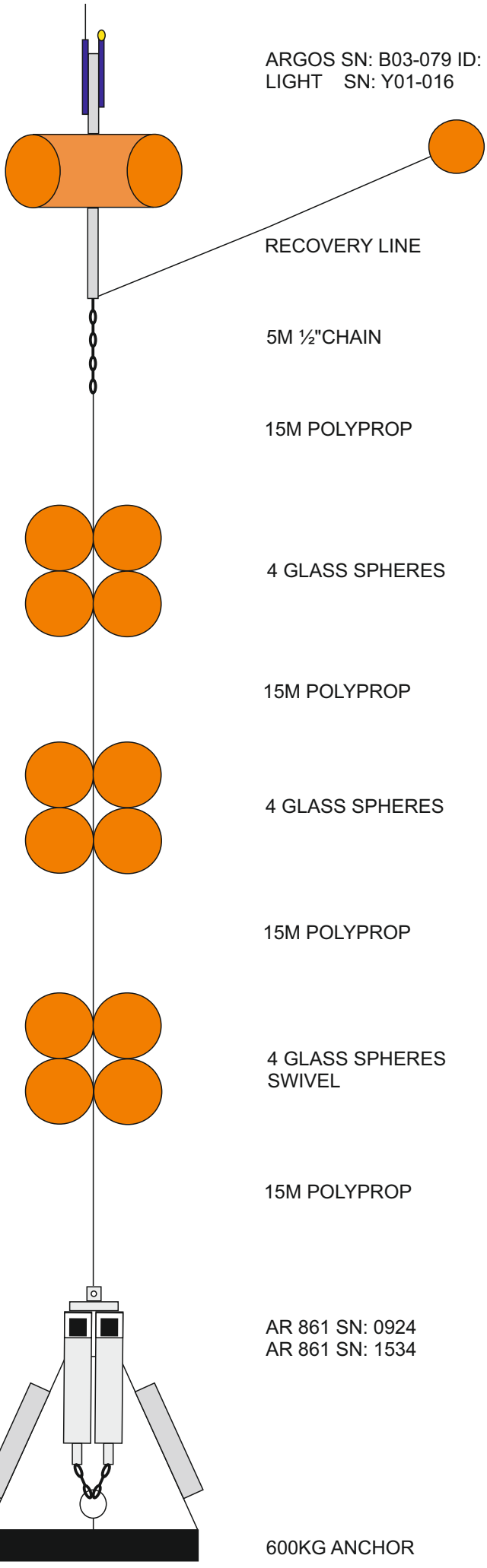
DATE: 25/10/2018
POSN: 27° 13.36'N
15° 25.33'W
DEPTH: 3046m



RAPID WATCH

EBH1L
DEPLOYED
2018

DATE: 25/10/2018
POSN: 27° 13.02'N
15° 25.97'W
DEPTH: 3052m



ARGOS SN: B03-079 ID: 129572/C02344C
LIGHT SN: Y01-016

RECOVERY LINE

5M ½"CHAIN

15M POLYPROP

4 GLASS SPHERES

15M POLYPROP

4 GLASS SPHERES

15M POLYPROP

4 GLASS SPHERES
SWIVEL

15M POLYPROP

AR 861 SN: 0924
AR 861 SN: 1534

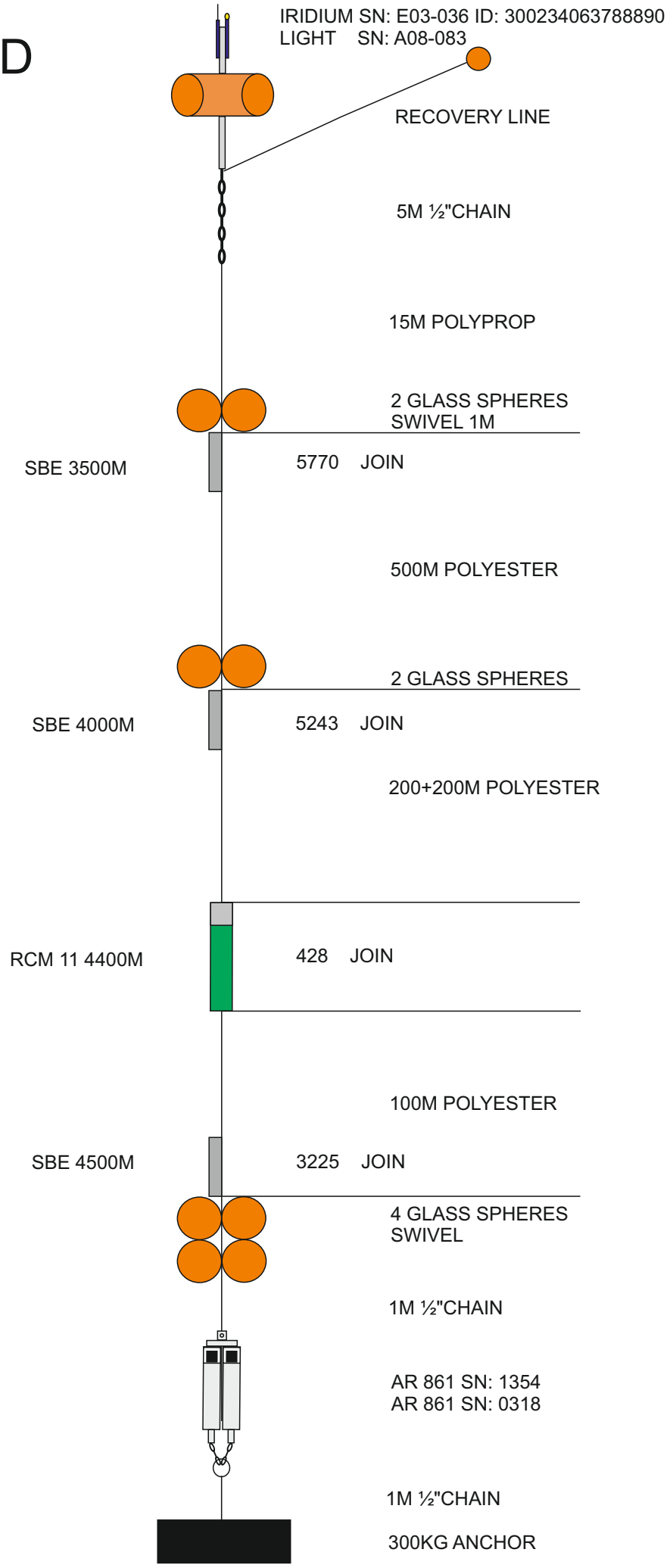
STAINLESS FRAME
2 OFF BPR'S
SN: 53-0039
SN: 53-0035

600KG ANCHOR

RAPID WATCH

EBHi DEPLOYED 2018

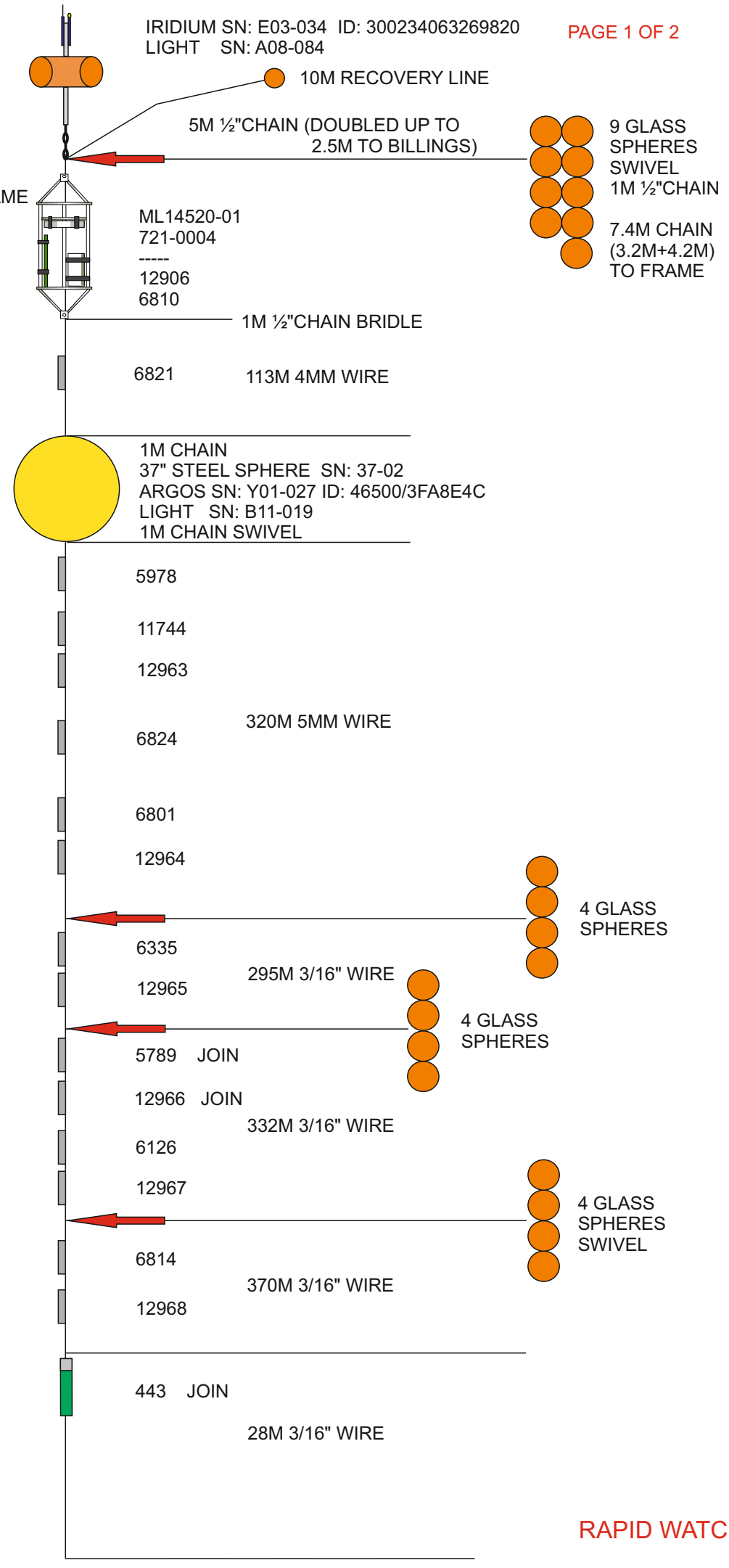
DATE: 27/10/2018
POSN: 24° 55.98'N
21° 15.93'W
DEPTH: 4499m



