National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Oceanography Centre

Cruise Report No. 37

RRS *Discovery* Cruise DY039

17 OCT – 01 DEC 2015

Southampton, UK to Nassau, Bahamas

RAPID moorings cruise report

Principal Scientist

D Rayner

2016

National Oceanography Centre, Southampton
University of Southampton Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 3038
Email: darren.rayner@noc.ac.uk

DOCUMENT DATA SHEET

AUTHOR	*PUBLICATION DATE*
RAYNER, D et al	2016

TITLE

RRS *Discovery* Cruise DY039, 17 Oct - 01 Dec 2015, Southampton, UK to Nassau, Bahamas. RAPID moorings cruise report

REFERENCE

Southampton, UK: National Oceanography Centre, Southampton, 183pp.
(National Oceanography Centre Cruise Report, No. 37)

ABSTRACT

This cruise report covers scientific operations conducted during RRS *Discovery* Cruise DY039. The purpose of the cruise was the refurbishment of an array of moorings spanning the latitude of 26.5°N from the Bahamas to the Canary Islands. Cruise DY039 departed from Southampton, UK on Saturday 17 October 2015, calling at Tenerife, Spain and Nassau, Bahamas before ending in Nassau, Bahamas on 21 November 2015.

The moorings are part of a purposeful Atlantic wide mooring array for monitoring the Atlantic Meridional Overturning Circulation and the associated heat transport. The array is a joint UK-US programme and is known as the RAPID-MOCHA array.

During DY039 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.

RAPID-AMOC continues the measurements at 26°N started with the RAPID and RAPID-WATCH programmes and through the ABC Fluxes project extends the measurements to include biological and chemical measurements in order to determine AMOC links to climate and the ocean carbon sink on interannual-to-decadal time scales. This is the first deployment of the ABC Fluxes biogeochemical samplers and sensors to the array (aside from initial oxygen sensors that were deployed in 2014).

The ABC Fluxes sensors include pCO2 sensors, pH sensors, additional oxygen sensors and autonomous water samplers to collect samples for nutrient and carbonate chemistry analysis following mooring recovery.

Additionally the RAPID telemetry MkIII system was deployed for the first time on the array at EBHi with 6 data pods set to release over the 18-month deployment period. 24 temperature sensors and 2 75kHz ADCPs were also added to mooring WB1 for the MerMEED project.

Mooring EB1L was not able to be recovered but a replacement was deployed. A sediment trap mooring NOGST was also recovered and redeployed for the Ocean Biogeochemistry and Ecosystems Group at the NOCS.

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.

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 the two vessel mounted Acoustic Doppler Current Profilers (one 75 kHz and one 150 kHz).

KEYWORDS	
ISSUING ORGANISATION	**National Oceanography Centre** **University of Southampton Waterfront Campus** **European Way** **Southampton SO14 3ZH UK** Tel: +44(0)23 80596116 Email: nol@noc.soton.ac.uk

A pdf of this report is available for download at: http://eprints.soton.ac.uk

1. Scientific and Ship's Personnel

Name	Position	Affiliation
Joanna Cox	Master	
Vanessa Laidlow	Chief Officer	
Sean Hoxby	2nd Officer	
Colin Leggett	3rd Officer	
Robert Ives	Chief Engineer	
Geraldine O'Sullivan	2nd Engineer	
Ian Collin	3rd Engineer	
Edin Silajdzic	3rd Engineer	
Felix Brooks	ETO	
Mark (Alan) Rogers	Junior ETO	
Paul Lucas	Purser	
Robert Hoyland	Cadet	
Oliver Page	Cadet	
Stephen Smith *	CPO (Scientific)	
Robert Spencer ±	CPO (Scientific)	
Thomas (Greg) Lewis	CPO (Deck)	
William McLennan	PO (Deck)	
Gary Crabb	A/B	
Craig Lapsley	A/B	
Christopher Peppin	A/B	
William Strudley	A/B	
Emlyn Williams	ERPO	
Mark Ashfield	Head Chef	
Amy Whalen	2nd Chef	
Jeffrey Osborn	Steward	
Thomas Docherty	Assistant Steward	
Darren Rayner	Chief Scientist	NOCS
Michael Boniface *	Scientist	University of Exeter
Sofia Darmaraki	Scientist	Student (MSc NOCS)
Sara Fowell	Scientist	Student (PhD NOCS)
Stephen Mack *	Scientist	NOCL
David Smeed *%	Scientist	NOCS
Shenjie Zhou	Scientist	Student (MSc NOCS)
Dave Childs	Technician (CTD)	NOCS/NMFSS
Gareth Knight	SST	NOCS/NMFSS
Robin Craft	Technician (Trainee)	NOCS/NMFSS
Christian Crowe	Technician (Moorings)	NOCS/NMFSS
Colin Hutton	Technician (Moorings)	NOCS/NMFSS
Thomas Roberts[$]	Technician (Moorings)	NOCS/NMFSS
Owain Shepherd	Technician (trainee)	NOCS/NMFSS
Lisa Symes	SST (trainee)	NOCS/NMFSS
Stephen Whittle	Technician (Moorings)	NOCS/NMFSS
Gerard McCarthy §	Scientist	NOCS
Bengamin Moat §	Scientist	NOCS
Peter Brown §	Scientist	NOCS
Robert McLachlan §	Technician (Moorings)	NOCS/NMFSS

John Hopley§ Carl Hewson § Andrew Henson%	A/B Engine Room Cadet Technician	NOCS/NMFSS
± Disembarked by med-evac offshore of Portugal * Disembarked Santa Cruz de Tenerife § Embarked Santa Cruz de Tenerife $ Disembarked Nassau %Embarked Nassau		

Table 1.1: Scientific and Ship's Personnel on DY039

2. Itinerary

Cruise DY039 aboard the RRS *Discovery* sailed from Southampton, UK on Saturday 17th October 2015 arriving Santa Cruz de Tenerife Saturday 24th October 2015. Sailed from Santa Cruz de Tenerife Monday 26th October 2015. and arrived Nassau, Bahamas 1st December 2015 after an initial stop just offshore of Nassau for customs clearance and a personnel change on the 21st November 2015.

3. Introduction

This cruise report is for cruise DY039 conducted aboard RRS *Discovery* 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 the first 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, with these new instruments being deployed on the array for the first time on this cruise.

The RAPID telemetry MkIII system was deployed for the first time on the array at EBHi with 6 data pods set to release over the 18-month deployment period.

Further information on the RAPID-MOC/MOCHA array please see previous cruise reports (detailed in Table 3.1), or the list of papers on the programme website at http://www.rapid.ac.uk/publications.php.

As with previous RAPID cruises we also serviced the Northern

Oligiotrophic Gyre (NOG) mooring, which is part of the FixO3 network (more information at: http://noc.ac.uk/observatories/nog). Additional work was also conducted for the newly funded 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.

3.1 Results and Data Policy

All data and data products from this programme 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.noc.soton.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/.

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.

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*	4 Apr – 10 May	Transatlantic hydrography (125 CTD stations)	Southampton Oceanography Centre, Cruise Report, No 54, 2005
P319	RV *Poseidon*	9th – 17th 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*	4th – 17th Oct 2006	Service and redeployment of key Eastern Boundary moorings	National Oceanography Centre Southampton Cruise Report No. 28, 2008.
P345	RV *Poseidon*	28th Nov – 7th 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*	April 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*	April – 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*	21 Nov – 6 Dec 2009	Recovery and redeployment of US Western Boundary moorings, and WBTS hydrography section	RAPID/MOCHA Program Report (W. Johns, RSMAS).
D346	RRS *Discovery*	5 Jan – 19 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*	28 Nov – 1 Dec 2010	Recovery of WB4 and WB3L3. Redeployment of WB4.	Appendix in: National Oceanography Centre Cruise Report, No -01, 2010
D359	RRS *Discovery*	17 Dec 2010– 15 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*	13 Apr – 4 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*	10 Sep – 9 Oct 2011	Service and redeployment of the Eastern Boundary and Mid-Atlantic Ridge moorings	National Oceanography Cruise Report, No. 14, 2012
RB1201	RV *Ronald H. Brown*	15 Feb – 5 Mar 2012	Service and redeployment of Western Boundary Moorings and WBTS hydrography section	National Oceanography Centre, Cruise Report No. 19, 2012
EN517	RV *Endeavor*	24 Sep – 10 Oct 2012	Service of US moorings in Western Boundary	RV Endeavor Cruise EN-517 Cruise Report
D382	RRS *Discovery*	8 Oct – 24 Nov 2012	Service and redeployment of full UK RAPID array	National Oceanography Centre Cruise Report No. 21, 2012
AE1404	RV *Atlantic Explorer*	15 Mar – 31 Mar 2014	Service of US moorings in Western Boundary	RV Atlantic Explorer Cruise AE-1404 Cruise Report
JC103	RRS *James Cook*	23 Apr – 3 Jun 2014	Service and redeployment of full UK RAPID array	National Oceanography Centre Cruise Report No. 30, 2015
EN570	RV *Endeavor*	3 Oct – 19 Oct 2015	Service of US moorings in Western Boundary	RV Endeavor Cruise EN-570 Cruise Report
DY039	RRS *Discovery*	17 Oct – 1 Dec 2015	Service and redeployment of full UK RAPID array	This report
DY049	RRS *Discovery*	9 Dec - 2015 – 22 Jan 2016	Transatlantic hydrography	*Not published yet*

Table 3.1: Cruises conducted as part of the RAPID-MOC project, or otherwise relevant (NB: doesn't include all NOAA WBTS hydrography cruises)

4. Cruise Narrative

Darren Rayner

Wednesday 14th October

Began mobilisation of RRS *Discovery* outside NOCS. Loading of containers, mooring hardware and deck winches. Started loading cages of instrumentation boxes.

Thursday 15th October

Continued mobilisation with loading of remaining instrumentation cages and mooring hardware. Equipment for DY040 stored in containers and the hold. The vessel moved berth from outside NOCS to berth 101 at 19:00.

Friday 16th October

Finished mobilisation and stowing of gear. Science party joined the vessel.

Saturday 17th October

Sailed at 08:30 heading down Southampton water and out the Solent past the Isle of Wight before heading west down the English Channel. Started collecting underway data and ADCP data in bottom track mode.

Sunday 18th October

Continued transiting to CTD test site. Crossing the Bay of Biscay. Light winds, gentle sea, building to force 6 in the evening. Load test of CTD termination.

Monday 19th October

Continued transiting to CTD test site. Weather building to force 7, but tail wind so still making good speed (10.5-11kts). Planned CTD test site revised as was likely to be bad weather when we got there so planned a site further on the track to Tenerife. Port aft crane damaged when stowing and requires repair in Tenerife.

Tuesday 20th October

Continued transiting. Weather too bad for a CTD (force 7 with 4-5m waves at 10-11 seconds period). Still making good speed. A large ship roll in the night caused some boxes in the hangar to shift and smash the fire alarm panel triggering the alarm.

In the morning a fire in the incinerator room meant all science and technical parties were mustered by the lifeboats whilst the crew dealt with the fire. It was contained and everyone was stood down after about an hour.

Wednesday 21st October

First test cast of the CTD to 1000m after breakfast. All ok. Diverted towards Lisbon after the CTD and rendezvoused with Portuguese Navy Air Sea Rescue helicopter for med-evac of CPO(Sci). Med-evac at 13:30. Proceeded to a newly selected CTD site in international waters on way to Tenerife. CTD to 3500m completed without incident.

Thursday 22nd October

Completed 2nd CTD in the morning and then continued to Tenerife. The ship has accumulated a collection of birds with a pair of owls on the foredeck, a pair of hawks (suspected to be Merlins) on the aft deck and various smaller birds flying around the labs and accommodation including a very friendly robin.

Friday 23rd October

Continued transiting to Tenerife. Loss of ship's power and temporary loss of propulsion around 14:40. Engines back on within minutes, electrical power back up within half an hour but potentially some issues for the underway instruments and data streams – although the majority of these were on UPS backup so were unaffected.

Saturday 24th October

Alongside in Tenerife from 08:00. Repairs on crane started.

Sunday 25th October

Alongside in Tenerife. Continuing crane repairs.

Monday 26th October

Load testing of crane in the morning and sailed at midday towards the deep water site north of Gran Canaria for a CTD. CTD in the evening to test MicroCATs for some of the more inshore moorings after having to un-allocate some instruments that were out of specification. Transit overnight to EBH3.

Tuesday 27th

Recovered and redeployed EBH3 without any problems. Due to making up time overnight and efficient mooring recoveries we were able to get to the EBH4 site in Moroccan waters and recover the EBH4 mooring the same day.

Wednesday 28th

Recovered EBH4L and redeployed the replacement EBH4 and EBH4L mooring and lander. We then trilaterated the positions of both of these and the EBH3 mooring deployed the previous day. We did not trilaterate EBH3 overnight as the vessel would have left Moroccan waters for Spanish waters and it would have necessitated additional contact to inform the Moroccan authorities about the double entry to their waters. We transited to EBH2 and again because of the efficient recovery and deployment of the moorings in the morning there was sufficient time to reach EBH2 before daylight and recover it before dinner, and redeploy afterwards. A manta ray was spotted in the water close to the ship when manoeuvring in to pick up the EBH2 mooring.

Thursday 29th

Transited to EBH1 overnight. Started with the recovery of EBH1L after breakfast. Recovered EBH1L and EBH1 without incident and redeployed the same day before starting our transit to EBHi.

Friday 30th

Continued transiting to EBHi and arrived in the evening shortly after dinner. Straight into a CTD with the oxygen MicroCATs on so one with long bottle stops and a total time of approximately 7 hours.

Saturday 31st October

Recovered EBHi first thing and redeployed the replacement. We trilaterated the mooring to confirm its seabed position to allow us to land the MYRTLE lander nearby for a good acoustic link for the telemetry system. This is the first operational deployment of the combined mooring/lander telemetry system. After checking the ADCP near-surface currents and the trilaterated position of EBHi we deployed the lander approximately 300m southeast of the mooring and ranged it down. A descent rate of 49m/min was recorded. The final position of the lander was determined and after several failed attempts to connect to the MYRTLE modem to release a pod we repositioned the ship directly over the lander and successfully connected and sent the release command. An expected surfacing time of 75 minutes was an overestimate and the pod was spotted on the surface after around 60 minutes. The large swell running made recovery difficult but the small recovery rope was eventually hooked by fishing with a grapnel at midships and the pod hauled aboard.

We then started the transit to EB1.

Sunday 1st November

The swell built overnight and forced the ship to have to take a more southerly route. As a consequence the transit took longer than expected with us arriving early evening at EB1. Conducted a 1000m CTD at the EB1 site to obtain cal-dip measurements for the two new SeapHOx pH sensors, with water samples collected for Oxygen, DIC and Total Alkalinity measurement along with salts. Second CTD to 5000m for a MicroCAT cal dip.

Monday 2nd November

Setup ready to release EB1L9 first thing but problems with the bow thruster meant we had to wait whilst this was fixed. When sorted we attempted to trigger the releases on the lander but despite receiving the command and replying the lander did not move. 1 release did not reply at all but was attempted to be blind fired, however the ranges from the other release still weren't seen to be decreasing. We abandoned this and headed to the recovery of EB1 in the hope that the lander would free itself with time and we would keep an eye out for the Argos alert.

Recovery of EB1 started smoothly, but after about 1600m of wire was recovered a temporary termination with wire grips (required for sorting out a large tangle) parted when going round the double barrel winch. The rest of the mooring was recovered from the release end as this was the only pack of buoyancy left on the surface.

Tuesday 3rd November

Deployed EB1 in the morning with a slow towing speed because of concerns over the vulnerability of the new RAS water sampler that is being added to the top of the design. The mooring was deployed without incident and we shall see how the RAS fared with 5 hours on the surface during deployment, when we come to recover it in 18 months time.

Deployed EB1L11 at a slightly different position to the abandoned EB1L9. We trilaterated both EB1 and the lander once the lander ranges confirmed that it had reached the seabed. Once completing the three points for ranging we conducted a shallow CTD to 125m in order to collect water samples at the time of the first sampling of the RAS at 18:00 GMT. A series of stops were completed to cover a range of possible depths of the RAS (dependent on whether the mooring was laying over in a current) and water samples were collected for Oxygen, DIC and TA analysis as per the cast testing the pH sensors.

Began the transit to MAR3.

Wednesday 4th November

Continued transiting to MAR3. We had a short diversion southwards to investigate a possible distress signal but with no further information and no sight of anything near the position given it was thought that the partial message was a spurious repeat of an earlier signal (with the same position) from a few days previous that had since been cancelled. We enjoyed a barbecue on the starboard deck for the evening meal.

Thursday 5th November

Continued transiting to MAR3. A 5750m CTD cast in the afternoon before carrying on to MAR3.

Friday 6th November

Continued transiting to MAR3.

Saturday 7th November

Swell building overnight from the north and wind up force 5 from the northeast. Arrived at MAR3 site around 13:00 and recovered the lander first, closely followed by the MAR3 mooring. Both had tangles to deal with but otherwise ok. CTD in the evening to 5000m.

Sunday 8th November

Deployed MAR3 first thing with a pod of, what were thought to be, melon-headed whales observed swimming gently about 50m off the starboard quarter.

Deployed MAR3L and taking a look at the sea state we decided that it would be a little risky recovering the sediment traps on the NOG mooring – especially considering the wind was due to ease overnight and we would have had to stay in the area for NOG redeployment anyway. Trilaterated the MAR3 mooring and MAR3L. CTD reterminated during the day.

Monday 9th November

Started with trying to recover the NOG mooring at 07:15, but no replies were received from the release. Despite blind firing and waiting, and then repositioning and trying again there was no evidence of the mooring coming to the surface. We tried multiple deck units and both the hull and “superducer” but nothing was received. We abandoned attempts at 11:00 after receiving no replies when almost immediately over the top of the mooring.

We repositioned for the deployment of the replacement mooring with a target position approximately 1 mile to the south of the unrecovered one. On deployment we decided to “watch” the mooring down by ranging to it, but could not communicate with the releases. We swapped the transducer and cable to a spare and established communications fine. This suggests it was one of these that was at fault when trying to recover NOG despite having worked fine up till this point of the cruise.

We returned to the original NOG position and tried again to fire the releases. There were very few ranges and often no reply but the release command was obviously heard and acted on by the release as the mooring surfaced and was hauled inboard.

Began the transit to MAR1.

Tuesday 10th November

Continued transiting to MAR1.

Wednesday 11th November

Arrived at MAR1 at about 11am and fired the release without problems using the “superducer”. On recovery there was seen to be a length of longline wrapped around the 2nd section of wire beneath the small syntactic. The line parted not long afterwards but the mooring was hooked and pulled on board again from the steel sphere. On inspection of the recovered ends of the wire it appears that the longline had cut the plastic jacketing of the wire rope exposing it to corrosion. This weakened the wire so that it broke when hauling the steel sphere closer to the ship. This was lucky not to have broken prior to recovery as the top section of the mooring would have been drifting free. This is similar to what happened to the same mooring as recovered in 2010 whereby the mooring broke loose approximately 1 month before recovery due to damage by longline fishing.

We recovered the MAR1L lander immediately after finishing the mooring and although tangled it was recovered ok. A planned CTD for the evening was cancelled due to losing communications with the package a couple of hundred metres down. A fault with the electrical termination was discovered and this was repaired ready for a CTD the following night.

Thursday 12th November

We recovered MAR2 first thing and then deployed and trilaterated the replacement MAR1 and MAR1L10 landers. A shallow CTD was completed to collect samples for DIC, TA and oxygen at the depth of the RAS, which had been programmed to sample around the same time.

This was followed by a deeper CTD to obtain an oxygen profile next to the whole mooring for later comparison with the newly deployed oxygen sensors. Immediately on completion we headed for MAR0.

Friday 13th November

Recovered MAR0 in the late afternoon with the mooring coming aboard in a massive tangle due to the deepest buoyancy overtaking the rest of the mooring on the ascent from the seabed. A quick redesign was completed with the aim of reducing tangles and a replacement was deployed after dinner before starting the long transit to WB6.

This is seemingly a cruise for lost birds as a heron-like wading bird took up residence on the foredeck, followed soon after by a gull.

Saturday 14th November

Continued transiting to WB6.

Sunday 15th November

Continued transiting to WB6.

Monday 16th November

Continued transiting to WB6.

Tuesday 17th November

CTD in the morning, then continued transiting to WB6.

Wednesday 18th November

Arrived at WB6 in the morning but the weather had built to an unworkable sea state for recovering the mooring. Winds were up to force 7 with the swell building and there was concern over lifting the dual syntactics as the bottom of the current WB6 design.

Instead of recovering the mooring we completed two more CTDs, one for the remaining MicroCAT-ODOs with long bottle stops, and the 2nd a shallow one for the RBR Solo-Ts that are being added to WB1 for the MeRMEED project.

Thursday 19th November

Waited till the afternoon for the weather to abate. The wind eased but it took a while longer for the swell to drop off. Recovered WB6 after 13:00 with acoustic communications poor. Upon sending the first few release commands no reduction in the ranges was observed, but ranges were very infrequent. Then none were received for a long time until the release that had up until that point not spoken replied with good decreasing ranges from about 1800m depth. The mooring was spotted on the surface shortly afterwards and not tangled as feared. The extra drag of the lander is clearly sufficient to slow the ascent of the syntactics compared to MAR0 where they rose so much faster than everything else on the mooring that they surfaced first with the top Billings last. WB6 surfaced with the top glass first and then the rest of the mooring a few minutes apart until the syntactics were last with the deeper of the two being held under the surface by the weight of the lander frame, BPRs and releases.

We deployed the replacement before dinner and completed a deep CTD cast to post-calibrate the 5 instruments recovered from the mooring. Then we proceeded to Nassau for customs clearance and repair of the starboard thruster which had developed a fault with the steering cooling system.

Friday 20th November

Entry into Bahamian waters – all underway data logging stopped. Continued transiting to Nassau.

Saturday 21st November

On dynamic positioning just outside Nassau for customs clearance and personnel change with David and Andy joining and Tom leaving. Some additional instruments were also brought on board and the engineers worked on by-passing the thruster coolant unit as a short term fix until the next port call when the necessary parts would be available. This all happened quickly and we were back underway to WB4 by 13:00.

Sunday 22nd November

We began with a CTD in the early hours next to WB4 to provide a comparison of the oxygen profile obtained from the CTD with that obtained from the oxygen sensors on the mooring.

Then came recovery and redeployment of the tall WB4 mooring – both without incident. A reasonably long day, but all finished just after dark. Then a CTD in the evening at 21:00 to provide an oxygen profile at the newly deployed WB4.

Monday 23rd November

Released WB4L9 at 07:05 and waited for it to surface before recovering. Recovered and redeployed smoothly and headed for WBH2 where we arrived with sufficient time to recover that mooring too. Winds were around force 6 throughout the day but the swell hadn't built to much yet.

CTD overnight with MicroCAT-ODOs on the frame.

Tuesday 24th November

The swell built a little overnight and combined with the wind made conditions borderline. Conditions were deemed ok for deployment but there were concerns over how the tubing on the RAS at the top of WBH2 would fare in the increased swell. With the weather forecast looking like we may lose the next few days the decision was made to proceed with the deployment and take the risk of not being able to collect some samples. If the RAS were not deployed we would be guaranteed of not getting any samples! All went in smoothly but we'll see what happened to the RAS when recovered in 18 months.

The conditions meant that no tall mooring recovery could take place in case the mooring was lying across the direction of the ship making the pickup difficult. So instead we picked up WB2L9 and WBADCP and redeployed the small moorings (WB2L11, WBADCP and WABL6), with all done before dinner.

We then trilaterated WBH2 in force 6-7 winds and an increasing swell.

Wednesday 25th November

Hove to in rough weather. No work as too rough for moorings and with the starboard thruster restricted in its ability to steer the weather was deemed too bad for a CTD too.

Thursday 26th November

Hove to. Force 7 winds and 4.5-5m swell.

Friday 27th November

Still hove to although winds starting to drop.

Saturday 28th November

The optimism of yesterday was short lived with the winds not having reduced beneath a force 6 before evening and the swell around 5.5-6m.

Sunday 29th November

The swell and wind dropped overnight, but with there still being some concerns about approaching a mooring with what was left of the swell a CTD was conducted at WB1. This allowed the swell to drop even further and recovery of WB1 and WB2 followed.

An overnight CTD allowed the MicroCAT-ODOs from WBH2 and WB1 (along with a few standard instruments) to be cal-dipped.

Monday 30th November

The last day! Deployment of WB2 started first thing followed by the deployment of WB1 with both operations completed smoothly. Packed everything that hadn't already been packed during transit to Nassau.
Tuesday 1st December
Docked Nassau and the science party disembarked.

5. NMFSS Ship Systems Computing and Underway Instruments

Gareth Knight and Lisa Symes

5.1 Ship scientific computing systems.

Data were logged by the Techsas data acquisition system into NetCDF files. The format of the NetCDF files is given in the file d_039_netcdf_file_descriptions.docx in the cruise data backup. Data were additionally logged into the RVS Level-C format, which is described in the NetCDF document.

Techsas stopped logging data on the 14th Nov 2015 (see Table 5.1 below). The enterprise alarm was sounding, and we had to restart the acquisition on Techsas which seemed to solve the problem. There was no obvious reason for this having stopped.

Date and time logging stopped			Date and time logging started		
Jday	Date	Stop	JDay	Date	Start
318	14/11/2015	06:24:54	318	14/11/2015	09:43:11

Table 5.1: Date and time of gaps in Techsas data acquisition

30/10/2015 Noticed that the clock on Techsas was in front of the NTP clock 192.168.62.221 by eight seconds though oddly the light next to the clock was green. Needed to manually resync the NTP Service on Techsas. Had to do this on another occasion 02/11/2015, on this occasion noticed that there were two IP addresses one for the meinberg NTP server and another for the steatite NTP server 192.168.62.222 setup. Looking into the second clock the steatite NTP server it was obvious the clock was wrong. Restarted the steatite server the clock problem persisted. The antenna is not seeing any satellites, will remove antenna and cable from the monkey island next to the VSAT dome once in port. Deleted the IP address for the steatite out of the clock sync for Techsas. Have not had to resync Techsas with the meinberg NTP since, in some way the second clock not working had interfered with the time on Techsas. See table 2 for dates and times of the NTP clock drift.

Jday	Date	Time	Drift
303	30/10/2015	13:49:11	8 seconds
306	02/11/2015	11:20:17	3 seconds

Table 5.2: Techsas NTP clock drift

5.2 Position and attitude.

All GPS and attitude measurement systems were run throughout the cruise. The Seapath system is the vessel's primary GPS system, outputting the position of the ship's common reference point in the gravity meter room. Throughout this cruise Seapath330 is the primary GPS used for the EM122 multibeam. The POSMV is the GPS that is repeated around the vessel and sent out to other

systems. SeaPath 330 and POSMV Data were logged by the Techsas data acquisition system into NetCDF files. Attitude data from the POSMV were logged in Level-C. A Techsas data logging module for the iXSea PHINS is under development.
The Techsas module logging ship's gyro data crashed on nine occasions causing a gap in the ship's gyro data in the NetCDF and Level-C files. The dates and times of the gaps are given in Table 5.3.

Date and time logging stopped			Date and time logging started		
Jday	Date	Stop	Jday	Date	Start
307	03/11/2015	19:21:37	308	04/11/2015	08:06:36
311	07/11/2015	17:25:21	311	07/11/2015	17:37:33
311	07/11/2015	19:14:25	311	07/11/2015	20:01:01
315	11/11/2015	05:03:43	315	11/11/2015	09:55:36
316	12/11/2015	22:22:32	317	13/11/2015	09:46:46
322	18/11/2015	01:57:00	322	18/11/2015	10:53:18
322	18/11/2015	18:03:55	322	18/11/2015	21:27:07
326	22/11/2015	15:21:58	326	22/11/2015	15:52:12

Table 5.3: Date and times of the gaps in the ship's gyro data.

5.3 Meteorology and Sea Surface monitoring package.

The Surfmet system was run throughout the cruise. (Please see table 6 for details of the sensors used and the calibrations that need to be applied). The system was turned off once as the ship didn't have diplomatic clearance for the Bahamas to take data. The system was cleaned on the morning of 20/11/2015 as well as at the end of the cruise. Please see table 5.4 for more details.