RAPID WATCH

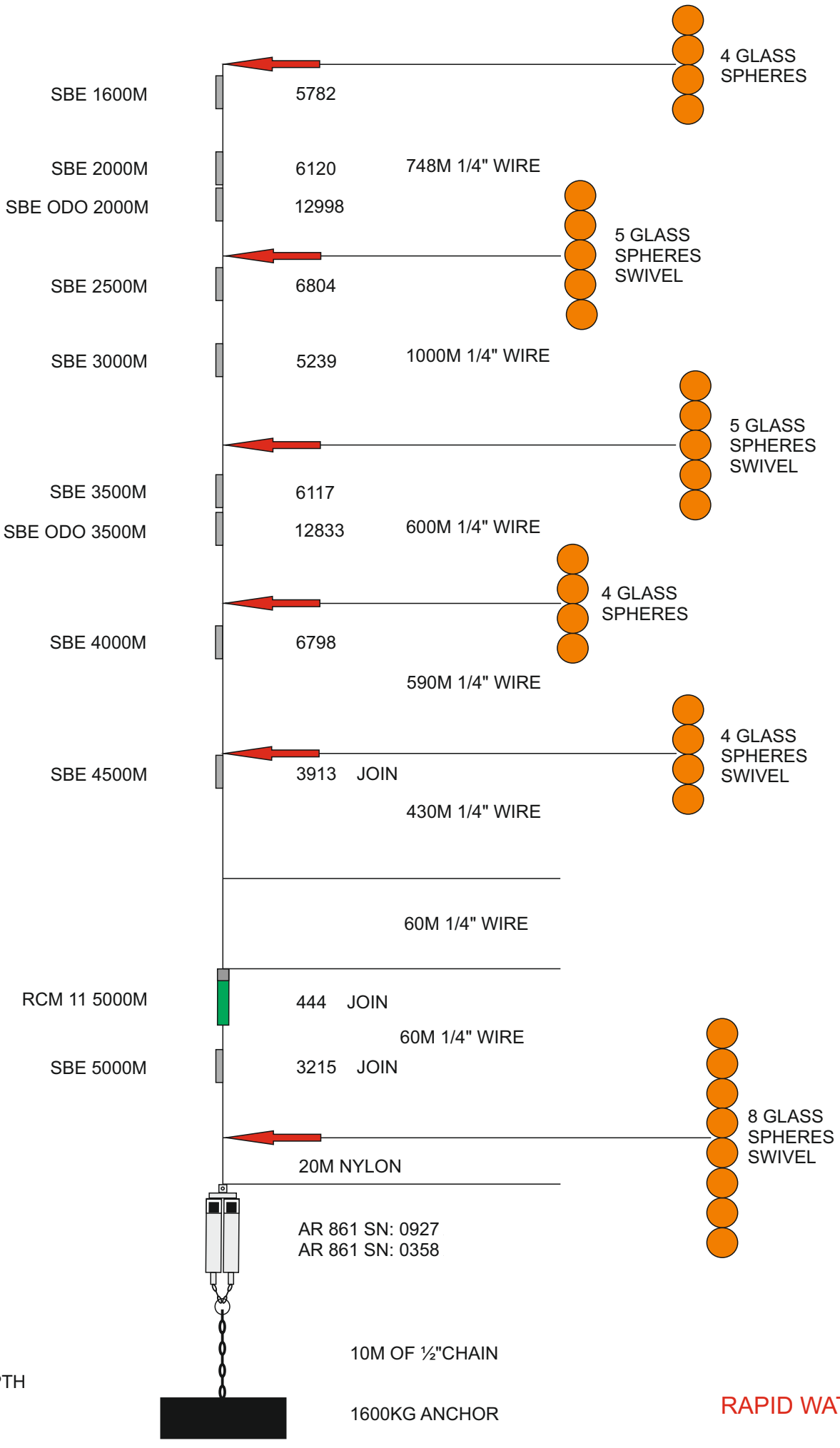
EB 1 DEPLOYED 2018

DATE: 29/10/2018
POSN: 23° 44.15'N
24° 10.66'W
DEPTH: 5123m



RAPID WATCH

EB 1 DEPLOYED 2018

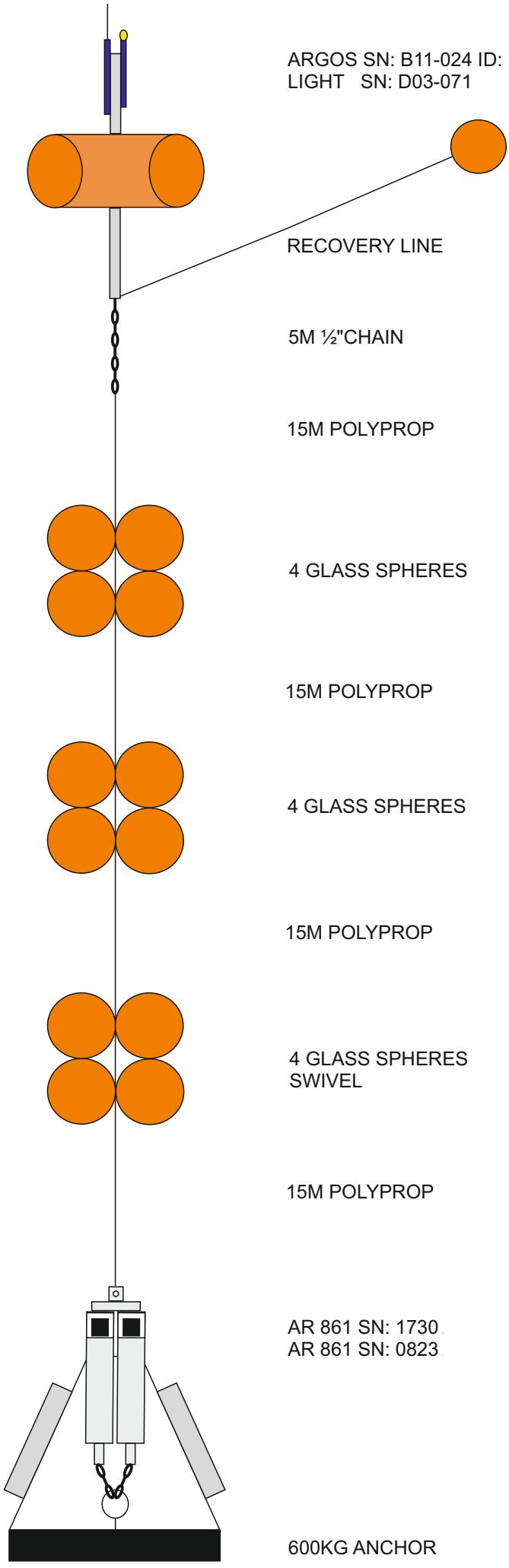


WATER DEPTH
5123m

RAPID WATCH

EB1L13 DEPLOYED 2018

DATE: 29/10/2018
POSN: 23° 47.92'N
24° 07.74'W
DEPTH: 5093m



ARGOS SN: B11-024 ID: 134365/C93E1D4
LIGHT SN: D03-071

RECOVERY LINE

5M ½"CHAIN

15M POLYPROP

4 GLASS SPHERES

15M POLYPROP

4 GLASS SPHERES

15M POLYPROP

4 GLASS SPHERES
SWIVEL

15M POLYPROP

AR 861 SN: 1730
AR 861 SN: 0823

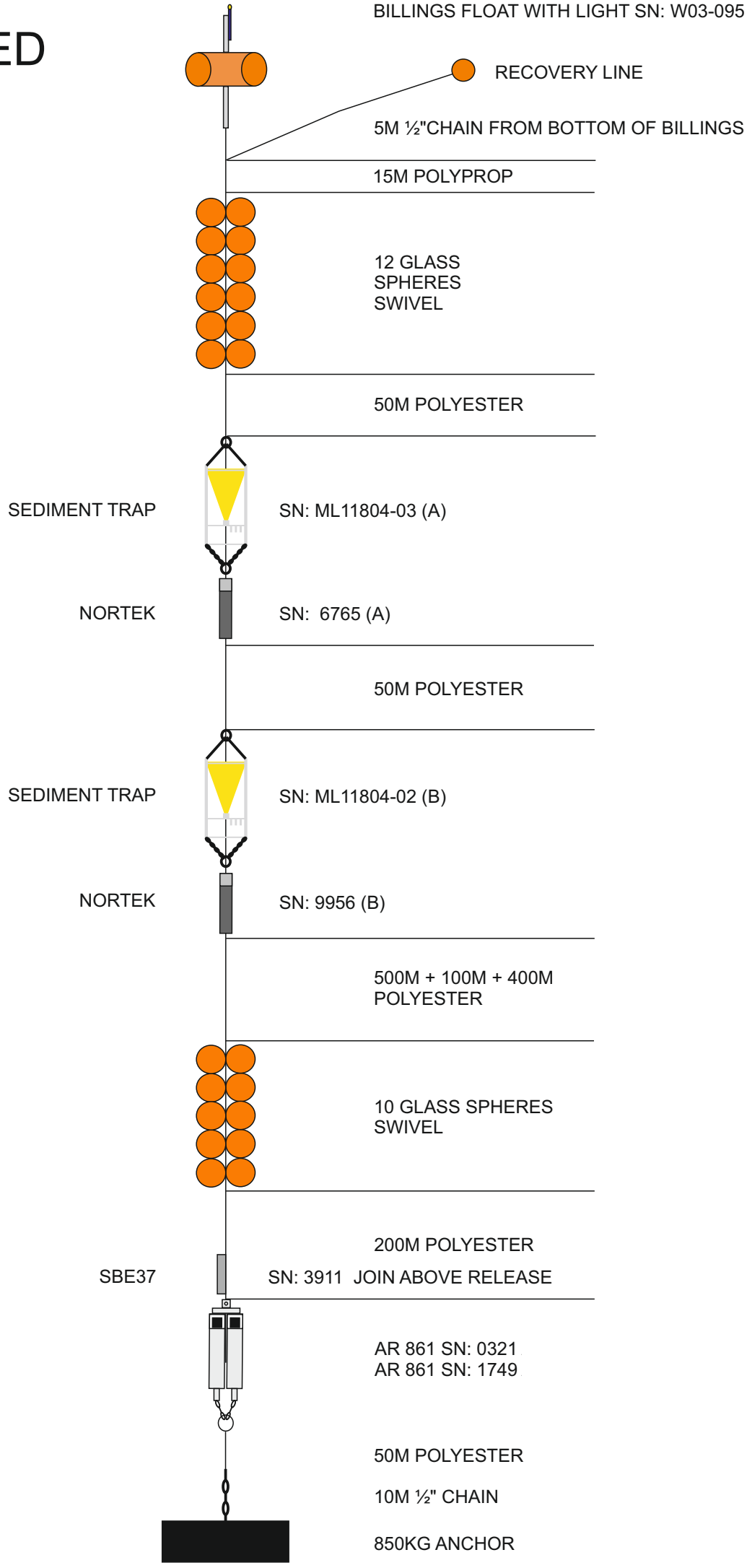
2 OFF BPR'S
SN: 53-0033
SN: 53-0419

600KG ANCHOR

RAPID WATCH

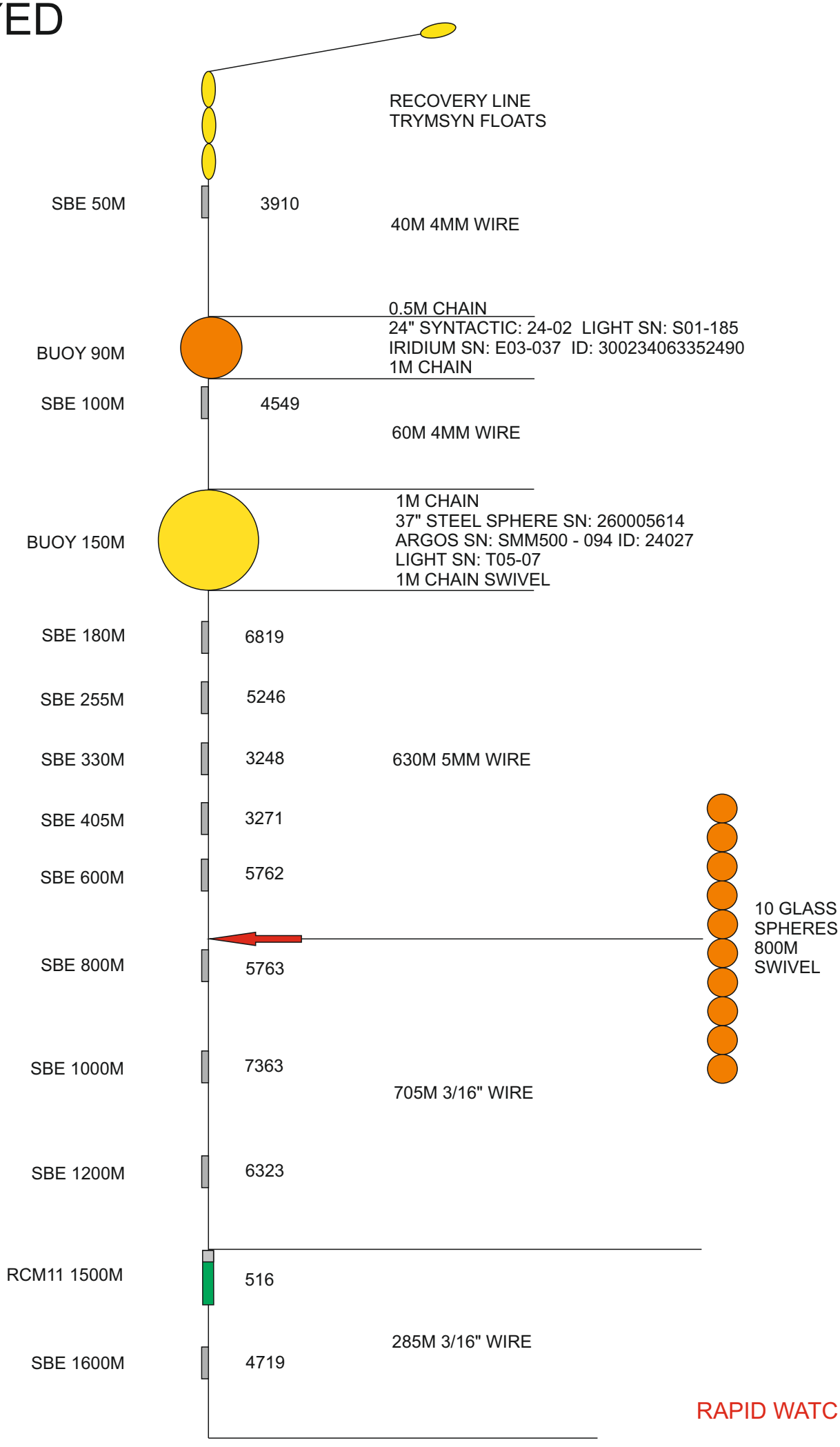
NOG DEPLOYED 2018

DATE: 04/11/2018
POSN: 23° 45.30'N
41° 05.77'W
DEPTH: 4251m



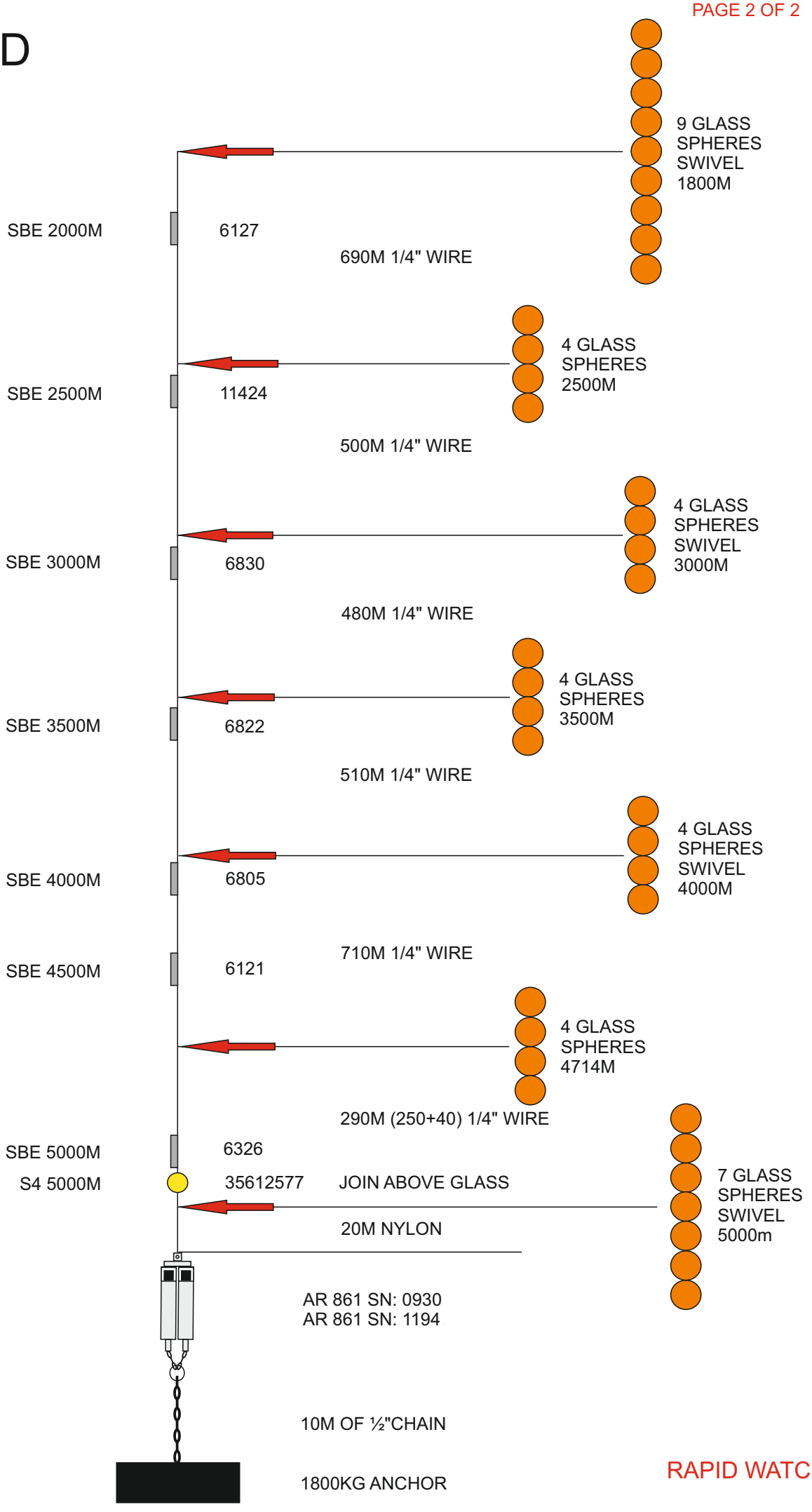
MAR 3 DEPLOYED 2018

DATE: 04/11/2018
POSN: 23° 52.14'N
41° 05.41'W
DEPTH: 5058m



RAPID WATCH

MAR 3 DEPLOYED 2018

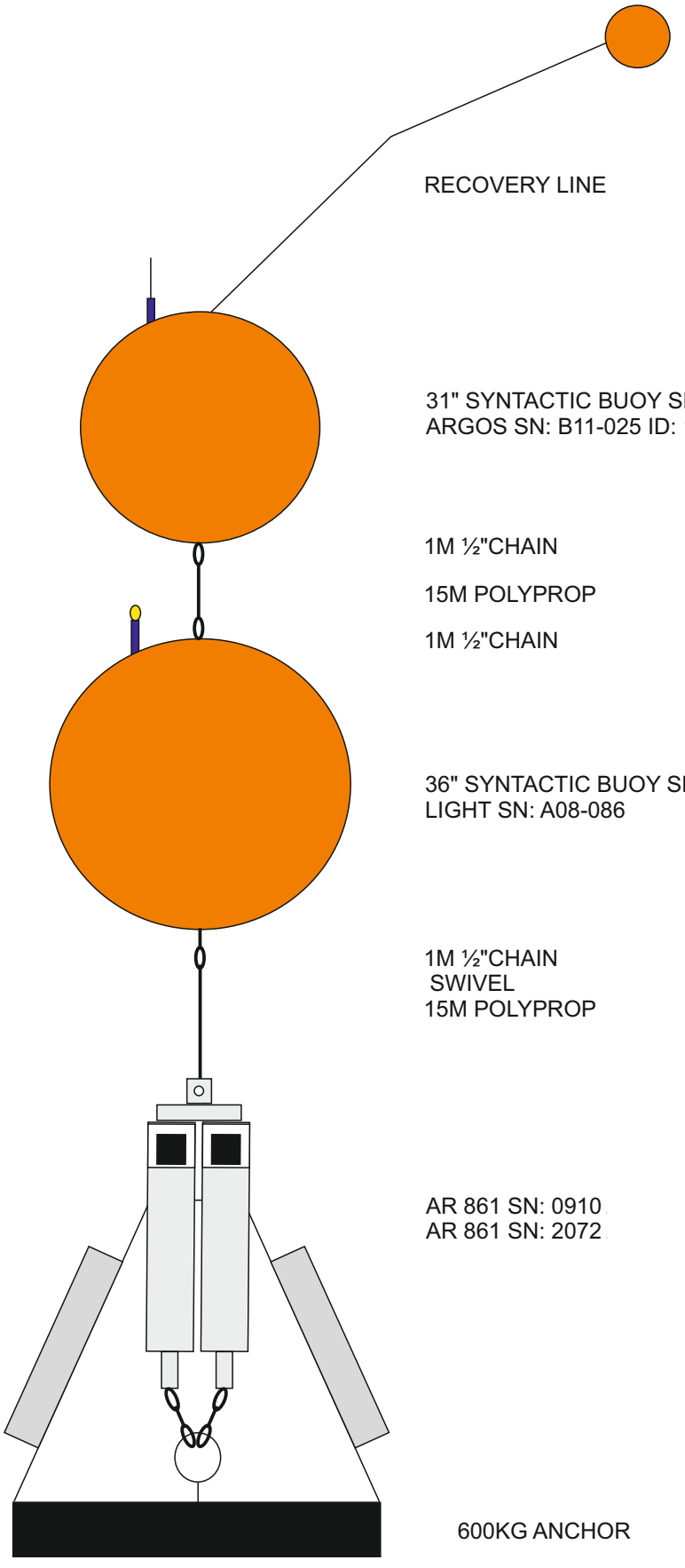


WATER DEPTH
5058M

RAPID WATCH

MAR3L12
DEPLOYED
2018

DATE: 04/11/2018
POSN: 23° 51.54'N
41° 05.36'W
DEPTH: 5072m



RECOVERY LINE