Jday	Date	Time	Comment
290	17/10/2015	12:00	Non-toxic turned on departing Southampton
296	23/10/2015	13:34	Non-toxic turned off approaching Santa Cruz, Tenerife
300	26/10/2015	10:27	Non-toxic turned on departing Santa Cruz, Tenerife
324	20/11/2015	12:20	Non-toxic turned off approaching Nassau, Bahamas
324	20/11/2015	12:40	Surfmet sensors transmissometer and fluorometer cleaned whilst system turned off
326	22/11/2015	11:40	Non-toxic turned on departing Nassau, Bahamas
			Non-toxic turned off approaching Nassau, Bahamas

Table 5.4: Surfmet Underway data detail.

The Techsas module logging sbe45 data crashed on four occasions causing a gap in the sbe45 data in the NetCDF and Level-C files. The dates and times of the gaps are given in Table 5.5.

Date and time logging stopped			Date and time logging started		
Jday	Date	Stop	Jday	Date	Start
293	20/10/2015	17:20:35	293	20/10/2015	20:56:02
296	23/10/2015	13:37:26	296	23/10/2015	14:04:11
307	03/11/2015	03:33:32	307	03/11/2015	07:49:51
311	07/11/2015	00:31:30	311	07/11/2015	08:56:00

Table 5.5: Date and times of the gaps in the sbe45 data

Initially when this happened on 20/10/2015 we realised that the SSDS outputs for Surfmet didn't have any data for Water Temp, Fluorometer, Transmissometer. Without checking Techsas first checked that everything was ok in the wet met room swapped the SBE45 out with the spare onboard (spare S/N: 4548881-0229) still didn't work. All connections seemed to be visually ok, LEDs were flashing on the SBE box indicating data transfer. Checked the baud rate was ok for the sbe45. In the end just had to restart sbe45 on Techsas, did this for all subsequent sbe45 outages. However there is no obvious reason as to why the sbe45 stopped logging in Techsas.

5.4 Kongsberg EA640 10 & 12 kHZ single beam echo sounder.

The EA640 single beam echo sounder was run throughout the cruise. The 10kHz transducer was used for the whole of the cruise. The EA640 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. As well as depths being logged to the Techsas and Level-C data loggers, files were saved as .BMP images and in raw Kongsberg format. The EA640 was synchronised to the K-Sync synchronisation system.

5.5 Kongsberg EM122 and EM710 Multi-beam echo sounders.

The EM122 multibeam echo sounder was run throughout the cruise and was synchronised to the K-Sync synchronisation system throughout.
The EM710 was not used at all during the cruise.

5.6 Sound Velocity Profiles.

The sound velocity profiles used in the EM122 multi-beam systems are shown in table 5.6. Nine profiles were made in total with eight profiles derived from the Valeport SVP S/N 41603, and one profile CTD derived.

Jday	Date	CTD No.	Time at Start	Time at Bottom	Depth of Cast	Lat (N)	Lon (W)	Time applied to SIS	Comments
294	151021	0	07:20	07:42	1015	36°22.452	13°12.662	294 151021 10:14	41603 Valeport SVP deployed on CTD frame
303	151031	4	19:22	20:43	4488	24°53.957	21°21.299	304 151031 08:58	41603 Valeport SVP deployed on CTD frame
305	151101	6	21:39	?	5073	24°50.157	24°10.692	306 151102 11:54	CTD derived
309	151105	9	14:24	16:15	5837	23°19.376	32°22.094	309 151105 20:13	41603 Valeport SVP deployed on CTD frame
312	151108	10	20:53	22:30	5567	23°45.899	41°06.510	312 151108 12:09	41603 Valeport SVP deployed on CTD frame
317	151113	12	00:20	02:27	3494	24°11.076	49°46.134	317 151113 11:41	41603 Valeport SVP deployed on CTD frame
321	151117	14	13:03	14:07	3577	26°23.360	69°06.219	321 151117 20:01	41603 Valeport SVP deployed on CTD frame
326	151122	17	05:04	06:30	1538	26°29.228	75°43.629	326 151122 12:04	41603 Valeport SVP deployed on CTD frame

Table 5.6: Sound velocity profiles used in the multi-beam systems.

5.7 75 kHz and 150 kHz hull mounted ADCP systems.

Both the 75 kHz and 150 kHz ADCP systems were run during the cruise. The raw data files and configuration files are included on the data disk. Both systems were not synchronised to the K-Sync synchronisation system.

5.8 WAMOS Wave Radar.

The WAMOS wave radar was run throughout the cruise. Data were logged by the Techsas data acquisition system into NetCDF files and is included on the data disk.

6. UNDERWAY DATA AND PROCESSING

Sofia Darmaraki, Shenjie Zhou, Ben Moat, Gerard McCarthy

6.1 Scientific party computing

The IBM workstation "Banba" (40GB of RAM, 8x2.4 GHz Intel processors) was used on DY039 as the main location for scientific data processing. Ship data systems directly mounted included the Techsas file server, CTD data and DiscoFS file server. Most processing was done by the Matlab v2011a using the mstar suite of programs. The speed of processing on Banba was satisfactory throughout.

The workstation was set up via a UPS. This was called into use on one occasion during the transit from Southampton to Tenerife during a blackout. The workstation was shutdown at this time.

Backups were made daily to two external hard disks mounted remotely on a Mac.

6.2 Navigation

RRS *Discovery* has three navigation systems for science: C-Nav 3050, POSMV and SEAPATH 330. High quality navigation data is essential for making accurate underway measurements of meteorological parameters. The ships location is necessary to orient measurements in space, while the ships speed and heading are necessary to measure absolute measurements of ocean currents. Navigation data were logged at 1 Hz to the TECHAS system. More details of the processing can be found in previous cruise reports and will not be duplicated here.

The Trimble Applanix POSMV provides position, roll and pitch, true heading and heave. The Konsberg SEAPATH 330 provides position and heading. The C-Nav3050 GPS instrument only provides position.

6.2.1 GPS Accuracy

The accuracy of the GPS data from all three systems was determined by comparing positions between 24th -25th of October 2015 (Jday 297 and 298) whilst moored in Tenerife. All the GPS systems anomalies seem to overlap (Figure 6.1), having quite a large spread (~20 m in latitude and 5 m in longitude). There are similarities in the scatter of data in the posmvpos and the cnav, which could be attributed to the differential corrections not being perfect. The more accurate GPS system was the SEAPATH 330

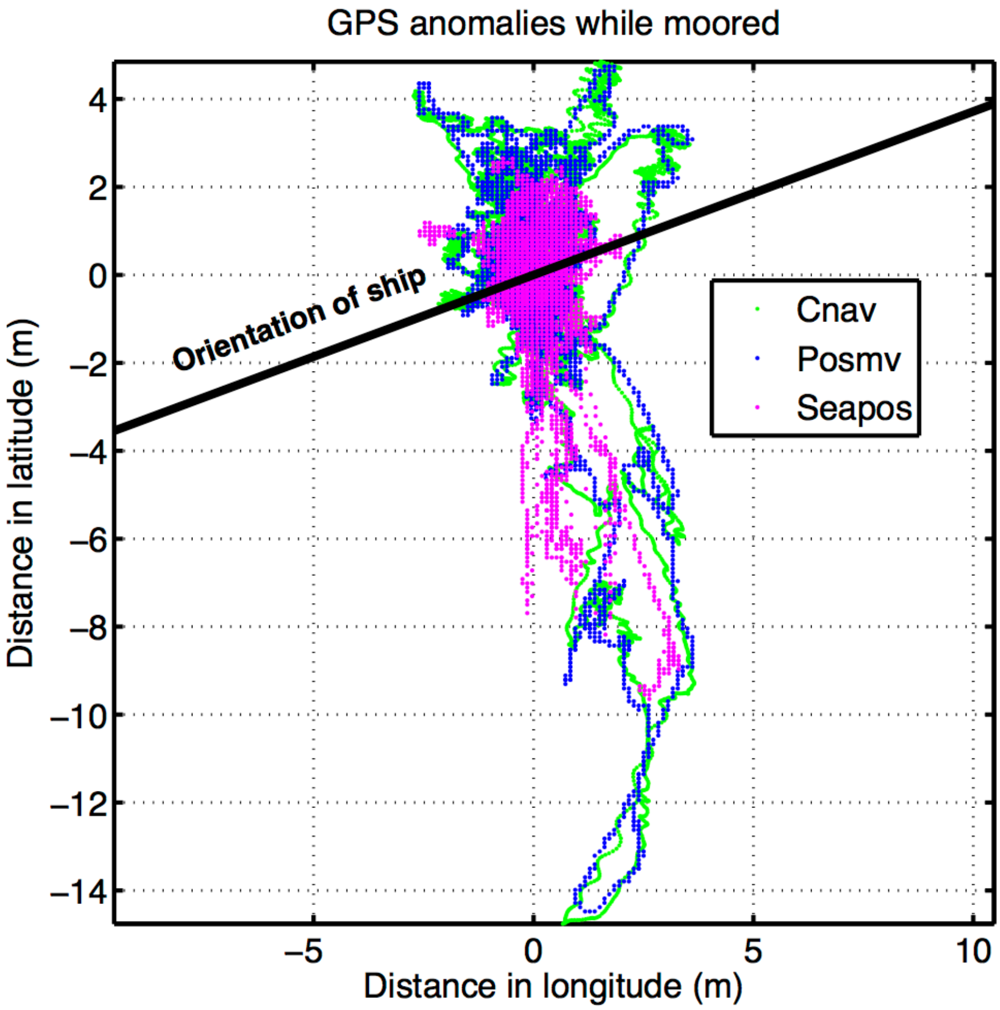


Figure 6.1 Comparison of different GPS systems on RRS *Discovery* while moored in Tenerife. Ship's orientation is indicated with the black line.

6.3 Bathymetry

A Simrad EA640 hydrographic echo sounder and an EM122 swath system were used to obtain bathymetry data throughout the duration of the cruise. The EA640 transducer was located on the ships hull and operated at 12kHz. Processing of the EA640 bathymetry data was conducted following the same procedures as described in previous cruise reports. The EA640 assumes a constant speed of sound and requires a correction to determine the actual depth. The swath system requires an accurate sound velocity profile to give sensible data and for this profiles were made at regular intervals (details in section 5.6).

When the ship was communicating with mooring releases on the sea bed or on the CTD, all the echo-sounder systems were turned off. On day 323 from 08.20 the EM122 was turned off due to restrictions in the research activities around the Nassau area until day 325 at 01.00hr.

6.3.1 Bathymetry problems

As we approached the Mid-Atlantic Ridge, the data from the EA640 often became unreliable. This was due to the multi-echo response of the single-beam to the rapidly varying bathymetry. The reliability of the depth measured by the

EA640 was determined by comparing the EA640 and the measurements from the centre beam of the EM122 swath system. Linear relationships were obtained to predict the depth from the EA640 using the EM122. Sections of EA640 bathymetry data were removed where there was a poor agreement with the depth predicted from the swath centre beam (Figure 6.2). Different linear relationships were applied for each sound velocity profile obtained (Table 6.1).

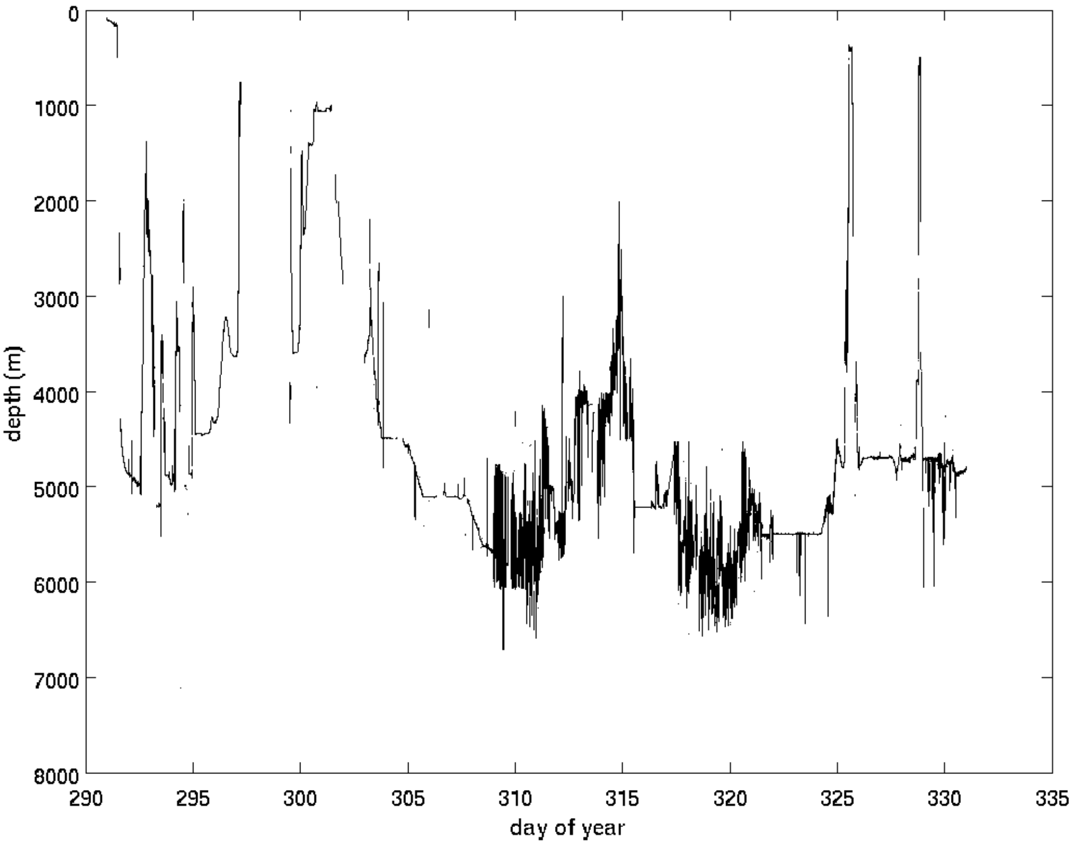


Figure 6.2 Bathymetry data from the EA640. The gaps indicate periods when the system was unreliable.

Sound velocity profile (date of start)	EA640=a+b*EM122	
	a	b
21/10/2015	-71.42	1.01
31/10/2015	94.11	0.97
02/11/2015	169.70	0.95
05/11/2015	862.11	0.82
08/11/2015	116.95	0.96
13/11/2015	378.30	0.92
17/11/2015	927.61	0.82

Table 6.1: Table of liner equations predicting the depth of the EA640 from the centre beam of the EM122

6.4 Vessel Mounted Acoustic Doppler Current Profiler (VMADCP)

The current velocities beneath the ship were measured using the two vessel-mounted Acoustic Doppler Current profilers (VMADCPs) on board RRS *Discovery*. These instruments, installed on the port drop keel, are 75 kHz and 150 kHz Ocean Surveyor (OS) instruments supplied by Teledyne RD Instruments.

Since the velocities measured by the VMADCPs were relative to the ships position and direction is relative to the ships heading, an accurate measurement of heading and position record of the ship is needed to offset the bias. During this cruise, the navigation on RRS *Discovery* is fed directly into VmDas from the Applanix POS MV, which incorporates a GPS heading source.

Each instrument works at a different frequency. The 150 kHz instrument reaches a depth of around 200 m, with a high vertical resolution. The 75kHz has the advantage of a deeper scope (around 600 m), but lacks the finer resolution of the 150 kHz instrument when set to profile this range.

6.4.1 Software configuration

The software used to record the data is the Teledyne RD Instrument VmDas software package. Initially, the software requires a command file that will configure the instrument for the way we want to measure. The command file specifies the narrowband or broadband mode, the bin sizes, and whether bottom-tracking mode is on or off. Typically, in water shallower than 1000m, bottom tracking was set to on. Bottom tracking allows the ADCP to estimate the speed and heading referenced to the seabed, hence one can obtain the rotation angle of the ADCP instrument relative to the ship direction. The setups of the configuration can be modified in 'options/view Data Options'. The configuration being used in this cruise was:

Communications ADCP Input: COM2. 9600. N. 8. 1, COM3. 9600. N. 8. 1, COM4. 9600. N. 8. 1. Communication parameters: Enable serial. Comport: COM2. Baud rate: 9600. No parity. Data bits: 8. Stop bits: 1.
ADCP Setup
Set profile parameters checked. Number of Bins: 60 (75 kHz) or 64 (150 kHz). Bin Size: 16 m (75 kHz) or 8 m (150 kHz). Blank Distance: 8 m (75 kHz) or 4 m (150 kHz). Transducer depth: 6.6 m (for both). Maximum range of bottom track was set as 1200 m (75 kHz) or 800 m (150 kHz).
Recording
Name: `OS075_DY039` or `OS150_039` depending on the instrument frequency.
Number: 001 for the first dataset, increasing by one every time the recording is stopped and restarted. If system has to be rebooted or VmDas software is restarted, the sequence number should be modified to avoid overwriting the previous datasets.
Max size: 10MB (every time when the volume of data written into the file accumulates higher than this value, the system will start a new file)
Primary path: `C:\adcpdata\dy039\raw_data\` for both 75kHz and 150kHz
Backup path: 75 kHz: `E:\75adcpdata\DY039\`
150 kHz: `E:\150adcpdata\DY039\`
Transform
Heading Source: PRDID, NMEA Port: NMEA2. No fixed heading was applied.

Tilt Source: PRDID, NMEA Port: NMEA2. No tilt corrections enabled.
Averaging
Temporal averaging method checked. First time interval (STA): 120 seconds. Second time interval: 600 seconds. Profile ping normalization was not enabled.

6.4.2 Data Acquisition, post-processing and calibration

All data acquisition and post-processing was conducted as per the steps described in the JC103 cruise report and will not be repeated here apart from where there were significant differences.

During the processing, some files contain too small an amount of data for the processing procedure to create a new data file. This problem is usually because a new sequential file was generated in the last few minutes before the instrument was stopped and restarted. Considering the little information and narrow time range contained by these files, we simply deleted them before running the main processing program.

To calibrate the VMADCPs, several files made with the bottom-tracking mode on are needed. For the first calibration, the sequence file 5 for 75 kHz and sequence files 1 and 2 for 150 kHz were used. Tables 6.2 and 6.3 detail the derived bottom track calibration results for this cruise.

Time range	Data Points	Parameter	Median	Mean	STD
289.54 to 290.46	181	Amplitude	1.0007	1.0008	0.0026
		Phase	0.1608	0.1568	0.1920
DY039 final correction		Amplitude = 1.0		Phase=0.2	

Table 6.2: Bottom track calibration results for os150 kHz and final correction

Time range	Data Points	Parameter	Median	Mean	STD
289.63 to 290.46	159	Amplitude	1.0109	1.0108	0.0025
		Phase	0.6058	0.5839	0.2148
DY039 final correction		Amplitude = 1.0		Phase=0.6	

Table 6.3: Bottom track calibration results for os75 kHz and final correction

Due to the deep waters around Tenerife (and therefore little bottom track information from this time) only one calibration has been applied to the VMADCP using that obtained in the few days after sailing from Southampton. The second day after leaving Tenerife, the VMADCPs were set to work without bottom tracking.

6.4.3 Significant events

The 75 kHz data starts from sequence 5 because before that the 75kHz was not working properly. The VmDas software was restarted several times during a short period when trying to resolve the issue and the resultant sequence files were deleted afterwards. A similar incident happened a few days after sailing for the 150 kHz; data files from sequence 9 to sequence 19 were generated during this incident and again discarded afterwards. All the events and incidents that occurred during VMADCP recording (except for daily routines) are listed in table 6.4.

Time range (Julian day start from 000)	Reason for events
Before 289.63	Wrong setup for unknown reason
293.70 to 293.79	Wrong setup due to an inappropriate way to restart
296.28 to 298.52	In port at Santa Cruz.
319.18 to 319.57	os150 kHz stopped logging for unknown reason

Table 6.4: Irregular events for VMADCPs.

6.5 Underway sea surface salinity and sea surface temperature

The near surface temperature (SST) and salinity were measured during the cruise. The SST was measured using an SBE38 probe in the seawater intake at a depth of 5.3m. The salinity was measured using a SBE45 Thermosalinograph in the seawater laboratory. To avoid contamination when in shallow water the pumps for the seawater supply where turned off (see Table 5.4).

Bottle salinity samples were collected from the TSG at 4 hourly intervals for the duration of the cruise. A total of 120 samples were taken. These were processed on the Autosal along with the CTD salinity samples.

6.5.1 SST Calibration

The SST measurement was calibrated by comparing the measured SST to the downcast CTD temperature at a depth of 5dbar (Figure 6.3). A temperature dependent correction of SST_corrected = -0.0775+1.0039*SST was found and applied to the SST record. The maximum correction applied was of the order 0.03 degC.

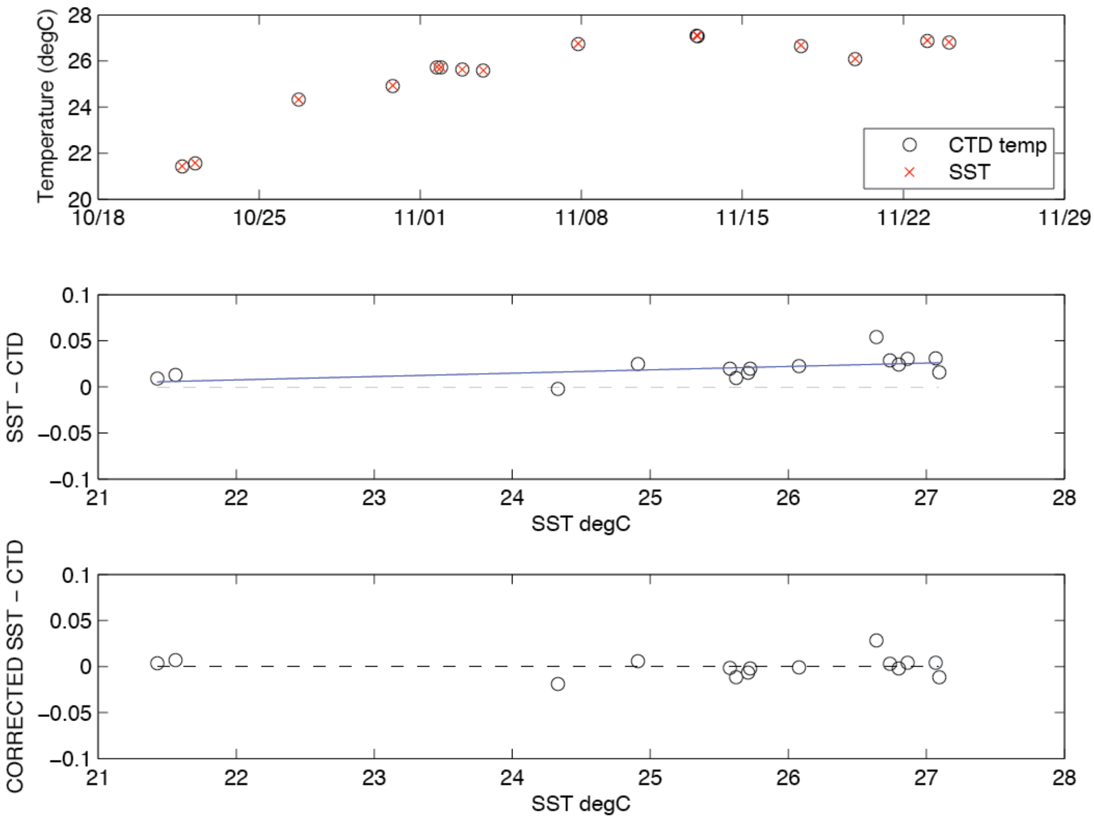


Figure 6.3: Comparison of SST with the CTD temperature at a depth of 5 dbar. Top panel: measured SST and CTD temperature. Middle panel: difference between SST and CTD. Bottom panel: corrected SST measurement.

6.5.2 TSG Calibration

Bottle salinity files of the name tsg_dy039_NNN.csv (where NNN refers to the incremental crate number) were created from the Autosal output files with the addition of a time variable of the form JJJHHMMSS, referring to Julian day, hour, minute and seconds that each sample was gathered at. Standards were run infrequently prior to CTD station 10 but run before and after each crate thereafter. Each standard was given an incremental number consistent with the time of its running with respect to the other standards run during the cruise.

These data were ingested into mstar format using mtsg_01. This program requires input of adjustment to be applied, if there is salinometer drift, and bath temperature. It creates a file tsg_dy039_NNN.nc and a file tsg_dy039_all.nc, which is an appended file of all the individual files.

To merge and compare the bottle samples with the salinity, the programs mtsg_medav_clean_cal, which creates a 1-minute average, and mtsg_bottle_compare, which extracts the underway data corresponding to each bottle were run.

The comparison between the bottles and the underway TSG is shown in Figure 6.4. Following the change of sensor near Tenerife, the sensor behaved admirably and the residuals were contained in an envelope of ±0.005. A number of wayward points are evident around Julian day 307 and 313. These are believed to be bad salinometer bottles similar to those noted during the CTD processing. No further calibration was applied to the sensor.

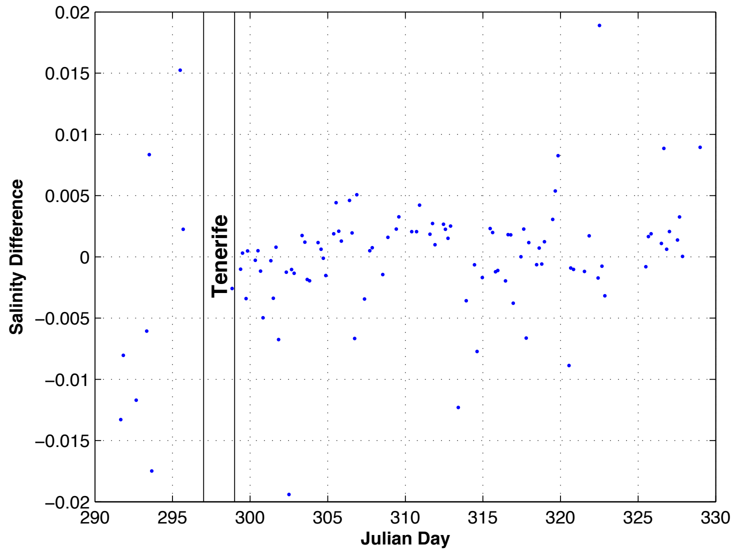


Figure 6.4: Salinity difference between TSG bottle samples and TSG underway sensor on -DY039.

6.6 Surface meteorology

6.6.1 Introduction

The surface meteorological conditions were measured throughout the cruise. The ship was equipped with a variety of meteorological sensors that made daily measurements of short wave radiation, temperature, humidity, atmospheric pressure, wind speed and direction. All the meteorological instruments were mounted on the ship's foremast. The heights of the instruments above the foremast platform were: port anemometer, 2.4 m; starboard anemometer 2.35 m; Vaisala air temperature and humidity 1.15 m; and barometric pressure 0.9m. The foremast platform was 5.65m above the forecastle deck (17.4m above the waterline - as taken from the NMFSS SurfMet sensor information sheet supplied with the cruise data).

The daily files were transferred from the onboard logging system (TECHSAS) to the UNIX system and processed on the workstation banba. Manual editing was used to remove spikes, navigation data was merged onto each daily file and true wind was calculated. More details of processing can be found in previous cruise reports and will not be duplicated here.

The foremast vibrates a great deal when steaming. This is a major concern for any dedicated air-sea interaction cruises taking place in the future. As the RRS *James Cook* does not appear to have this problem it is assumed that the stern thrusters on the RRS *Discovery* cause the vibration.

6.6.2 Light sensors

The ship carried two pyranometer total irradiance sensors, one (PTIR) on the port side of the foremast platform and the other (STIR) on the starboard. In addition, the ship carried two photosynthetic active radiation (PAR) sensors. These sensors were checked daily for any discontinuities or absence of data. A comparison of the TIR and PAR shortwave sensors showed that the sensors were in good agreement with each other. The average daily mean difference for the TIR was 3.09±7.84 W/m^2 and PAR was 7.45± 2.77 W/m^2. It is worth noting that the irradiance sensors need a calibration to be applied to the raw data stream, rather than being applied by the instruments themselves.