31" SYNTACTIC BUOY SN: J18250-003
ARGOS SN: B11-025 ID: 134366/C93E1E1

1M ½"CHAIN

15M POLYPROP

1M ½"CHAIN

36" SYNTACTIC BUOY SN: J18251-002
LIGHT SN: A08-086

1M ½"CHAIN
SWIVEL
15M POLYPROP

AR 861 SN: 0910
AR 861 SN: 2072

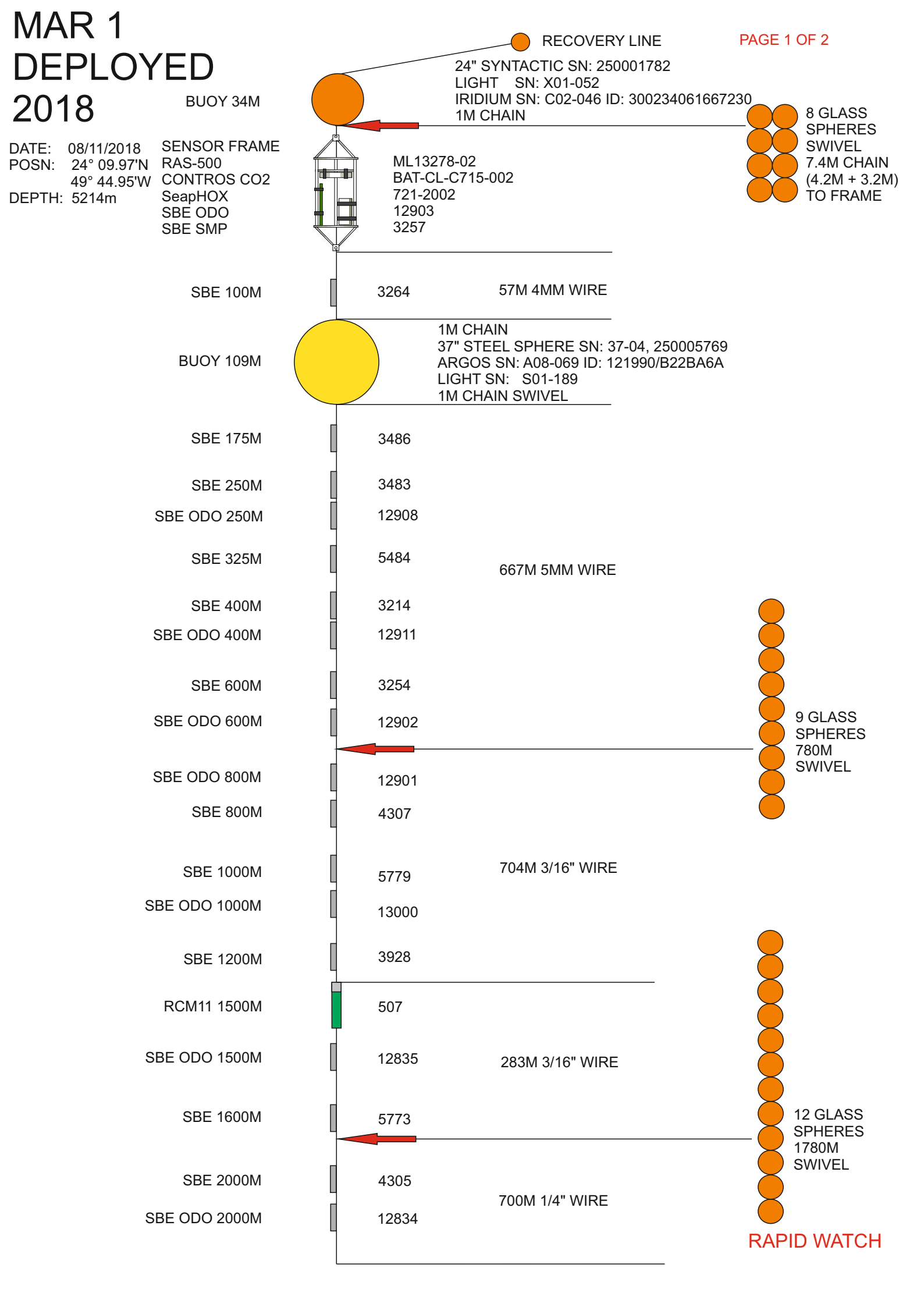
2 OFF BPR'S
SN: 53-0038
SN: 53-0059

600KG ANCHOR

RAPID WATCH

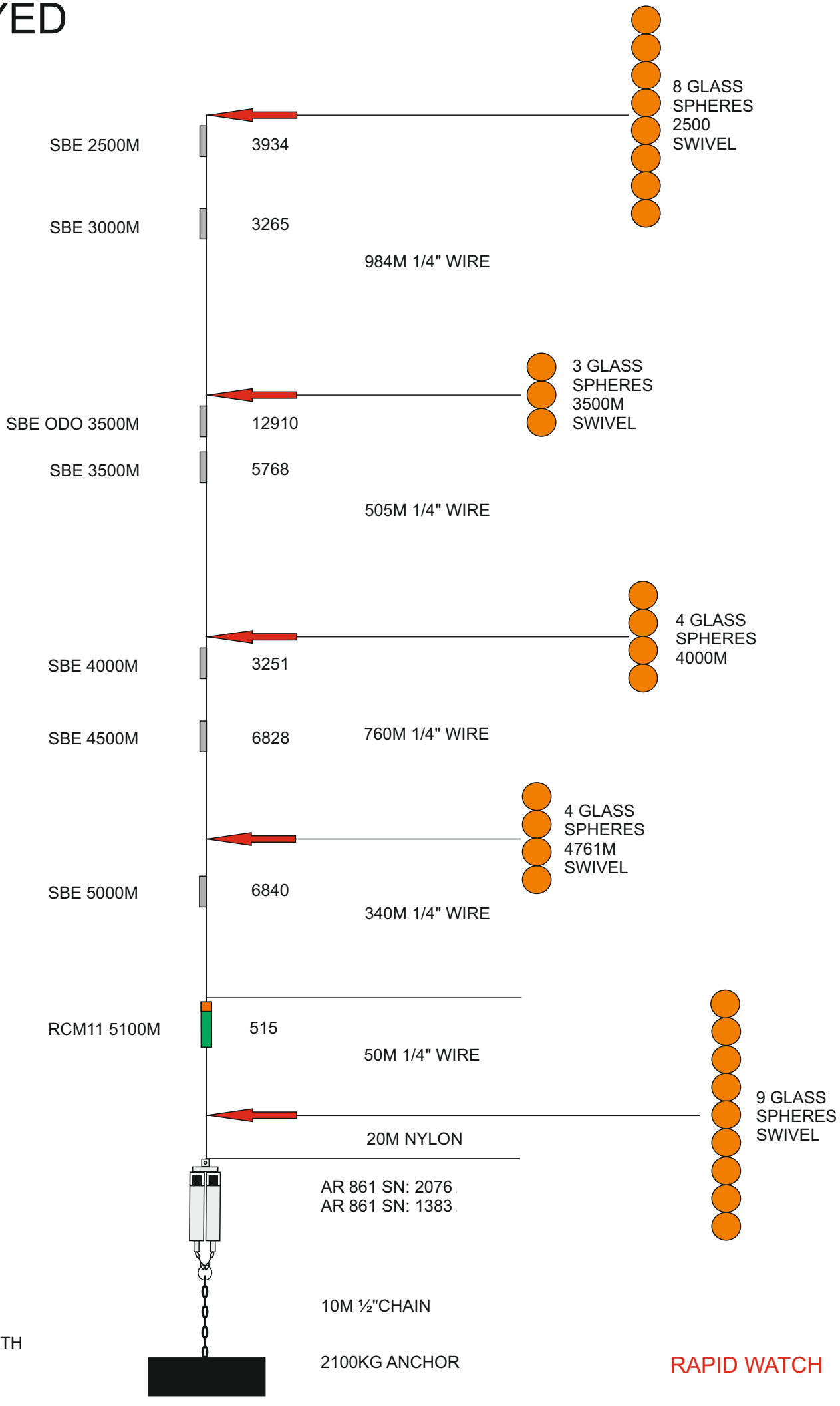
MAR 1 DEPLOYED 2018

DATE: 08/11/2018
POSN: 24° 09.97'N
49° 44.95'W
DEPTH: 5214m



RAPID WATCH

MAR 1 DEPLOYED 2018

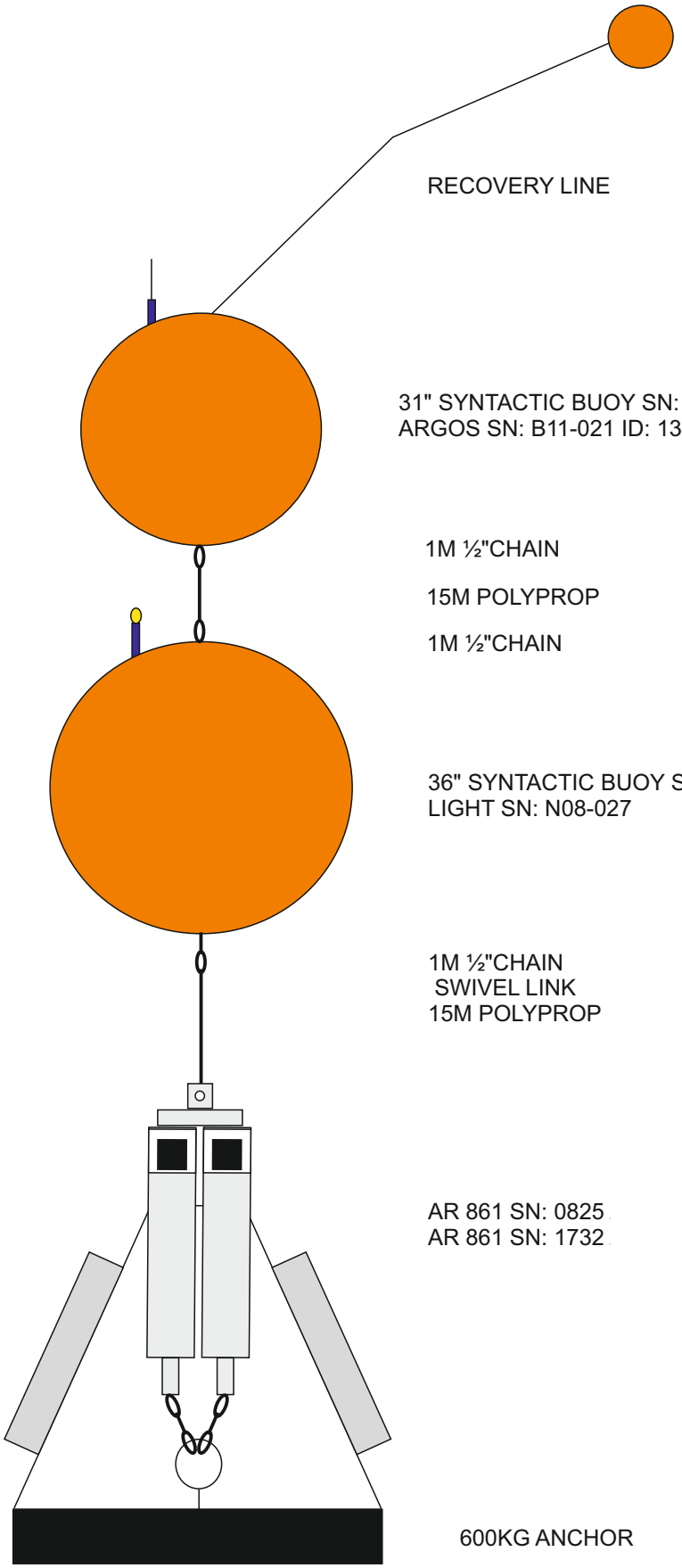


WATER DEPTH
5214M

RAPID WATCH

MAR1L12
DEPLOYED
2018

DATE: 06/11/2018
POSN: 24° 10.97'N
49° 43.97'W
DEPTH: 5215m



RECOVERY LINE

31" SYNTACTIC BUOY SN: J18250-002
ARGOS SN: B11-021 ID: 134362/C93E1AD

1M ½"CHAIN

15M POLYPROP

1M ½"CHAIN

36" SYNTACTIC BUOY SN: J18251-003
LIGHT SN: N08-027

1M ½"CHAIN
SWIVEL LINK
15M POLYPROP

AR 861 SN: 0825
AR 861 SN: 1732

2 OFF BPR'S
SN: 53-0014
SN: 53-0013

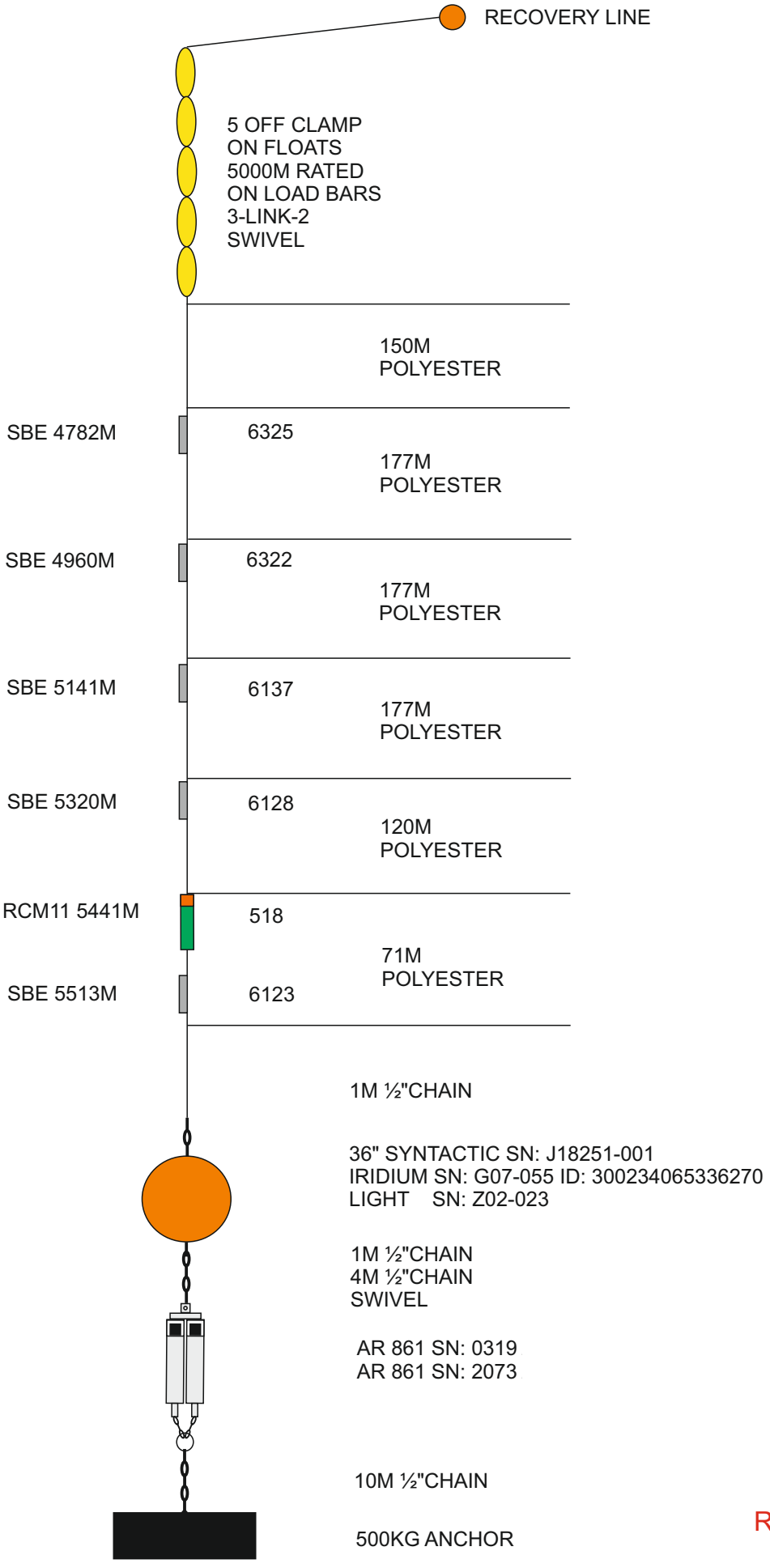
600KG ANCHOR

WATER DEPTH
5215M

RAPID WATCH

MAR0
DEPLOYED
2018

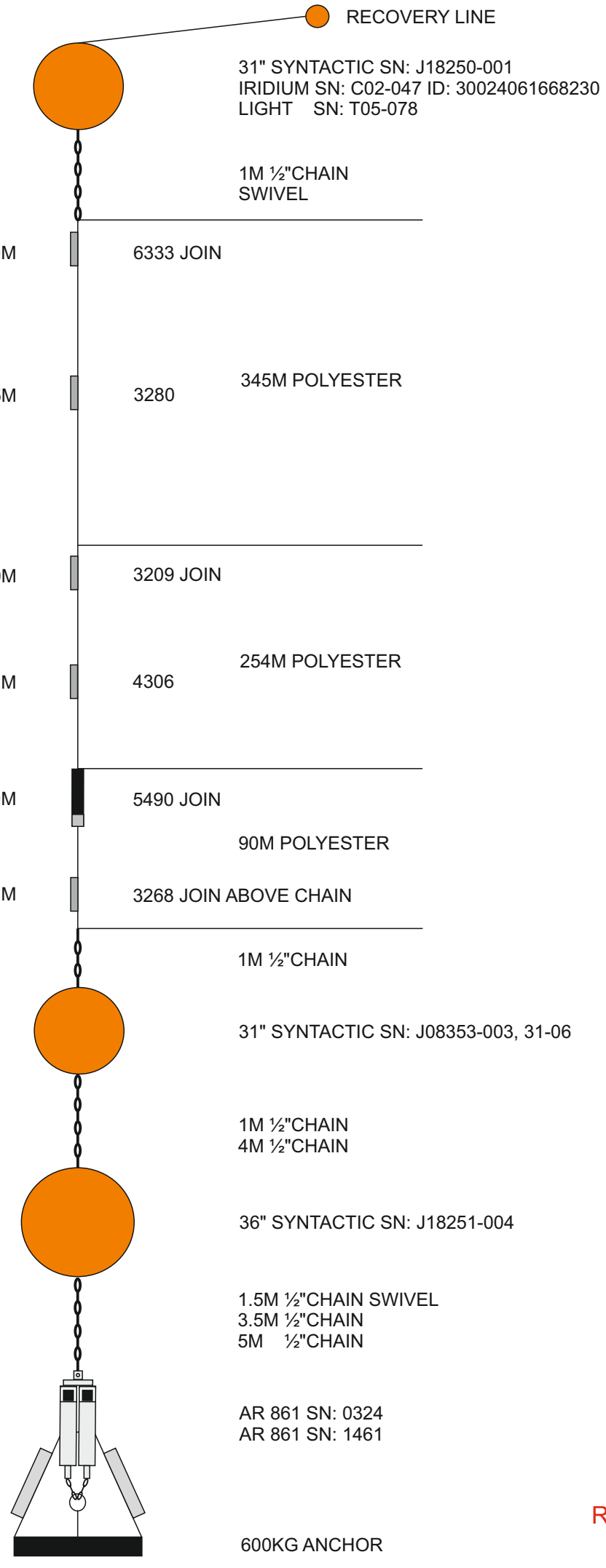
DATE: 09/11/2018
POSN: 25° 08.68'N
52° 01.26'W
DEPTH: 5459m



RAPID WATCH

WB 6 DEPLOYED 2018

DATE: 14/11/2018
POSN: 26° 29.73'N
70° 31.40'W
DEPTH: 5495m

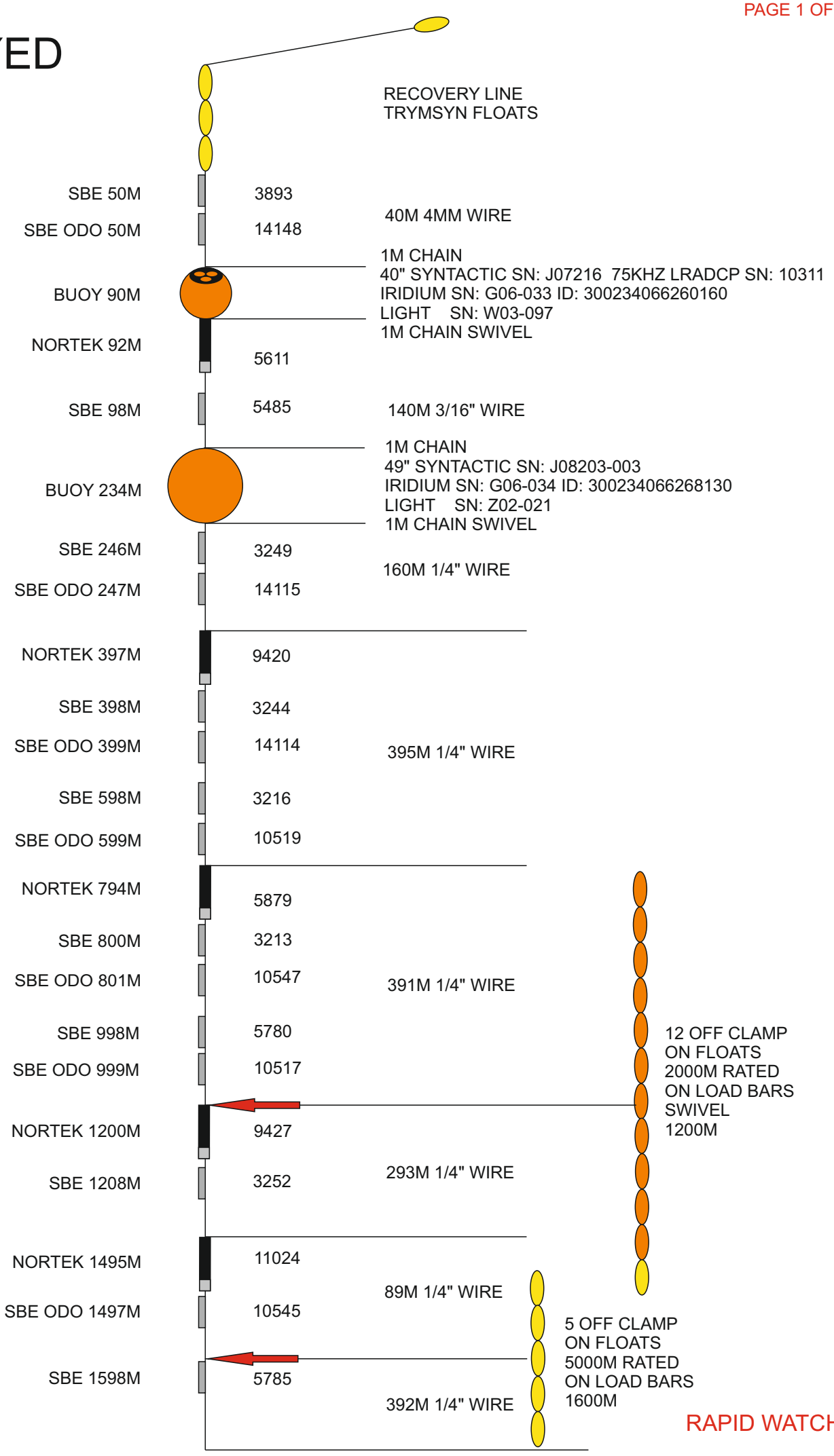


WATER DEPTH
5495M

RAPID WATCH

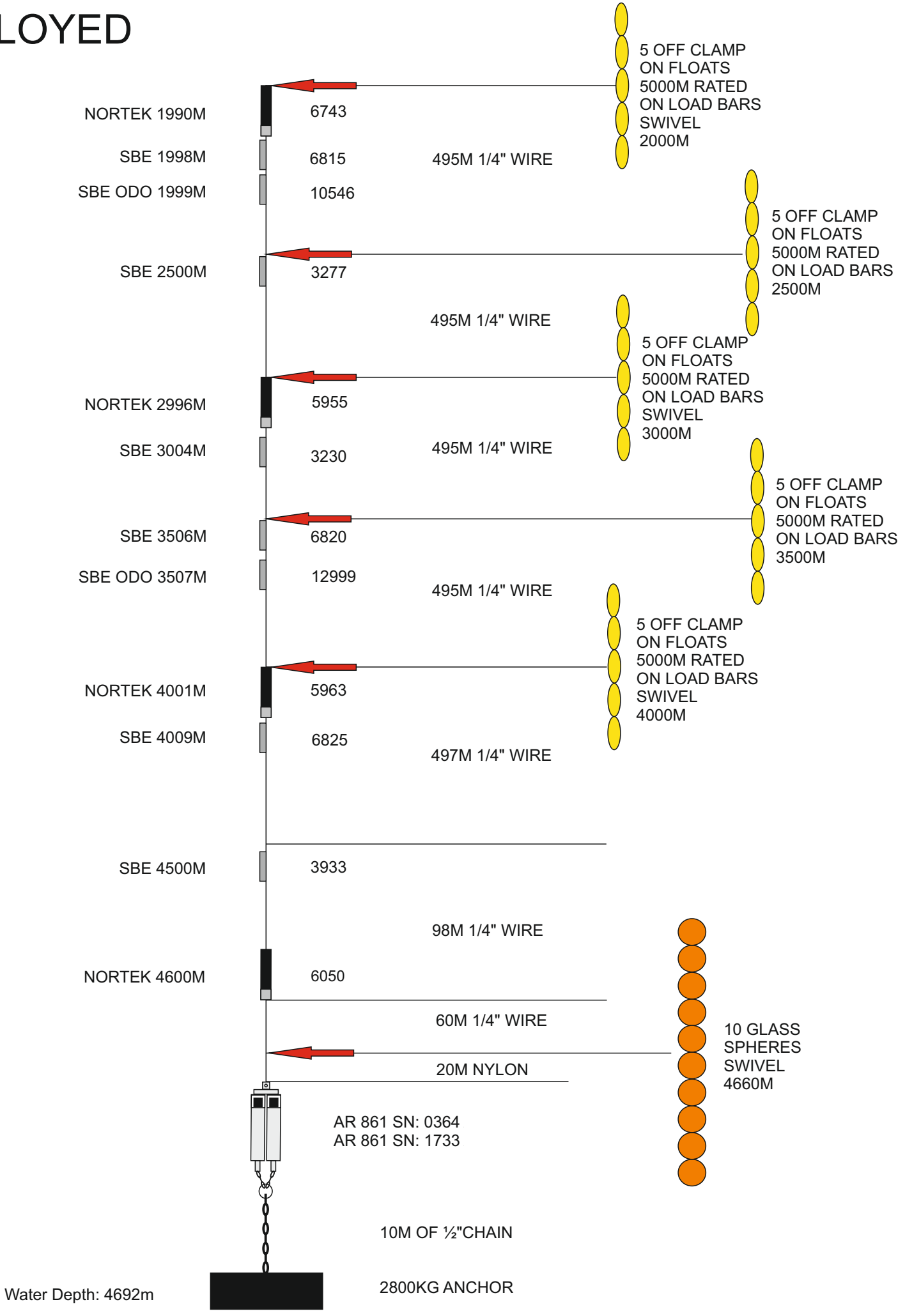
WB 4 DEPLOYED 2018

DATE: 18/11/2018
POSN: 26° 27.10'N
75° 43.61'W
DEPTH: 4692m



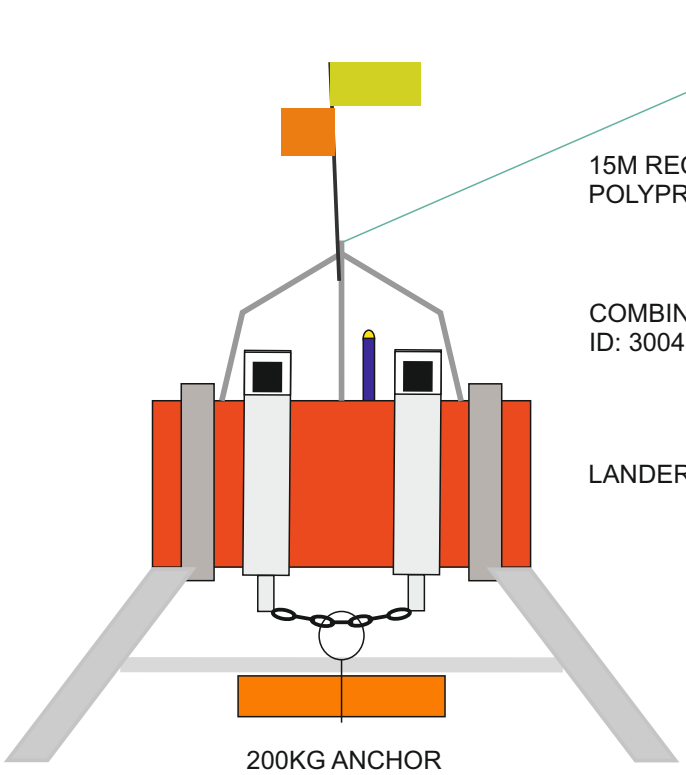
RAPID WATCH

WB 4 DEPLOYED 2018



WB4L13
DEPLOYED
2018

DATE: 18/11/2018
POSN: 26° 28.75'N
75° 43.54'W
DEPTH: 4704m



15M RECOVERY LINE &
POLYPROP MONKEY FIST

COMBINED IRIDIUM & LIGHT SN: XEOS_0059
ID: 300434061881140

LANDER SN: J18228-002

2 OFF BPR
SN: 53-0037
SN: 53-0040

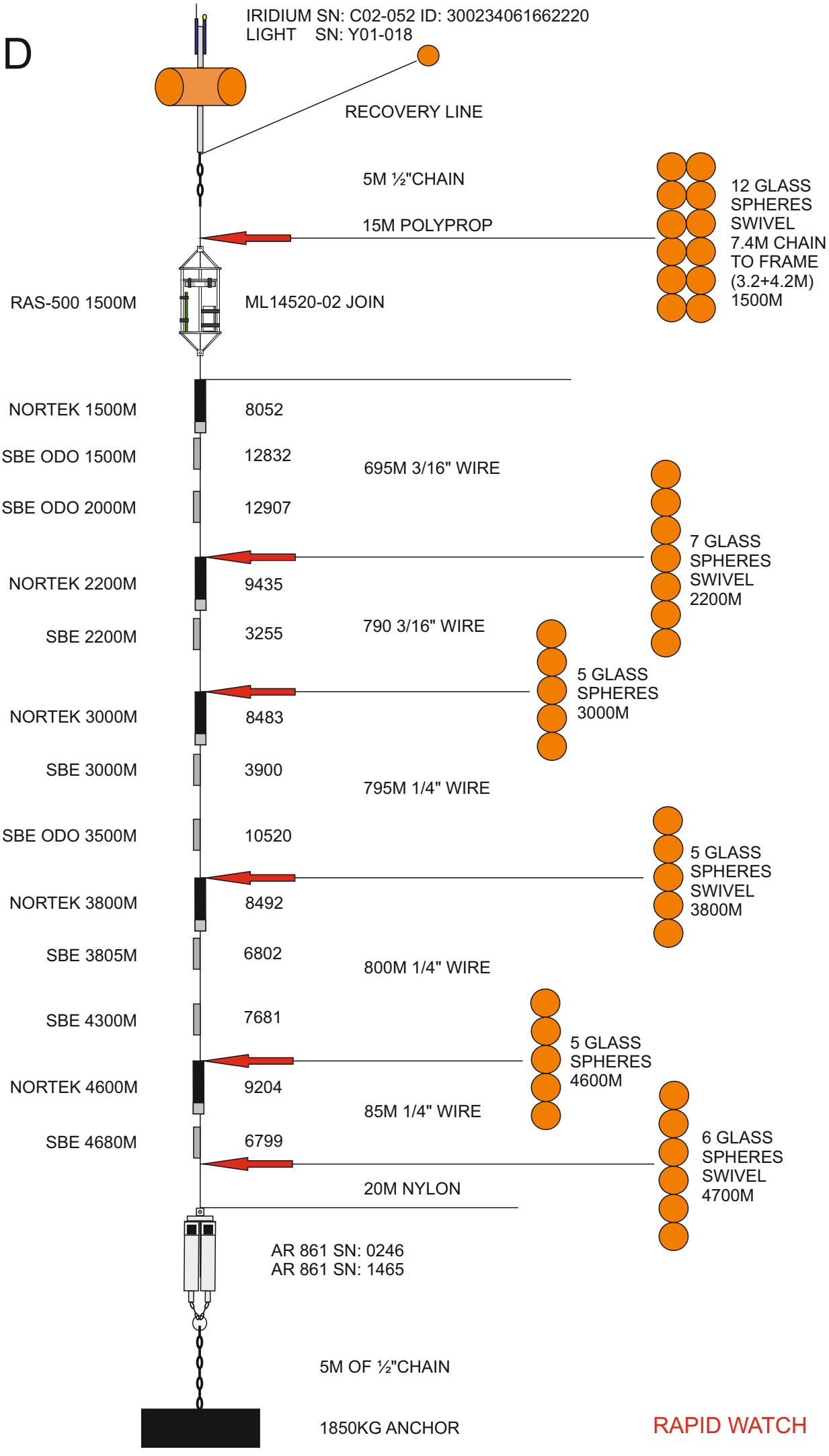
200KG ANCHOR

AR 861 SN: 1463
AR 861 SN: 2065

RAPID WATCH

WBH 2 DEPLOYED 2018

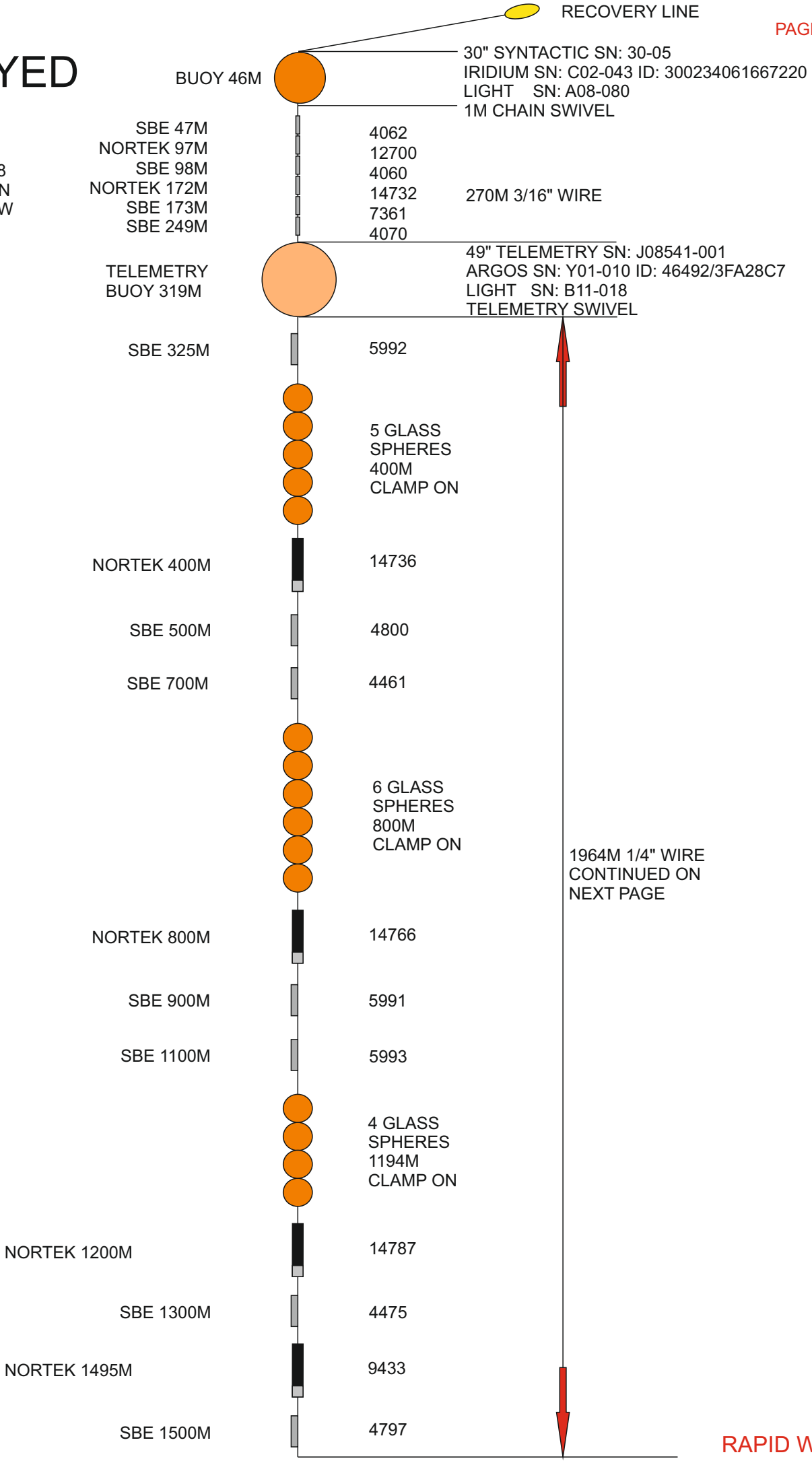
DATE: 20/11/2018
POSN: 26° 28.79'N
76° 37.64'W
DEPTH: 4748m



RAPID WATCH

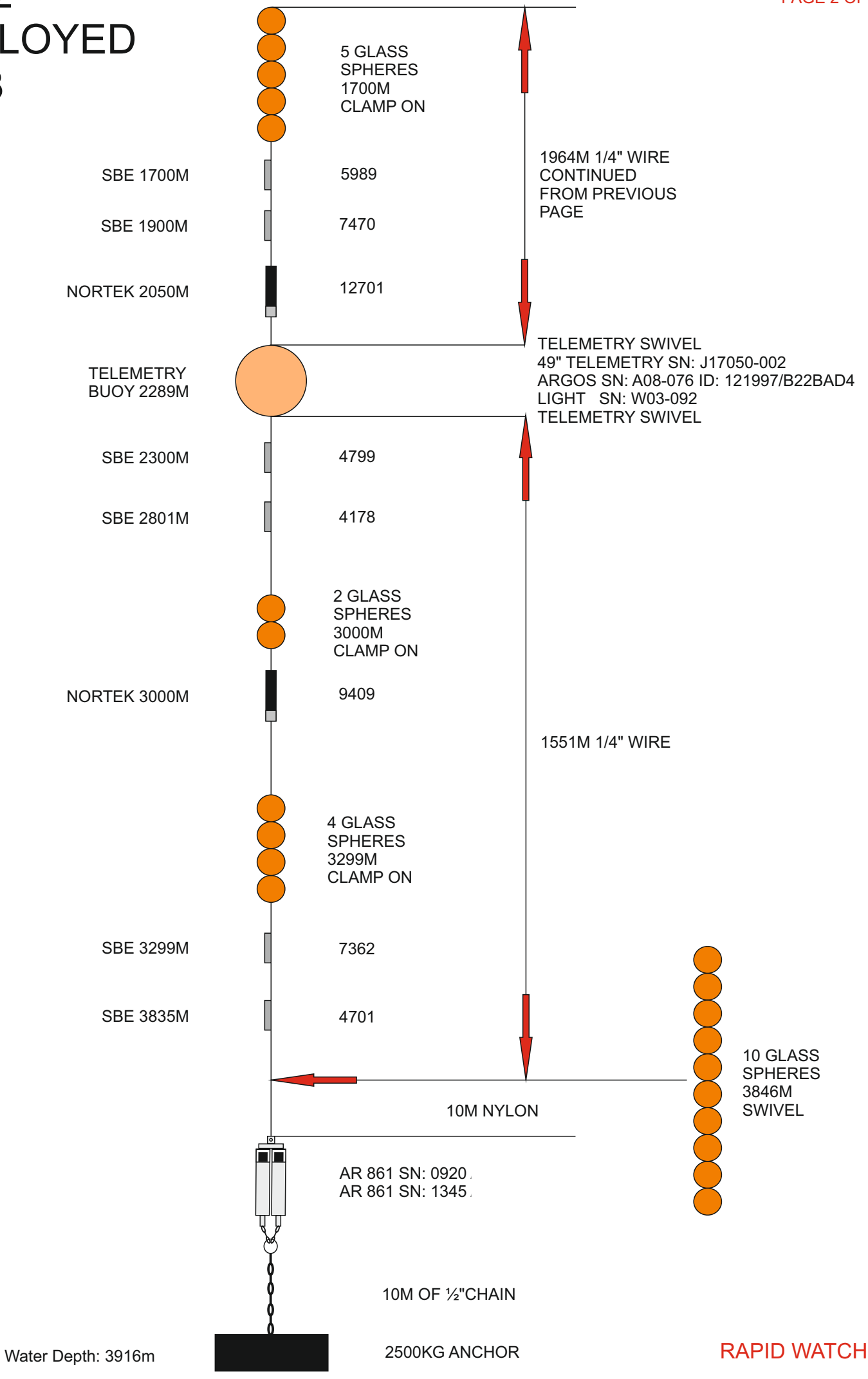
WB 2 DEPLOYED 2018

DATE: 23/11/2018
POSN: 26° 31.01'N
76° 44.46'W
DEPTH: 3916m



RAPID WATCH

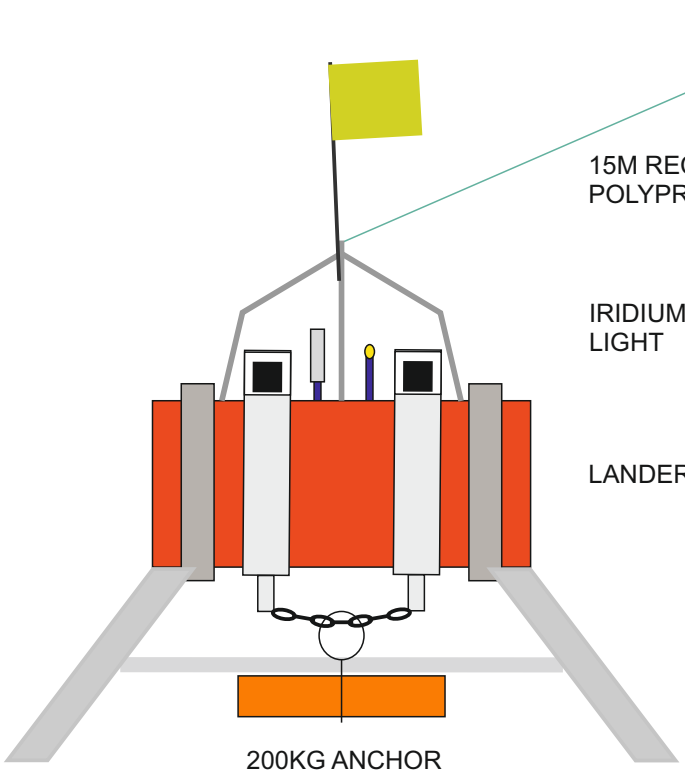
WB 2 DEPLOYED 2018



RAPID WATCH

WB2L13
DEPLOYED
2018

DATE: 22/11/2018
POSN: 26° 30.26'N
76° 44.72'W
DEPTH: 3885m



15M RECOVERY LINE &
POLYPROP MONKEY FIST

IRIDIUM SN: C02-038 ID: 300234061669220
LIGHT SN: Z02-020

LANDER SN: J18228-001

2 OFF BPR
SN: 53-0433
SN: 53-0080

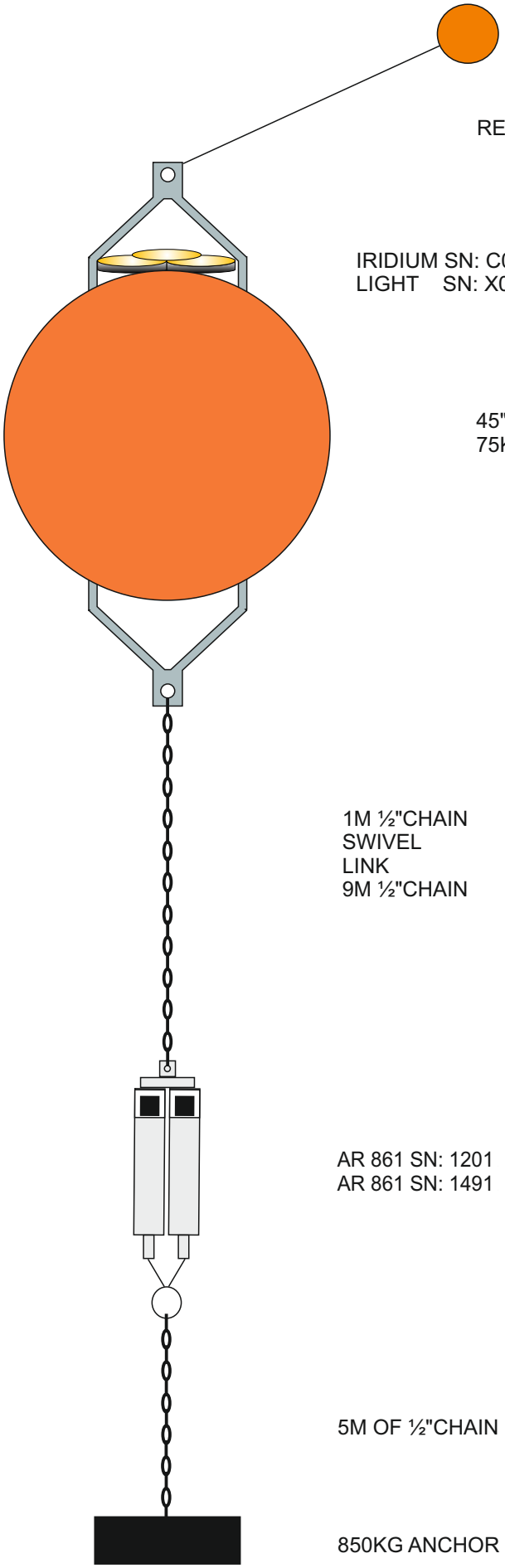
200KG ANCHOR

AR 861 SN: 1405
AR 861 SN: 2079

RAPID WATCH

WB ADCP DEPLOYED 2018

DATE: 19/11/2018
POSN: 26° 31.89'N
76° 52.00'W
DEPTH: 610m



RECOVERY LINE

IRIDIUM SN: C02-04 ID: 300234061666230
LIGHT SN: X01-050

45" SYNTACTIC SN: J17041-002
75KHZ LRADCP SN: 15579

1M ½"CHAIN
SWIVEL
LINK
9M ½"CHAIN

AR 861 SN: 1201
AR 861 SN: 1491

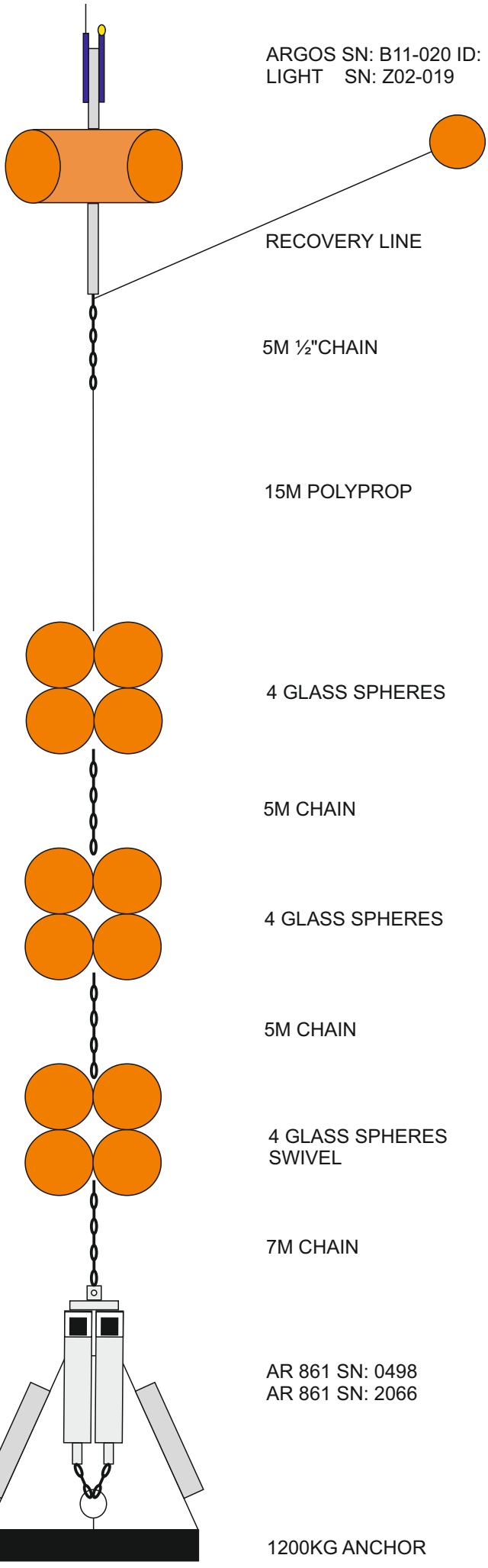
5M OF ½"CHAIN

850KG ANCHOR

RAPID WATCH

WBAL DEPLOYED 2018

DATE: 19/11/2018
POSN: 26° 31.46'N
76° 52.00'W
DEPTH: 625m



ARGOS SN: B11-020 ID: 134361/C93E198
LIGHT SN: Z02-019

RECOVERY LINE

5M ½"CHAIN

15M POLYPROP

4 GLASS SPHERES

5M CHAIN

4 GLASS SPHERES

5M CHAIN

4 GLASS SPHERES
SWIVEL

7M CHAIN

STAINLESS FRAME
2 OFF BPR
SN: 53-0434
SN: 53-0012

AR 861 SN: 0498
AR 861 SN: 2066

1200KG ANCHOR

RAPID WATCH

Appendix B: Logsheets of recovered moorings

35 pages

EBH4 ranged but not recovered

[redacted]

Ranging

Time	Range 1	Range 2	Command/comment
08:36	1319.9	1035.5	[redacted] range.
~~08:39:5~~			rel
08:38:40	1035	1035	osm release
08:39:10			
08:49:	1022.8	1022.4	release [redacted] vertical
08:50.	1022		diagnostic.
08:50	1023.8	v	diagnostic [redacted] vertical
08:52:40	1022	1021	[redacted] release.
08:53:40	1021	1021	release.
08:54:54	1021	1021	
08:56:36	1020.9	1021	
08:57	1020	1020	[redacted] release.
08:58:35	1021	1021	[redacted]
08:59:14	1022	1022	
09:00:00	1022		
09:24:20	1160.2	1159	[redacted]
09:24:50	1159.8	1159.9	
09:47:05	1135	1135	[redacted]
09:47:40	1136	1136	ARM+ RELEASE
09:48:10	1136	1137	
~~10:18:05~~	~~1131.5~~	~~1131.5~~	
~~10:18:45~~	~~1131.5~~	~~1131.3~~	
10:18:15	1131.5	1131.5	
10:18:40	1131.5	1131.6	
~~10:18:59~~			
10:19:12	1131.7	1131.7	

16:05:20	1451	1451	ARM+ REL. AFTER MAKING DIVE FROM [redacted]
16:05:53	1451	1451	
16:10:00	1435.6	1435.3	
16:11:00	1436	1435	
16:15:00	1435.6	1435.8	
16:16:00	1416.	1413.	
16:17:00	1392	1392.	
16:18:00	1373	1371	
16:19:00	1360	1360	

16:20:00	1345	1344
16:21:00	1331	1330

23/Oct/2018

[redacted]	21:05:45	1198
	21:06:25	1198 1198.1

all diag.

[redacted]

16:23:00	1308	1308
16:24:00	1299	1298
16:26:00	1276	1275
16:27:00	1266	1265
16:28:00	1254	1253
16:29:00	1243	1241
16:31:00	1220	1220.
16:33:00	1199	1198.
16:35:00	1176	1176.
16:37:00	1156	1155
16:39:00	1129	1127
16:41:00	1103	1102
16:43:00	1091.	—
17:02:15	1125	1125
17:03:15	1125	1125
17:04:15	1125	1125
17:05:15	1125	1125
17:06:15	1125	1125
17:11:20,	1162	1162.

ship moving

~~23rd October 2018~~

19:20:15 3639 4563
vertical

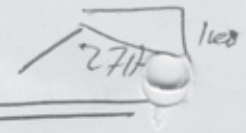
[redacted]

19:22:35 — —
19:23:20 — —
19:24:20 — —

[redacted]

19:26:15 — —

19:27:20 2717.7 —
19:27:48 — —
19:28:27 — —



23rd October 2018

[redacted]

vertical

07:20:24	1348.4	1348.5.
07:20:58	1348.8	1348.8
~~07:23:43~~		
07:24:00	1349.4	1349.5
~~ship moving~~		
07:25:00.	1349.5	1349.7.
07:26:00	1349	1349.

0927

07:26:45	1349.3	1349.
07:27:45	1349	1350.
07:28:45	1350	1350.

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH4L6** Cruise **JC174**

NB: all times recorded in GMT

Date 23/10/18 **Site arrival time** overnight.

Time of first ranging 6:51

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		07:28
Billings Float	n/a		~~07:28~~
with Light	Y01-016		07:40
and Argos Beacon	Y01-028	Beacon iD: 46501	
4 x 17" glass	n/a	Tangled.	07:35 40
4 x 17" glass	n/a		07:~~40~~ 35
4 x 17" glass	n/a		07:54 (top)
BPR	396 ✓		08:00
BPR	397 ✓		08:00
Acoustic Release #1	2068		08:00
Acoustic Release #2	2075		08:00

Ascent Rate ~~65 m/min~~. 81 m/min.