Instrument	Calibration (y=c0+c1*X)	Serial number	Sensor location	Parameter accuracy
SBE45 Micro TSG	Calibration applied by SBE45	00231 swapped to 0229 on 20th October 7:15 GMT	Sea water lab	Temperature 0.0002 Conductivity: 0.0003 mS/cm Salinity: 0.003psu
SBE38 remote temperature	Calibration applied by SBE38	0491	Seawater intake	Temperature ±0.001
Wetlabs Fluorometer	14.5*(X-0.053) Not applied	WS3S-246	Sea water lab	
Wetlabs Transmissometer	$Tr=(V_{sig}-V_{dark})/(V_{ref}-V_{dark})$ $V_{dark}=0.058$ $V_{air}=4.726$ $V_{ref}=4.623$ Not applied	CST-11R	Sea water lab	
Barometer PTB110	c0=800, c1=52	L0650612	foremast	±0.3hPa
Viasala HMP45A	c0=-40, c1=100	K0950058	foremast	Temperature: ±0.2C at 20°C Humidity: ±1% at 20°C
PAR Skye energy sensor (400 – 700nm)	1/1.093 1/1.005	28563 (starboard) 28561 (port)	foremast	±2%
TIR Kipp and Zonen CMB6 (305 2800nm)	1/1.014 1/1.097	962276 (starboard) 973134 (port)	foremast	0.14x10^{-6} V/W/m^2
Wind speed Gill	Speed:	10280018	Foremast starboard	Speed:±2% at 12m/s Direction: ±3° at 20m/s

Table 6.5 Surface meteorological instrumentation aboard *RRS Discovery* and calibrations applied

6.7 Wave measurements

A WaMoS II Wave and Surface current monitoring system (WinWaMoS V 4.1.1 541) was operational throughout the cruise. Wave heights (significant and maximum), peak wave period and direction, primary and secondary swell periods and directions, and surface current speed and direction were output to Techas (Figure 6.5). The temporal averaging of the sea state measurements was set to 20 minutes.

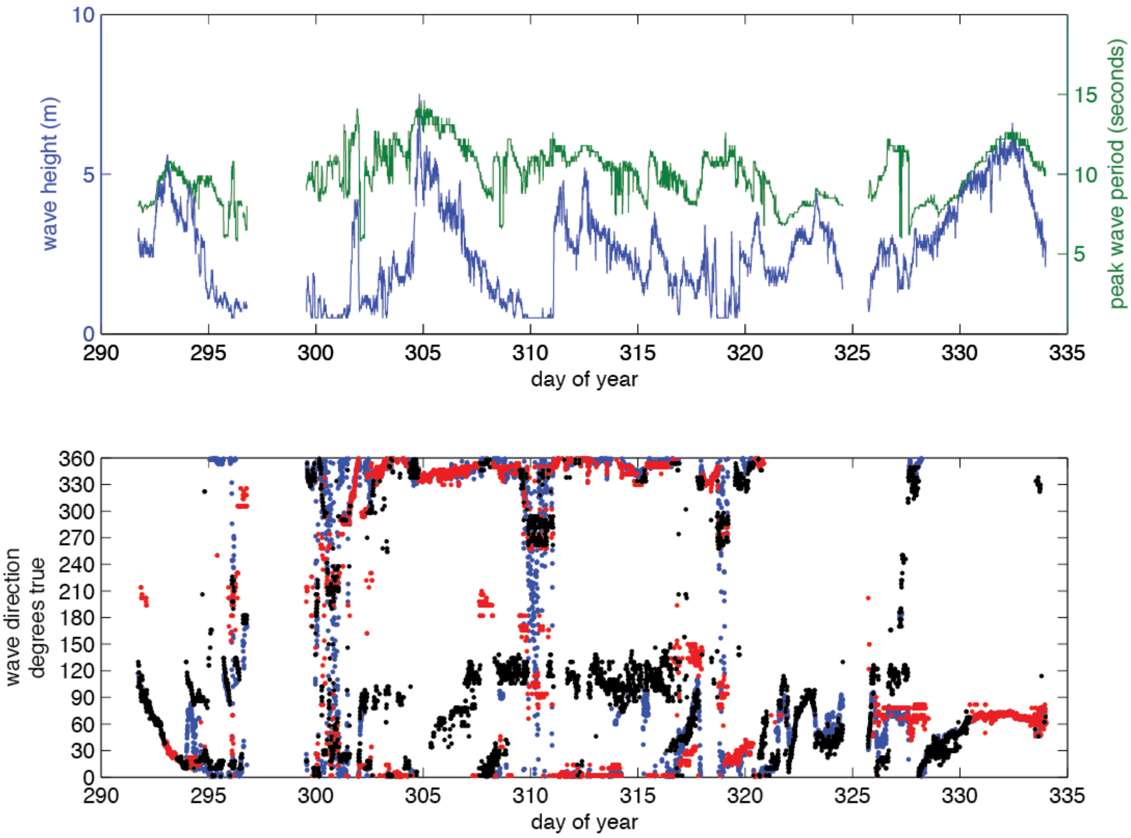


Figure 6.5: Timeseries of WaMos data from DY039. Top panel: significant wave height (blue) and peak wave period (green). Bottom panel: peak wave direction (blue), primary swell direction (red) and secondary swell direction (black). Direction indicates the direction that the waves are coming from.

Peak wave periods were typically around 10 seconds and the maximum significant wave height (max peak to trough wave height) was 7.5m (11.8m). Peak and primary swell directions were from the north throughout most of the cruise. Secondary swell associated with the trade winds were from the east.

7. CTD Data

A total of 25 CTD casts were performed to calibrate the MicroCATs, other moored instruments and to provide reference profiles for biogeochemical samples. The stations are summarised in Table 7.1.

Standard variables were output from the CTD data conversion: two temperature, two conductivity, two oxygen, pressure and scan number. Sea-Bird routines to align the CTD and perform a cell thermal mass correction were applied using the default values. Sea-Bird oxygen hysteresis correction was not applied at this stage as it was applied in a modified form later in the processing. Data were copied from the mounted directory to the cruise CTD directory using `ctd_linkscript`, a shell script.

Typical mstar processing steps were then applied and are summarised in Table 7.2. The scripts used were those developed on JC103 to use the TEOS-10 equation of state software.

CAST	START DATE	START TIME	END TIME	DURATION	LATITUDE	LONGITUDE	DEPTH
1	21/10/15	15:40:18	19:09:22	03:29	36.0524	-12.9873	3570
2	22/10/15	05:07:10	08:30:05	03:23	34.7508	-12.5852	3569
3	26/10/15	17:15:19	20:28:33	03:13	28.6184	-15.5004	3565
4	30/10/15	19:25:56	26:34:56	07:09	24.9522	-21.2192	4545
5	01/11/15	17:33:41	20:26:55	02:53	23.8359	-24.1782	1017
6	01/11/15	21:42:28	26:09:00	04:27	23.8359	-24.1782	5167
7	02/11/15	19:58:25	24:07:15	04:09	23.8079	-24.1445	5164
8	03/11/15	17:54:14	18:15:28	00:21	23.7980	-24.1597	128
9	05/11/15	14:27:53	19:37:53	05:10	23.3229	-32.3683	5893
10	07/11/15	20:53:45	25:32:40	04:39	23.9022	-41.0680	5572
12	13/11/15	00:23:27	00:38:08	00:15	24.1846	-49.7689	129
13	13/11/15	01:29:05	05:24:31	03:55	24.1847	-49.7689	4097
14	17/11/15	13:06:49	19:19:17	06:12	26.3893	-69.1037	3581
15	18/11/15	14:10:50	19:11:13	05:00	26.4913	-70.5359	5553
16	18/11/15	20:51:39	23:08:35	02:17	26.4914	-70.5359	1528
17	19/11/15	21:46:36	25:48:42	04:02	26.5098	-70.5087	5563
18	22/11/15	05:07:52	9:05:12	03:57	26.4871	-75.7259	4719
19	23/11/15	01:02:42	05:00:50	03:58	26.4751	-75.7188	4719
20	23/11/15	23:43:41	30:41:24	06:58	26.4842	-76.6315	4718
21	25/11/15	01:03:00	04:57:42	03:55	26.4585	-76.6490	4717
22	29/11/15	12:50:10	15:43:20	02:53	26.4949	-76.8209	1402
23	30/11/15	00:55:32	7:24:40	06:29	26.5165	-76.7361	3888
24	30/11/15	18:32:13	19:38:36	01:06	26.4987	-76.8055	1371
25	30/11/15	21:22:04	24:45:07	03:23	26.5115	-76.7107	3888

No Cast 11, retermination needed
Cast 18 had multiple PC failures, backup PC switched to primary afterwards
Secondary sensor pump failed on cast 19 leading to many spikes in the data

Table 7.1: Summary of CTD stations

Script Name	Description	Output
msam_01	Creates blank sample file	sam_dy039_NNN
mctd_01	Reads raw CTD cnv data to mstar	ctd_dy039_NNN_raw
mctd_02a	Converts Sea-Bird names to mstar names	ctd_dy039_NNN_24Hz
mctd_condcal	Calls cond_apply_cal for calibration information	
mctd_oxycal	Calls oxy_apply_cal for calibration information	
mctd_02b	Applies oxygen hysteresis correction using (**mcoxyhyst_mod** on dy039)	ctd_dy039_NNN_1hz
mctd_03	Creates 1 hz average, adds salinity, potential and conservative temperature, includes **mctd_sensor_choice**	ctd_dy039_NNN_psal
mdcs_01	Creates a firing file file	dcs_dy039_NNN
mdcs_02	Inserts data for bottom of cast into firing file	
mdcs_03g	Graphically select the start and end of the cast	
mctd_04	Creates 2db up and downcast	ctd_dy039_NNN_2db; ctd_dy039_NNN_2up
mdcs_04	Adds position to files	
mfir_01	Creates fir file to identify bottle stops	fir_dy039_NNN
mfir_03	Merge CTD time firing file	
mfir_04	Merge CTD data to firing file	
mwin_01	Creates a winch data file	win_dy039_NNN
mwin_03	Merges winch data to firing file	
mwin_04	Paste winch data onto sample file	
msal_01	Read salinity from csv file	sal_dy039_NNN
msal_02	Add salinity to sample file	
moxy_01	Read oxygen from csv file	oxy_dy039_NNN
moxy_02	Add oxygen to sample file	
msam_oxykg	Converts from umol/l to umol/kg	
mdcs_05	Adds best position to files	

Table 7.2: Summary of CTD mstar processing scripts

7.1 Oxygen Hysteresis

Modifications to the previous mstar script versions pertained only to the oxygen variables. It was seen early in the trip that the standard Sea-Bird hysteresis correction did not remove hysteresis from stations deeper than 3500 dbar (Figure 7.1a). A fix was found by modifying the application of the Sea-Bird hysteresis correction parameters at depth:

```
p ≤  2000 db, H = [-.033 5000 1450];
p >  2000 db, H = [-.033 4200 5000];
```

This modification was found to remove the hysteresis in the sensor satisfactorily (Figure 7.1b). Note that it was important to return to the Sea-Bird parameters at the shallower depths so that the upcast and downcast agree in shallow waters.

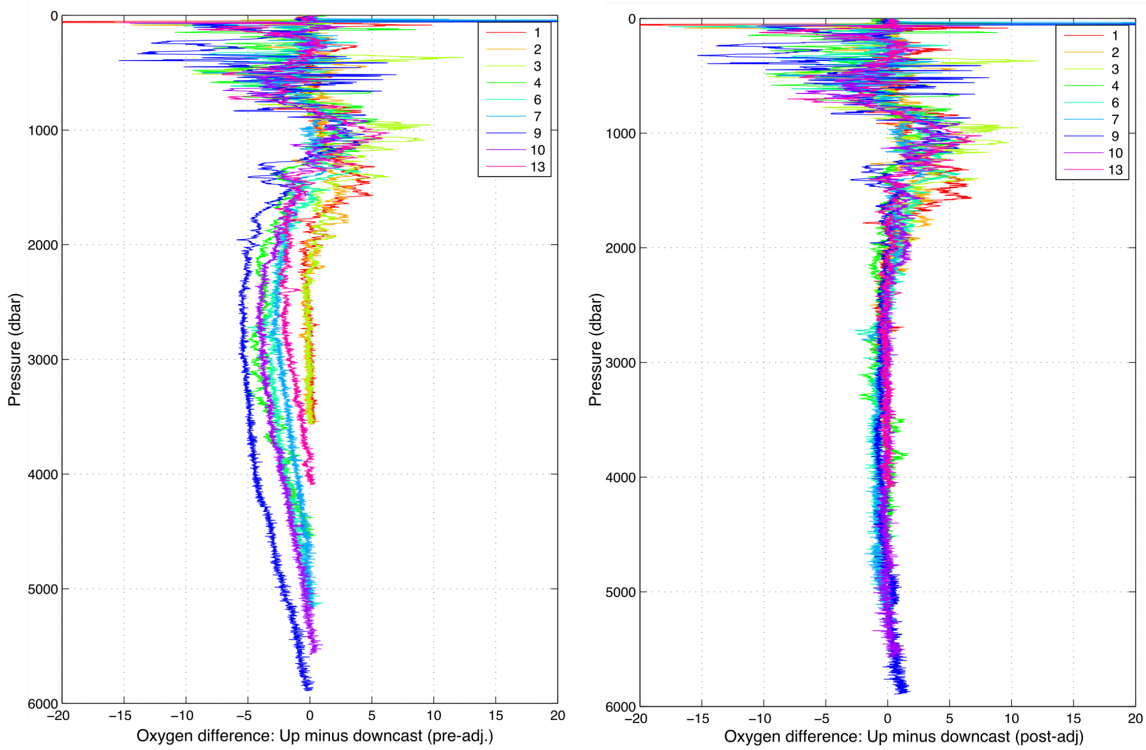


Figure 7.1: Oxygen hysteresis (upcast - downcast) using (l) the default Sea-Bird parameters and (r) the modified parameters.

7.2 Sensor Choice

There was a 2 millidegree offset between the two temperature sensors. To decide which one was best calibrated, a comparison with the MicroCATs was made. While the absolute accuracy of the MicroCATs is not as good as the CTD, there are many samples, enabling better precision. Figure 7.2 shows the difference between temperatures from the MicroCATs and both sensors at the deepest bottle stop on each cast (up to cast 20). From this investigation, the primary sensor was judged to be superior, having a mean offset of 0.0007 in comparison with the secondary sensor, which had a mean offset of -0.0014. Correspondingly, primary sensors for temperature, conductivity and oxygen were selected in `mctd_sensor_choice`.

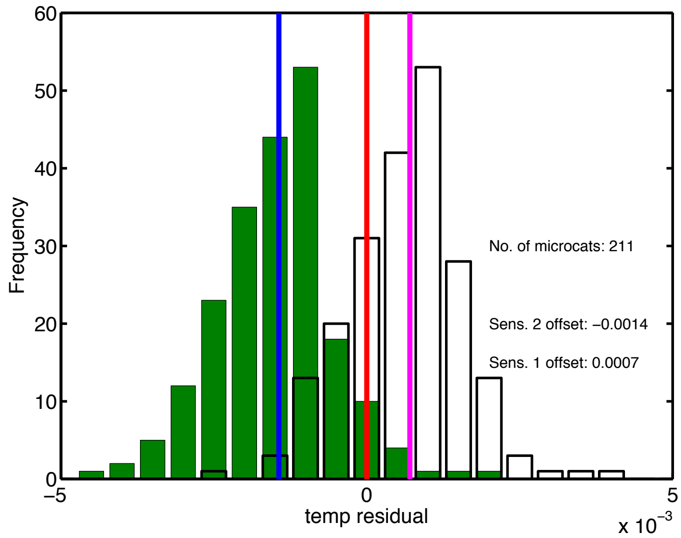


Figure 7.2: Histogram of difference between MicroCAT temperature and CTD primary (white) and secondary (green) temperature sensors at deepest bottle stop. Zero line (red) and median differences between (magenta) primary and (blue) secondary sensors are also shown.

7.3 Calibration of the conductivity sensor

Salinity water samples were taken on stations 1 to 21 with the exception of stations 8, 12 and 16, which were shallow stations with a maximum depth of 100 m, 100 m and 1500 m respectively. The samples were processed on a Guildline Autosal. The Autosal was standardized at the beginning of the cruise. Two standards were run on 4th November. Following Station 10, standards were run before and after each crate. A summary is shown in Figure 7.3. The Autosal was remarkably stable for the duration of the cruise and no additional offset was applied to the samples for Autosal drift. Standards 3, 5 and 9 were noted to be anomalously fresh. These were the first standards run in an Autosal session. Thus the freshness was linked with millicue water remaining in the Autosal. Additional flushing was performed for the remainder of the cruise and this problem was resolved.

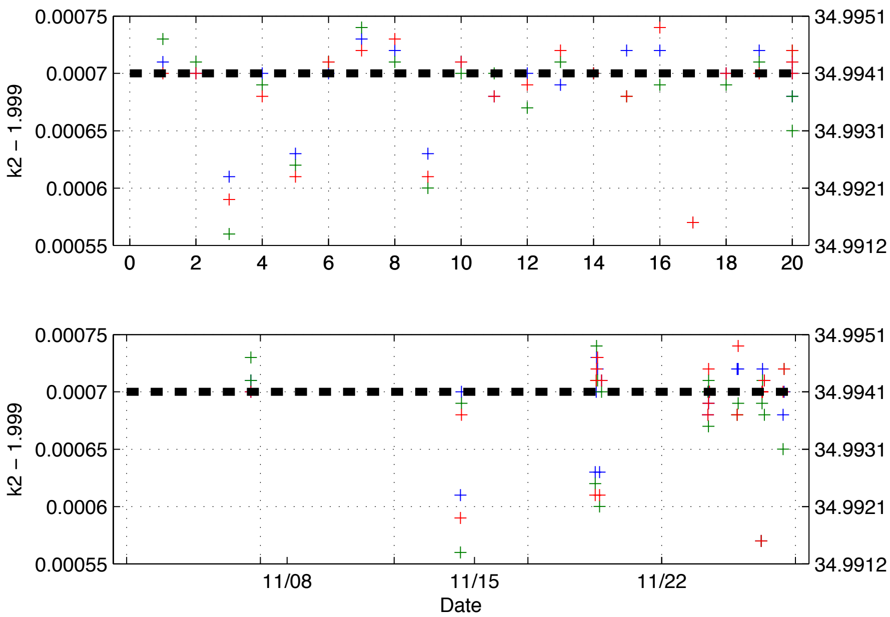


Figure 7.3: Drift of the Autosal over the course of the cruise plotted against (top) incremental sample number and (bottom) date. The black dashed line shows k2 =1.99985 for standard salinity batch P157. Each cross represents an individual run for each standard. Values of k2 are shown on the left hand axis and equivalent salinity on the right hand axis.

The bottle samples were used to calibrate the primary conductivity sensor. The secondary sensor showed a much larger dependence on pressure (up to 0.005 at full depth) and was associated with the less preferred temperature sensor so was not calibrated on this cruise. The primary sensor was very well calibrated and needed only minor adjustment to match the salinity bottles.

A small dependency on pressure and temperature was noted. A scaling for the primary conductivity was derived from the residuals with the bottle conductivity (Figure 7.4). A pressure scaling was first derived of the form:

```
a1*press + a2.
```

A subsequent temperature scaling was then applied of the form:

```
b1*temp + b2.
```

The calibration to the conductivity for both temperature and pressure scaling applied in serial was:

```
a1 = -1.5186e-08;
a2 = 1 + 4.3419e-5;
b1 = -2.9895e-06;
b2 = 1 + 1.0117e-5;

cond_cal = cond_uncal.*(a1*b2*press+a2*b1*temp+a2*b2)
```

where the `a1*b1` term is neglected.

This calibration was applied in the CTD processing between `mctd_02a` and `mctd_02b`. The final residuals are shown in Figure 7.5.

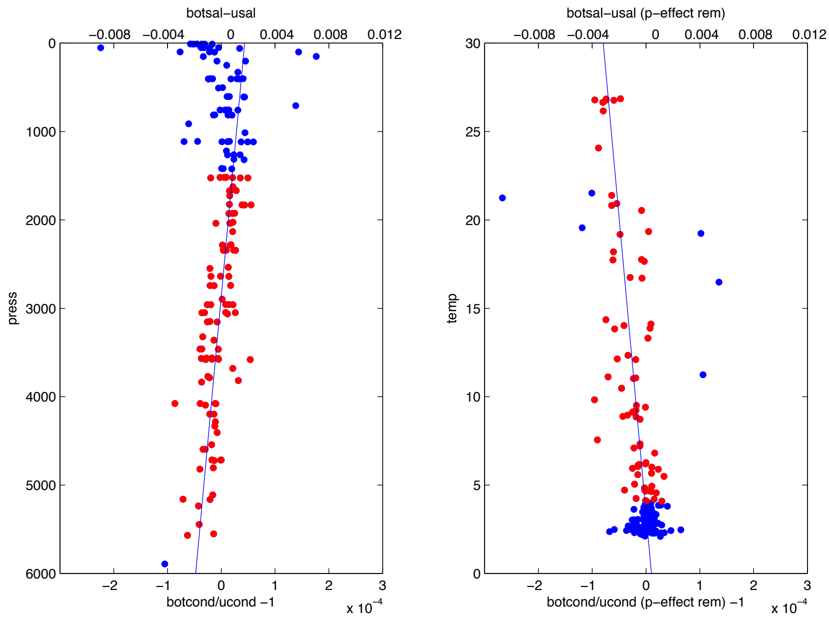


Figure 7.4: Calculation of adjustment to primary conductivity sensor. Conductivity ratio between the bottles and CTD sensor are plotted against (l) pressure and (r) temperature (following the removal of the pressure dependent term). Red data indicate points chosen to calculate the fit, which is shown with a blue line. The equivalent salinity difference is shown on the top axis.

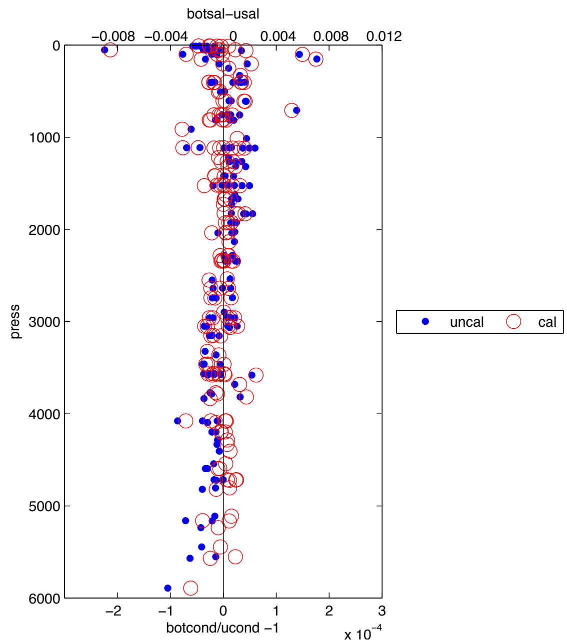


Figure 7.5: Primary conductivity scaling relative to bottle conductivity from before (blue, dots) and after (red, circles) calibration.

7.4 Calibration of the oxygen sensor

Bottle oxygen samples were used to calibrate the CTD oxygen sensor on DY039. Following the improvements to the hysteresis correction, upcast oxygen was sufficient to calibrate. The primary sensor was again chosen as it showed less drift with depth than the secondary and was advantageously co-located with the temperature and conductivity sensors of choice. A dependency of the CTD oxygen on pressure and a secondary (minor) dependency on oxygen concentration was identified (Figure 7.6).

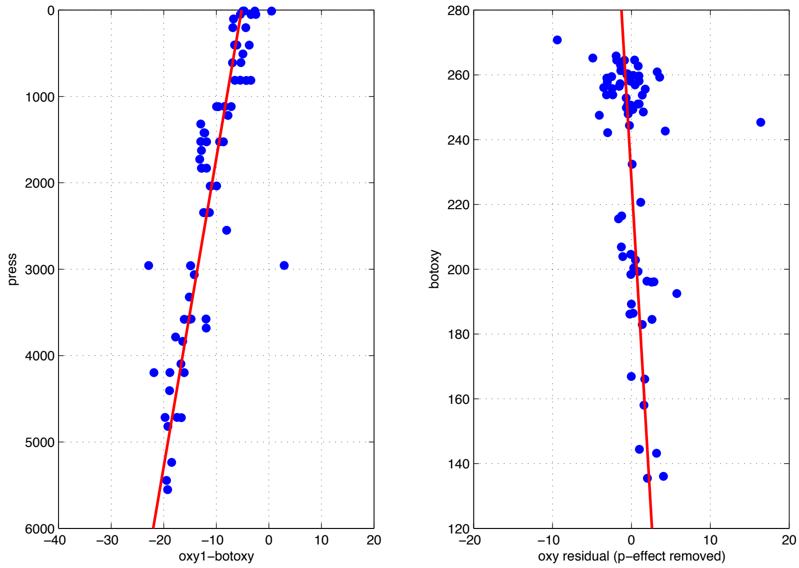


Figure 7.6: Residuals between CTD oxygen and bottle oxygen against (l) pressure and (r) oxygen concentration. The pressure dependency had been removed prior to calculating the latter. Fits to both are shown in red.

The dependence on pressure and oxygen concentration was applied as an offset correction of the form:

```
pfac = +0.0028;
ofac = +0.0242;
oxyout = oxyin+pfac*press+ofac*oxyin,
```

where `pfac` and `ofac` are the pressure and oxygen scalings respectively. No residual dependency on temperature was identified. The final calibrations are shown in Figure 7.7.

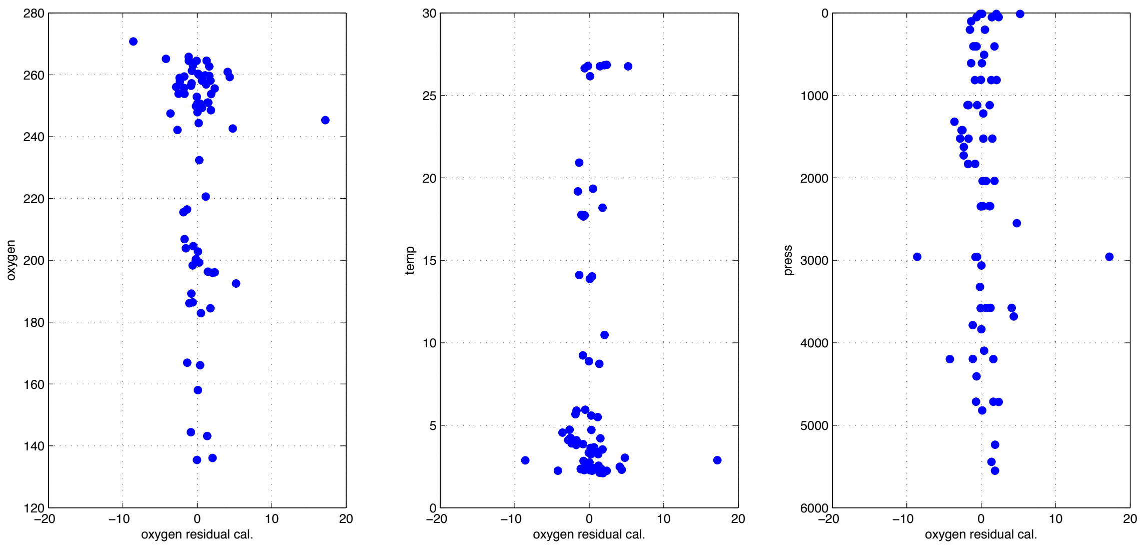


Figure 7.7: Oxygen residuals post-calibration plotted against oxygen, temperature and pressure.

7.5 Bottle files

The CTD was fitted with twelve 10-litre Niskin bottles. All twelve bottles were closed on most casts with the following exceptions: Casts 8 and 10 closed 10 bottles, Cast 9 closed 11 as the final bottle firing failed, and Cast 17 closed 6 bottles. In addition to this, due to the intermittent failure of the primary CTD PC, a number of bottle files were split and needed to be reconstructed in post-processing. Additionally, for Cast 9 no bottle firing information was recorded for bottle 11 and, on Cast 2, bottle 14 was fired with no Niskin in the position.

7.6 Moored instrument Cal-dips

A total of 17 CTD casts were used to lower moored MicroCAT CTDs for comparison with the shipboard CTD. Of these, four included MicroCATs with SBE63 oxygen sensors (MicroCAT-ODOs). An additional cast was used to check the operation of the RBR-SoloT temperature loggers prior to their deploymeny on WB1, and two further casts were used to test the new Deep SeapHOx pH and oxygen sensor pairings (more information on these is given in section 10).

Bottle stops for the cal dip casts were extended to 5 minutes duration, except when MicroCAT-ODOs were lowered, where the stops were 30 minutes long to allow the slower sampling sensors to stabilise.

A summary of the instruments deployed on each cal dip along with the QC findings on the sensor performance is given in Appendix C.