Ranging

Time	Range 1	Range 2	Command/comment
6:51:18	5316	4402	[redacted] range
6:53:15	—	—	
6:54:36	—	—	range
6:56:50	—	—	range.
6:58:00	—	—	
			new deck unit
6:59:58	1050	1049.	[redacted] range.
7:00:46	1050.4	1050.6	release
7:01:46	982.1	982	
7:03:46	819.5	819.5	

~~On surface~~

On Surface 07:12.

[redacted]

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH3** Cruise **JC174**

NB: all times recorded in GMT

Date 21/10/2018 **Site arrival time** 14:30

Time of first ranging 14:41

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled at 15:21	15:21
Billings Float	n/a		15:31
with Light	D03-071		
and Iridium Beacon	E03-034	Beacon ID:300234063269820	
4x17" glass	n/a	lots of Growth	15:32
MicroCAT	5978 ✓	lots of Growth	15:32
MicroCAT	3248 ✓	mild growth	15:38
MicroCAT	6321 ✓		15:40
MicroCAT	6323 ✓		15:43
3x17" glass	n/a	Tangled	15:46
MicroCAT	7363 ✓	Tangled	15:46
MicroCAT	5989 ✓		15:53
5x 17" glass	n/a ✓	Tangled	15:55
MicroCAT	5763 ✓		15:58
Nortek (clamp on)	8465 ✓		16:02
MicroCAT	4062 ✓		16:04
4 x 17" glass	n/a ✓	Tangled.	16:07
MicroCAT	5991 ✓		16:09
MicroCAT	5993 ✓		16:12
Nortek (clamp on)	11846 ✓		16:17
3 x 17" glass	n/a ✓		16:16
MicroCAT	4060 ✓		16:20
Nortek(clamp on)	11855 ✓		16:23
MicroCAT	7361 ✓		16:25
3 x 17" glass	n/a		16:28
MicroCAT	5992 ✓		16:28
Nortek (clamp on)	12701 ✓		16:32
MicroCAT	6805 ✓	Tangled. grow	16:37
4 x 17" glass	n/a	Tangled growth on wire	
Acoustic Release 1	1461 ✓	fired from Bott releases	16:37
Acoustic Release 2	1463 ✓		16:37

Ascent Rate 1420m / 15 mins = 94 m/min.

ON SURFACE AT 14:49

LAST PACK ON SURFACE 15:04

[redacted]

Ranging

Time	Range 1	Range 2	Command/comment
14:41	—	—	
1442	—	—	[redacted] range.
14:43	—	—	[redacted] range.
1444	—	—	[redacted] range
1445	—	—	range.
14:46	—	—	range.
14:46	—		"
14:48	—	—	release. [redacted] no response
~~14:49~~			~~no response~~
			Surface 14:49.

[redacted]

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH2** Cruise **JC174**

NB: all times recorded in GMT

Date 24/OcT/2018 **Site arrival time** overnight

Time of first ranging 06:52

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		
Billings Float	n/a ✓	TANGLED. RECOVERED SECOND.	08:01
with Light	A08-083 ✓		08:01
and Argos Beacon	B11-025 ✓	Beacon ID: 134366	08:01
2 x 17" glass	n/a ✓	~~TANGLED. RECOVERED BEFORE BILLINGS.~~	08:01
MicroCAT	6840 ✓		08:01
2 x 17" glass	n/a ✓		08:14
MicroCAT	4066 ✓	TANGLED IN ROPE ON RECOVERY.	08:13
RCM11	383 ✓		08:19
MicroCAT	6815 ✓		08:24
4 x 17" glass	n/a ✓		08:24
Acoustic Release #1	1405 ✓	RELEASED.	08:24
Acoustic Release #2	324 ✓		08:24

Ascent Rate 94m/min.

Ranging

Time	Range 1	Range 2	Command/comment
06:52:03	—	—	~~release~~ range.
06:53:17	—	—	"
06:54:23	—	—	range.
06:55:10	—	—	"
	changed	transducer	
06:59:10	—	—	range.
07:00:15	—	—	"
07:01:28	—	—	
07:02:34	—	—	
	changed deck unit.		
07:08:33	2036.0	2035.8	ding
07:09:48	2035	2034	release. Ok.
07:10:48	1958	1950	r.
07:11:48	1874	1866.	

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH1** Cruise **JC174**

NB: all times recorded in GMT

Date 25/Oct/2018 **Site arrival time** 08:35:00

Time of first ranging 08:36

SPOTTED AT ~~09:14~~ 09:19

ITEM	SER NO		COMMENT	TIME
Recovery line	n/a	✓	Grapnel at	09:42:24
Billings Float	n/a	✓	CAME UP AFTER FIRST MICRO CAT.	09:51:22
with Light	Z08-052	✓		09:51:22
and ~~Argos~~ Beacon	E03-035	✓	Beacon ID: 300234063352630	09:51:22
2 x 17" glass	n/a	✓		09:51:10
MicroCAT	6125	✓	TANGLED with glass cluster + Ropes.	09:50:12
2 x 17" glass	n/a	✓		10:04:00
RCM11	305	✓	WINCH DRUM REALIGNMENT (10:14)	10:09:40
MicroCAT	4549	✓		10:16:08
4 x 17" glass	n/a	✓		10:16:10
Acoustic Release #1	1465	✓		10:16:38
Acoustic Release #2	246	✓	RELEASED.	10:16:38

Ascent Rate 90m/min.

Ranging

Time	Range 1	Range 2	Command/comment
08:36:00	—	6791	range
08:37:33	0.0	—	"
08:38:20	0.0	0	range
08:39:00	0.0	3037	"
08:39:39	0	3038	"
08:40:10	0	no range.	release (release 04)
08:41:10	0	0	"
08:42:10	0	2896	range.
08:42:40	—	2798	"
~~08:43:40~~			
08:44:10	2723	2715	" "
08:45:10		2615	
8:50:10	~~2549339~~	2549	" "

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBH1L11** Cruise **JC174**

NB: all times recorded in GMT

Date 25/Oct/2018 **Site arrival time** overnight

Time of first ranging 06:49

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		07:58
Billings Float	n/a		08:03
with Light	N08-027 ✓		"
and Argos Beacon	A08-070 ✓	Beacon ID: 121991	"
4 x 17" glass	n/a	bangled.	08:03
4 x 17" glass	n/a	bangled	08:07
4 x 17" glass	n/a	bangled.	08:07
BPR	398 ✓		08:14
BPR	399 ✓		08:14
Acoustic Release #1	2076 ✓	Fired.	"
Acoustic Release #2	2079 ✓		"

Ascent Rate 90 m/min

Ranging

Time	Range 1	Range 2	Command/comment
	hull	mounted	transducer
06:49:12	—	1004.1	range
06:51:17	—	—	
06:52:50	—	—	range
06:53:58	—	—	"
06:54:37	—	—	"
06:55:30	—		range
	over		
07:00:59	—	—	
07:02:22	3035.2	3034.9	range
07:03:00	—	3034	ding
07:03:50	3034	3033	release
07:04:50	—	—	"
07:05:50	2886	2878	range.
07:06:50	—	2787	range

RAPID-AMOC MOORING LOGSHEET **RECOVERY**

Mooring **EBHi** Cruise **JC174**

NB: all times recorded in GMT

Date 27/10/18 **Site arrival time** OVERNIGHT

Time of first ranging 07:26

ITEM	SER NO		COMMENT	TIME
Recovery line	n/a	✓	Grapnel at.	08:57:53
49" telemetry buoy	n/a	✓	tangled with first microcat.	09:03:40
with Light	A08-084	✓		09:03:40
and Iridium Beacon	E03-036	✓	Beacon ID:300234063788890	09:03:40
MicroCAT	5246	✓	tangled with telemetry buoy	09:02:58
2 x 17" glass	n/a	✓		09:04:50
MicroCAT	6819	✓	tangled up near floats.	09:21:56
2 x 17" glass	n/a	✓		09:21:56
RCM11	303	✓	tangled, kept ~~twit~~ cable bundle.	09:32:36
MicroCAT	6828	✓		09:36:49
4 x 17" glass	n/a	✓		09:37:41
Acoustic Release #1	1345	✓	Released	09:39:41
Acoustic Release #2	1733	✓		09:77:41

Ascent Rate 77m/min

Ranging

Time	Range 1	Range 2	Command/comment
07:26:40	/	4456	[redacted]
07:27:33	4453	4454	ARM + DIAG VENTCH 8-3
07:28:03	3171	4434	[redacted] ARM+ARM
07:28:38	/	/ 11129	
07:29:15	/	/	
07:29:32	/	/	
07:30:24	4454	4453	[redacted] + RELEASE NOT CONFIRMED
07:31:30	/	4364	PULL OK.
07:32:30	0	6073	
07:33:35	/	1494	ARM + ARM
07:34:18	/	0	
07:34:56	/	0	[redacted]
07:35:36	0	4045	
07:36:00	4025	1692	
07:37:00	/	4459 ?	
07:38:00	3870	/	[redacted]
07:39:00	0	3786	

ETA 08:14
Surface at 08:28
2ND PEAK AT 08:38
BOTTOM PEAK AT 08:45

5 x 17" glass	n/a	✓ CHANGING WIRE DRUM	13:54
MicroCAT	5768	✓	14:15
MicroCAT-ODO	10546	✓	14:15
4 x 17" glass	n/a	✓	14:27
MicroCAT	3251	✓	14:31
4 x 17" glass	n/a	✓ tangled. BIG TANGLE BETWEEN 3251 & GLASS	15:30
MicroCAT	4799	✓	15:29
RCM11	450	✓	15:08
MicroCAT	5762	✓	15:10
8 x 17" glass	n/a	✓ CHAIN TANGLED	15:13
Acoustic Release #1	322	✓	15:18
Acoustic Release #2	1491	✓ RELEASED	15:18

ON CUT LOOP FROM TANGLE

Ascent Rate 94 m/min.

Ranging

Time	Range 1	Range 2	Command/comment
10:18:20	0.0	0.0	[redacted] Range
10:18:37	0.0	0.0	"
	changed transducer		
10:22:25	—	—	[redacted] Range
10:23:09	—	—	
10:23:55	—	5034.9	range
10:24:45	5034	5034	diag. vertical
10:25:45	5035	5034	release..
10:26:30	4975	4900	"
10:27:30	4880	4866	"

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EB1L11** Cruise **JC174**

NB: all times recorded in GMT

Date 28/OCT/2018 **Site arrival time** _____

Time of first ranging _____

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		
31" syntactic	n/a		
With light	X01-051		
and Argos Beacon	B03-075	Beacon ID: 129568	
4 x 17" glass	n/a		
4 x 17" glass	n/a		
4 x 17" glass	n/a		
Lander tripod			
With BPR #1	0058		
And BPR #2	394		
And Acoustic Release #1	2070		
And Acoustic Release #2	497		

Ascent Rate _____

Ranging

Time	Range 1	Range 2	Command/comment
15:5040	9066.1	3837	Range.
15:51:30	—	3314	" vertical.
15:52:24			
1553 15	—	—	
1553 56	—		
15:5540		5471	Ra Vertical.
15:56:22	5476		release ok " "
15:58:22	5475	5474	
15:58:32	5475	5475	range.
15:59:32	5475	5475	range
16:01:07	5474	5474	"
16:01:50	5475	5474	release ok.
16:02:53	5475	5475	" "
16:03:55	—	—	range.
16:05:30	—	—	release
16:06:45	5475	5475	range.
16:07:58	~~5474~~ —		~~range~~ release
	moved	Position	

25th Oct.

08:16 —
08:16:58 5047
08:17:30 5047 — 5047

16:30:10 5043 5042
16:30:50 5042 5042
16:31:59 5043 5043
16:33:00 — 5044
16:34:00 5043 5043

range
release. ok.
rang.
ALM - release. ok.

29/oct/2018
08:10:25 3596 —
08:11:00 — —
08:12:10 — 5047
08:12:50 — —
08:13:40 — —
08:15:15 —

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR3** Cruise **JC174**

NB: all times recorded in GMT

Date 3/Nov/2018 **Site arrival time** 11:35

Time of first ranging 11:35

ITEM	SER NO		COMMENT	TIME
Recovery line	n/a	✓	Grappled at 13:05:04	13:05:04
3 x Mini-Trimsyn	n/a	✓		13:11:23
MicroCAT	3254	✓	Bumped deck on recovery, Bio growth	13:11:83
24" syntactic float	n/a	✓		13:18:41
with Light	S01-185	✓		13:18:41
and Iridium Beacon	E03-037	✓	Beacon ID: 300234063352490	13:18:41
MicroCAT	6818	✓		13:19:15
37" Steel Sphere	n/a	✓		13:24:08
with Light	T05-079	✓		13:24:08
and Argos Beacon	094	✓	Beacon ID: 24027	13:24:08
Swivel	n/a	✓		13:24:58
MicroCAT	6817	✓		13:27:53
MicroCAT	6115	✓	Tangled in longline	13:29:56
MicroCAT	3257	✓		13:35:44
MicroCAT	4307	✓	Tangled in longline	13:58:44
MicroCAT	5779	✓		13:47:04
10 x 17" glass	n/a	✓		13:52:26
MicroCAT	4710	✓		13:55:53
MicroCAT	3214	✓		14:01:30
MicroCAT	5484	✓		14:07:04
RCM11	448	✓		14:15:05
MicroCAT	3268	✓		14:19:24
9 x 17" glass	n/a	✓	Tangled 3/16" + 1/4" wire crawled	14:25:03
MicroCAT	3893	✓		14:36:12
4 x 17" glass	n/a	✓		14:47:26
MicroCAT	4306	✓		14:49:34
4 x 17" glass	n/a	✓	Drums changed. - restarted 15:21	15:03
MicroCAT	3230	✓		15:22
4 x 17" glass	n/a	✓		15:35
MicroCAT	3209	✓		15:38
4 x 17" glass	n/a	✓		15:51
MicroCAT	5485	✓		15:53
MicroCAT	7470	✓		16:08
4 x 17" glass	n/a	✓		16:14
MicroCAT	7362	✓		16:24
SA	35612568	✓		16:25

7 x 17" glass	n/a ✓	3 spheres imploded on 4 pack	16:28
Acoustic Release 1	2228 ✓		16:32
Acoustic Release 2	2244 ✓	Fired	"

Ascent Rate _____

Ranging

on Surface 11:51.

Time	Range 1	Range 2	Command/comment
11:35:00	—	—	range
11:35:50	—	—	" "
11:36:30	—	—	" "
11:37:12	—	—	" "
11:37:50	—	—	" "
11:38:40	✓	—	" "
11:43:17	5006		" " changed to large transducer.
11:43:57	—	—	ding
11:44:57	—	5018	"
11:45:43	—	5019	ding.
11:48:06	—	—	" "
11:49:05	—	—	release no 'ok' replies
11:49:49	—	—	"
50:26			"

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR3L10** Cruise **JC174**

NB: all times recorded in GMT

Date 3/11/2018 **Site arrival time** Overnight

Time of first ranging 08:08 on Subsee 100907

Grappled at 10:27

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	Float imploded	10:48
Billings Float	n/a	completely gone	10:46
with Light	A08-081	gone	
and Iridium Beacon	CO2-042	Beacon ID: 300234061664230 gone	
4 x 17" glass	n/a	all 4 imploded	10:41
4 x 17" glass	n/a		10:35
4 x 17" glass	n/a		10:49
BPR	0053	✓	10:52
BPR	0036	✓	10:52
Acoustic Release #1	922	✓ Released	10:52
Acoustic Release #2	1346	✓	10:52

Ascent Rate 64m/min

Ranging

Time	Range 1	Range 2	Command/comment
0808	5168		1)
0811	5168		1)
0812			2)
081350	5165		No reply to release
1436	12714		!
1630	2599	5045	!
1801	4995	4967	
2009	—	4893	
2112	4860	4851	
08:55:20	—	3344	
08:56:00	127	1764	
08:56:20	—	—	
08:57:20	—	—	
08:58:20	—	3199	
08:59:20	3163	2890	64 m/min. 8:50? shipping
09:00:20	—	—	
09:01:20	—	—	
09:02:20	—	—	
09:03:20	—	—	
09:04:20	2918	2910	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **NOG** Cruise **JC174**

NB: all times recorded in GMT

Date 3/Nov/2018 **Site arrival time** 17:36

Time of first ranging 17:38:35

on surface 18:36
grapped 19:07

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	✓	~~19:18~~ 19:00
Billings Float	n/a	✓tangled w. 12x glass	19:18
with Light	W03-095	✓	19:18
12 x 17" glass	n/a	✓	19:18
Sediment Trap	12283-02	✓fell onto side on deck 19:26	19:24
Nortek	8421	✓~~5695~~	19:24
Sediment Trap	12432-01	✓~~12283-02~~	19:30
Nortek	8430	✓	19:30
10 x 17" glass	n/a	✓6x imploded	20:00
MicroCAT	3280	✓	20:08
Acoustic Release #1	282	✓ RELEASED	20:08
Acoustic Release #2	248	✓	20:08

Ascent Rate 62 m/min.

Ranging

Time	Range 1	Range 2	Command/comment
17:38:35	10248	4618	RANGE
17:39:45	—	—	ding.
17:40:11	—	4189.	ding, ~~vertical~~
17:40:56	—	—	ding, vertical
17:41:35	—	4189.	vertical.
17:42:28	4184	4189.	release
17:44:05	4164	708	"
1743:58	—	—	range
17:45:09	—	—	"
~~17:45:53~~	—	—	"
17:47:10	—	~~3877~~	"
17:49:10	—	—	"
17:50:10	—		"
17:52:10	3639.	3646.	"
17:53:10	3574		"
17:54:10	3521	-	"
17:55:10	—	—	"
17:57:10			"
17:59:0	3241.		

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR1** Cruise **JC174**
NB: all times recorded in GMT

Date 7/Nov/2018 **Site arrival time** overnight
Time of first ranging 10:14

ITEM	SER NO	COMMENT	TIME
Mini-Trimsyn	n/a	✓ Grappled at 11:36:57 regrappled 11:40:41	11:36:57
24.5" syntactic float		✓	11:46:29
with Light	A08-082	✓	11:46:29
and Iridium Beacon	C02-047	✓	11:46:29
8 x 17" glass	n/a	✓	11:46:29
RAS-500	13278-01	✓	11:55:14
Contros pCO2	CO2-0812-005	✓	11:55:14
SeaFET	104	✓	11:55:14
MC-SMP-ODO	14150	✓	11:55:14
SBE37 MICROCAT (in frame)	3890	✓ Slight fouling (slimey) potentially in intake.	11:55:14
SBE37 MICROCAT	3912	✓ Surrounded in fishing line. Completely enveloped. Large hooks near microcat.	12:06:40
37" McLa. SS		Slight fouling on CT intake	12:11:19
with Light	S01-189	✓ Lots fishing line tangled around float + badly, coming into beacons/light (corrosion)	12:11:19
and Argos Beacon	Y01-026	✓ Beacon ID: 46499 . No Ariel.	12:11:19
SBE37 MICROCAT	3249	✓ Some longline caught around device, corroded wire	12:20:35
SBE37 MICROCAT	5765	✓ Long line above + below microcat, corroded wire.	12:29:59
SBE37 MICROCAT	3207	✓ Lots of long line gathered around microcat	12:32:13
SBE37 MICROCAT	5780	✓ Lots of long line gathered around microcat	12:42:27
MC-SMP-ODO	10518	✓ Lots of long line gathered around ODO	12:42:27
SBE37 MICROCAT	6827	✓	13:09:25
9 x 17" glass	n/a	Corroded wire.	13:13:12
MC-SMP-ODO	14114	✓ Bashed against stern on deck under glass. tangled cable	13:07:22
SBE37 MICROCAT	3244	✓ Bashed against stern scraped, 5mm/3/16th crack	13:07:22
SBE37 MICROCAT	3216	✓	13:26:54
SBE37 MICROCAT	3213	✓	13:33:00
RCM-11	445	✓	13:41
MC-SMP-ODO	14115	✓	13:44
SBE37 MICROCAT	3252	✓	13:48
12 x 17" glass	n/a	✓ tangled.	13:53
SBE37 MICROCAT	5785	✓	14:04
MC-SMP-ODO	14148	✓	14:04
8 x 17" glass	n/a	✓ tangled.	14:18
SBE37 MICROCAT	6825	✓	14:23
SBE37 MICROCAT	6820	✓	14:37
3 x 17" glass	n/a	✓ Drum change	14:50
MC-SMP-ODO	10520	✓	15:06

SBE37 MICROCAT	4178 ✓		15:07
4 x 17" glass	n/a ✓		15:20
SBE37 MICROCAT	6333 ✓		15:22
SBE37 MICROCAT	3933 ✓		15:36
4 x 17" glass	n/a ✓		15:43
SBE37 MICROCAT	3277 ✓		15:51
S4	35612572 ✓		15:54
9 x 17" glass	n/a	Tangled	15:57
Acoustic Release #1	2223 ✓		16:02
Acoustic Release #2	2226 ✓	Fired.	"

Ranging

Time	Range 1	Range 2	Command/comment
10:14:30	—	—	range
10:15:20	—	—	"
10:16:15	—	—	"
10:17:38	—	—	"
10:18:10	—	—	"
10:19:00	—	—	"
10:20:48	—	—	"
10:21:25	—	—	"
10:22:14	—	—	"
10:24:00	5127	—	"
10:36:55	49643	—	doing 'vertical'
10:37:32	—	1683?	"
~~:38~~			"
10:39:12	—	5122	"
10:40:08	—	—	"
10:41:04	—	—	release
10:42:			

SPOTTED ON SURFACE STRAIGHT AWAY.
LONGLINE FLOAT VISIBLE TOO - SOME LONGLINE PRESENT AT SITE BEFORE RECOVERY.