8. Moorings operations

8.1 Summary

Darren Rayner

In total 16 moorings and 6 landers were recovered, with 15 moorings and nine landers deployed to replace them for the UK Rapid-MOC project. One lander could not be recovered despite the acoustic releases acknowledging the release command. The moorings are intended to be recovered in Spring 2017, with all but one of the landers intended to be deployed for three years with recovery in Autumn 2018. One of the landers is the MYRTLE-X lander deployed as part of the RAPID MkIII telemetry system and will be recovered after 18 months with the associated mooring. An additional mooring was recovered and redeployed at the NOG site for the FixO3 project. Positions of the mooring depoloyments and recoveries are given in tables 8.1 and 8.2

Mooring	Anchor drop Latitude N	Anchor drop Longitude W	Anchor seabed Latitude N	Anchor seabed Longitude W	Corr depth at anchor launch (m)	date	Time (GMT)	Duration (including any towing)
EBH3	27° 48.35'	13° 44.94'	27° 48.44'	13° 44.85'	1422	27/10/15	13:59	01:26
EBH4	27° 51.11'	13° 32.43'	27° 51.05'	13° 32.43'	1060	28/10/15	09:41	01:14
EBH4L6	27° 52.56'	13° 30.74'	27° 52.65'	13° 30.70'	1017	28/10/15	10:28	00:07
EBH2	27° 36.87'	14° 12.70'	not trilaterated		2017	28/10/15	18:23	00:09
EBH1	27° 13.37'	15° 25.30'	not trilaterated		3040	29/10/15	12:21	00:12
EBH1L11	27° 13.00'	15° 25.92'	not trilaterated		3047	29/10/15	12:49	00:03
EBHi	24° 56.04'	21° 15.87'	24° 55.96'	21° 16.05'	4496	31/10/15	11:37	01:11
EBHiM	24° 55.86'	21° 15.92'	24° 55.88'	21° 16.03'	4496	31/10/15	13:54	n/a
EB1	23° 45.46'	24° 09.26'	23° 45.42'	24° 09.50'	5080	03/11/15	14:46	04:45
EB1L11	23° 48.01'	24° 07.14'	23° 48.02'	24° 07.17'	5098	03/11/15	15:37	00:04
MAR3	23° 52.27'	41° 05.21'	23° 52.18'	41° 05.41'	5058	08/11/15	15:13	04:16
MAR3L10	23° 51.61'	41° 05.69'	23° 51.21'	41° 05.51'	5039	08/11/15	15:54	00:03
MAR1	24° 09.96'	49° 44.77'	24° 10.01'	49° 44.93'	5212	12/11/15	17:54	04:15
MAR1L10	24° 11.48'	49° 44.43'	24° 11.46'	49° 44.41'	5222	12/11/15	18:43	00:04
MAR0	25° 08.45'	52° 01.33'	not trilaterated		5463	13/11/15	21:47	00:21
WB6	26° 29.69'	70° 31.45'	not trilaterated		5496	19/11/15	21:05	00:17
WB4	26° 28.43'	75° 42.13'	26° 28.59'	75° 42.16'	4691	22/11/15	21:52	04:24
WB4L11	26° 28.51'	75° 42.40'	26° 28.40'	75° 42.38'	4694	23/11/15	13:07	00:04
WBH2	26° 27.99'	75° 44.09'	26° 29.08'	76° 37.57'	4713	24/11/15	14:58	02:17
WB2L11	26° 30.43'	76° 44.37'	26° 30.43'	76° 44.42'	3877	24/11/15	18:00	00:06
WBADCP	26° 31.85'	76° 52.00'	not trilaterated		592	24/11/15	20:07	00:06
WBAL6	26° 31.61'	76° 52.34'	not trilaterated		499	24/11/15	20:32	00:04
WB2	26° 30.87'	76° 44.09'	26° 30.92'	76° 44.31'	3886	30/11/15	14:56	02:56
WB1	26° 29.87'	76° 48.76'	26° 29.92'	76° 48.85'	1398	30/11/15	18:07	01:58
NOG	23° 45.33'	41° 05.74'	23° 45.25'	41° 05.84'	4260	09/11/15	15:39	01:21

Table 8.1: Summary of moorings deployed on DY039

Mooring	Deployment Cruise	Mooring anchor position Latitude N	Longitude W	Release date	Release time (GMT)	Duration from release to final recovery
EBH4L4	D382	27° 52.31'	13° 30.89'	27/10/15	17:28	00:53
EBH4	JC103	27° 50.98'	13° 32.45'	27/10/15	15:23	01:19
EBH3	JC103	27° 48.36'	13° 44.91'	27/10/15	09:07	01:52
EBH2	JC103	27° 36.86'	14° 12.68'	28/10/15	16:17	01:05
EBH1L9	D382	27° 12.73'	15° 24.17'	29/10/15	07:53	01:03
EBH1	JC103	27° 13.33'	15° 25.39'	29/10/15	09:29	01:41
EBHi	JC103	24° 56.05'	21° 16.04'	31/10/15	07:33	01:49
EB1L9	D382	23° 47.93'	24° 06.69'	not recoverable		
EB1	JC103	23° 45.39'	24° 09.51'	02/11/15	11:57	06:00
MAR3	JC103	23° 52.12'	41° 05.52'	07/11/15	17:19	03:07
NOG	JC103	23° 46.28'	41° 05.82'	09/11/15		19:17
MAR3L8	D382	23° 51.39'	41° 05.93'	07/11/15	14:09	02:36
MAR1L8	D382	24° 11.72'	49° 42.84'	11/11/15	18:57	01:26
MAR1	JC103	24° 09.98'	49° 44.97'	11/11/15	14:14	04:30
MAR2	JC103	24° 10.96'	49° 45.64'	12/11/15	10:09	02:09
MAR0	JC103	25° 08.22'	52° 01.58'	13/11/15	17:09	02:47
WB6	JC103	26° 29.69'	70° 31.42'	18/11/15	17:54*	02:04
WB4	JC103	26° 28.73'	75° 42.24'	22/11/15	11:41	04:29
WB4L9	D382	26° 28.38'	75° 42.30'	23/11/15	11:07	01:32
WBH2	JC103	26° 28.97'	76° 37.88'	23/11/15	19:41	02:41
WB2	JC103	26° 30.97'	76° 44.30'	29/11/15	18:35	03:55
WB2L9	D382	26° 30.43'	76° 44.43'	24/11/15	16:17	01:18
WB1	JC103	26° 30.45'	76° 48.92'	29/11/15	16:04	01:48
WBADCP	JC103	26° 31.81'	76° 52.02'	24/11/15	19:06	00:30
*exact release time uncertain as communications with release unreliable						

Table 8.2: Summary of moorings recovered on DY039

All mooring recoveries and deployment of the larger moorings used the double barrel capstan winch and reelers along with a block mounted on one of the stern knuckle cranes. Deployment of the heavier anchors was completed using the Lebus deck winch to reduce shock loading the cranes. Short rope moorings and landers were deployed by hand from baskets.

Communciations with the acoustic releases was either through the new hull-mounted transducer fitted for this purpose, or using the “Super-ducer” acoustic command module when communications were poor (which was more often than not the case for all moorings greater than approximately 3000m deep).

The majority of the moorings were trilaterated after deployment to accurately determine their seabed position. This is important for those moorings that are likely to have fallen back a significant distance along the deployment track or at the sites that have a small landing area (WB2 and WB1 especially).

The lander at EB1L (deployed in 2012) was not recovered after it did not rise following acknowledged release commands. The cause is unknown but is thought to be either multiple implosions of buoyancy, physical jamming of the release mechanism or entanglement with abandoned fishing gear.

We also deployed extra sensors on mooring WB1 for the newly funded MeRMEED project (http://gtr.rcuk.ac.uk/projects?ref=NE/N001745/1).

In addition to the mooring design changes to accommodate the ABC Fluxes (see section 10) and MeRMEED sensors the following array changes were made: addition of a 75kHz ADCP at the top of WB4 to measure currents to the surface when the mooring is pulled down; removal of the MAR2 mooring; and extension of MAR3 to reach 50m depth from the previous shallowest depth of 2000m.

Diagrams of the moorings and landers deployed on this cruise are given in Appendix A, and deployment tracks and fall back positions of selected moorings are given in Appendix D.

8.2 RAPID MkIII Telemetry system

This cruise saw the first deployment of the RAPID MkIII telemetry system on the array. Deployment of the system went well with the mooring deployed first and trilaterated to accurately determine the seabed position. The lander was then deployed 150m from the seabed anchor position (see figure 8.1).

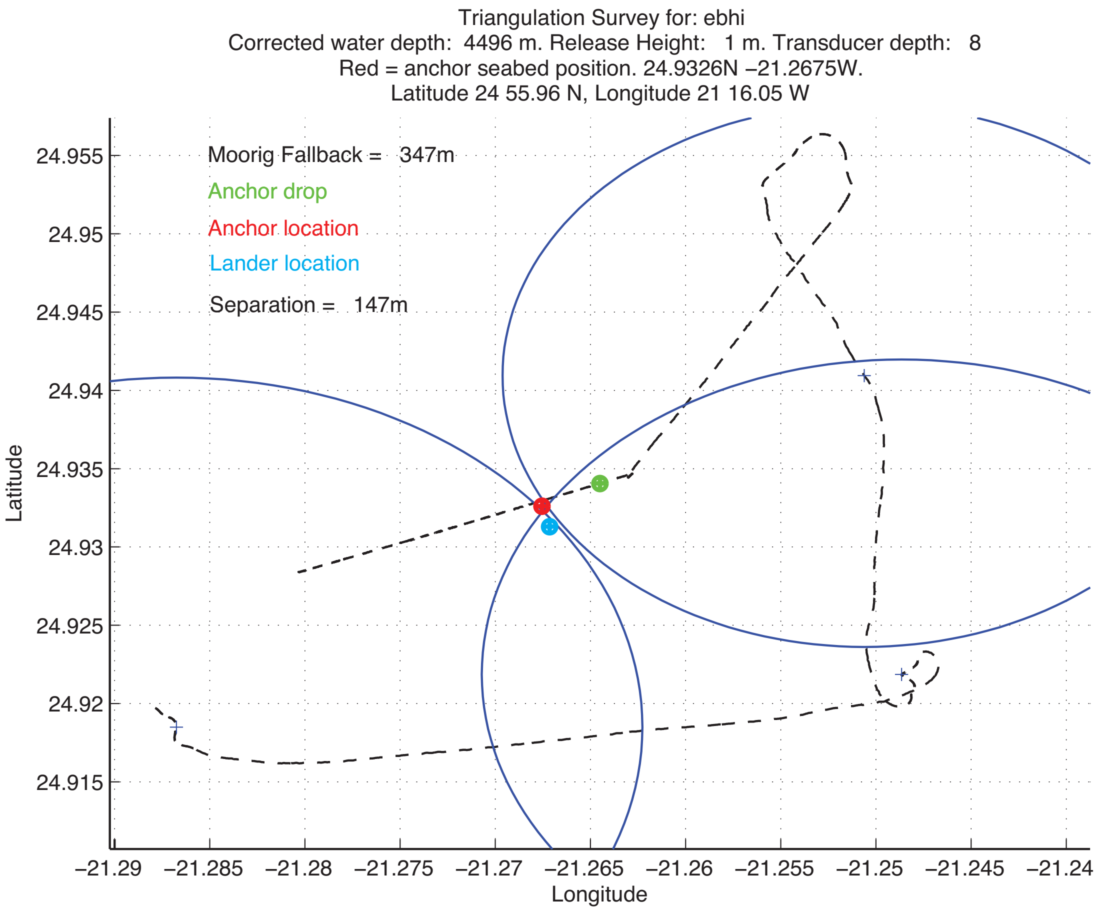


Figure 8.1: Trilateration survey of mooring EBHi with the position of the MYRTLE-X lander also shown. Dashed line = ship track during survey, blue circles = ranges obtained from the mooring acoustic releases at three points around the mooring. The lander was also trilaterated after deployment but only the final position is

shown.

The lander was rigged with eight data pods, of which: one was set to be manually triggered shortly after deployment; six were scheduled to be released spread through the 18 month deployment; and the eighth had the release mechanism physically secured so that it would still be present on the frame when we come to recover the lander in 2017. The mooring sends its data via acoustic modem to the nearby lander which writes them into the datapods. On surfacing the datapods are intended to send the data back to NOC via Iridium short burst data messages.

9. Moored instrumentation and data processing

Ben Moat and Gerard McCarthy

9.1 Instrument setups

The MicroCATs (those without oxygen sensors) deployed on this cruise were all set to sample at hourly intervals with the start time set to be before the mooring was deployed. The MicroCAT-ODOs deployed on WB1, WBH2 and WB4 were set to sample with adaptive sampling turned on, once every four hours, but those on EB1 and MAR1 were mistakenly set to sample hourly. This may mean that the deeper instruments deplete their batteries before the recovery cruise in Spring 2017 as the adaptive sampling runs the pump for longer when at higher pressures and in colder water.

All RCM11s were set to sample hourly with 600 pings per ensemble in burst mode.

All Norteks were set with the following:

Measurement interval (s) : 1800
Average interval (s) : 30
Blanking distance (m) : 0.50
Measurement load (%) : 9
Power level : HIGH
Diagnostics interval(min) : 720:00
Diagnostics samples : 20
Compass upd. rate (s) : 10
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35

All BPRs were set to sample at hourly intervals, with the SBE53s set to average a 60 minute burst into one sample with a frequency reference measurement every 192 tide samples. The SBE26s were set to collect a wave measurement every 999 tide samples to essentially switch off this function.

There were four 75kHz Longranger ADCPs deployed on the array this cruise, with all four set the same way with the parameters shown in table 9.1. The two ADCPs on WB1 were offset in timing by 3 minutes to prevent any interference.

ADCP sn	10311	5575	15579	5599
Mooring	WBADCP	WB1 - looking up	WB1 - looking down	WB4
Transducer depth (ED)	6000 dm	6840 dm	6950 dm	860 dm
Salinity (ES)	35	35	35	35
Time per ensemble (TE)	01:00:00	01:00:00	01:00:00	01:00:00
Time of first ping (TF)	16-Nov-15 16:00	16-Nov-15 15:00	16-Nov-15 16:03	16-Nov-15 18:00
Time per ping (TP)	00:06:00	00:06:00	00:06:00	00:06:00
Blank after transmit (WF)	704 cm	704 cm	704 cm	704 cm
Nuber of depth cells (WN)	40	40	40	40
Pings per ensemble (WP)	10	10	10	10
Depth cell size (WS)	1600 cm	1600 cm	1600 cm	1600 cm

Table 9.1: ADCP setup parameters

24 RBR-SoloT temperature sensors were added to WB1 and these were set with a very high sampling rate of 4 seconds. The low power usage predicts that these sensors will last until 2019 at this high sampling rate.

The setup of the Contros pCO_2 sensors, the Sea-Bird Scientific SeapHOx sensors and the McLane RAS instruments deployed as part of the ABC Fluxes project are covered in section 10.

9.2 Recovered instruments and issues

Appendix B gives the instrument record lengths of the instruments recovered on this cruise, but some additional comments are given below for those instruments that had problems with the data.

9.2.1 MicroCATs

MicroCAT 6803 on MAR0 was not setup for deployment during JC103. No data were recorded.

MicroCAT 6125 on WB4 stopped mid October 2015 due to depleted battery.

MicroCAT 6801 on EB1 had a 125dBar increase in pressure from mid August 2015.

MicroCAT 6126 on WB2 stopped early on the 28th October 2015 due to a battery failure.

MicroCAT ODO 10518 on WB2 has a known pressure offset. Refer to JC103 cruise report.

MicroCAT 6321 on WB2 had a conductivity offset of 8 mS/cm after 24 July 2015

Issues arising from the cal dips are presented in Appendix C.

9.2.2 Current meters

Nine RCM11s were recovered with three having short data records due to depleted batteries. These three instruments typically only lasted five months which is much less than expected and may have been caused by high current drain from the older instruments, but it seems that the RCM11s are on their endurance limits if we wish to maintain at least an hourly sampling rate. RCM11 303 did not record conductivity and RCM11 310 temperature was suspect. Note: the important current meter moorings in the west are measured using Norteks.

Sontek 322 on ebh3 had questionable high current speeds.

Sontek 281 on ebh4 was flooded and returned no data.

Nortek 5896 on WB6 had a low pressure flood on deployment and returned no data.
Nortek 6743 on WB2 had a faulty roll sensor.

Of the three S4 currents meters recovered 35612571 and 35612568 had pressure sensor failures, but this is a known fault that is too expensive to warrant repair.

9.2.3 Bottom pressure recorders

SBE53 s/n 0053 deployed on EBH4L4 suffered a pressure jump of 0.1dbar after 2nd August 2015.
SBE53 s/n 0031 deployed on MAR3L8 suffered a low-pressure flood. No data was recovered.
SBE53 s/n 0002 deployed on WB2L9 was a short record (finished 6th April 2014) due to a pressure sensor failure.

9.3 Moored instrument processing

All data from recovered moored instrumentation were downloaded to PCs, transferred to the network file system and processed on the workstation banba using the matlab processing scripts.

The directory structure used on the NOCS network is mimicked onboard so that under …/rapid/data/moor/ there is a raw directory containing the data copied from the download PCs, and a proc directory containing the processed data arranged by mooring name.

For this cruise the absolute paths on banba were:

/local/users/pstar/rpdmoc/rapid/data/exec/dy039
For the processing scripts arranged by instrument type in sub directories.
/local/users/pstar/rpdmoc/rapid/data/moor/raw/dy039
For the raw data downloaded from the instruments arranged by instrument type, eg. microcat, nor, adcp etc.

/local/users/pstar/rpdmoc/rapid/data/moor/proc
For the processed rodb format data arranged in subdirectories by mooring name, e.g. eb1_12_201425, with sub directories under this by instrument type.

Individual scripts are used for each instrument type and are written so that stage 1 scripts convert the data into rodb ASCII format from the raw files as downloaded from the instruments. Stage 2 scripts remove the launch and recovery periods as defined in the accompanying _info.dat files in the mooring proc directory. If appropriate further processing during stage3 routines is used to apply corrections for magnetic declination and speed of sound assumptions for current meters. More details of the processes can be found in previous cruise reports and will not be duplicated here.

10. ABC Fluxes sensors and sampling

Pete Brown and Darren Rayner

10.1 McLane Remote Access Samplers (RAS)

10.1.1 Background

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.

The RAS has been successfully deployed among other places on a Hawaiian coral reef [*Shamberger et al.*, 2011] and in the North West Pacific [*Honda and Watanabe*, 2007]. However, there has not yet been a long-term (2 weeks +) deployment of the RAS that has successfully been able to capture samples for analysing the marine carbonate system. Systematic biases in both dissolved inorganic carbon and total alkalinity compared to discrete sampling approaches have been identified and attributed to various aspects of the sample collection and storage process. As yet, these have not been fully answered.

Four RAS are being deployed 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). These will hopefully capture the signal of much higher frequency variability in concentrations of carbon and associated parameters that are currently beyond the capabilities of repeat hydrography.

Mooring	Sampler S/N	Colour code	Deployment date	Last sample to be collected
EB1	13278-05	Green	03-11-2015	24-03-2017
MAR1	13278-04	Blue	12-11-2015	02-04-2017
WBH2	13278-02	Yellow	24-11-2015	25-04-2017
WB1	13278-02	Red	30-11-2015	20-04-2017

Table 10.1: RAS summary

10.1.2 Instrument preparation

The NOC Standard Operating Procedure for RAS deployment [*Brown and Rayner*, 2015] was followed during the instrument setup for all four RAS deployed as part of this trip. In each case the following main considerations were made:

- Controller unit opened, power connected to main circuit board and back-up batteries (2xAAA) installed. Controller housing o-ring checked for dirt and hairs, and cap reinstalled. RAS then connected to PC and woken up.
- Pump test carried out to check correct pumping rate.

- Pressure compensation tubes and fittings were removed from each sample cap to enable filling of sample cylinders.
- Sample bags installed in acrylic cylinders
- Samples lines filled with dilute mercuric chloride as sample preservative
- Acrylic cylinders filled with water, sample bag on/off valves opened and sample caps secured. Acrylic cylinders back-filled through compensation tube openings
- Sample inlet cap removed, replacement installed and instrument set up to deploy.

10.1.3 Sampling parameters / program

At each specified time-point, the RAS will follow the same schedule of activities:

- Valve turns from Home to Port 49
    - freshwater flush of 10 mL (from freshwater [milliQ] reservoir in bag at port 49)
- Valve turns from 49 to home
    - local seawater flush of 100 mL
- Valve turns from Home to port of sample bag to be filled
    - Local seawater fills sample bag: 500mL
- Valve turns from sample port to Home

The pump works at approximately 70-80 mL/min, meaning the collection of a single sample takes approximately 10 minutes.

A number of deviations from the standard operating procedure were noted for individual mooring deployments. The standard operating procedure has been modified to account for the issues that arose:

EB1 – deployed 03/11/2015

- RAS time and date was set to UTC. Local time was UTC -1.
- The bolt between sample locations A & 1 could not be fully tightened due to a possible issue with the thread.
- The bolt between sample locations 13 & 15 could not be fully tightened due to a possible issue with the thread.
- Due to the possible hydrophilic/static nature of sample bag material, multiple tiny air bubbles are stuck to the outside of multiple sample bags. These occurred during the filling of the acrylic cylinders.
- The water filter tubing was not attached to anything. Tubing was not grouped together and cable-tied prior to being directed beneath the retaining bars.
- During instrumental setup (pump primed, top line filled, bottom lines prefilled, acrylic cylinders 90% filled than backwards pumped to full), some air managed to get into the sample lines / push the sample preservative bag. This was thought initially be due to the sample inlet cap not being in place until ~sample bottle 10. An assessment of the quantity of air in the lines was made and displayed in Table 10.2.

Sampling schedule:

The first sample was set to be not long after deployment for calibration. The second sample was at midnight (local time) so that the offset can be compared to the deployment sample. A further 46 samples at 11-day intervals were programmed. Therefore, 507 days plus 11 days for replacement RAS to be deployed to continue 11 day timeseries. The specific sample times are given in table 10.3.

At the time of deployment, the final readout from the RAS was:

Date	Time	Battery	Temp	Port
11/02/15	22:48:23	32.6 Vb	26.1C	00 (home)

MAR1 – deployed 12/11/2015

- RAS time and date was set to UTC. Local time was UTC -1.
- The water filter tubing was not attached to anything. Tubing was not grouped together and cable-tied prior to being directed beneath the retaining bars.
- During instrumental setup (pump primed, top line not filled, bottom lines not prefilled, acrylic cylinders 90% filled than backwards pumped to full), 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:

Substantial quantities of air were present in practically every line. The sample inlet cap was in place throughout this time so it was thought that this was not the cause. Instead, it was thought that because the top (filter) line had not been filled that this was the source of the air entering the sample line and pushing the preservative into the bag. This should not be an issue, as the volume of the sample line is known, and so a suitable correction to the sample CO_2 concentrations can be made to account for this headspace.
During filling of cylinders, valve location was accidentally left on port 1. This led to water draining from cylinder and water entering bag. This bag was removed, replaced with fresh, and retained for use as a freshwater flush bag (49).

Sampling schedule:
First sample on deployment for calibration. Second sample at 0100 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 11 day timeseries. Timing of sampling changed from EB1 – it was realised that it would take the Contros pCO_2 sensor ~57 minutes to make a measurement. Starting at midnight, it would therefore be very nearly 0100 by the time it captured a measurement. It was therefore thought better to time the collection of the water sample to be as close as possible to this.

At time of deployment, final readout of RAS was:

Date	Time	Battery	Temp	Port
11/12/15	01:33:39	32.9 Vb	28.9°C	00 (home)

WBH2 – deployed 24/11/2015
- RAS time and date was set to UTC. Local time was UTC -4.
- 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 in table 10.2

Compared to RAS-MAR1, there is a vast difference in the quantity of air in the lines. This is due to the way the cylinders were filled, requiring no use of the valve.

An issue was found when taping the fittings located at the bottom of the sample cylinders. Doing this in the incorrect direction can cause it to become detached. This was the case with cylinder ~18 where the fitting did detach. Only a couple of drops of water were lost before the fitting was reattached. This happened similarly for sample cylinder 20.

When the sample inlet cap was removed for deployment and replaced, water could be seen to drain from the filter tubing. It was thought that this was because the pump waste outlet was now located well below the valve, causing it to draw the water through.

Sampling schedule:
First sample on deployment for calibration. As it was located at midnight local, there was no need for a second offset sample to be taken. Further 47 samples at 11-day interval. Therefore, 518 days plus 11 days for replacement RAS to be deployed to continue 11 day timeseries.

At time of deployment, final readout of RAS was:

Date	Time	Battery	Temp	Port
11/24/15	01:33:39	33.1 Vb	25.0°C	00 (home)

WB1 – deployed 30/11/2015

- RAS time and date was set to UTC. Local time was UTC -4.
- 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 in table 10.2.

Sampling schedule:
First sample on deployment for calibration. As this was afternoon, a second was scheduled to be taken at 00:05 local to compare with other sensor measurements. Further 46 samples at 11-day interval. Therefore, 507 days plus 11 days for replacement RAS to be deployed to continue 11 day timeseries.