9-PACK SURFACED AT 10:50
12-PACK —11— 11:07

RAPID-WATCH MOORING LOGSHEET **RECOVERY** .

Mooring **MAR1L10** Cruise **JC174**

NB: all times recorded in GMT

Date 6/Nov/2018 **Site arrival time** 1745

Time of first ranging 18:22 ON SURFACE 1930

ITEM	SER NO	COMMENT	TIME	
Recovery line NOT SURFACED	n/a	GRAPNELLED 19:39, STARTED LINE HAULING 19:44	imploded.	
31" syntactic			19:59	
with light	X01-052 ✓		"	
and Iridium Beacon	~~G02-046~~ C02-046 ✓	Beacon ID: 300234061667230 ~~300234061667156~~	"	
4 x 17" glass	n/a	} All glass very tangled. Order not certain.	19:48	Glass 19:48?
4 x 17" glass	n/a		20:02	20:04
4 x 17" glass	n/a		20:04	20:02
Lander frame with			20:11	
BPR #1	0012 ✓		"	
BPR #2	0037 ✓		"	
Acoustic Release #1	1462 ✓	Fired	"	
Acoustic Release #2	1536 ✓		"	

Ascent Rate 86 m/min

Ranging

Time	Range 1	Range 2	Command/comment
18:22:16	5285		range
18:22:49	9824?	5285	range
18:23:31	—	—	range
18:24:13	—	—	ding
18:25:00	—	—	ding
18:25:44	—	—	ding
18:26:46	—	—	release (no response)
18:28:13	—	5177	release ok.
18:28:55	—	—	
18:29:55	—	9216?	range
18:30:30	—	6251	"
18:31:05	—	6324	"
18:32:15	—	—	"
18:32:50	—	4805	"
18:33:50	—	134?	"
18:34:30	—	4689	"
18:35:30	4603	4592	"
18:36:40	4002	4517	"

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR0** Cruise **JC174**

NB: all times recorded in GMT

Date 9/Nov/2018 **Site arrival time** 14:15

Time of first ranging 14:18:10

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		
Billings Float	n/a		
with Light	U01-026		
and Iridium Beacon	C02-049	Beacon ID: 300234061661230	
4 x 17" glass	n/a		
MicroCAT	6823		
MicroCAT	3266		
MicroCAT	6832		
MicroCAT	6327		
S4	35612571		
MicroCAT	4179		
34' Syntactic	34-02		
Acoustic Release #1	2227		
Acoustic Release #2	2230		

Ascent Rate _____

Ranging

Time	Range 1	Range 2	Command/comment
14:18:10	—	5384	range
14:18:50	5384	5381	
14:19:35	5382	5382	diag
14:20:10	5384	—	"
14:21:40	—	5373	diag vertical
14:22:30	5373	5371	release ok
14:23:30	5356	5356	" "
14:24:30	5356	5356	range.
14:25:20	5356	5356	
14:26:28	5356	—	release
14:27:28	5356	5356	
14:28:30	5357	—	release othr.
14:29:20	5356	5356	
14:30:25	5356	5356	
14:31:20	5356	5356	
15:17:08	—	5372	range
15:18:00	5371	5372	range.
15:20:05	—	5372	release.
15:20:35	—	✓	
15:21:20	✓	✓	
15:22:20	✓	✓	

19:05:41	/	5612	
19:06:41	/	/	
19:07:31	/	/	
19:08:31	5612	5614	
19:09:23	5613	5612	
19:09:38	5612	5613	
200600	5554	5553	
200719	5548	5541	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB6** Cruise **JC174**

NB: all times recorded in GMT

Date 14/Nov/2018 **Site arrival time** 10:30

Time of first ranging 11:24:00

ITEM	SER NO		COMMENT	TIME
Recovery Line	n/a	✓	Grappled	13:24
5 x CF16 clamp on floats	n/a	✓		13:53
SBE MicroCAT	6332	✓		13:39
SBE MicroCAT	5245	✓		13:44
SBE MicroCAT	5238	✓		13:50
SBE MicroCAT	3907	✓		13:55
Nortek	6088	✓		13:57
SBE MicroCAT	6113	✓		14:01
31" SYNTACTIC	n/a	✓		14:03
with light	Z02-021	✓		14:08
34" SYNTACTIC	n/a	✓		14:06
with Iridium beacon	C02-052	✓		14:00
BPR #1	0060	✓		14:09
BPR #2	0081	✓		14:09
Acoustic Release #1	917	✓	Released	14:09
Acoustic Release #2	2077	✓		14:09

Ascent Rate

Time at end of recovery 14:09:43

Ranging

Time	Range 1	Range 2	Command/comment
11:24:00	~	~	SN 2077
11:24:30	~	~	
11:25:27	4010	~	
11:26:20	~	~	
11:27:10	~	~	
11:27:55	~	~	
11:28:34	~	9537	
11:30:12	~	13141	
11:30:55	~	~	
11:33:17	~	~	
11:34:10	5424	~	SN 917
11:34:40	5435	~	
11:35:28	~	~	
11:36:05	~	~	
11:46:23 ~~11:37:00~~	~	~	SN 917 release
11:45:04	~	~	" "
11:46:15	~	~	
11:47:25	~		SN 2077 range
11:48:30	~		
11:50:20	4962	~	SN 917 release
11:51:20	~	~	

11:52:20	—	—	S/n 917 release,
11:53:20	/	/	
11:54:20	/	/	S/n 917 range
11:55:20	—	4565	
11:56:20	—	4484	
11:57:20	—	/	
11:58:20	4348	4338	8 lm/min
11:59:20	7266		
12:00:04	—	—	
12:03:15	3962	3956.	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB4** Cruise **JC174**

NB: all times recorded in GMT

Date 17/Nov/2018 **Site arrival time** 11:30

Time of first ranging 11:50:18

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	Grappled at: 12:47:41	12:48
3 TRYMSYN floats	n/a		12:53
MicroCAT	3233 ✓	MILD GROWTH	12:53
MicroCAT-ODO	10542 ✓	MILD GROWTH CABLE ~~DAMAGED~~ REPAIR 12:59	12:55
40" syntactic + ADCP	10584	Regrappled: 13:21 Growth on ADCP	13:33
with Iridium beacon	C02-040 ✓	300234061660210	13:37
and light	W03-093 ✓		13:33
Nortek	6805 ✓	MILD ALL OVER GROWTH	13:35
MicroCAT	6839 ✓	MILD ALL OVER GROWTH	13:42
49" syntactic	n/a ✓		13:49
with Iridium beacon	C02-039 ✓	300234061660230	13:49
and light	A08-079 ✓		13:49
MicroCAT	3901 ✓	TANGLED AROUND CABLE ~~DAMAGED - MISSING END, MISSING~~	13:53
Nortek	8502 ✓	CABLE PRIOR TOO JOIN BEEN KINKED BY LONG LINE, SOME INTERNAL DAMAGE	14:03
MicroCAT	3247 ✓		14:03
MicroCAT-ODO	10543 ✓		14:03
MicroCAT	6838 ✓	MISSING CLAMP + END CAP MISSING	14:11
Nortek	9210 ✓		14:17
MicroCAT	6802 ✓		14:18
MicroCAT-ODO	10544 ✓		14:18
MicroCAT	6841 ✓		14:25
11 ~~8~~ x Orange CF-16s	n/a ✓	Line caught at top swivel.	14:31
1 x Yellow CF-16	n/a ✓		"
Nortek	9409 ✓		14:38
MicroCAT	7681 ✓		14:37
Nortek	9433 ✓		14:49
MicroCAT-ODO	10555 ✓		14:49
5 x yellow CF-16s	n/a ✓		14:54
MicroCAT	4475 ✓		14:57
5 x yellow CF-16s	n/a ✓		15:08
Nortek	9439 ✓		15:08
MicroCAT	3255 ✓	Rope behind guard.	15:12
MicroCAT-ODO	14117 ✓	Rope wrapped around	15:12
5 x yellow CF-16s	n/a	CHANGING WIRE DRUM OVER	15:29
MicroCAT	3900 ✓		15:48
5 x yellow CF-16s	n/a ✓		16:03

Nortek	9444 ✓		16:03
MicroCAT	6799 ✓		16:06
5 x yellow CF-16s	n/a ✓		16:21
MicroCAT	3484 ✓		16:22
MicroCAT-ODO	10556 ✓		16:23
5 x yellow CF-16s	n/a		16:36
Nortek	13482	✓ CLAMPS SLID DOWN BAR	16:39
MicroCAT	5979	✓	16:40
MicroCAT	5776	✓	16:53
Nortek	13588	✓	16:57
10 x glass	n/a	IMPLODED x 6 (BOTTOM 6)	17:00
Acoustic Release 1	2221	✓ RELEASED	17:04
Acoustic Release 2	918	✓	17:04

Ranging

Time	Range 1	Range 2	Command/comment
11:50:18	—	—	S/N 2221 range
11:50:58	4624	4624	"
11:52:30	—		S/N 918 range
11:53:10	—	—	
11:54:30	4627	4626	S/N 2221 range
11:56:44	4627	—	" release, 04.
11:57:46	4528	—	"
11:58:44	4428	—	"
11:59:46	4330	4320	"

~~Blank Position~~

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB4L11** Cruise **JC174**

NB: all times recorded in GMT

Date 17/11/18 // 18/11/18 **Site arrival time** OVERNIGHT

Time of first ranging 18:33

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	Argos - Y01 - 010	13:06
Billings float	n/a ✓	Light: A08-078	12:58
4 x 17" glass	n/a ✓	Line tangled, recovered together	12:53
4 x 17" glass	n/a ✓		12:53
4 x 17" glass	n/a ✓		13:01
BPR #1	0429 ✓		13:07
BPR #2	0029 ✓		"
Acoustic Release #1	316 ✓		"
Acoustic Release #2	2069 ✓	Fired.	"

Ascent Rate 83-89 m/min

Time at end of recovery 13:07

Ranging

Time	Range 1	Range 2	Command/comment
17/11/2018 18:33:40	/	4656	[redacted] ARM+ARM.
18:34:20	4656	4652	
18:35:45	/	/	ARM+ARM
18:36:25	/	/	
18:37:05	/	/	
18/11/18 11:19:33	/	4634	ARM+ARM [redacted]
11:20:12	4634	4634	
11:21:20	/	4635	ARM+REL REL OK
83m/min 11:22:00	4597	4585	
11:23:00	4514	12256	
89m/min 11:24:00	4435	4426	
			ETA ~ 12:15

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB4L12** Cruise **JC174**

NB: all times recorded in GMT Spotted at 20:28

Date 17/11/18 **Site arrival time** 18:15

Time of first ranging 18:15

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	✓ Grappled at: 20:49	20:49
Deepwater Buoyancy Lander		✓	20:57
with Iridium beacon	n/a	✓ S/N: C62 0044	
and light	n/a	✓ S/N: X01 0500	
and BPR #1	n/a	✓ S/N: 0431	
and BPR #2	~~0039~~	✓ S/N 0389	
and Acoustic release #1	~~0040~~	✓ SN: ~~69~~ 2074: RELEASED.	
and Acoustic release #2	~~358~~	✓ SN: 1535	20:57

Ascent Rate 36.3 m/min

Time at end of recovery 20:57

Ranging

Time	Range 1	Range 2	Command/comment
18:19:20	/	4647	[ ] ARM + ARM.
18:20:00	/	4646	
18:21:10	4646	4646	ARM + RELEASE RELEASE OK.
18:22:00	/	/	
18:22:50	4603	/	
18:24:00	/	/	[ ] ARM + ARM
18:24:50	/	—	
18:25:50	4494] 37	4489	[ ] ARM + ARM
18:26:50	4457] 36	/	
18:27:50	4421] 35	4416	
18:28:50	4386] 38	4382.	
18:29:50	4348	4343	
18:38:50	4021	4017	
			16:28 ETA
19:51:11	1798	1796	[ ] ARM+ARM
19:52:11	1777	1775	21 m/min.
19:54:11	1737	1733	

327m/9min = 36.3m/min

-4446. = 3456. 1860 1190 6700

630 12m 400 36h/mn. 9bmins

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBH2** Cruise **JC174**

NB: all times recorded in GMT

Date 20/Nov/2018 **Site arrival time** 11:40

Time of first ranging _____

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a		13:27
Billings float	n/a		13:34
with light	W03-092		"
and Iridium beacon		ID 300234031663230 – ID + S/N worn away	"
12 x 17" glass	n/a		13:41
RAS-500	13278-04		13:45
Nortek	6751		13:45
MicroCAT-ODO	14147		13:48
MicroCAT-ODO	12900		14:01
7 x 17" glass	n/a		14:09
Nortek	6753		14:09
MicroCAT	6118		14:11
5 x 17" glass	n/a	2 glass imploded.	14:32
Nortek	9266		14:33
MicroCAT	6811		14:36
MicroCAT-ODO	14149		14:50
5 x 17" glass	n/a		14:58
Nortek	9402		14:58
MicroCAT	5984		15:01
MicroCAT	6122		15:15
5 x 17" glass	n/a		15:23
Nortek	9406		15:23
MicroCAT	4468	Nylon rope tangled with line	15:28
6x 17" glass	n/a		15:30
Acoustic Release #1	2225	Fired.	15:31
Acoustic Release #2	2222		"

Ascent Rate _____

Ranging

Time	Range 1	Range 2	Command/comment
11:54:20	/	/	S/N: 2222 Range
11:55:00	/	/	" "
11:55:50	/	/	S/N: 2225 range
11:57:05	4677	4676	" "
11:57:48	4676	4676	" " release drag vertical.
11:58:30	4676	4676	" " release ok.
11:59:30	4612	4601	
12:00:30	4533	4523	79 m/min
			SPOTTED 12:30 BUT SOME WAY OFF
			SO MAY HAVE BEEN UP A WHILE.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB2L11** Cruise **JC174**

NB: all times recorded in GMT

Date 20/11/18 **Site arrival time** _____

Time of first ranging _____

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a		
Billings float	n/a		
with Argos beacon	Z02-006		
and light	U01-028		
4 x 17" glass	n/a		
4 x 17" glass	n/a		
4 x 17" glass	n/a		
BPR	0430		
BPR	0055		
Acoustic Release #1	1195		
Acoustic Release #2	1200		

Ascent Rate _____

Time at end of recovery _____

Ranging

Time	Range 1	Range 2	Command/comment
21 1231	3853	3853	
	3853		Vertical 8V
211410	4713	—	
21 1447	24		
21 1625			
1703			
21 1750	3854		
211830	3853	2852	Released OK
1900	3853	3852	Release OK
1925	3853	3853	
1955	3853		Release OK
212120	3854	3853	
2248	3853		
2335	3853	3853	
2425	3853		
21 2514	3853		
22:03:05	~~3047~~	3855	
22:04:05	—	—	
22:05:45	—	—	
22:06:15	3859	3860	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB2** Cruise **JC174**

NB: all times recorded in GMT
Date 21/NOV/2018 **Site arrival time** _____
Time of first ranging 14:11:30

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a		
3 x Trymsyn floats	n/a		
MicroCAT	4795		
30" Syntactic			
with Iridium beacon	C02-038	ID: 300234061669220	
and light	Z02-018		
Nortek	6516		
MicroCAT	3221		
51" syntactic	n/a		
with Argos beacon	304	ID: 82895	
and light	Z02-020		
Nortek	5899		
MicroCAT	6834		
MicroCAT	4721	Not recovered.	
2 x 17" glass	n/a	Wire broken above glass (at termination)	18:15
Nortek	5967		18:14
MicroCAT	6829		18:12
MicroCAT	4714		18:06
2 x 17" glass	n/a		18:03
Nortek	6049		18:03
MicroCAT	3253		18:00
MicroCAT	5783		17:54
10 x 17" glass	n/a		17:32
Nortek	6083	3/16" wire tangled below Nortek	17:31
MicroCAT	3234		17:28
Nortek	6119		17:22
MicroCAT	3222		17:21
5 x 17" glass	n/a		17:11
MicroCAT	5777	TWISTED UP WITH WIRE ABOVE GLASS	17:11
MicroCAT	3206		17:05
Nortek	6132		16:59
5 x 17" glass	n/a		16:50
MicroCAT	5766	ON AT 2800 WITH S256. 500m out of PLACE	16:36
MicroCAT	3256		16:35
2 x 17" glass	n/a		16:29

at same depth

Nortek	6176	✓	16:29
5 x 17" glass	n/a	✓	16:20
MicroCAT	3229	✓	16:19
MicroCAT	3224	✓	16:01
10 x 17" glass	n/a	✓ Stopped at 15:51 2x implosions	15:56
Acoustic Release #1	361	✓ Released.	16:02
Acoustic Release #2	1351	✓	16:02

Surface @ ~14:35

Ranging

Time	Range 1	Range 2	Command/comment
14:11:30	—	3856	S/N 361 Range.
14:11:10	3861	3862	" "
14:12:30	3862	3862	" " slight vertical
14:13:15	3862	3862	" " release OK
14:14:15	—	—	" "
14:15:15	3694	3686	" "
14:16:15	3608		S/N 1351
14:17:15	3524	3516	" "
14:18:15	~~[illegible]~~	—3432	" "
14:19:15	3356	—	" "
14:35:20	2072	2064	" "

80 m/min.

84 m/min.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB1** Cruise **JC174**

NB: all times recorded in GMT
Date 21/Nov/2018 **Site arrival time** _____
Time of first ranging _____

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	✓	19:52
30" syntactic	n/a	✓ Heavy growth	20:05
with Iridium Beacon	C02-043	✓ ID: 300234061667220 ✓	"
and light	B11-018	✓	"
6 x 17" glass	n/a	✓ Heavy growth.	20:07
RAS-500 with	13278-05	✓ Very heavy growth.	20:14
Contros	CO2-1114-002	✓	"
SeaFET	105	✓	"
MicroCAT ODO	14151	✓	"
MicroCAT	6833	✓	"
RBR-SoloT	~~100281~~	✓ 100261	"
6 x 17" glass	n/a	✓	20:20
Nortek	5590	✓ Heavy growth	20:21
MicroCAT	3916	✓ Growth	20:21
RBR-SoloT	100274	✓ Growth	20:25
RBR-SoloT	100257	✓ ~20 m lower than mark.	20:27
45" syntactic	n/a	✓	20:30
with Argos Beacon	A08-073	✓ ID: 121994	"
and light	A08-080	✓	"
RBR-SoloT	100268	✓ (100268 at same height as 100267	20:35
RBR-SoloT	100267	✓ (At same height, slipped down)	20:35
RBR-SoloT	100269	✓	20:37
Nortek	5885	✓	20:38
MicroCAT	6831	✓	20:38
MicroCAT-ODO	14145	✓	20:38
RBR-SoloT	100258	✓	20:42
RBR-SoloT	100270	✓ 100270 slipped to same	20:45
RBR-SoloT	100260	✓ height as 100260.	20:45
RBR-SoloT	100273	✓	20:47
RBR-SoloT	100259	✓	20:49
45" Syntactic and ADCP	5476	✓	20:51
ADCP (down looking)	10583	✓	20:55
RBR-SoloT	100279	✓	20:59
RBR-SoloT	100266	✓	21:02
Nortek	5890	✓	21:04

MicroCAT	6816	✓	21:04
MicroCAT-ODO	14146	✓	21:04
RBR-SoloT	100262	✓	21:04
RBR-SoloT	100264	✓	21:07
RBR-SoloT	100265	✓	21:09
RBR-SoloT	100272	✓	21:10
RBR-SoloT	100275	✓	21:12
RBR-SoloT	100276	✓	21:13
RBR-SoloT	100277	✓	21:15
RBR-SoloT	100278	✓	21:17
2 x 17" glass	n/a	✓	21:19
Nortek	12722	✓ TANGLED IN WITH THE GLASS SPHERES	21:19
MicroCAT	5772	✓	21:19
RBR-SoloT	100255	✓	21:23
RBR-SoloT	100256	✓	21:24
RBR-SoloT	100271	✓	21:26
7 x 17" glass	n/a	✓	21:26
Acoustic release #1	1202	✓	21:29
Acoustic release #2	251	✓ Released.	21:29

Ranging

Time	Range 1	Range 2	Command/comment
19:11:43	—	1379	S/N 251 ranging
19:12:13	1379	1380	" ranging
19:12:42	—	—	" timing
19:13:19	1380	1380	" vertical 8.3 ✓
~~19:13:~~			
19:14:03	—	—	" release (no answer)
19:14:44	1381	1381	" release OK.
19:15:44	1295	1286	" 95 m/min on surface @ ~19:15

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBADCP** Cruise **JC174**

NB: all times recorded in GMT

Date 19/Nov/2018 **Site arrival time** 15:50

Time of first ranging _____

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	UP A FEW SECONDS LATER. Grappled 16:13	16:14
ADCP in float	23643 ✓	UP FIRST	16:22
with light	W03-096		16:22
and Argos beacon	A08-074	ID: 121995	16:22
Acoustic Release #1	2220 ✓		16:30
Acoustic Release #2	2224 ✓		16:30

Ascent Rate 74m/min

Time at end of recovery _____

Ranging

Time	Range 1	Range 2	Command/comment
15:52:42	✓	652	ARM + ARM
15:53:17	654	654	
15:54:15	661	662	ARM + REL RELEASE OK
15:54:45	640	633	
15:55:15	603	596	SPOTTED 16:01

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBAP1** Cruise **JC174**

NB: all times recorded in GMT

Date 19/11/18 **Site arrival time** ~18:45

Time of first ranging _____

ITEM	SER NO	COMMENT	TIME
Pickup line	n/a		19:57
PIES	131 ✓		19:59

Ascent Rate _____

Ranging

Time	Command	Range	Comment
18:56:20	XPND		~~XPND~~ 2 PULSE NOISY HEARD
			BUT NEGATIVE PULSES @ 18:57 — SAMPLING?
			EVERY 4-5 SECONDS
19:04:10	CLEAR		
19:04:33	CLEAR		NO NOISY HEARD
19:05:00	XPND		NOISY HEARD
19:05:20	RANGE	NOISE	MULTIPLE PINGS HEARD.
19:06:50	CLEAR		NOISY HEARD.
19:07:12	XPND		—11— RUBBISH RANGES
19:08:08	XPND		—11—
19:21:40	CLEAR		
			CLEAR STOPS ACOUSTIC TRANSMISSIONS
			WHY DOES XPND START THEM?
19:22:30	RELEASE		12 Hz PULSES FOLLOWED BY ½ Hz PULSES

SN 131:

Spotted 19:48.