Date	Time	Battery	Temp	Port
11/30/15	00:47:24	33.0 Vb	26.6°C	00 (home)

Sample line	Notes on preservative			
	EB1	MAR1	WBH2	WB1
1	Air fills sample line. Preservative likely in bag.	60% air	No air in line	No air in line
2	A few bubbles	75% air	No air in line	No air in line
3	As for 1	80% air	No air in line	~5cm air at sample cap end
4	As for 1	60% air	~3cm air at sample cap end	~12cm air at sample cap end
5	~5 cm of preservative still visible	95% air	~1cm air at sample cap end	2 small bubbles
6	~1 cm of preservative still visible	95% air	~1cm air at sample cap end	1 small bubble
7	As for 6	66% air	~3cm air at sample cap end	~5cm air at sample cap end
8	As for 1	75% air	~1cm air near valve head	No air in line
9	As for 1	99% air	No air in line	1 small bubble
10	~2 cm air in total	90% air	~1cm air at	1 small bubble

			sample cap end	
11	1 small bubble	100% air	2 small bubbles	Air from middle to sample cap
12	~7 cm air in total	50% air	~1cm air at sample cap end	2 small bubbles
13	~4 cm air in total	100% air	No air in line	~3cm air in middle
14	~1 cm air in total	75% air	~3cm air at sample cap end	2 small bubbles at sample cap
15	~4 cm air next to valve head	45% air	No air in line	~3cm air in middle
16	2 small bubbles	30% air	No air in line	No air in line
17	~2 cm air next to valve head	40% air	No air in line	~1cm air at sample cap end
18	~2 cm air next to valve head	40% air	No air in line	~1cm air in middle
19	1 small bubble	45% air	No air in line	2 small bubbles
20	1 small bubble	No air in line	No air in line	~1cm air in middle
21	1 tiny bubble	50% air	No air in line	~10cm air at valve head
22	~6cm of air	95% air	No air in line	No air in line
23	~10 cm air	99% air	No air in line	~3cm air at valve head
24	As for 22	85% air	1 small bubble	No air in line
25	~5 cm air next to valve head	65% air	~1cm air at sample cap end	~7cm air in middle
26	No air in line	99% air	No air in line	1 small bubble
27	~7 cm air in total	100% air	No air in line	~7cm air at valve head
28	1 small bubble	90% air	No air in line	No air in line
29	~1 cm air in total	100% air	~3cm air at sample cap end	~7cm in middle
30	No air in line	90% air	No air in line	No air in line
31	1 small bubble	100% air	No air in line	No air in line
32	No air in line	100% air	No air in line	~5cm air in middle
33	1 small bubble	100% air	No air in line	No air in line
34	~2 cm air in total	90% air	No air in line	~3cm air at valve head
35	~7 cm air in total	80% air	No air in line	No air in line
36	No air in line	100% air	~3cm air at sample cap end	~10cm air at sample cap end
37	~1 cm air in total	100% air	~5cm air at sample cap end	No air in line
38	~1 cm air in total	50% air	~1cm air at sample cap end	~7cm air in middle
39	~6 cm air in total	60% air	~1cm air at sample cap end	~7cm air in middle
40	1 small bubble	100% air	~0.5cm air at sample cap end	3 small bubbles
41	1 small bubble	3 small bubbles	~8cm air at sample cap end	2 small bubbles
42	~1 cm air at valve head	No air in line	No air in line	No air in line
43	1 small bubble	40% air	~5cm air at	No air in line

			sample cap end	
44	No air in line	100% air	1 small bubble	~1cm air at valve head
45	~4 cm air at valve head	30% air	~1cm air at sample cap end	No air in line
46	~2 cm air in total	60% air	~5cm air at sample cap end	1 small bubble
47	No air in line	95% air	No air in line	~3cm at valve head
48	~1 cm air in total	95% air	1 small bubble	2 small bubbles
49	No air in line	No air in line	No air in line	No air in line

Table 10.2: RAS Pre-deployment sample line assessment: location of preservative

Sample number	RAS Sampling Date/Time (GMT)			
	EB1	**MAR1**	**WBH2**	**WB1**
1	03/11/15 18:00	13/11/15 00:30	25/11/15 04:00	30/11/15 18:45
2	04/11/15 01:00	13/11/15 04:00	06/12/15 05:00	01/12/15 04:05
3	15/11/15 01:00	24/11/15 04:00	17/12/15 05:00	12/12/15 04:05
4	26/11/15 01:00	05/12/15 04:00	28/12/15 05:00	23/12/15 04:05
5	07/12/15 01:00	16/12/15 04:00	08/01/16 05:00	03/01/16 04:05
6	18/12/15 01:00	27/12/15 04:00	19/01/16 05:00	14/01/16 04:05
7	29/12/15 01:00	07/01/16 04:00	30/01/16 05:00	25/01/16 04:05
8	09/01/16 01:00	18/01/16 04:00	10/02/16 05:00	05/02/16 04:05
9	20/01/16 01:00	29/01/16 04:00	21/02/16 05:00	16/02/16 04:05
10	31/01/16 01:00	09/02/16 04:00	03/03/16 05:00	27/02/16 04:05
11	11/02/16 01:00	20/02/16 04:00	14/03/16 05:00	09/03/16 04:05
12	22/02/16 01:00	02/03/16 04:00	25/03/16 05:00	20/03/16 04:05
13	04/03/16 01:00	13/03/16 04:00	05/04/16 05:00	31/03/16 04:05
14	15/03/16 01:00	24/03/16 04:00	16/04/16 05:00	11/04/16 04:05
15	26/03/16 01:00	04/04/16 04:00	27/04/16 05:00	22/04/16 04:05
16	06/04/16 01:00	15/04/16 04:00	08/05/16 05:00	03/05/16 04:05
17	17/04/16 01:00	26/04/16 04:00	19/05/16 05:00	14/05/16 04:05
18	28/04/16 01:00	07/05/16 04:00	30/05/16 05:00	25/05/16 04:05
19	09/05/16 01:00	18/05/16 04:00	10/06/16 05:00	05/06/16 04:05
20	20/05/16 01:00	29/05/16 04:00	21/06/16 05:00	16/06/16 04:05
21	31/05/16 01:00	09/06/16 04:00	02/07/16 05:00	27/06/16 04:05
22	11/06/16 01:00	20/06/16 04:00	13/07/16 05:00	08/07/16 04:05
23	22/06/16 01:00	01/07/16 04:00	24/07/16 05:00	19/07/16 04:05
24	03/07/16 01:00	12/07/16 04:00	04/08/16 05:00	30/07/16 04:05
25	14/07/16 01:00	23/07/16 04:00	15/08/16 05:00	10/08/16 04:05
26	25/07/16 01:00	03/08/16 04:00	26/08/16 05:00	21/08/16 04:05
27	05/08/16 01:00	14/08/16 04:00	06/09/16 05:00	01/09/16 04:05
28	16/08/16 01:00	25/08/16 04:00	17/09/16 05:00	12/09/16 04:05
29	27/08/16 01:00	05/09/16 04:00	28/09/16 05:00	23/09/16 04:05
30	07/09/16 01:00	16/09/16 04:00	09/10/16 05:00	04/10/16 04:05
31	18/09/16 01:00	27/09/16 04:00	20/10/16 05:00	15/10/16 04:05
32	29/09/16 01:00	08/10/16 04:00	31/10/16 05:00	26/10/16 04:05
33	10/10/16 01:00	19/10/16 04:00	11/11/16 05:00	06/11/16 04:05
34	21/10/16 01:00	30/10/16 04:00	22/11/16 05:00	17/11/16 04:05
35	01/11/16 01:00	10/11/16 04:00	03/12/16 05:00	28/11/16 04:05
36	12/11/16 01:00	21/11/16 04:00	14/12/16 05:00	09/12/16 04:05
37	23/11/16 01:00	02/12/16 04:00	25/12/16 05:00	20/12/16 04:05
38	04/12/16 01:00	13/12/16 04:00	05/01/17 05:00	31/12/16 04:05
39	15/12/16 01:00	24/12/16 04:00	16/01/17 05:00	11/01/17 04:05

40	26/12/16 01:00	04/01/17 04:00	27/01/17 05:00	22/01/17 04:05
41	06/01/17 01:00	15/01/17 04:00	07/02/17 05:00	02/02/17 04:05
42	17/01/17 01:00	26/01/17 04:00	18/02/17 05:00	13/02/17 04:05
43	28/01/17 01:00	06/02/17 04:00	01/03/17 05:00	24/02/17 04:05
44	08/02/17 01:00	17/02/17 04:00	12/03/17 05:00	07/03/17 04:05
45	19/02/17 01:00	28/02/17 04:00	23/03/17 05:00	18/03/17 04:05
46	02/03/17 01:00	11/03/17 04:00	03/04/17 05:00	29/03/17 04:05
47	13/03/17 01:00	22/03/17 04:00	14/04/17 05:00	09/04/17 04:05
48	24/03/17 01:00	02/04/17 04:00	25/04/17 05:00	20/04/17 04:05

Table 10.3: Sample timing for RAS deployed on EB1, MAR1, WBH2 and WB1

10.2 Sea-Bird/Satlantic SeapHOx sensors

10.2.1 Background

The Sea-Bird Scientific Deep SeapHOx pH, temperature, salinity, pressure and oxygen sensor is the combination of a Satlantic (www.satlantic.com) SeaFET pH sensor with a Sea-Bird MicroCAT CTD and SBE63 oxygen optode. Although the MicroCAT-ODO is a well-developed piece of instrumentation, the Deep SeaFET pH sensor is very novel with sensor serial numbers 2, 3 & 4 being used on this deployment (S/N 1 was the prototype). Previously rated to 50m depth, a new pressure housing developed over summer 2015 and the removal of the internal electrode has increased its depth capacity to 2000m.

The pH sensor uses ion-selective field effect transistor (ISFET) technology – essentially a pH sensitive electrode whose electric potential is related to the activity of protons ([H^+] ions) in the surrounding medium. Using concurrent measurements of temperature, salinity and pressure provided by the MicroCAT-ODO, pH measurements can be generated at a frequency of 10Hz to a resolution of 0.0001 pH units and a precision of 0.001 pH units. Battery endurance is thought to be 18 months +, depending on deployment strategy employed.

This is the first time that these deep-rated pH sensors have been used in the SeapHOx configuration. However, the same deep-water pH sensors are currently being employed on SOCCOM profiling floats in the Southern Ocean (www.soccom.princeton.edu), and the ISFET technology has been widely characterised in laboratory, shallow mooring and buoy settings [*Bresnahan Jr et al.*, 2014; *Cullison Gray et al.*, 2011; *Martz et al.*, 2010]. The downside of their novelty is that they have not been thoroughly tested and field-proven, and neither has the software to control them (SeaFETCom) nor the manual been updated to accommodate them and their unique characteristics.

The SeapHOx sensors used on this trip were built, configured and calibrated to a depth rating of 2000m at SBE in the US and Satlantic in Halifax, Canada. Serial Numbers 2 and 4 were despatched to Tenerife, Spain and joined the ship at its port call there on 24 October. Production and calibration issues with SN3 meant that its despatch was delayed, instead being delivered to the ship at Nassau during its port call on 21 November.

10.2.2 Communication / setup

SeaFETCom software provided by Satlantic was used to communicate and program each sensor. The process entailed the same general steps:

- Ensure batteries are in both SeaFET and MicroCAT. If not then install, and ensure the two are connected by cable.
- Connect the communication cable to the combined SeapHOx cable

- Plug the USB cable into either PC or Mac
- Start SeaFETCom software
- Click "Connect to sensor". At this point it will either establish a live link to the sensor or if the sensor is in storage 'deep sleep' mode, it will request the sensor be woken up. This is done by holding a magnet to the end of the sensor housing until a green LED starts flashing. A connection can then be re-sought.
- Settings can then be checked / changed and uploaded to instrument.
- Click "Start". A message stating when the next sampling interval will start will be issued, plus a warning regarding the fact that this will drain the battery.
- Close the SeaFETCom software
- Eject the mounted sensor in Finder (Mac) or through connected USB devices (Windows)
- Remove USB cable from computer, communication cable from the SeapHOx and install the dummy plug.

10.2.3 SeapHOx SN2 & SN4 Pre-deployment calibration CTD

There was some initial confusion as to the necessity of conditioning the sensor electrodes in local seawater prior to deployment. However, after consultation with *Bresnahan Jr et al.* [2014] it was decided that this was actually best practice. Electrode conditioning is unique to each electrode and can take anything between 24 hours to 1 week plus.

To learn how to set up and deploy the sensors and to better understand how they behave a test CTD was conducted to 1000m. While this was to initiate the conditioning, it was also hoped that sensor outputs could be compared with discrete bottle samples collected for analysis of the inorganic carbon system and act as an additional pre-deployment calibration/comparison. Both sensors were put into continuous mode and attached to the CTD frame for a cast on the 1st November.

Analysis of the outputs showed that SN4 was much more stable, with SN2 showing much more variable outputs, even during the bottle stops. It was also found that SN2 did not compute pH. Both instruments did however collect the voltage, temperature, salinity, pressure and oxygen data necessary to calculate it. Due to these results it was decided to use SN4 for the first deployment at EB1 so that more time could be devoted to SN2, and advice could be sought from the manufacturers.

10.2.4 Battery endurance calculation – SN4

An estimate of the battery endurance was made using the example scenarios (specifically example II, SeaFET coupled to a CTD) within the SeaFET manual (vSAT-DN-00590-1.2.4-51, Date: 2015-01-08 03:36). Following this method, for a frame burst size of 20 (number of 10Hz measurements to collect) and an average of 1 (the number of these that should be averaged at any one time), it was calculated that with a sampling interval of 20 minutes the instrument would have an endurance of 594 days. This gave substantially different values to those within the SeaFETCom software, but we were advised to follow the manual. SN4 was thus programmed with these settings and deployed at EB1 on the RAS frame. As the CTD pump would not start until it sensed water then it was safe to set the SeapHOx deployment going prior to putting on the frame, rather than inputting a sampling delay.

10.2.5 Laboratory testing – SN2

Given the poor data quality relative to SN4 and the issue with it not producing pH outputs (just the raw voltages), SN2 was run in a seawater reservoir in the General

Purpose Laboratory and settings varied to investigate its response. Firstly, pH was calculated using the raw values from the CTD profile. Following the calculation scheme in the manual gave very erroneous outputs (pH >11 throughout the water column). Following the MATLAB scripts from *Bresnahan Jr et al.* [2014], gave much more reasonable numbers, but did not include a pressure correction. The manufacturer was contacted and MATLAB scripts including the pressure correction were received and true pH outputs generated.

Investigation of experiments with frame/burst size and averaging schemes revealed critical sampling behaviour of the SeapHOx that was not apparent from the software/manual/communication with the manufacturer. No matter the average/burst setting (up to a maximum of 30) individual data points appeared to only be generated every 3-4 seconds, rather than the 0.1s stated in the instrument specifications. Settings of average 1 burst 20 did not produce 20 measurements over a period of 2 seconds, but 20 measurements spaced 3.1-3.9 seconds apart. Settings of average 20 burst 1 (interval 5 minutes) did however produce a single data point every 300 seconds. Moving between the two sampling regimes (for the same water) also worrying gave a small systematic jump in pH levels that has not yet been addressed.

The cause of the sampling issues was found to be the slave CTD. This only takes a measurement every 3 seconds and so is the rate-limiting step in the instrument relationship. Specifying a SeaFET burst of 30 actually leads to 30 CTD samples being requested, taking a total of 105s (3.5s /sample x 30), plus the initial CTD flushing time of 40s. Thus, 145s in total rather than the expected 43s.

Following these results the battery endurance of SN4 was recalculated. The initial estimate used a sample time of 0.1s, but for the new calculation this was increased to 3.5s (the time of the CTD sampling). The new endurance calculated was 263.9 days for the main battery and 623.5 for the isolated battery, the lower value being the realistic expectation. Battery endurance was also calculated separately for the MicroCAT-ODO. Assuming that 60 samples were being taken an hour (sampling interval 30 minutes, 30 samples per interval) and there were two flush times gave an endurance of either 150.1 days (assuming 1 pump = 1s) or 64.4 days (assuming 1 pump = 2.8s). Clearly the SN4 MicroCAT-ODO will run out of power before the SeaFET, and together they will not be able to cover even 9 months, let alone the expected 18 months.

10.2.6 Battery endurance calculation – SN2

The sampling strategy for the remaining SeapHOxes was adapted to account for the new battery endurance paradigm. SN2 was set to a sampling interval of every 4 hours (240 minutes) with an average of 30 and a burst of 1. This meant that the maximum number of data points could be collected during the CTD sampling time, but that only a single CTD sample would be taken. Using these new settings, the SeaFET battery endurance calculation gave a main battery life of 1935.2 days and 580.1 for the isolated battery. For the MicroCAT-ODO, new estimates of 554.1 days (1 pump = 1s) or 1416.9 days (1 pump = 2.8s) were achieved.

SN2 was filled with new batteries the day before deployment. This is because the electrode requires up to 24 hours to get up to working temperature after power has been removed. The sensor was programmed the night before deployment and left in a seawater reservoir to start its sensing, prior to being removed and attached to the RAS frame first thing in the morning before deploying.

10.2.7 Laboratory testing – SN3

SN3 was delivered to the ship on the 21st November. It was filled with batteries the following day, and installed in the seawater reservoir in the General Purpose Laboratory for testing prior to being setup for deployment. Initial settings were interval 30 minutes, average 1 and burst 30. Over the next few days this gave relatively stable outputs, but with a dual population in values, with every 4th/5th data point being separated low to the rest. Settings were changed to interval 5 minutes, average 30, burst 1. This gave stable outputs at the level of the high population obtained using the former settings.

10.2.8 SN3 – test CTD profile and mooring setup

The senor was placed in continuous mode and installed on the CTD so that a test profile (to 1400m) could be performed for calibration of the oxygen sensor (and enabling discrete bottle samples for carbon analysis to be taken). At ~875m on the downcast the performance of the pH sensor became very erratic and didn't recover, with both calculated pH and raw voltages showing an enormous range. The MicroCAT oxygen measurements were not affected. Back in the lab, the sensor was reprogrammed to its prior formation, interval 5 minutes. Performance did recover to normal levels, but had periods of very atypical data (systematically offset). It was decided that although the sensor was not in perfect functioning order, it was now only periodically outputting bad numbers, and that it could be deployed in this state (there was also no alternative).

SN3 was filled with new batteries the evening before deployment. The sensor was programmed the night before deployment and left in a seawater reservoir to start its sensing, prior to being removed and attached to the RAS frame first thing (after its 0800 local sampling) before deployment.

Mooring Location	Deployment date	Serial Number	Sampling time:	Settings
EB1	03-11-2015	SN4	Every 20 minutes	Average 1, Burst 20
MAR1	12-11-2015	SN2	Every 4 hours starting 00:00 local (03:00 UTC)	Average 30, Burst 1
WB1	30-11-2015	SN3	Every 4 hours starting 00:00 local (04:00 UTC)	Average 30, Burst 1

Table 10.4: Summary of SeapHOx setups

10.3 Contros HydroC CO_2 sensors

10.3.1 Background

The Contros Systems & Solutions GmbH (www.contros.eu) HydroC is a membrane-diffusion-based submersible pCO_2 sensor that can be deployed in all conditions and up to 6000 m in depth. It uses a gas-permeable membrane to equilibrate seawater pCO_2 with an internal headspace that is continually circulated, dried by soda lime, and analysed by non-dispersive infrared absorption (NDIR) spectroscopy. The sensor is capable of measurements at intervals of 1s to 1week for a period up to and including 18 months dependent on deployment conditions, and can be used in an online or autonomous mode.

Although this is the first time that we have used these instruments, HydroC sensors have been widely used, including mock seabed CO_2 release studies [*Atamanchuk et al.*, 2015], profiling floats [*Fiedler et al.*, 2013], ship-based underway systems [*Fietzek et al.*, 2014] and multiple buoy and mooring installations.

The sensors used on this trip were configured with flow-through head and pumps (in this instance low-power Sea-Bird Electronics 5M pumps) that directly move seawater across the anti-fouling copper-protected membrane, speeding up the equilibration and response time.

10.3.2 Calibration

Each sensor was specially calibrated in Kiel, Germany on 27-28 Nov 2014, and was unused until this trip. Calibration conditions had been chosen to optimize performance in subtropical waters at ~50 m depth, but allowing for substantial knockdown (200m+). Specifically, calibration was performed in waters of 15-30°C for a measuring range of 200-1000 µatm.

10.3.3 Sensor specific information

Mooring Location	Deployment date	Serial Number	Sampling time: local (UTC)	Settings
EB1	03-11-2015	1114-001	10:00-10:58 (11:00-11:58)	Zero (Average 10s, Log 10s) Flush (Av. 1, Log 1) Measure (Av. 10, Log 60)
MAR1	12-11-2015	1114-002	23:03-00:00 (02:03-03:00)	Flush (Average 5s, Log 5s) Measure (Av. 10s, Log 10s)
WB1	30-11-2015	1114-003	23:03-00:00 (03:03-04:00)	Zero (Average 5s, Log 10s) Flush (Av. 5s, Log 5s) Measure (Av. 10s, Log 10s)

Table 10.5: HydroC sensor specific information

10.3.4 Setup

As the sensors were to be used in autonomous mode, external battery packs were used. Due to the length of the deployment, bespoke Contros HydroB for single cell battery packs (7S12P) were used, accommodating 84 Lithium D-cells (Saft LSH-20). Following conversations with the manufacturer prior to the cruise, it was felt that this should be sufficient power for a daily measurement over a period of 18 months.

A combined power / communication cable supplied with sensor was used to connect it to the mains / computer respectively. Unfortunately, due to the lack of a combined cable for connecting a computer and battery pack at the same time, it was not possible to setup the sensor when already connected to the battery power source. The sensors were set up using the Contros Detect software package (currently PC only). It was not possible to program the sensor with a completely bespoke sampling schedule. Instead, programming was limited to continuous mode, polled mode or specific autonomous repeatable timepoints (e.g. same hour of each day).

A daily measurement at the same time each day was therefore chosen as the best sampling strategy, with the target being for the instrument to wake up at midnight (local) each day. Each daily measurement was set to comprise the steps shown in Table 10.6.

Step	Action	Duration (minutes)	Cumulative time	Time of day (local)
1	Sensor wake up	2	(0)	
2	Warm-up	35	35	23:03 – 23:38
3	Zero	2	37	23:38 – 23:40
4	Flush	18	55	23:40 – 23:58
5	Measure	2	57	23:58 – 00:00
6	Sleep	1383	1440 (24 hours)	00:00 – 23:03

Table 10.6: Process steps during single sample measurement for HydroC.

10.3.5 Individual sensor deployments

EB1 – S/N 1114-001 - deployment on morning of 03 November 2015

Due to a quirk of the instrument setup procedure, once the sampling schedule has been set and power is connected to the sensor then it will run continuously until the end of the first sampling period, at which point it will enter sleep mode. Due to a lack of hands-on experience with the sensor prior to the cruise and lack of clarity in the sensor manual, this was only picked up as the sensor was being readied for deployment by attaching to the RAS frame at approximately 0830. Final connection of the battery pack caused both the sensor and pump to start running; without further intervention, they would have continued running until the end of the first programmed sample at 0057, nearly 15 hours later. This would likely have had a catastrophic effect on the battery life and future sampling capabilities. The sampling schedule for this sensor was thus quickly changed before it went into the water. Wake-up time was set to 10:00 local with sleep mode starting at 10:58. The instrument was deployed at 09:13 local, meaning the system would only be running for ~1 hour longer than hoped for (equivalent to 1 daily measurement). Unlike the other deployments, this sensor will be out of sync with the other instruments attached to the RAS frame, measuring at 10:00 local time instead of midnight.

MAR1 – S/N 1114-002 - deployment on morning of 12 November 2015

Following deployment of the EB1 sensor suite and the sampling/power issues that were raised at the last moment (and due to the gap before the next timed deployment) laboratory testing of 1114-002 was carried out. A local surface seawater reservoir was set up in a plastic crate in the sink of the main laboratory and the sensor was submerged, connected to mains power and a PC and set to sample every 24 hours, mimicking a true deployment. Exact timings of the measurement process were interrogated to see if they could be optimized further. It was found that the wake-up time did not need accounting for in the process schedule, and that warm-up mode was being reinitialized for the remaining time left set after the measurement phase had completed. Output files were found to be colon-separated rather than comma-separated. These were changed in time for the MAR1 deployment.

Sensor output frequencies were also analysed. The HydroC typically outputs at 1Hz, but has the capacity to average measurements to user-specified intervals. Factory settings use different intervals for the individual stages of the measurement: Zero, data recorded every 10 s as an average of the preceding 10s; Flush, data recorded every 1s; Measure, data recorded every 60s as an average of preceding 10s. These were the settings in use for EB1. In order to increase the data frequency during the measurement stage and at the same time decrease the size of the result file, the Flush stage was changed to 1 data point every 5 s as an average of 5 s, and the Measure stage was changed to 1 data point every 10 s as an average of 10 s.

To overcome the issue regarding the start-up procedure, the sensor was programmed to make its first measurement the night before final deployment in the laboratory. Wake-up / warm-up was set to begin at 23:03 local time, so the final measurement phase would occur from 23:58 – 00:00. The sensor was connected to its battery pack at 22:55 and was found to have entered sleep mode at 00:00 following a measurement. The following morning it was removed from its laboratory reservoir and attached to the RAS frame prior to being deployed at 10:46 local time.

WB1 – S/N 1114-003 - deployment on morning of 30 November 2015

Similar to MAR1, the sensor was set up to begin measurements the night before deployment. Settings and local sampling times were as for MAR1.

10.4 Discrete Chemical Sampling

Pete Brown, Darren Rayner, Gerard McCarthy

Discrete bottle samples were collected for the later analysis of dissolved inorganic carbon, total alkalinity, inorganic nutrients and organic nitrogen on a number of CTD stations. These were either for providing an independent, in situ pH sensor calibration profile, or Niskin closures were timed to coincide with the collection of the first water sample by a recently deployed Remote Autonomous Sampler (RAS).

10.4.1 Inorganic carbon

A total of 6 stations were sampled. Details of these are given in Table 10.7, including details of the number / depth of samples collected. In each case borosilicate glass bottles supplied by the University of Exeter were used to collect seawater from the rosette immediately after oxygen samples were taken. A short piece of Tygon tubing, pre-soaked in freshwater to keep supple and to reduce the build-up of bubbles, was attached to the Niskin spigot and used to draw water into clean, pre-washed bottles. Bottles were rinsed once, then filled slowly from the bottom and overflown a minimum of a full bottle volume. The stopper was washed using overflowing water prior to being inserted into the bottle, making sure to not trap any bubbles. Samples were fixed in the general purpose laboratory by first creating a headspace (by removing 1% of bottle volume using Pasteur pipette) prior to preserving with saturated mercuric (II) chloride ($HgCl_2$) according to *Dickson et al.* [2007]. The ground glass of the bottle neck and stopper were then dried with blue tissue, Apiezon grease applied and the stopper inserted completely. The stopper was twisted to remove residual air from the grease and to ensure a complete seal was made. Finally, a securing elastic band was placed on the bottle and the sample preservative mixed through by inverting the bottle a number of times. Samples were stored in a fridge at approximately 6°C until the end of the cruise. At the time of first sampling of each surface layer RAS (i.e. not the one on WBH2), additional replicates were also taken from the ship's non-toxic seawater supply. Apart from for the pH calibration dips, a minimum of 4 duplicate samples were collected at different depths.

10.4.2 Inorganic nutrients / organic nitrogen

Samples were collected directly (without Tygon tubing) into 125 mL (4 oz) Nalgene plastic screw-top bottles. Each bottle was rinsed out 2-3 times before being filled to approximately 75% full and immediately frozen for later analysis. All Niskins noted in Table 10.7 were sampled in duplicate for nutrients.

Date	Station	Location	Sample Depths	Comments
01-11-15	CTD 5: pH sensor pre-deployment calibration	23.50°N 24.11°W	1000, 750, 500, 250, 100, 50 m	No nutrient samples taken
03-11-15	EB1 post-deployment RAS calibration	23.76°N 24.16°W	125, 100, 75, 50, 25m	Oxygen and carbon/nutrient samples from different Niskins at 25m. Two underway samples also taken during CTD
12-11-15	MAR1 post-deployment RAS	24.11°N 49.46°W	125, 100, 75, 50, 25 m	One underway carbon sample also taken during CTD

	calibration			
25-11-15	WBH2 post-deployment RAS calibration	26.27°N 76.39°W	1800, 1700, 1600, 1500, 1400, 1300	Carbon & nutrient samples taken 20 minutes after Niskins opened
29-11-15	pH sensor pre-deployment	26.30°N 76.49°W	1400, 1100, 800, 400, 25	Oxygen and carbon samples only
30-11-15	WB1 post-deployment RAS calibration	26.30°N 76.49°W	175, 125, 100, 75, 50, 25	Oxygen and carbon/nutrient samples

Table 10.7. Summary of CTD casts sampled for carbon / nutrients

10.5 References

Atamanchuk, D., A. Tengberg, D. Aleynik, P. Fietzek, K. Shitashima, A. Lichtschlag, P. O. J. Hall, and H. Stahl (2015), Detection of CO_2 leakage from a simulated sub-seabed storage site using three different types of pCO_2 sensors, *International Hournal of Greenhouse Gas Control*, *38*, 121-134, doi: 10.1013/j.ijggc.2014.10.021.

Bresnahan Jr, P. J., T. R. Martz, Y. Takeshita, K. S. Johnson, and M. LaShomb (2014), Best practices for autonomous measurement of seawater pH with the Honeywel Durafet, *Methods in Oceanography*, *9*, 44-60, doi: 10.1016/j.mio.2014.08.003.

Brown, P. J., and D. Rayner (2016), Standard operating procedure for the pre-deployment setup of the McLane Remote Access Sampler (RAS) - ABC fluxes. *Internal Document No. 19*, National Oceanography Centre, Southampton, UK.

Cullison Gray, S. E., M. D. DeGrandpre, T. S. Moore, T. R. Martz, G. E. Friederich, and K. S. Johnson (2011), Applications of in situ pH measurements for inorganic carbon calculations, *Marine Chemistry*, *125*, 82-90, doi: 10.1016/j.marchem.2011.02.005.

Dickson, A. G., C. L. Sabine, and J. R. Christian (2007), Guide to best practices for ocean CO2 measurements, PICES Special Publication 3, p. 191.

Fiedler, B., P. Fietzek, N. Vieira, P. Silva, H. C. Bittig, and A. Körtzinger (2013), In Situ CO_2 and O_2 Measurements on a Profiling Float, *Journal of Atmospheric and Oceanic Technology*, *30*, 112-126, doi: 10.1175/JTECH-D-12-00043.1.

Fietzek, P., B. Fiedler, T. Steinhoff, and A. Körtzinger (2014), In situ Quality Asessment of a Novel Underwater pCO_2 Sensor Based on Membrane Equilibration and NDIR Spectrometry, *Journal of Atmospheric and Oceanic Technology*, *31*, 181-196, doi: 10.1175/JTECH-D-13-00083.1.

Honda, M. C., and S. Watanabe (2007), Utility of an Autonomous Water Sampler to Observe Seasonal Variability in Nutrients and DIC in the Northwestern North Pacific, *Journal of Oceanography*, *63*, 349-362

Martz, T. R., J. G. Connery, and K. S. Johnson (2010), Testing the Honeywell Durafet® for seawater pH applications, *Limnol Oceanogr-Meth*, *8*, 172-184, doi: 10.4319/lom.2010.8.172.

Shamberger, K. E. F., R. A. Feely, C. L. Sabine, M. J. Atkinson, E. H. DeCarlo, F. T. Mackenzie, P. S. Drupp, and D. A. Butterfield (2011), Calcification and organic production on a Hawaiian coral reef, *Marine Chemistry*, *127*, 64-75, doi: 10.1016/j.marchem.2011.08.003.

11. Dissolved oxygen analysis

Sara Fowell

11.1 CTD sampling

Seawater samples were collected in borosilicate glass flasks from the CTD frame for oxygen titration. A total of 18 CTD casts were sampled for dissolved oxygen. The oxygen concentration from these analyses were for the purpose of calibrating the sensors mounted on the CTD frame, and for the newly deployed RAS and pH sensors. For the majority of casts, samples were collected from 12 Niskin bottles, plus an additional 4 samples which served as replicates. Four shallow casts were taken at the RAS stations, for which only 6 Niskin bottles were sampled, plus an additional 2 replicates.

Flasks were thoroughly cleaned at the beginning of the cruise. Silicon tubing was attached to the spigot of each Niskin bottle to transfer the seawater into the flask. This tubing was stored in deionized water for the duration of the cruise to reduce the tendency of bubbles to form. Seawater was flushed through the tube until there were no bubbles remaining. It was often necessary to pinch the tubing to remove the air. Seawater was not collected until there were no more bubbles in the tubing. The flask and the stopper were thoroughly rinsed in the seawater (precontaminated) before collection. The most efficient way to do this was to invert the flask and ensure that the tubing reached the bottom, and to rotate the flask. The outside of the bottle was also rinsed to ensure temperature equilibration. Both the flasks and the stoppers were labelled – each stopper is unique to the flask so that the exact volume of each bottle is known. A minimum of 5 flask volumes were allowed to flow through the flask (approximately 15 seconds), and during this time, the temperature of the seawater was measured and recorded.

The oxygen in the samples was fixed by adding 1ml of manganese chloride followed by 1ml of alkaline iodide solution. Before each sampling session, approximately 3mls were dispensed from each bottle to remove any bubbles that may have accumulated in the dispenser pipettes. When adding the reagents to the samples, the tips of the dispensers were carefully inserted into the seawater to at least 1cm below the surface so that the reagents sink, minimizing their loss when the stopper is reinserted. The stopper was inserted when the flask was tilted, and it was twisted whilst being depressed so that air was not trapped. The flasks were shaken well to mix the reagents, and allow the manganous precipitate to increase in surface area and disperse. This increases the efficiency of the oxidation of $Mn(OH)_2$ and therefore oxygen scavenging. After the samples had been shaken, the rim between the stopper and the flask was filled with deionized water to make the seal more airtight. Thirty minutes after the initial shaking, the samples were shaken a second time to be sure that all of the oxygen was scavenged.

11.2 Titration system

Dissolved oxygen was measured using the Winkler method. On this cruise, the Metrohm Titrino system was used with an amperiometric electrode and a Dosimat unit. At the beginning of each analysis session, the thiosulphate and potassium iodate standards were shaken, and the droplets around the bottle (from evaporation) were homogenized. Importantly, the bubbles from all of the tubing must be removed. To do this, the burettes were filled and emptied multiple times at a fast speed (dV/dt=10). The most efficient way to do this was to introduce a large bubble into the system, and to continuously flick the tubes to help the bubbles pass. To remove bubbles that got stuck at the end of the aspirator, the valve was removed and solution was passed through the end until the bubble was removed.

11.3 Blank measurements

Before any samples can be analysed, "blank" samples and "standards" must be characterized. This was done at the beginning of every analytical session (1-3 CTDs). Blank samples were made in empty bottles which had been triple washed in tap water and once in deionized water. The bottles were filled with deionized water just below shoulder height before adding 1ml sulphuric acid and stirred. Next, 1ml of manganese chloride was added and stirred, and then 1ml of alkaline iodide and stirred. The reagents were stirred separately into the water to avoid the formation of precipitate. 1ml of the iodate standard was then injected into the sample using the Dosimat before the mixture was titrated against sodium thiosulphate. When the titration was finished, the volume of the titrant was recorded and another 1ml of iodate standard was added to the same bottle. A total of 3ml of standard is added to the blank sample. Five blanks were measured a total of 3 times each (at the beginning of each analytical session). We aimed for a maximum difference of 0.002ml between replicates. However, during the beginning of the cruise, this was not always achieved. This problem was solved by reducing the dose rate to 1ml/min, reducing dV/dt to 2.5, and by diluting the sodium thiosulphate by 5 times (from 0.6M to 0.1M). This produced more reproducible blank measurements, and is demonstrated in Figure 11.1, where the blue data is from concentrated thiosulphate, and the red data is from diluted thiosulphate.

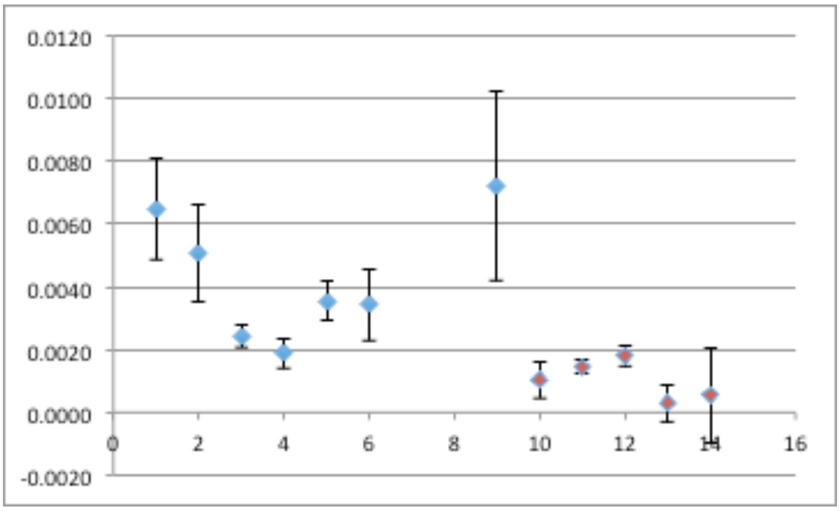


Figure 11.1: Blank measurements of dissolved oxygen reagents. Red data uses a 5 times diluted sodium thiosulphate solution. Error bars represent the standard deviation of the repeat measurements from each analytical session.

At the start of the cruise, the Metrohm Ti-Touch system was set up and only uncalibrated burettes were available. During the testing phase, it was found that the second blank addition was half the volume of the first. Because of this, samples were not collected from the first two CTD stations. New burettes were used after Tenerife. However, precision was still very poor. To this end, all of the available amperiometric electrodes were tested, but there were still differences of greater than 0.1ml. Because of these differences, the Titrino system was set up and tested with a potentiometric and an amperiometric electrode. From these, tests, we concluded that the Titrino system with an amperiometric electrode gave the best precision.

11.4 Standardisation of sodium thiosulphate

After the blanks had been measured, the sodium thiosulphate is standardized. This is the process of checking the molarity of the sodium thiosulphate molarity against the iodate standard molarity, which is known (1.667mM). Here, 5mls of potassium iodate standard is added to a blank sample and titrated to a dead stop. As with the blanks, the aim was to get values within 0.002mls. Reproducibility was improved by reducing the dose rate and molarity of the thiosulphate. This is evident in Figure 11.2.

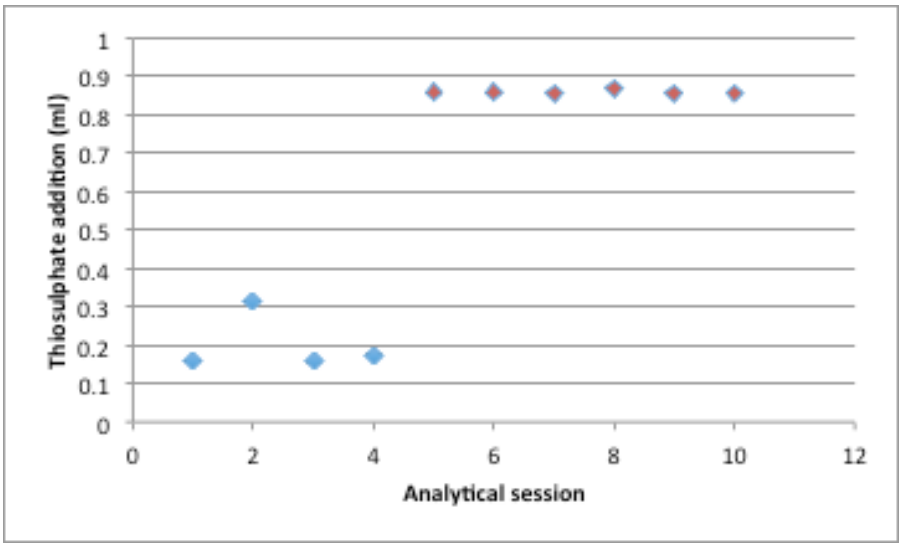


Figure 11.2: Standardisation of sodium thiosulphate during DY039. Red data is from 5 times diluted sodium thiosulphate.

11.5 Sample measurement

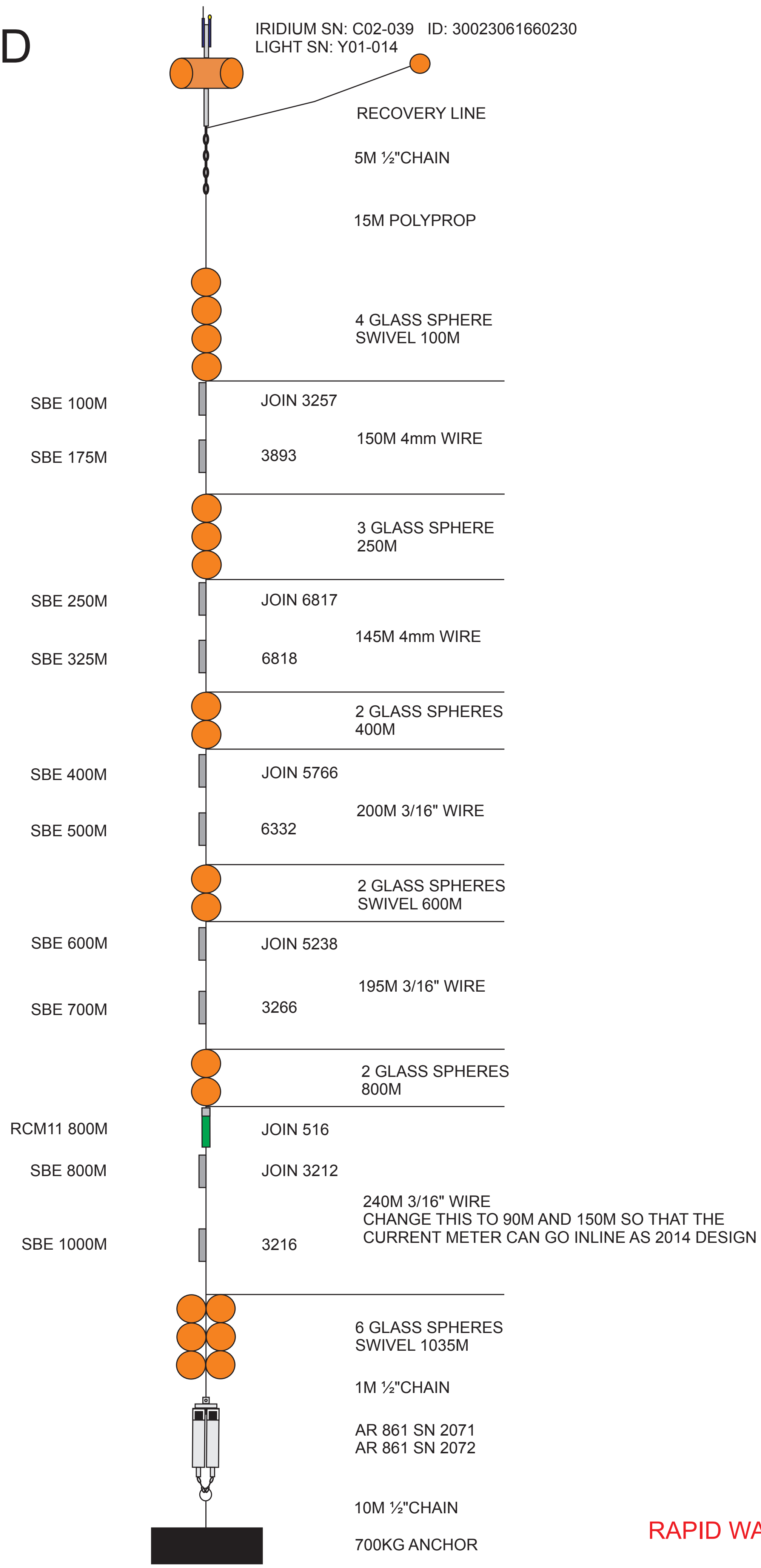
The basic steps for the sample titration are as follows: 1) Tip the deionized water from the rim and wipe off the excess. 2) Remove the stopper carefully to avoid sample loss. 3) Insert a magnetic stirrer into the sample, add 1ml of sulphuric acid and mix until the sample turns brown and there is no precipitate remaining. 4) Titrate the liberated iodine against sodium thiosulphate to a dead stop and record the volume of added thiosulphate.

11.6 Data processing

The oxygen concentration of each sample was calculated in an Excel spreadsheet. The spreadsheet contains the specific volume of each flask, the blank, standard and sample titres, fixing temperature the iodate molarity. Replicate samples were supposed to be within 0.5umol/l of each other. This was achieved more frequently following the dilution of the thiosulphate. Flags were also assigned to the oxygen data to suggest whether the data were good, questionable, bad, or a repeat measurement. Tables for each cast were saved separately as CTDxxx_oxygen.xlsx and read into the CTD calibration routines (section 7) for calibration of the oxygen sensors.

Appendix A: Mooring diagrams for those moorings deployed on DY039

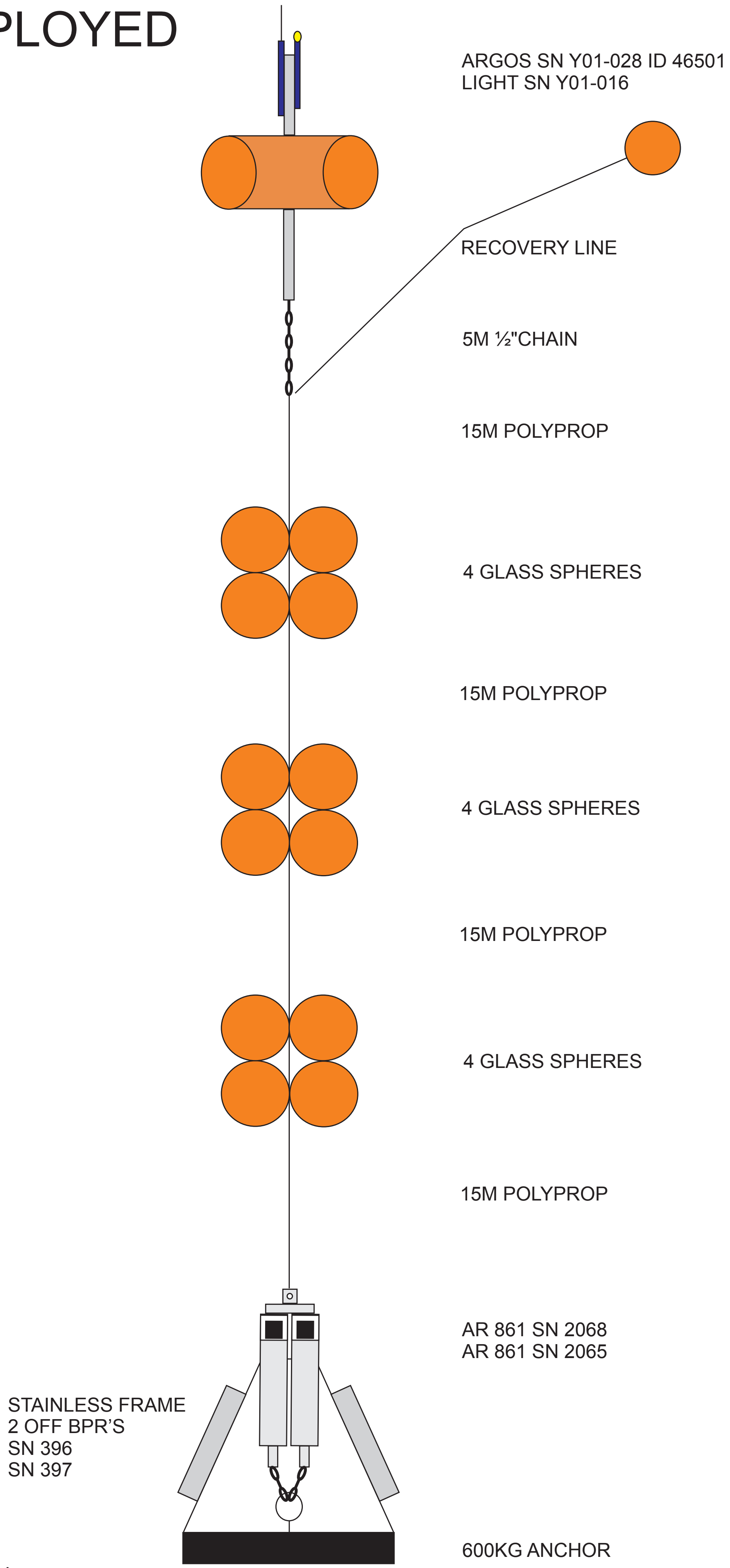
EBH4
AS DEPLOYED
2015



WATER DEPTH
1050M

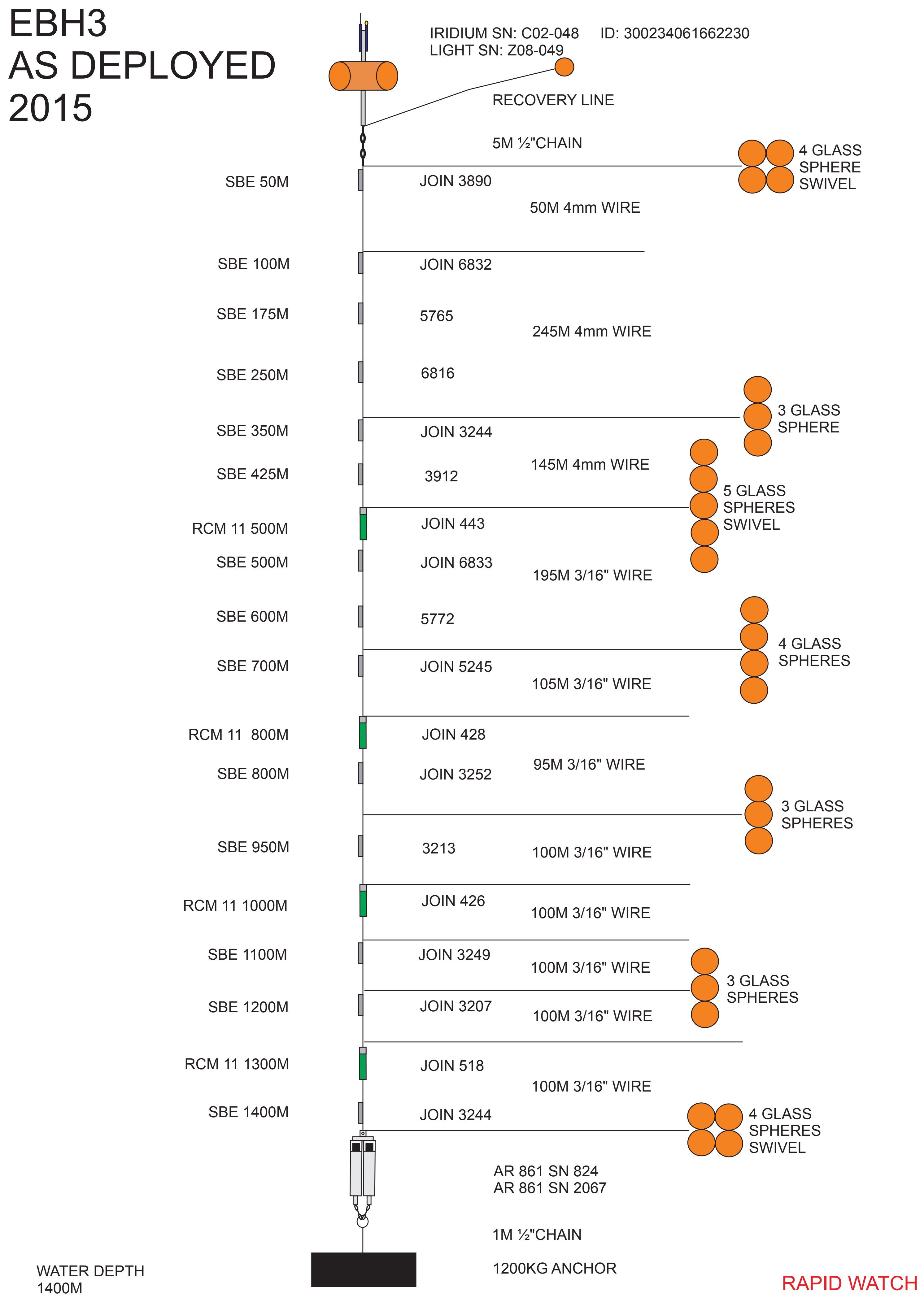
RAPID WATCH

EBH4L6
AS DEPLOYED
2015

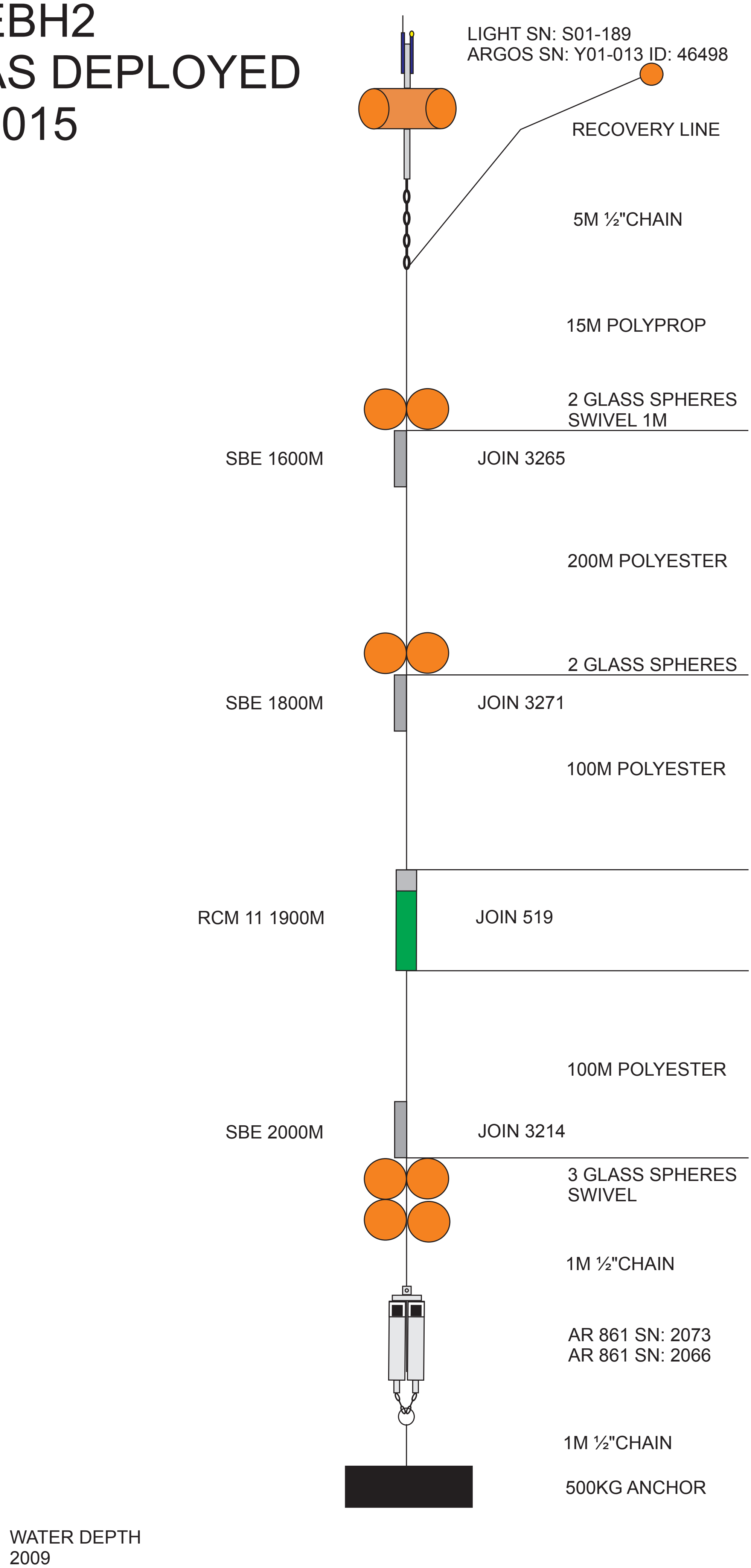


WATER DEPTH
1050M

RAPID WATCH

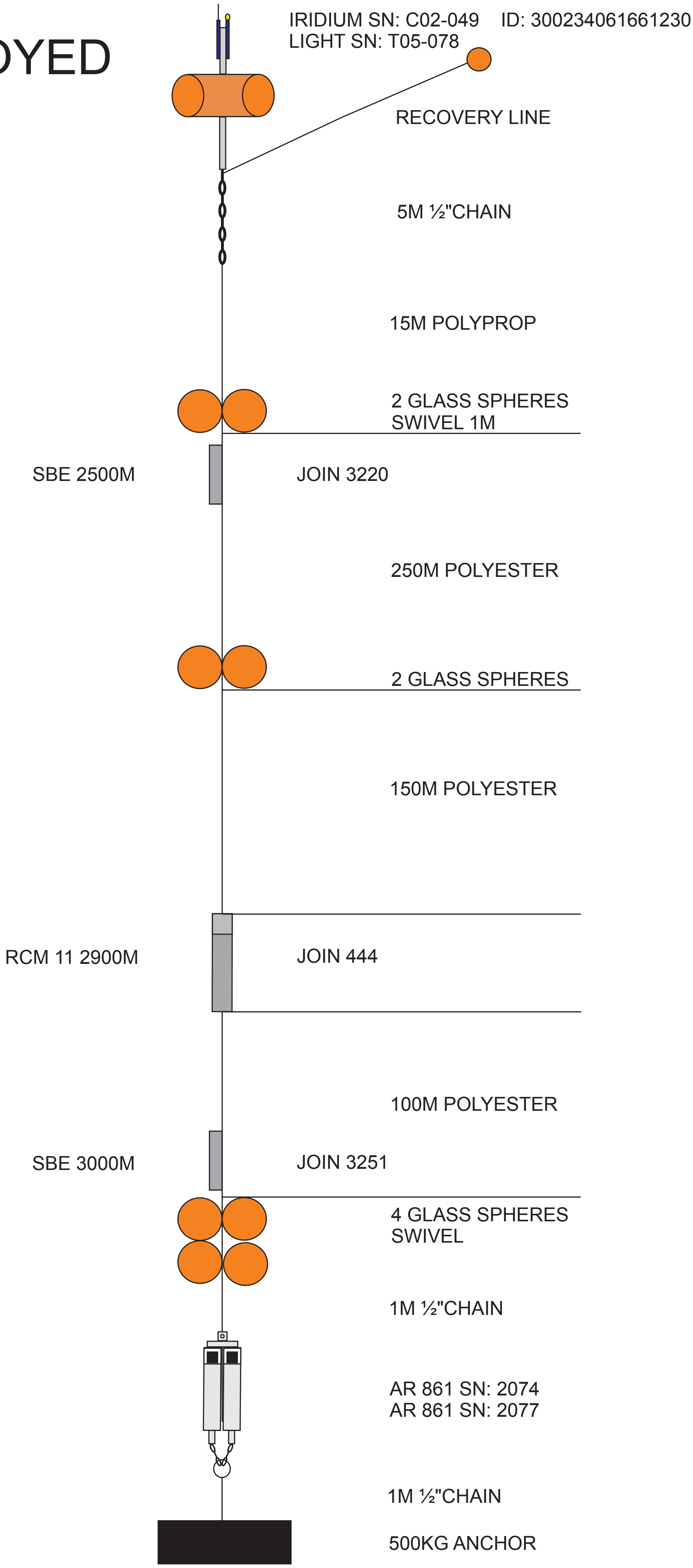

EBH3
AS DEPLOYED
2015
IRIDIUM SN: C02-048 ID: 300234061662230
LIGHT SN: Z08-049
RECOVERY LINE
5M ½"CHAIN
4 GLASS
SPHERE
SWIVEL
SBE 50M
JOIN 3890
50M 4mm WIRE
SBE 100M
JOIN 6832
SBE 175M
5765
245M 4mm WIRE
SBE 250M
6816
3 GLASS
SPHERE
SBE 350M
JOIN 3244
SBE 425M
3912
145M 4mm WIRE
5 GLASS
SPHERES
SWIVEL
RCM 11 500M
JOIN 443
SBE 500M
JOIN 6833
195M 3/16" WIRE
SBE 600M
5772
4 GLASS
SPHERES
SBE 700M
JOIN 5245
105M 3/16" WIRE
RCM 11 800M
JOIN 428
SBE 800M
JOIN 3252
95M 3/16" WIRE
3 GLASS
SPHERES
SBE 950M
3213
100M 3/16" WIRE
RCM 11 1000M
JOIN 426
100M 3/16" WIRE
SBE 1100M
JOIN 3249
100M 3/16" WIRE
3 GLASS
SPHERES
SBE 1200M
JOIN 3207
100M 3/16" WIRE
RCM 11 1300M
JOIN 518
100M 3/16" WIRE
SBE 1400M
JOIN 3244
4 GLASS
SPHERES
SWIVEL
AR 861 SN 824
AR 861 SN 2067
1M ½"CHAIN
1200KG ANCHOR
WATER DEPTH
1400M
RAPID WATCH