Appendix C: Logsheets of deployed moorings

33 pages

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH4** Cruise **JC174**

NB: all times recorded in GMT

Date 23/Oct/2018 **Site arrival time** 09:30

Setup distance 1.25 Nmiles

Start time 1003 **End time** 11:28:55

Start Position

Latitude 27.87206 **Longitude** -13.541833 Full back: 100m.

ITEM	SER NO	COMMENT	TIME
McLane-12"	n/a		10:03
Recovery line	n/a		10:04
Billings 3 sphere	n/a		10:04
with Light	G06-062		
~~Argos or~~ Iridium Beacon	51356Y	Beacon ID = 300234065336320	
4 x 17" glass	n/a		10:05
MicroCAT	5242		10:06
MicroCAT	5775		10:09
3 x 17" glass	n/a		10:14
MicroCAT	6826		10:15
MicroCAT	3905		10:18
2 x 17" glass	n/a		10:21
MicroCAT	3270		10:25
MicroCAT	7468		10:28
2 x 17" glass	n/a	overlap on double bevel 10:34	10:36
MicroCAT	3219		10:37
MicroCAT	6836		10:41
MicroCAT-ODO	12962		10:44
2 x 17" glass	n/a		10:47
MicroCAT	6800		10:48
RCM11	301		10:55
MicroCAT P	3228		10:57
Swivel-SS	n/a		11:25
6 x 17" glass	n/a		11:25
Acoustic Release #1	824	Record codes below	11:25
Acoustic Release #2	256	Record codes below	11:25
600kg Anchor	n/a		11:28

Release #1 arm code

Release #1 release code

Release #2 arm code

Release #2 release code

IRIDIUM **~~Argos~~ beacon #1 ID** 300234065336320.

Argos beacon #2 ID —

Anchor Drop Position

lat 27.85478 lng: -13.54107

drop depth: 1062 uncorrected

1065 corrected

Deployed before.

EBH4

Latitude 27.85478 Longitude -13.54107
Uncorrected water depth 1062 (at anchor launch)
Corrected water depth 1065 (at anchor launch)

Triangulation Sheet 23/oct/2018.

white mark on ~~a~~ cable, ctd Location

Location (e.g. 1, 2 3)	Release SN or ARM	Time	Latitude	Longitude	Range 1 (m)	Range 2 (m)
1		1936:11			1543.6	382.
1		1936:30			1544.1	1544.1
1		1936:55			1543.9	4852.3, ~~1086~~
1		19:44:50			1545.3	1545.5 ~~1111~~
2		20:23:40			[illegible]	533.2.
2		20:24:00			2149.3	2149.4
2		20:24:30			2149.3	2148.9.
3		21:02:00			1549.7	1549.9
3		21:02:30			1550.6	1550.8

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH4L8** Cruise **JC174**

NB: all times recorded in GMT

Date 23/Oct/2018 **Site arrival time** 08:19:00

Setup distance ~~08:38~~ 08:39:47

Start time 08:32 **End time**

Start Position

Latitude 27.87555 **Longitude** -13.51324

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		08:32
McLane-12"	n/a		
Billings 4 sphere	n/a		08:33
with Light		~~B0~~ G06081	
Argos or ~~Iridium Beacon~~		Beacon ID = B03-081	
4 x 17" glass	n/a		08:34
4 x 17" glass	n/a		08:34:30
4 x 17" glass	n/a		08:35
SBE26/53	[redacted]0395		
SBE26/53	0030		
Acoustic Release #1 (tripod)	906	Record codes below	08:39
Acoustic Release #2 (tripod)	264	Record codes below	08:39
600kg Anchor	n/a		

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID [redacted] B03-081
Argos beacon #2 ID

Anchor Drop Position

Latitude 27.87458 **Longitude** -13.51331

Uncorrected water depth 1007.5 (at anchor launch)

Corrected water depth 1011.4 (at anchor launch)

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH3** Cruise **JC174**

NB: all times recorded in GMT

Date 23/Oct/2018 **Site arrival time** 13:10:10

Setup distance 1.6 N Miles

Start time ~~13~~:32:41 **End time** 16:10:30

Start Position

Latitude 27.83314 **Longitude** -13.73394

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		13:32
McLane-12"	n/a		13:32
Billings 3 sphere	n/a		13:33
with Light	606-063	on	13:33
~~Argos~~ or Iridium Beacon	~~606-053~~	Beacon ID = 300234065548610 on	13:33 S/N 314RC
4 x 17" glass	n/a		13:33
MicroCAT	3239		13:33
MicroCAT-ODO	20253		13:33
MicroCAT	4723		13:36
MicroCAT	4471		13:39
MicroCAT	5981		13:42
Telemetry Buoy			14:12
Swivel-Telemetry		No serial number	14:12
MicroCAT	5982		14:12
MicroCAT-ODO	20254		14:15
MicroCAT	4464		14:17
3 x 17" glass	n/a	clamps wrong size	14:33
Nortek	12701		14:33
MicroCAT	4724		14:35
MicroCAT	5983	Washers missing from clamp	14:39
3 x 17" glass	n/a		14:49
MicroCAT	4180		14:50
MicroCAT-ODO	20255		14:54
Nortek	8465		14:56
MicroCAT	4072		14:58
3 x 17" glass	n/a		15:06
MicroCAT	4071		15:09
Nortek	11855		15:12
MicroCAT	4470		15:15
3 x 17" glass	n/a		15:25
MicroCAT	4068		15:25
Nortek	11846		15:31
MicroCAT	3282.	Moved ~1m up wire to stop hitting deck	15:41
Swivel-SS	n/a		15:41
4 x 17" glass	n/a		15:41

Fall back 250 m.

Acoustic Release #1	916	Record codes below	16:10
Acoustic Release #2	385	Record codes below	16:10
1200kg Anchor	n/a		16:10.

Release #1 arm code _____
Release #1 release code _____
Release #2 arm code _____
Release #2 release code _____
Argos beacon #1 ID _____
Argos beacon #2 ID _____

Anchor Drop Position
Latitude 27.80711 **Longitude** -13.74712

Uncorrected water depth 1417 (at anchor launch)
Corrected water depth 1419 (at anchor launch)

RAPID-AMOC MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH2** Cruise **JC174**

NB: all times recorded in GMT

Date 24/10/18 **Site arrival time** 09:09

Setup distance 0.5 miles

Start time 09:27:35 **End time** 09:59:03

Start Position

Latitude 27.61487 **Longitude** -14.22016

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		09:27
McLane 12"	n/a		09:27
Billings 3-sphere	n/a		09:27
with Light	CO2-037		09:27
Argos or ~~Iridium Beacon~~	803-080	Beacon ID =	09:27
2 x 17" glass	n/a		09:28
MicroCAT	5784		09:28
2 x 17" glass	n/a		09:33
MicroCAT	5767		09:33
RCM-11	302		09:36
MicroCAT	6808		09:37
4 x 17" glass	n/a		09:37
Swivel	n/a		09:37
Acoustic Release #1	370	Record codes below	09:59
Acoustic Release #2	821	Record codes below	09:59
500kg Anchor	n/a		09:59

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID
Argos beacon #2 ID

Anchor Drop Position

Latitude 27.61503 **Longitude** -14.21032

Uncorrected water depth 2019 (at anchor launch)

Corrected water depth 2019. (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH1** Cruise **JC174**

NB: all times recorded in GMT

Date 25/Oct/2018 **Site arrival time** 11:00

Setup distance 0.3

Start time 11:44:35 **End time** 12:17:41

Start Position

Latitude 27.21928 **Longitude** -15.42760

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		11:44
Billings 3-sphere	n/a		11:45
with Light	208-052		"
~~Argos or~~ Iridium Beacon	E03-035	Beacon ID = 300234063352630	"
Swivel-SS			"
2 x 17" glass	n/a		11:45
MicroCAT	6112		11:45
2 x 17" glass			11:55
RCM11	426		12:00
MicroCAT	3220		12:02
4 x 17" glass	n/a		"
Swivel-SS	n/a		"
Acoustic Release #1	907	Record codes below	12:17
Acoustic Release #2	253	Record codes below	12:17
500kg Anchor	n/a		12:17

Release #1 arm code _____

Release #1 release code _____

Release #2 arm code _____

Release #2 release code _____

Argos beacon #1 ID _____

Argos beacon #2 ID _____

Anchor Drop Position

Latitude 27.22274 **Longitude** -15.42210

Uncorrected water depth 3040 (at anchor launch)

Corrected water depth 3043 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBH1L 13** Cruise **JC174**

NB: all times recorded in GMT

Date 25/Oct/2018 **Site arrival time** 13:05:44

Setup distance —

Start time 13:06:14 **End time** 13:10:30

Start Position

Latitude 27.21691 **Longitude** -15.43292

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		13:06:14
McLane-12"	n/a		13:06:14
Billings 4 sphere	n/a		13:06:49
with Light	Y01 - 016		13:06:49
Argos or Iridium Beacon	B03 - 079	Beacon ID =	13:06:49
4 x 17" glass	n/a		13:07:22
4 x 17" glass	n/a		13:07:55
4 x 17" glass	n/a		13:08:45
SBE26/53	~~n/a~~ 0035		13:10:30
SBE26/53	0039		13:10:30
Acoustic Release #1 (tripod)	1534	Record codes below	13:10:30
Acoustic Release #2 (tripod)	924	Record codes below	13:10:30
600kg Anchor	n/a		13:10:30

Release #1 arm code [redacted]

Release #1 release code

Release #2 arm code

Release #2 release code

Argos beacon #1 ID

Argos beacon #2 ID

Anchor Drop Position

Latitude 27.21692 **Longitude** -15.43290

Uncorrected water depth 3048 (at anchor launch)

Corrected water depth 3052 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBHi** Cruise **JC174**

NB: all times recorded in GMT

Date 27/Oct/2018 **Site arrival time** 10:15

Setup distance 0.5miles

Start time 10:46:41 **End time** 11:22:25

Start Position

Latitude 24.93647 **Longitude** -21.27519

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:46
Billings float	n/a		10:47
with Light	A08-083		"
~~Argos~~ or Iridium Beacon	E03-036	Beacon ID = 300234063788890	"
2 x 17" glass	n/a		10:47
SBE37 MicroCAT	5770		10:47
2 x 17" glass	n/a		11:00
SBE37 MicroCAT	5243		11:00
RCM11	428		11:10
SBE37 MicroCAT	3225		11:13
4 x 17" glass	n/a		11:21
Acoustic Release #1	318	Record codes below	11:22
Acoustic Release #2	1354	Record codes below	11:22
300kg Anchor	n/a		11:22

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code

Anchor Drop Position
Latitude 24.93288 **Longitude** -21.26533

Uncorrected water depth 4472 (at anchor launch)
Corrected water depth 4498 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EB1** Cruise **JC174**

NB: all times recorded in GMT

Date 29/Oct/2018 **Site arrival time** 11:00

Setup distance 4.7 N miles

Start time 12:15:35 **End time** 16:29:11

Start Position

Latitude 23.68893 **Longitude** -24.20995

ITEM	SER NO	COMMENT	TIME
Mini-Trimsyn	n/a		12:13:35
24.5" syntactic float	n/a		12:16:00
with Light	A08-084		12:16:00
~~Argos or~~ Iridium Beacon	E03-034	Beacon ID = 300234063269820	12:16:00
8 x 17" glass (parallel)	n/a		12:16:10
Swivel-SS			12:16:10
RAS-500			12:23:18
With Contros pCO2			12:23:18
And SeaFET			12:23:18
And MicroCATODO			12:23:18
And SBE37 IMP	6810		12:23:18
SBE37 IMP	6821		12:24:58
37" McLa. SS			12:37:19
with Light	B11-019		12:37:19
Argos or ~~Iridium Beacon~~	Y01-027	Beacon ID = Hex/46500/3FA8E4C	12:37:19
Swivel-SS	n/a		12:37:19
MicroCAT	5978		12:37:25
MicroCAT	11744	Put on in reverse order ↕	12:43:28
MicroCAT-ODO	12963		12:43:28
MicroCAT	6824		12:46:40
MicroCAT	6801	Put on in reverse order ↕	12:51:07
MicroCATODO	12965		12:51:07
4 x 17" glass	n/a	knocked against Stern of vessel.	12:55:37
MicroCAT	6335	Put on in reverse order ↕	13:01:58
MicroCAT-ODO	12965		13:01:59
4 x 17" glass	n/a		13:10:57
MicroCAT	5789	Put on in reverse order ↕	13:14:05
MicroCAT-ODO	12966		13:14:11
MicroCAT	6126	Put on in reverse order ↕	13:22
MicroCAT-ODO	12967		13:22
4 x 17" glass	n/a		13:27
MicroCAT	6814		13:31
MicroCAT-ODO	12968		13:40
RCM11	443		13:43
4 x 17" glass	n/a		13:47

MicroCAT	5782		13:50	
MicroCAT	6120		14:03	
MicroCAT-ODO	12998		14:03	
5 x 17" glass	n/a		14:13	
MicroCAT	6804		14:20	
MicroCAT	5239		14:33	
5 x 17" glass	n/a		14:43	
MicroCAT	6117		14:50	
MicroCAT-ODO	12833		14:49	
4 x 17" glass	n/a		15:02	
MicroCAT	6798		15:05	
4 x 17" glass	n/a		15:20	
MicroCAT	3913		15:21	
RCM11	444		15:38	
MicroCAT	3215		15:40	
8 x 17" glass	n/a		15:50	
Acoustic Release #1	927	Record codes below TOWED	~~15:53~~	16:25
Acoustic Release #2	358	Record codes below	~~15:53~~	16:25
1600kg Anchor	n/a		16:29:11	

Release #1 arm code _____
Release #1 release code _____
Release #2 arm code _____
Release #2 release code _____
Argos beacon #1 ID _____
Argos beacon #2 ID _____

Anchor Drop Position
Latitude 23.73726 **Longitude** -24.17388

Uncorrected water depth 5090 m (at anchor launch)
Corrected water depth 5133.7m (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EB1L13** Cruise **JC174**

NB: all times recorded in GMT

Date 29/Oct/2018 **Site arrival time** Overnight

Setup distance —

Start time 09:10:10 **End time** 09:15:21

Start Position

Latitude 23.79923 **Longitude** -24.12886

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		09:10:10
McLane-12"	n/a		09:10:30
Billings float	n/a		09:10:30
with Light	DØ3-Ø71		09:10:30
Argos or Iridium Beacon	B11-Ø24	Beacon ID = C93EID4	09:10:30
4 x 17" glass	n/a		09:11:05
4 x 17" glass			09:11:39
4 x 17" glass			09:12:15
SBE26/53	0033		09:15:21
SBE26/53	0419		09:15:21
Acoustic Release #1 (tripod)	1730	Record codes below	09:15:21
Acoustic Release #2 (tripod)	823	Record codes below	09:15:21
600kg Anchor	n/a	Anchor hit Stern during deployment	09:15:21

Release #1 arm code —

Release #1 release code —

Release #2 arm code —

Release #2 release code —

Argos beacon #1 ID _____

Argos beacon #2 ID _____

Anchor Drop Position

Latitude 23.80008 **Longitude** -24.12833

Uncorrected water depth 4608 (at anchor launch)

Corrected water depth 4638 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR3** Cruise **JC174**

NB: all times recorded in GMT

Date 4/Nov/2018 **Site arrival time** overnight

Setup distance 4.5 N miles

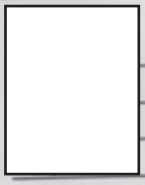
Start time 11:22:15 **End time** 15:20:51

Start Position

Latitude 23.8421 **Longitude** -41.16674

ITEM	SER NO		COMMENT	TIME
Pickup float	n/a	✓		11:22
3 x Mini-Trimsyn	n/a	✓		11:22
SBE37 MICROCAT	3910	✓		11:22
24" syntactic float	n/a	✓		11:28
with Light	501185	✓		"
and Iridium Beacon	E03-037		Beacon ID = 300434063352490	"
SBE37 MICROCAT	4549	✓		11:28
37" McLa. SS		✓		11:33
with Light	T05-079	✓		"
and Argos Beacon	094		Beacon ID = 24027	"
Swivel-SS	n/a	✓		"
SBE37 MICROCAT	6819	✓		11:35
SBE37 MICROCAT	5246	✓		11:38
SBE37 MICROCAT	3248	✓		11:41
SBE37 MICROCAT	3271	✓		11:44
SBE37 MICROCAT	5762	✓		11:50
10 x 17" glass	n/a	✓		12:00
SBE37 MICROCAT	5763	✓		12:02
SBE37 MICROCAT	7363	✓		12:09
SBE37 MICROCAT	6323	✓		12:15
RCM11	516	✓		12:25
SBE37 MICROCAT	4719	✓		12:28
9 x 17" glass	n/a	✓		12:38
Swivel-Ti	n/a	✓		"
SBE37 MICROCAT	6127	✓		12:44
4 x 17" glass	n/a	✓		12:59
SBE37 MICROCAT	11424	✓	missed depth, pulled back in to mount.	13:05
4 x 17" glass	n/a	✓		13:21
SBE37 MICROCAT	6830	✓		13:23
4 x 17" glass	n/a	✓		13:37
SBE37 MICROCAT	6822	✓		13:39
4 x 17" glass	n/a	✓		13:55
SBE37 MICROCAT	6805	✓		13:56
SBE37 MICROCAT	6121	✓		14:09
4 x 17" glass	n/a	✓		14:17

SBE37 MICROCAT	6326		14:27
S4	3561257		14:31
7 x 17" glass	n/a		14:34
Swivel-Ti	n/a		14:34
Acoustic Release #1	1194	Record codes below	15:20:51
Acoustic Release #2	930	Record codes below	15:20:51
1800kg Anchor	n/a		15:20:51



Release #1 arm code _____
Release #1 release code _____
Release #2 arm code _____
Release #2 release code _____
Argos beacon #1 ID _____
Argos beacon #2 ID _____

Anchor Drop Position
Latitude 23.87060 **Longitude** -41.08659

Uncorrected water depth 5106 (at anchor launch)
Corrected water depth 5150 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR3L12** Cruise **JC174**

NB: all times recorded in GMT

Date 4 NOV 2018 **Site arrival time** overnight

Setup distance

Start time 16:16:15 **End time** 16:20:16

Start Position

Latitude 23.86014 **Longitude** -41.09443

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		16:16
31" syntactic		~~LIGHT A08-086~~	16:17
with Argos Beacon	BII-025	Beacon ID = ~~[illegible]~~ 134566/HEXC93E1E1	16:17
36" syntactic			16:18
With light	~~A08~~ A08-086		16:18
Lander frame with	n/a		16:20
SBE26/53	0038		
SBE26/53	0059		
Acoustic Release #1	910	Record codes below	
Acoustic Release #2	2072	Record codes below	
600kg Anchor	n/a		16:20:16

Release #1 arm code [redacted]

Release #1 release code

Release #2 arm code

Release #2 release code

Argos beacon #1 ID

Argos beacon #2 ID

Anchor Drop Position

Latitude 23.86025 **Longitude** -41.09401

Uncorrected water depth 5076 (at anchor launch)

Corrected water depth 5119.3 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **NOG** Cruise **JC174**

NB: all times recorded in GMT

Date 4/Nov/2018 **Site arrival time** overnight

Setup distance 1.5 N miles

Start time 17:54:28 **End time** 19:46:05

Start Position

Latitude 23.74972 **Longitude** -41.12210

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		17:54
Billings Float	n/a		17:55
with Light	W03-095		"
12 x 17" glass	n/a		17:59
Swivel	n/a		17:59
Sediment Trap	11804-083	NOG TRAP A, LID OFF 18:02	18:06
Nortek	~~9956~~ 6765		18:06
Sediment Trap	11804-082	NOG TRAP B	18:12
Nortek	~~6765~~ 9956		18:12
10 x 17" glass +SWIVEL	n/a		18:47
MicroCAT	3911		18:55
Acoustic Release #1	1749		18:57
Acoustic Release #2	321		"
850kg Anchor	n/a		19:40:05

50m POLYESTER

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID
Argos beacon #2 ID

Anchor Drop Position
Latitude 23.75595 **Longitude** -41.09519

Uncorrected water depth 4252 m (at anchor launch)
Corrected water depth 4273.6 m (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR1** Cruise **JC174**