EBH2
AS DEPLOYED
2015



RAPID WATCH

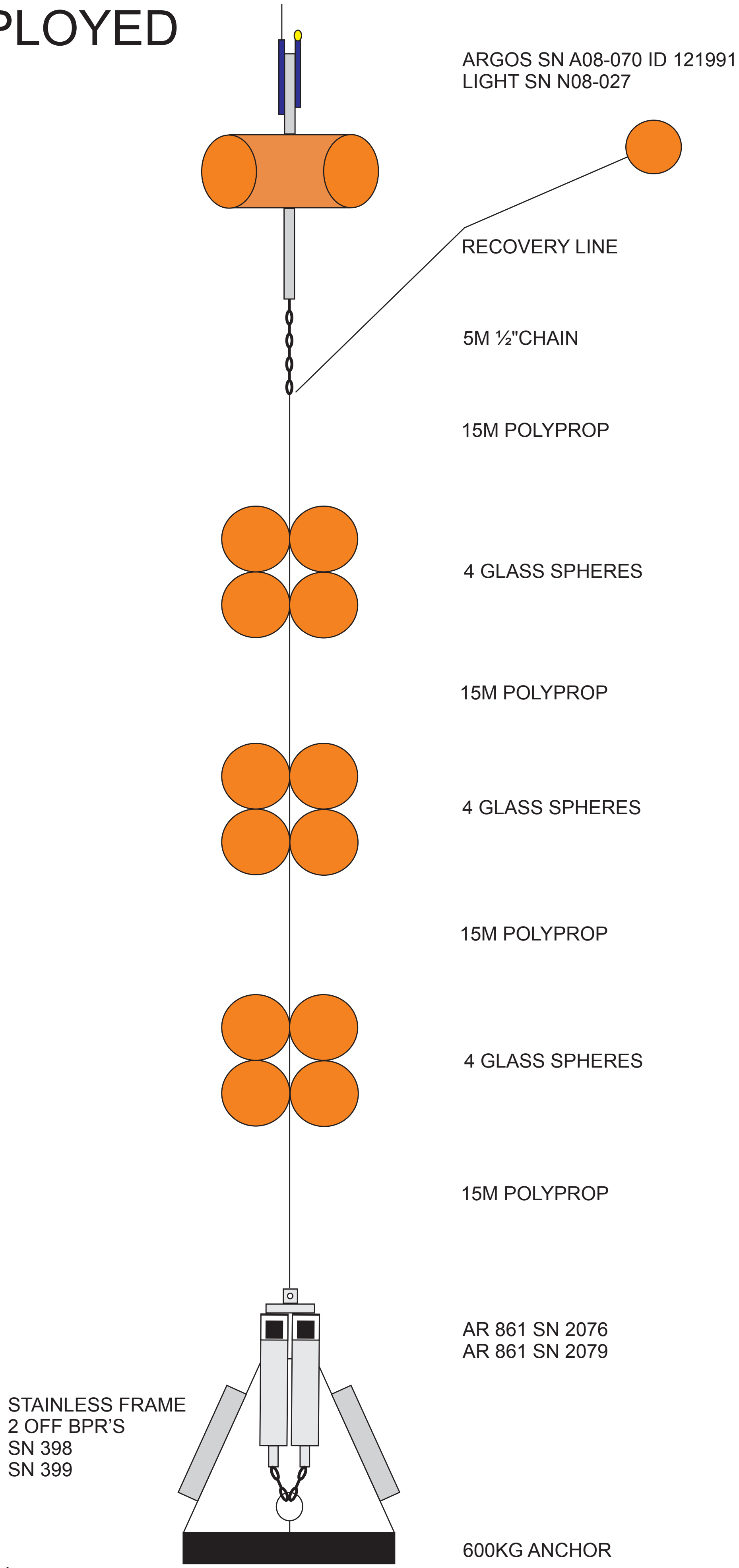
EBH1
AS DEPLOYED
2015



WATER DEPTH
3012M CORR

RAPID WATCH

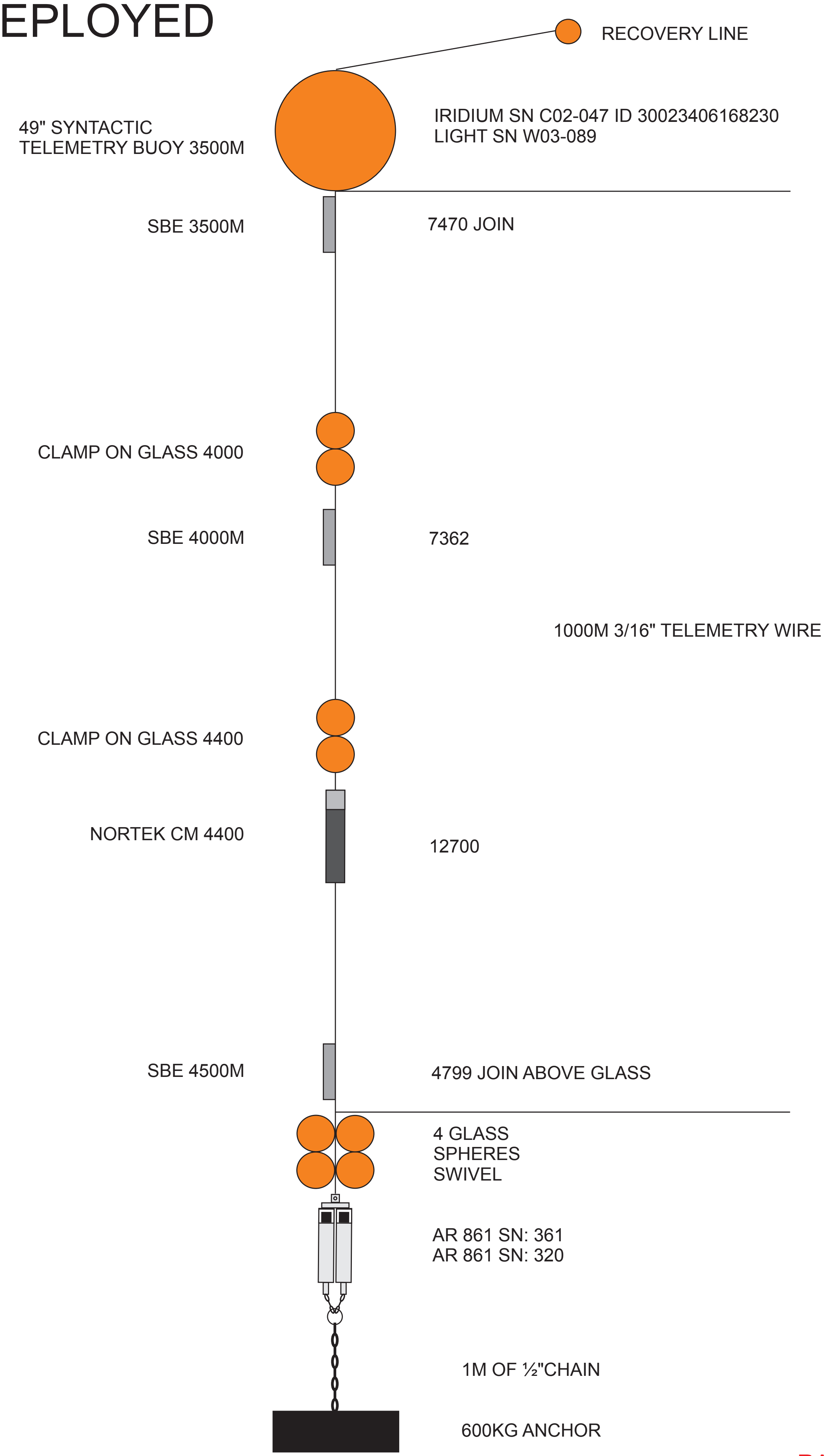
EBH1L11
AS DEPLOYED
2015



WATER DEPTH
3000M

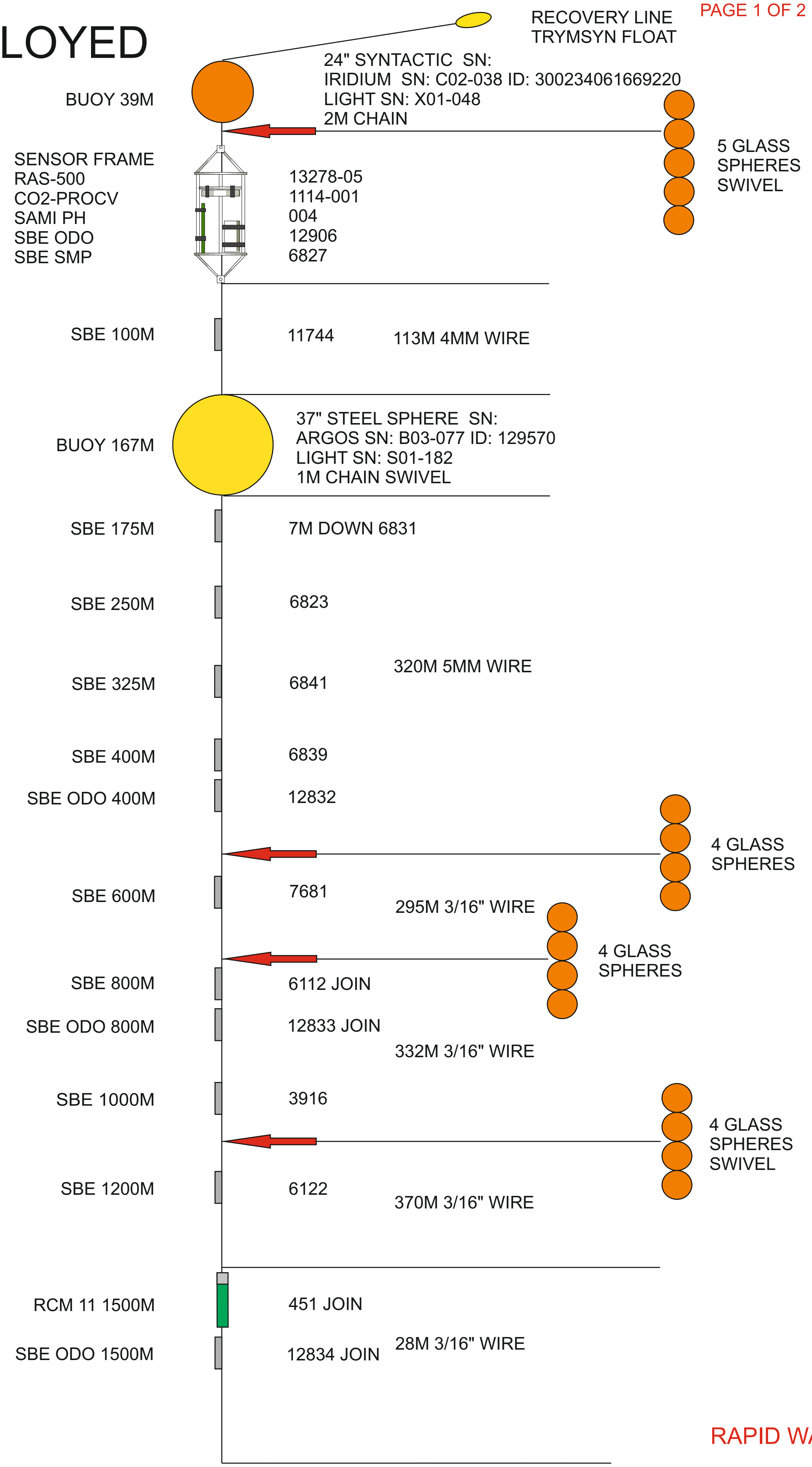
RAPID WATCH

EBHI
AS DEPLOYED
2015



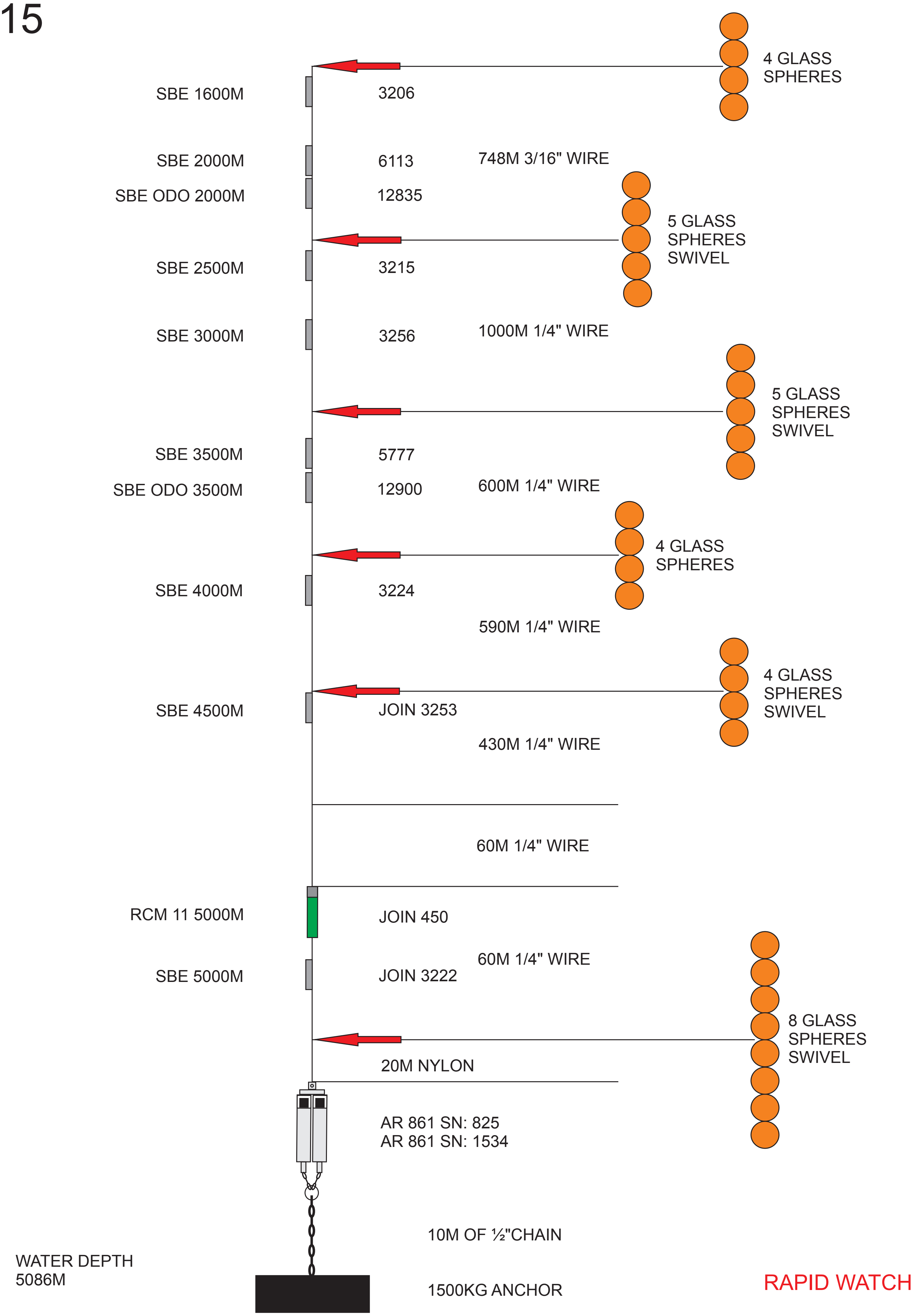
RAPID WATCH

EB 1
AS DEPLOYED
2015

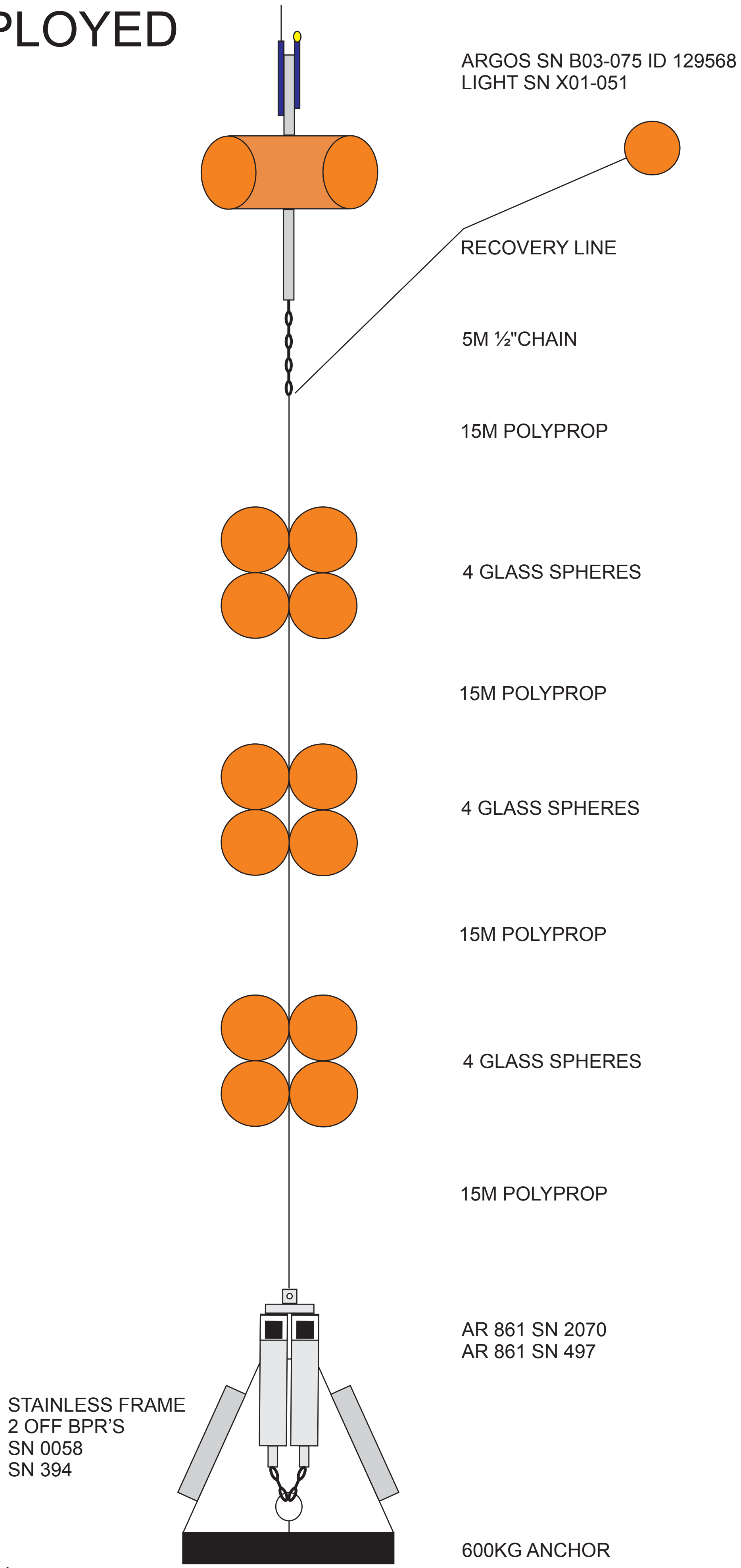


RAPID WATCH

EB 1
AS DEPLOYED
2015



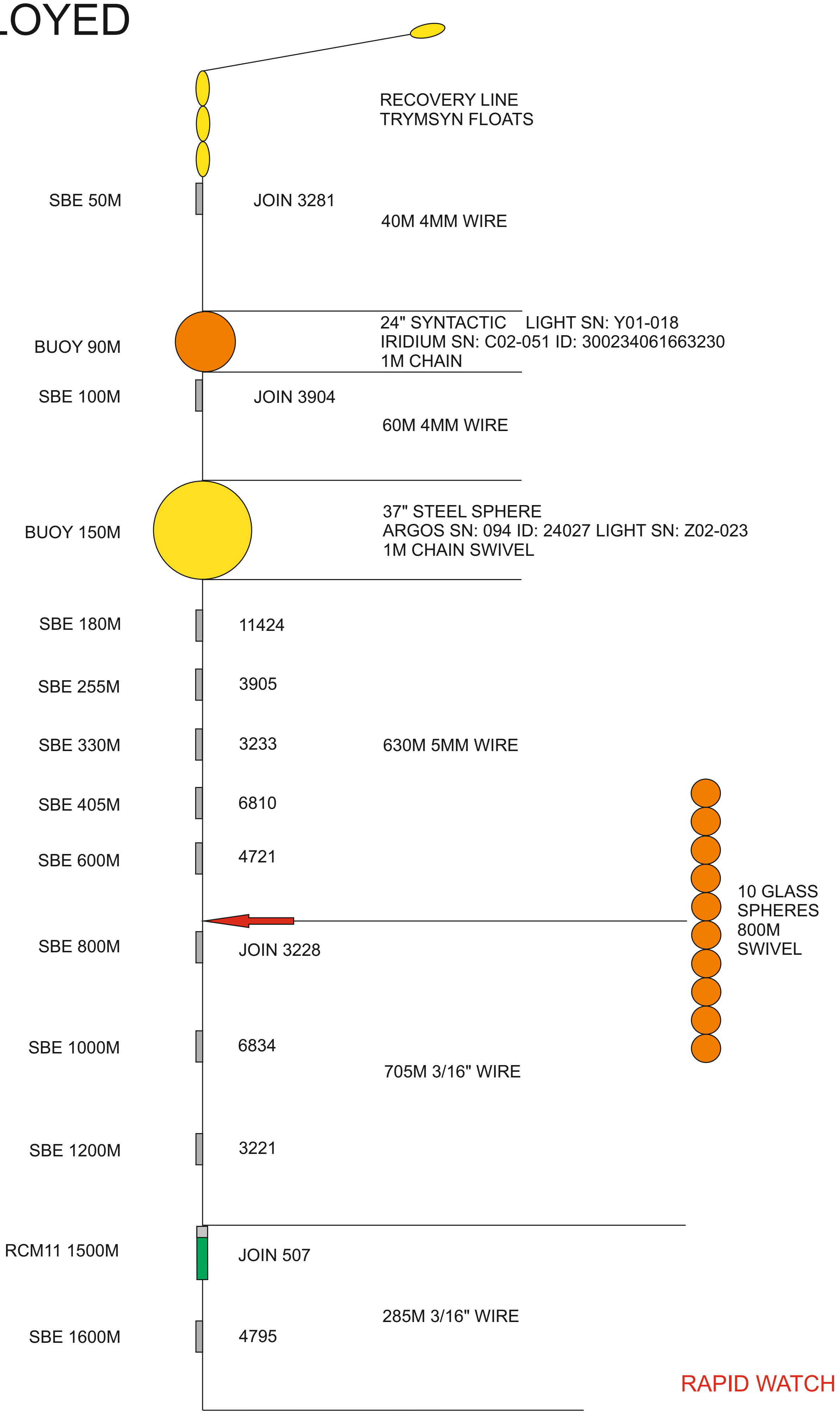
EB1L11
AS DEPLOYED
2015



WATER DEPTH
5000M

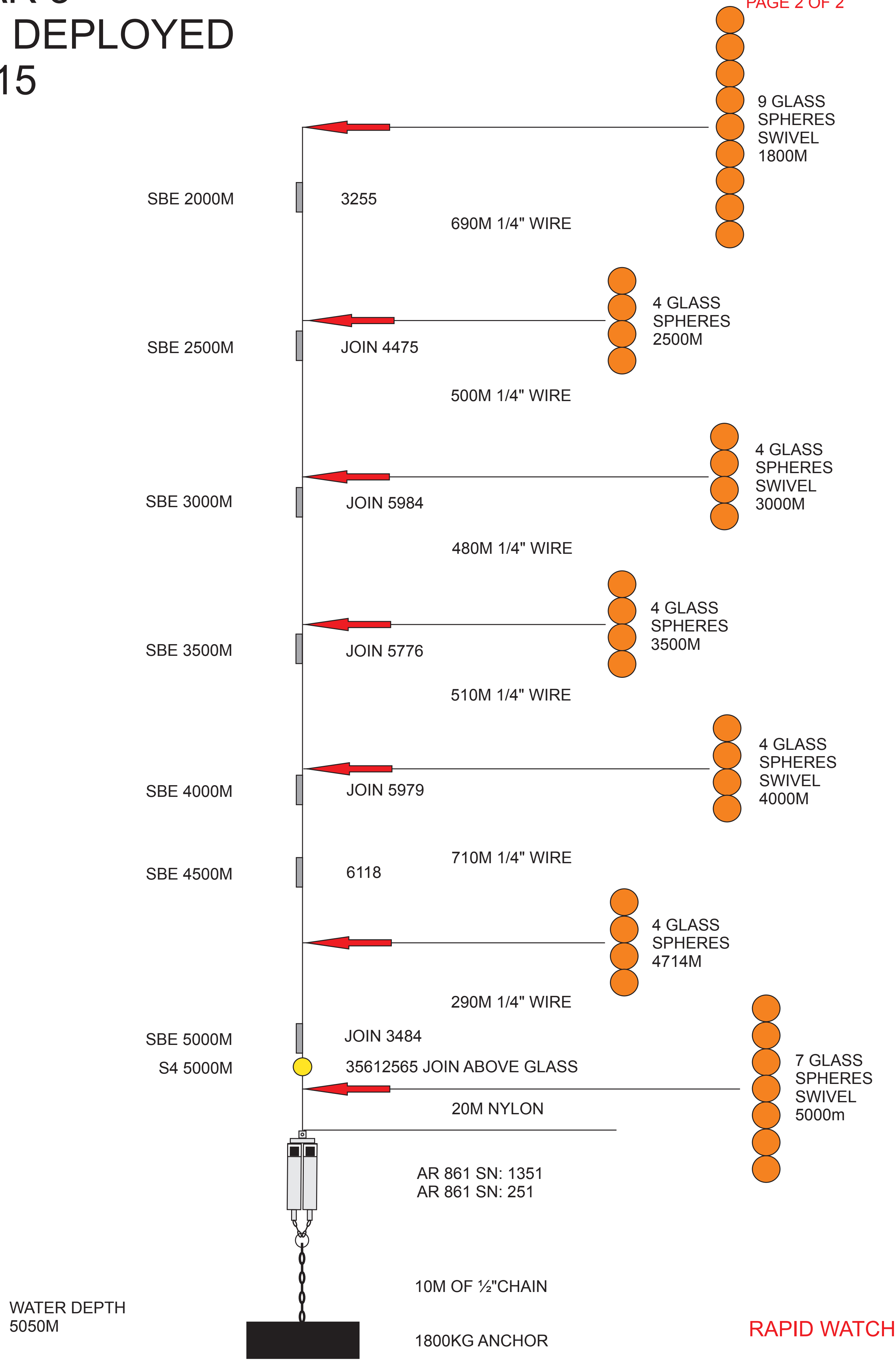
RAPID WATCH

MAR 3
AS DEPLOYED