NB: all times recorded in GMT

Date 8/Nov/2018 **Site arrival time** overnight

Setup distance 4.7 N miles

Start time 12:21:30 **End time** 17:15:07

Start Position

Latitude 24.16707 **Longitude** -49.83190

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	✓	12:21
24.5" syntactic float		✓	12:22
with Light	X01-052	✓	"
~~Argos or~~ Iridium Beacon	C02-046	Beacon ID = ~~1300~~ 300234061667230	"
8 x 17" glass	n/a	✓	12:25
RAS-500	13278-02	✓	12:29
Contros pCO2 (in frame)	~~SAT~~-CL-C715-002	✓	"
SeaFET (in frame)	721-2002	✓	"
MC-SMP-ODO (in frame)	12903	✓	"
SBE37 MicroCAT (in frame)	3257	✓	"
SBE37 MICROCAT	3264	✓	12:32
37" McLa. SS		✓	12:36
with Light	S01-189	✓	"
Argos or ~~Iridium Beacon~~	A08-069	Beacon ID = 121990/ HEX: B22BA6A	"
Swivel-SS	n/a	✓	"
SBE37 MICROCAT	3486	✓	12:39
SBE37 MICROCAT	3483	✓	12:44
SBE37 MICROCAT-ODO	12908	✓	12:44
SBE37 MICROCAT	5484	✓	12:46
SBE37 MICROCAT	3214	✓	12:50
SBE37 MICROCAT-ODO	12911	✓	12:50
SBE37 MICROCAT	3254	✓	12:56
SBE37 MICROCAT-ODO	12902	✓	12:57
9 x 17" glass	n/a	✓	13:06
SBE37 MICROCAT-ODO	12901	✓	13:12
SBE37 MICROCAT	4307	✓	13:12
SBE37 MICROCAT	5779	✓	13:19
SBE37 MICROCAT-ODO	13000	✓	13:19
SBE37 MICROCAT	3928	✓	13:26
RCM-11	507	✓	13:36
MC-SMP-ODO	12835	✓	13:37
SBE37 MICROCAT	5773	✓	13:41
12 x 17" glass	n/a	✓ Started 13:48 Finished: 13:52	13:52
Swivel-Ti	n/a	✓	13:52
SBE37 MICROCAT	4305		13:58

SBE37 MICROCAT-ODO	12834		13:58
8 x 17" glass	n/a		14:15
SBE37 MICROCAT	3934		14:17
SBE37 MICROCAT	3265		14:30
3 x 17" glass	n/a		14:45
SBE37 MICROCAT-ODO	12910		14:48
SBE37 MICROCAT	5768		14:48
4 x 17" glass	n/a		15:03
SBE37 MICROCAT	3257		15:05
SBE37 MICROCAT	6828		15:18
4 x 17" glass	n/a		15:~~25~~ 29
SBE37 MICROCAT	6840		15:~~30~~ 35
RCM11	515		15:41
9 x 17" glass	n/a		15:48
Swivel-Ti	n/a		"
Acoustic Release #1	2076	Record codes below	17:05
Acoustic Release #2	1383	Record codes below	"
2100kg Anchor	n/a		17:15:07

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID 300234061667230
Argos beacon #2 ID 121990

Anchor Drop Position
Latitude 24.16662 **Longitude** -49.74555

Uncorrected water depth 5163 (at anchor launch)
Corrected water depth 5212 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR1L12** Cruise **JC174**

NB: all times recorded in GMT

Date 6/Nov/2018 **Site arrival time** 17-45

Setup distance —

Start time 18:05:57 **End time** 18:10:54

Start Position

Latitude 24.18333 **Longitude** −49.73279

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	✓	18:05:57
31" syntactic float	n/a	✓ J18250-002	18:06:40
with Light	—	✓	18:06:40
Argos or ~~Iridium Beacon~~	B11-021	✓ Beacon ID = 134362/C93E1AD	18:06:40
36" syntactic float	n/a	J18251-003	18:08:29
with Light	N08-027	~~N/A~~	18:08:29
~~Argos or Iridium Beacon~~	—	Beacon ID = —	18:08:29
SBE26/53	0014		18:10:54
SBE26/53	0013		18:10:54
Acoustic Release #1 (tripod)	825	Record codes below	18:10:54
Acoustic Release #2 (tripod)	1732	Record codes below	18:10:54
600kg Anchor	n/a		18:10:54

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID 134362
Argos beacon #2 ID

Anchor Drop Position

Latitude 24.18333 **Longitude** −49.73228

Uncorrected water depth 5173 (at anchor launch)

Corrected water depth 5223 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR0** Cruise **JC174**

NB: all times recorded in GMT

Date 9/Nov/2018 **Site arrival time** _____

Setup distance 0.4 Nmiles **End time** ~~18:41:06~~

Start time ~~17:43:04~~

Start Position

Latitude 25.14657 **Longitude** -52.02838

ITEM	SER NO	COMMENT	TIME
McLane-12"	~~n/a~~		17:43
Billings 3 sphere	~~n/a~~		—
with Light	—		—
~~Argos or Iridium Beacon~~	—	~~Beacon ID~~ =	—
~~4 x 17" glass~~ 5 rugby ball Floats	n/a ✓		17:44
SBE37 SMP	[redacted]6325 ✓		17:51
SBE37 SMP	6322 ✓		17:56
SBE37 SMP	6137 ✓		18:00
SBE37 SMP	6128 ✓		18:03
~~S4 or~~ RMC11?	518 ✓		18:06
SBE37 SMP	6123 ✓		18:07
34" Syntactic buoy		✓	18:17
Acoustic Release #1	319	Record codes below	18:17
Acoustic Release #2	2073	Record codes below	"
500kg Anchor	n/a		18:41

Release #1 arm code [redacted]

Release #1 release code [redacted]

Release #2 arm code [redacted]

Release #2 release code [redacted]

IRID **~~Argos~~ beacon #1 ID** · 300234065336270

Argos beacon #2 ID _____

Anchor Drop Position

Latitude 25.14468 **Longitude** -52.02026

Uncorrected water depth 5399 (at anchor launch)

Corrected water depth 5457 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB6** Cruise **JC174**

NB: all times recorded in GMT

Date 14/Nov/2018 **Site arrival time** 14:00

Setup distance 0.4 Nmiles

Start time 16:44:41 **End time** 17:39:47

Start Position

Latitude 26.49398 **Longitude** -70.51585

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a ✓		16:12
31" syntactic	✓		16:15
With Light	TOS-078 ✓		"
And ~~Argos~~/Iridium	CO2-047 ✓	ID: 300234061668230	"
SBE MicroCAT	6333 ✓		16:15
SBE MicroCAT	3280 ✓	no mark estimated Position	16:24
SBE MicroCAT	3209 ✓		16:32
SBE MicroCAT	4306 ✓	No mark - roye measured position	16:38
Nortek	5490 ✓		16:42
SBE MicroCAT	3268 ✓		16:47
31" SYNTACTIC	✓		16:49
36" SYNTACTIC	00362	Released early, damaged lander frame.	16:51
BPR #1 (tripod)	~~0040~~		17:39
BPR #2 (tripod)	0414	Replaced due to damage.	"
Acoustic Release #1 (tripod)	1461	Record codes below	"
Acoustic Release #2 (tripod)	324	Record codes below	"
600kg Anchor	n/a	Lander frame re-attached. 5m chain ~~replaced~~ added.	"

Release #1 arm code _____

Release #1 release code _____

Release #2 arm code _____

Release #2 release code _____

Argos beacon #1 ID _____

Argos beacon #2 ID _____

Anchor Drop Position

Latitude 26.49520 **Longitude** -70.52471

Uncorrected water depth 5437 m (at anchor launch)

Corrected water depth 5497 m (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB4** Cruise **JC174**

NB: all times recorded in GMT

Date 18/NOV/2018 **Site arrival time** 13:30

Setup distance 4.3 N miles

Start time 16:10:50 **End time** 21:04:40

Start Position

Latitude 26.41984 **Longitude** -75.79674

ITEM	SER NO		COMMENT	TIME
Recovery Line	n/a	✓		16:10
3 TRYMSYN floats	n/a	✓		16:11
MicroCAT	3893	✓		16:11
MicroCAT-ODO	14148	✓		"
40" syntactic + ADCP		✓		16:18
with Argos beacon		✓		"
and light		✓		"
Nortek	5811	✓		16:19
MicroCAT	5485	✓		16:19
49" syntactic	n/a	✓		16:27
with Argos beacon		✓		"
and light		✓		"
MicroCAT	3249	✓		16:31
MicroCAT-ODO	14115	✓		16:31
Nortek	9420	✓		16:39
MicroCAT	3244	✓		16:39
MicroCAT-ODO	14114	✓		16:39
MicroCAT	3216	✓		16:47
MicroCAT-ODO	10519	✓		16:47
Nortek	5879	✓		16:54
MicroCAT	3213	✓		16:57
MicroCAT-ODO	10547	✓		16:57
MicroCAT	5780	✓		17:04
MicroCAT-ODO	10517	✓		17:04
12 x Orange CF-16s	n/a	✓		17:18
Nortek	9427	✓		17:20
MicroCAT	3252	✓		17:22
Nortek	11024	✓		17:32
MicroCAT-ODO	10545	✓		17:32
5 x yellow CF-16s	n/a	✓		17:38
MicroCAT	5785	✓		17:39
5 x yellow CF-16s	n/a			17:53
Nortek	6743			17:55
MicroCAT	6815			17:58
MicroCAT-ODO	10546			17:58

5 x yellow CF-16s	n/a		18:14
MicroCAT	3277		18:16
5 x yellow CF-16s	n/a		18:32
Nortek	5955		18:33
MicroCAT	3230		18:35
5 x yellow CF-16s	n/a		18:50
MicroCAT	6820		18:52
MicroCAT-ODO	12999		18:52
5 x yellow CF-16s	n/a		19:08
Nortek	5963		19:10
MicroCAT	6825		19:11
MicroCAT	3933		19:28
Nortek	6050		19:33
10 x glass	n/a		19:59
Acoustic Release 1	364		21:04:40
Acoustic Release 2	1733		21:04:40
2700kg Anchor	n/a		21:04:40

Release #1 arm code _____
Release #1 release code _____
Release #2 arm code _____
Release #2 release code _____
Argos beacon #1 ID _____
Argos beacon #2 ID _____

Anchor Drop Position
Latitude 26.45140 **Longitude** -75.72147

Uncorrected water depth 4656 (at anchor launch)
Corrected water depth 4619 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB4L** Cruise **JC174**

NB: all times recorded in GMT

Date 18/11/2018 **Site arrival time** 21:30

Setup distance —

Start time 21:43:45 **End time** 21:46:23

Start Position

Latitude _____ **Longitude** _____

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		21:46:23
DeepWater Buoyancy Lander		J18228-002	"
With Light		XEOS COMBINED BEACON + LIGHT.	"
Argos or Iridium Beacon	0059	Beacon ID = 300434061881140	"
SBE26/53	0040		"
SBE26/53	0037		"
Acoustic Release #1	1463	Record codes below	"
Acoustic Release #2	2065	Record codes below	"

Release #1 arm code _____

Release #1 release code _____

Release #2 arm code _____

Release #2 release code _____

Argos beacon #1 ID _____

Anchor Drop Position

Latitude _____ **Longitude** _____

Uncorrected water depth _____ (at anchor launch)

Corrected water depth _____ (at anchor launch)

RANGING ARM + ACM 0934

21:49:15	N/A ES ON.		WRONG CODE
21:50:10	—	—	
21:50:50	—		
21:51:40	—	274	
21:52:05	282	287	] 53 m/min
21:53:05	335	340	
21:54:05	389	394	] 54 m/min

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBH2** Cruise **JC174**

NB: all times recorded in GMT

Date 20/Nov/2018 **Site arrival time** 17:50

Setup distance 1.5NM.

Start time 18:10:55 **End time** 21:15:30

Start Position

Latitude 26.48334 **Longitude** -76.65057

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a		1810:55
Billings float	n/a	IRID: CO2-052 ID: 300234061 [redacted]	18:11:28
6x 17" glass	n/a		18:18:47
6 x 17" glass			18:16:01
RAS-500	1450-02		18:21:27
Nortek	8052.		18:20:52
MicroCAT-ODO	12832		18:25:45
MicroCAT-ODO	12907		18:37:21
7 x 17" glass	n/a		18:46:49
Nortek	9435		18:46:53
MicroCAT	3255		18:48:10
5 x 17" glass	n/a		19:12:36
Nortek	8483		19:12:44
MicroCAT	3900		19:14:19
MicroCAT-ODO	10520		19:29:
5 x 17" glass	n/a		19:39:34
Swivel	n/a		19:39:38
Nortek	8492		19:40:57
MicroCAT	6802		
MicroCAT	7681		19:54:54
5 x 17" glass	n/a		20:07:05
Nortek	9204		20:07:31
MicroCAT	6799		20:11:23
6x 17" glass	n/a		20:16:89
Acoustic Release #1	246		21:10:18
Acoustic Release #2	1465		21:10:18
1850kg Anchor	n/a		21:15:30

light Y01-018

Release #1 arm code _____

Release #1 release code _____

Release #2 arm code _____

Release #2 release code _____

Argos beacon #1 ID _____

Argos beacon #2 ID _____

Anchor Drop Position
Latitude 26.68338 **Longitude** -76.62202

Uncorrected water depth 4704 (at anchor launch)
Corrected water depth 4741 (at anchor launch)

Triangulation Sheet

Location (e.g. 1, 2 3)	Release SN or ARM	Time	Latitude	Longitude	Range 1 (m)	Range 2 (m)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB2** Cruise **JC174**

NB: all times recorded in GMT

Date 23/Nov/2018 **Site arrival time** overnight.

Setup distance 4 Nmiles

Start time 14:34:05 **End time** 19:04:03

Start Position

Latitude 26.47603 **Longitude** -76.77032

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		14:34
30" syntactic	n/a		14:35
SBE37 MICROCAT	4062		14:35
Nortek	12700		14:41
SBE37 MICROCAT	4060		14:41
Nortek	14732		14:50
SBE37 MicroCAT	7361		14:50
SBE37 MicroCAT	4070		14:53
49" Telemetry buoy (no instruments)	508-541		15:15
with Light	311-018		15:15
Argos or Iridium Beacon	Y01-010	Beacon ID = 46492/3FA28C7	15:15
SBE37 MICROCAT	5992		15:15
5 x clamp-on 17" glass	n/a		15:30
Nortek	14736		15:31
SBE37 MICROCAT	4800		15:35
SBE37 MICROCAT	4461		15:41
6 x clamp-on 17" glass	n/a		15:56
Nortek	14766		15:58
SBE37 MICROCAT	5991		16:02
SBE37 MICROCAT	5993		16:08
4 x clamp-on 17" glass	n/a		16:20
Nortek	14787		16:23
SBE37 MICROCAT	4475		16:27
Nortek	9433		16:34
SBE37 MICROCAT	4797		16:35
5 x clamp-on 17" glass	n/a		16:49
SBE37 MICROCAT	5989		16:50
SBE37 MICROCAT	7470		16:57
Nortek	12722		17:02
49" telemetry buoy	~~4799~~		17:25
SBE37 MICROCAT	4799		17:25
SBE37 MICROCAT	4178		17:42
2 x clamp-on 17" glass	n/a	Nick in wire - repaired.	18:00
Nortek	9409		18:00

4 x clamp-on 17" glass	n/a	↓	18:17
SBE37 MICROCAT	7362	✓	18:17
SBE37 MICROCAT	4710	✓	18:32
10 x 17" glass	n/a	✓ towing	18:38
Acoustic Release #1	920		19:01
Acoustic Release #2	1345	Record codes below	"
2500kg Anchor	n/a	Record codes below	19:04:03

Release #1 arm code _____
Release #1 release code _____
Release #2 arm code _____
Release #2 release code _____
Argos beacon #1 ID _____
Argos beacon #2 ID _____

Anchor Drop Position
Latitude 26.51818 **Longitude** -76.73735

Uncorrected water depth 3892m (at anchor launch)
Corrected water depth 3912m (at anchor launch)

	time	Range 1	Range 2
(1)	00:09:25	—	
	00:10:10	—	4182
	00:10:36	—	4183
(2)	00 48 00	4190	
	00 50 14	4177	
	25/11/18		
(3)	13:37:35	—	✓
	13:38:13	✓	4378
	13:38:47	✓	✓
0920	13:39:30	✓	✓
	13:40:09	✓	✓
	13:40:50	4376	4377

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB2L 13** Cruise **JC174**

NB: all times recorded in GMT

Date 22/NOV/2018 **Site arrival time** _____

Setup distance _____

Start time 20:46:21 **End time** 20:48:44

Start Position

Latitude 26.50680 **Longitude** -76.74335

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		
DeepWater Buoyancy Lander	5182 28-001		
With Light	~~Z02-020~~		
~~Argos or~~ Iridium Beacon	C02-038	Beacon ID = 300234061669220	
SBE26/53	0433		
SBE26/53	0080		
Acoustic Release #1	1405	Record codes below	
Acoustic Release #2	2079	Record codes below	

Release #1 arm code _____

Release #1 release code _____

Release #2 arm code _____

Release #2 release code _____

Argos beacon #1 ID _____

Anchor Drop Position

Latitude 26.50678 **Longitude** -76.74333

Uncorrected water depth 3860m (at anchor launch)

Corrected water depth 3879m (at anchor launch)

time range:

① 0:09:28

00:10:10 3845

00:10:36 3845

24 Nov 18

00 48 00 4786

00 48 19 4787

13: 41 : 35 4145 4145. 25 Nov

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB1** Cruise **JC174**

NB: all times recorded in GMT

Date 24/Nov/2018 **Site arrival time** 16:50

Setup distance 2 Nmiles

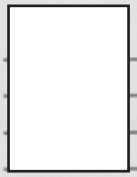
Start time 16:56:32 **End time** 19:22:38

Start Position

Latitude 26.44476 **Longitude** -76.83800

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	✓	16:56:32
30" syntactic float	n/a	✓	16:58
with Light	G06-060	✓	16:58
and Argos Beacon	G07-056	Beacon ID = 300234 0655 40620	16:58
6 x 17" glass	n/a	✓	16:58
RAS-500 with		✓	17:02
Contros	1114-003	✓	17:02
SeaFET	72 12006	✓	17:02
SBE37-MICROCAT-ODO	20312	✓	17:02
SBE37 MicroCAT	6841	✓	17:02
6 x 17" glass		✓	17:09
Nortek	8502	✓	17:09
SBE37 MICROCAT	5776	✓	17:09
45" syntactic float	n/a	✓	17:17
with Light	G06-059	✓	17:17
and Argos Beacon	A08-067	Beacon ID = 121988/B22BA4C	17:17
SBE37 MicroCAT-ODO	14147	✓	17:17
Nortek	6805	✓	17:25
SBE37 MICROCAT	3484	✓	17:25
SBE37-MICROCAT-ODO	14116	✓	17:25
SBE37-MICROCAT-ODO	10543	✓	17:31
7 x 17" glass		✓	17:42
Nortek	9210	✓	17:42
SBE37 MICROCAT	3907	✓	17:45
SBE37-MICROCAT-ODO	10544	✓	17:46
SBE37-MICROCAT-ODO	10555	✓	17:52
2 x 17" glass	n/a	✓	18:01
Nortek	13482	✓	18:01
SBE37 MICROCAT	6332	✓	18:01
6 x 17" glass	n/a	✓ Towing	18:12
Acoustic Release #1	322	Record codes below	19:15
Acoustic Release #2	2068	Record codes below	"
2400kg Anchor	n/a		19:22

Release #1 arm code _____
Release #1 release code _____
Release #2 arm code _____
Release #2 release code _____
Argos beacon #1 ID _____
Argos beacon #2 ID _____



Anchor Drop Position
Latitude 26.50134 Longitude -76.81364

Uncorrected water depth 1385m (at anchor launch)
Corrected water depth 1393 m (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBADCP** Cruise **JC174**

NB: all times recorded in GMT

Date 19/11/2018 **Site arrival time** 17:00

Setup distance — **End time** 17:23:31

Start time 17:17:04

Start Position

Latitude 26.53042 **Longitude** -76.8670

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		17:17
40" syntactic float	n/a		17:18
with Light	X01-050		17:18
Iridium Beacon	C02-044	Beacon ID = 300234061666280	17:18
ADCP	15579		17:18
Acoustic Release #1	1201	Record codes below	17:18
Acoustic Release #2	1491	Record codes below	17:18
800kg Anchor	n/a		17:23:31

Release #1 arm code —

Release #1 release code —

Release #2 arm code —

Release #2 release code —

Argos beacon #1 ID _____

Argos beacon #2 ID _____

Anchor Drop Position

Latitude 26.53042 **Longitude** -76.86710

Uncorrected water depth 579.6 (at anchor launch)

Corrected water depth 588.4 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBAL 8** Cruise **JC174**

NB: all times recorded in GMT

Date 19/Nov/2018 **Site arrival time** 17:56.

Setup distance 0

Start time 18:21:15 **End time** 18:25:38

Start Position

Latitude 26.52365 **Longitude** -76.86672

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	✓	18:21
Billing-12"	n/a	✓	18:21
Billings 3 sphere	n/a	✓	"
with Light	702-19	✓	"
Argos or ~~Iridium Beacon~~	BII-020	Beacon ID = 134361/HEX:C93E198	"
4 x 17" glass	n/a	✓	18:22
4 x 17" glass	n/a	✓	18:23
4 x 17" glass	n/a	✓	18:24
SBE26/53	0434	✓	18:25
SBE26/53	0012	✓	"
Acoustic Release #1 (tripod)	498	Record codes below	"
Acoustic Release #2 (tripod)	2066	Record codes below	"
1200kg Anchor	n/a	✓	"

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID _____
Argos beacon #2 ID _____

Anchor Drop Position
Latitude 26.52313 **Longitude** -76.86663

Uncorrected water depth 578 m (at anchor launch)
Corrected water depth 587m (at anchor launch)