2015



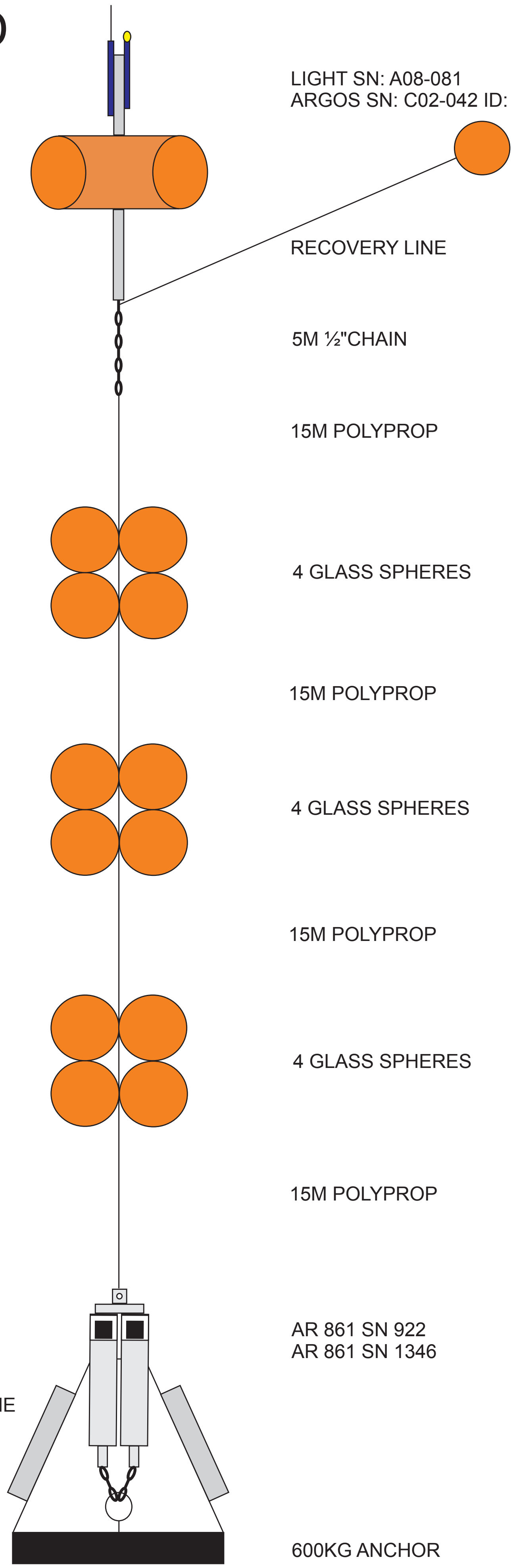
RAPID WATCH

MAR 3
AS DEPLOYED
2015



RAPID WATCH

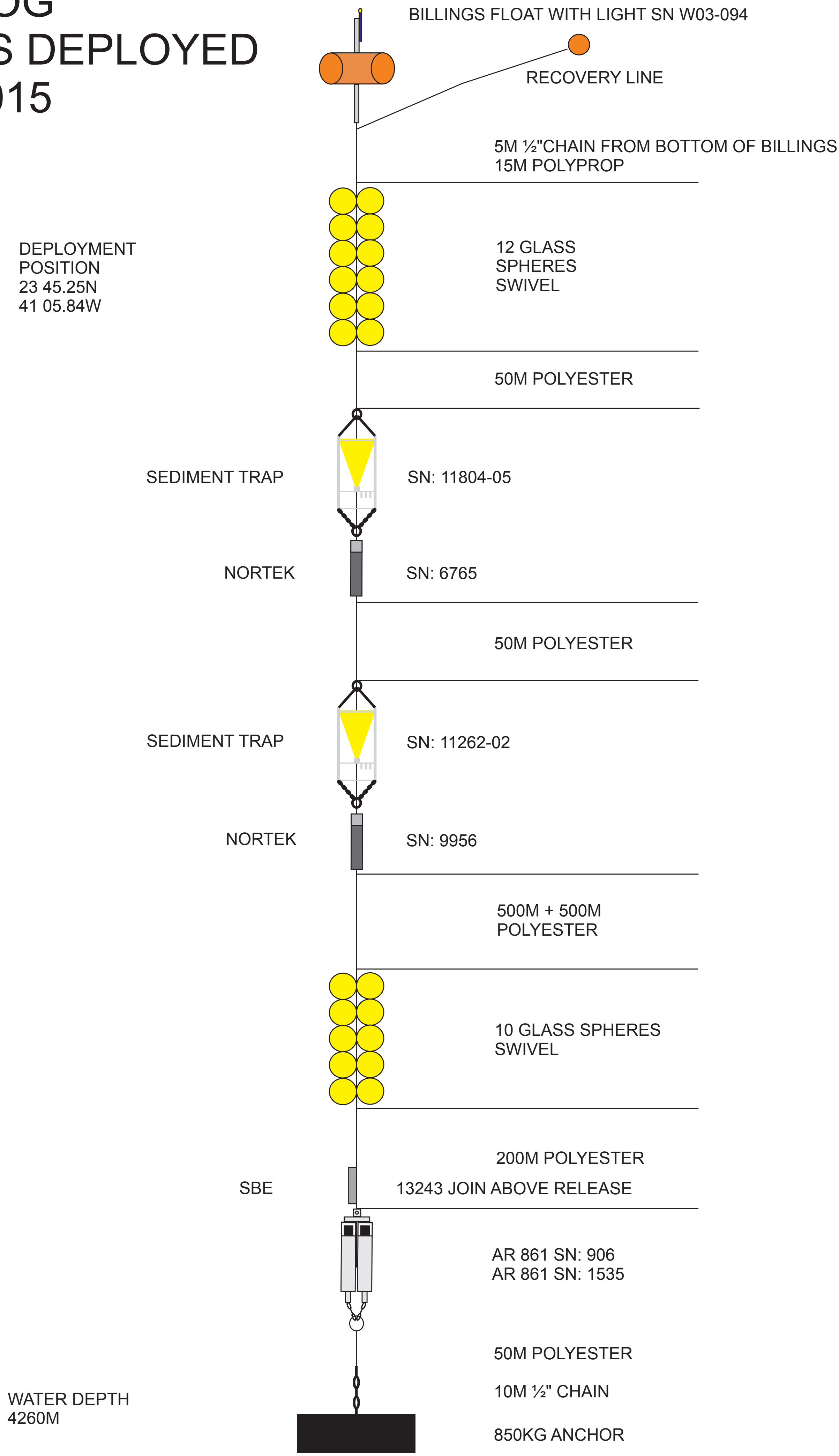
MAR3L10
AS DEPLOYED
2015



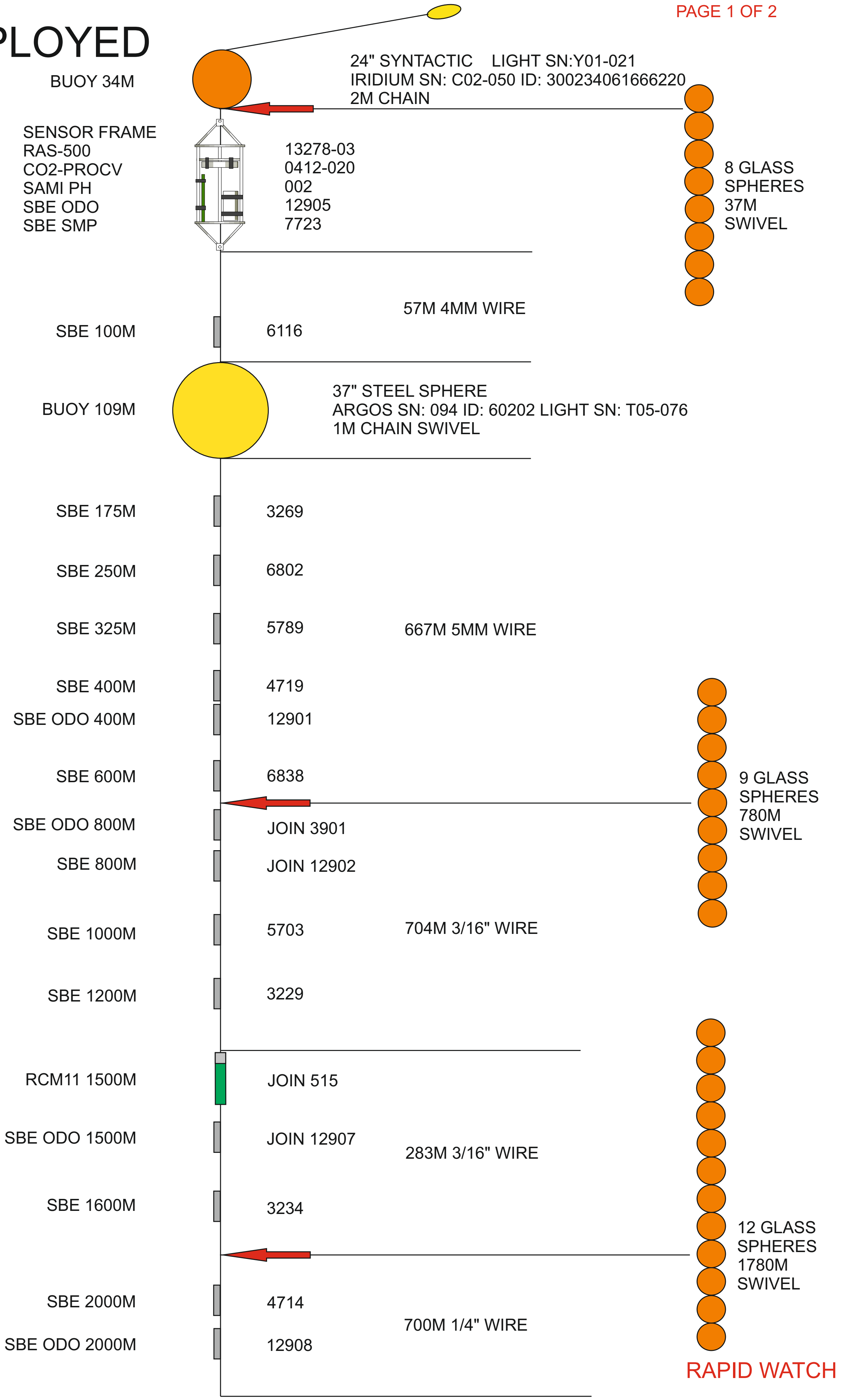
WATER DEPTH
5100M

RAPID WATCH

NOG
AS DEPLOYED
2015

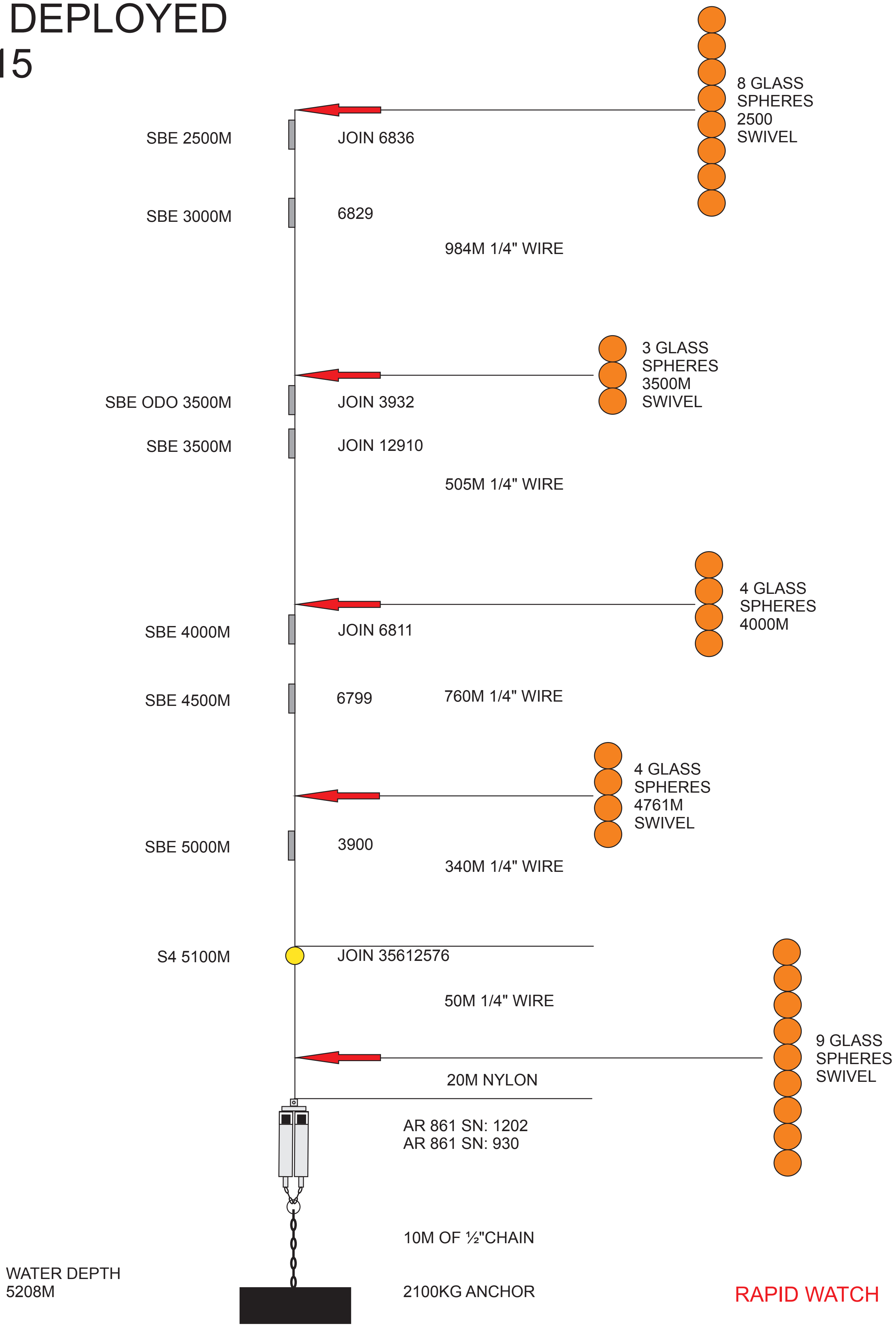


MAR 1 AS DEPLOYED 2015



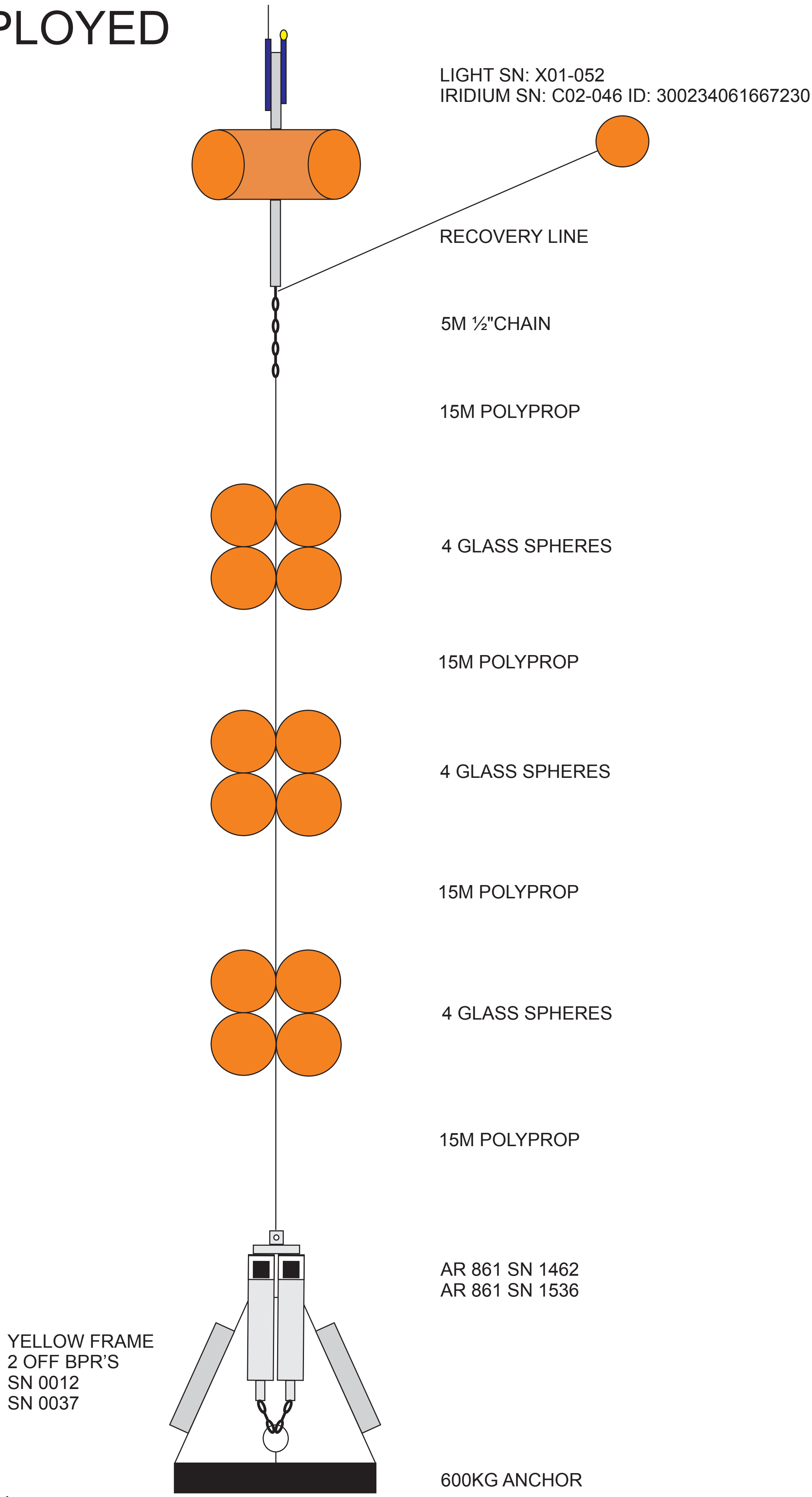
RAPID WATCH

MAR 1
AS DEPLOYED
2015



RAPID WATCH

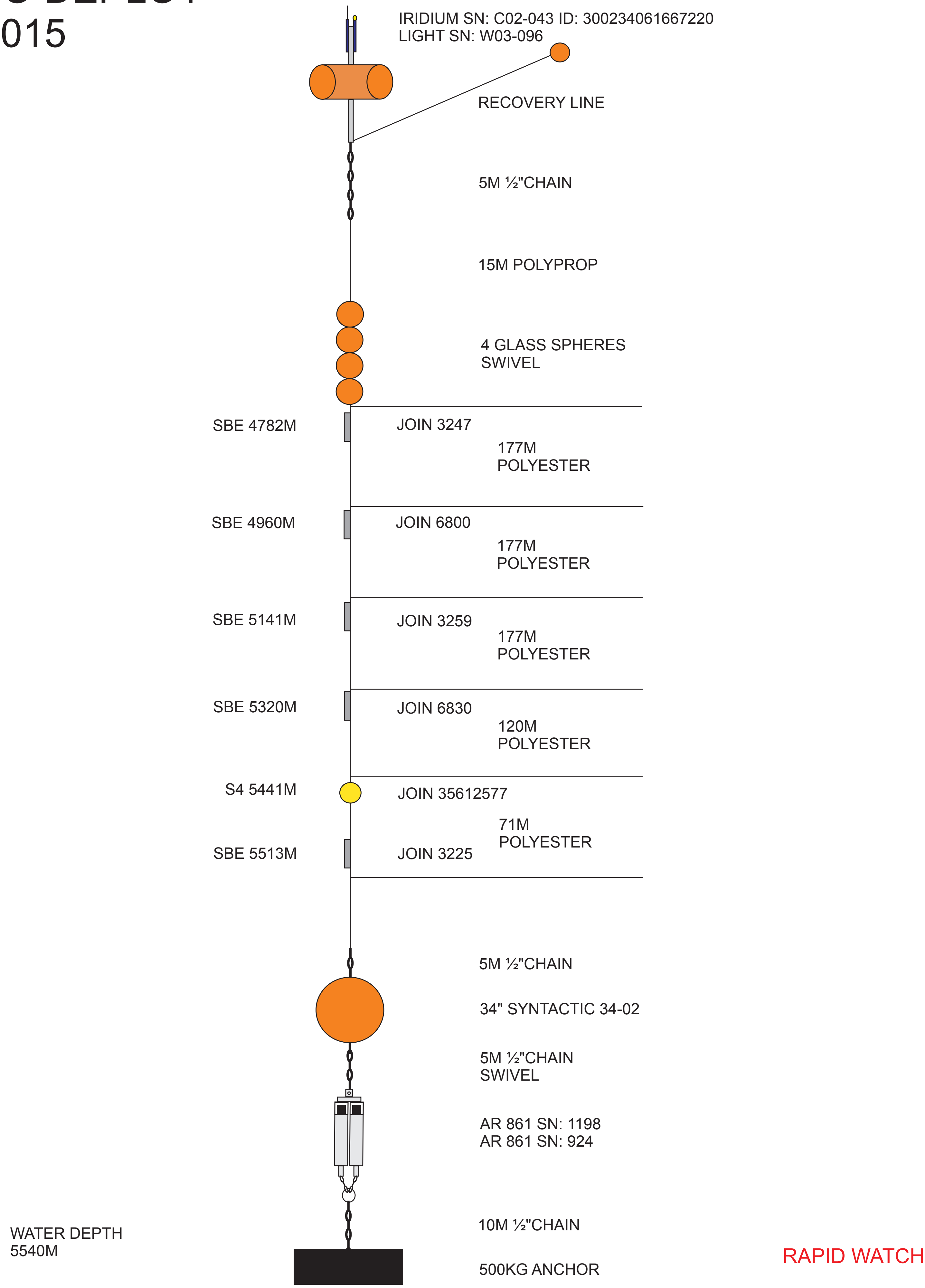
MAR1L10
AS DEPLOYED
2015



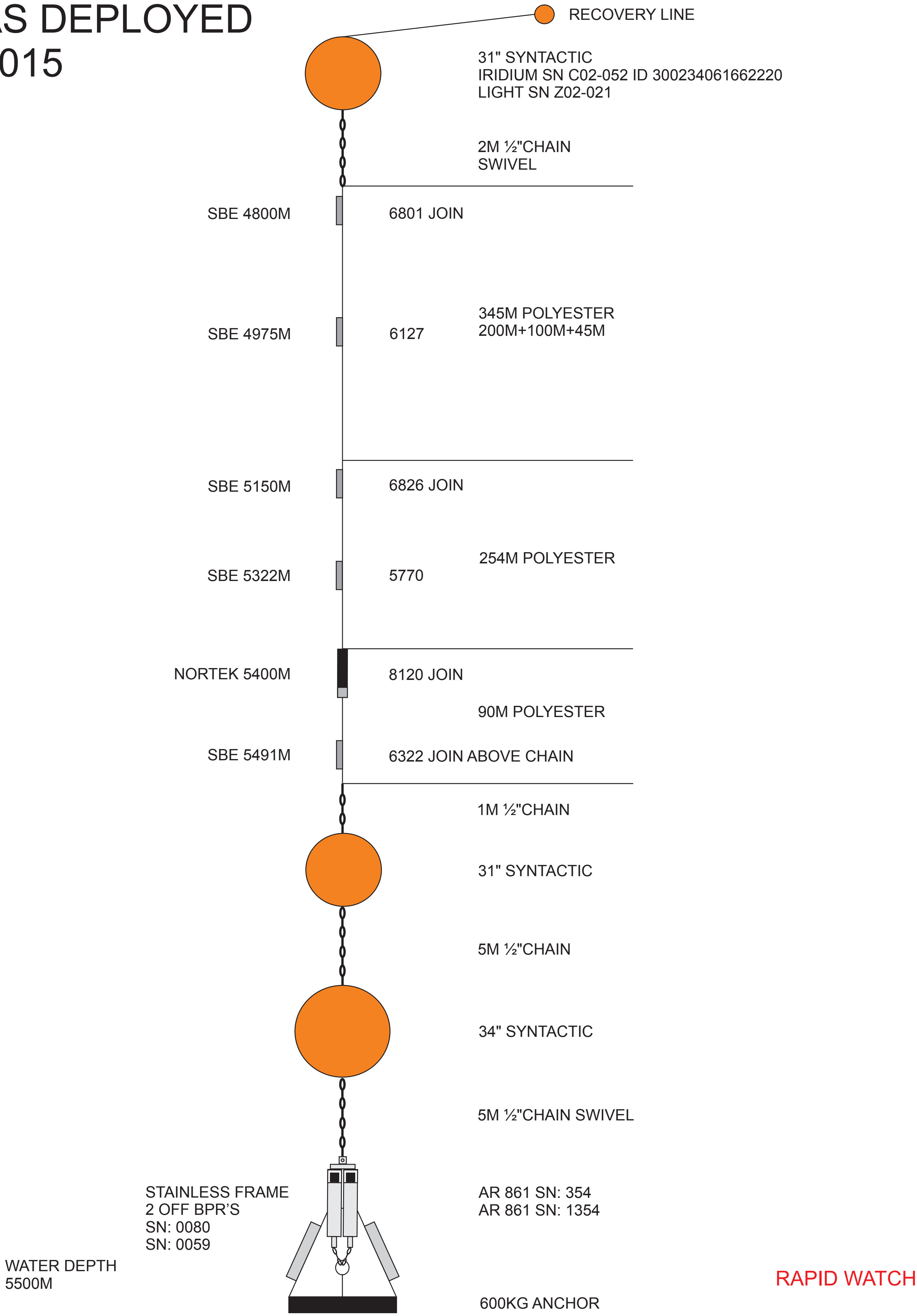
WATER DEPTH
5200M

RAPID WATCH

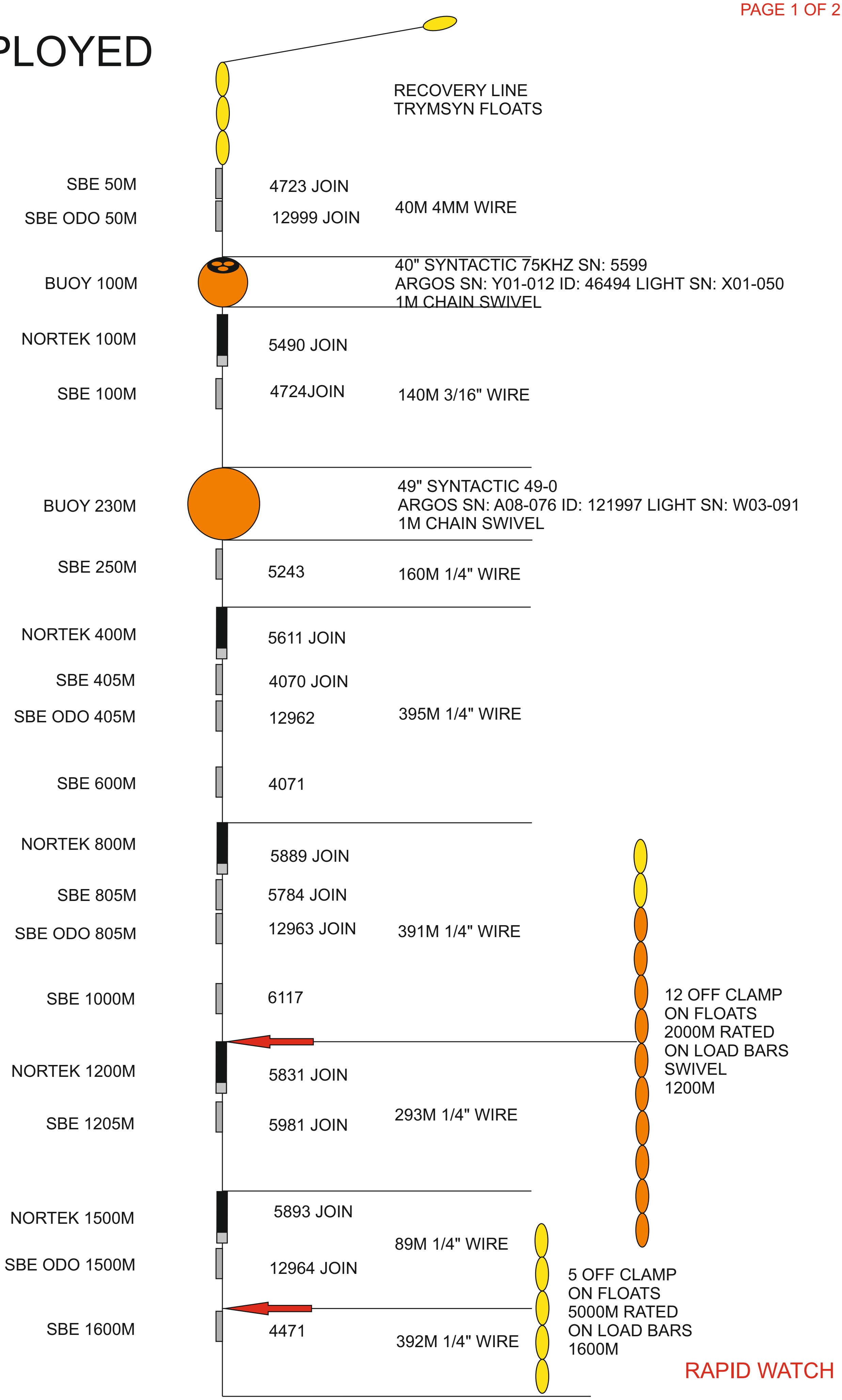
MAR0
TO DEPLOY
2015



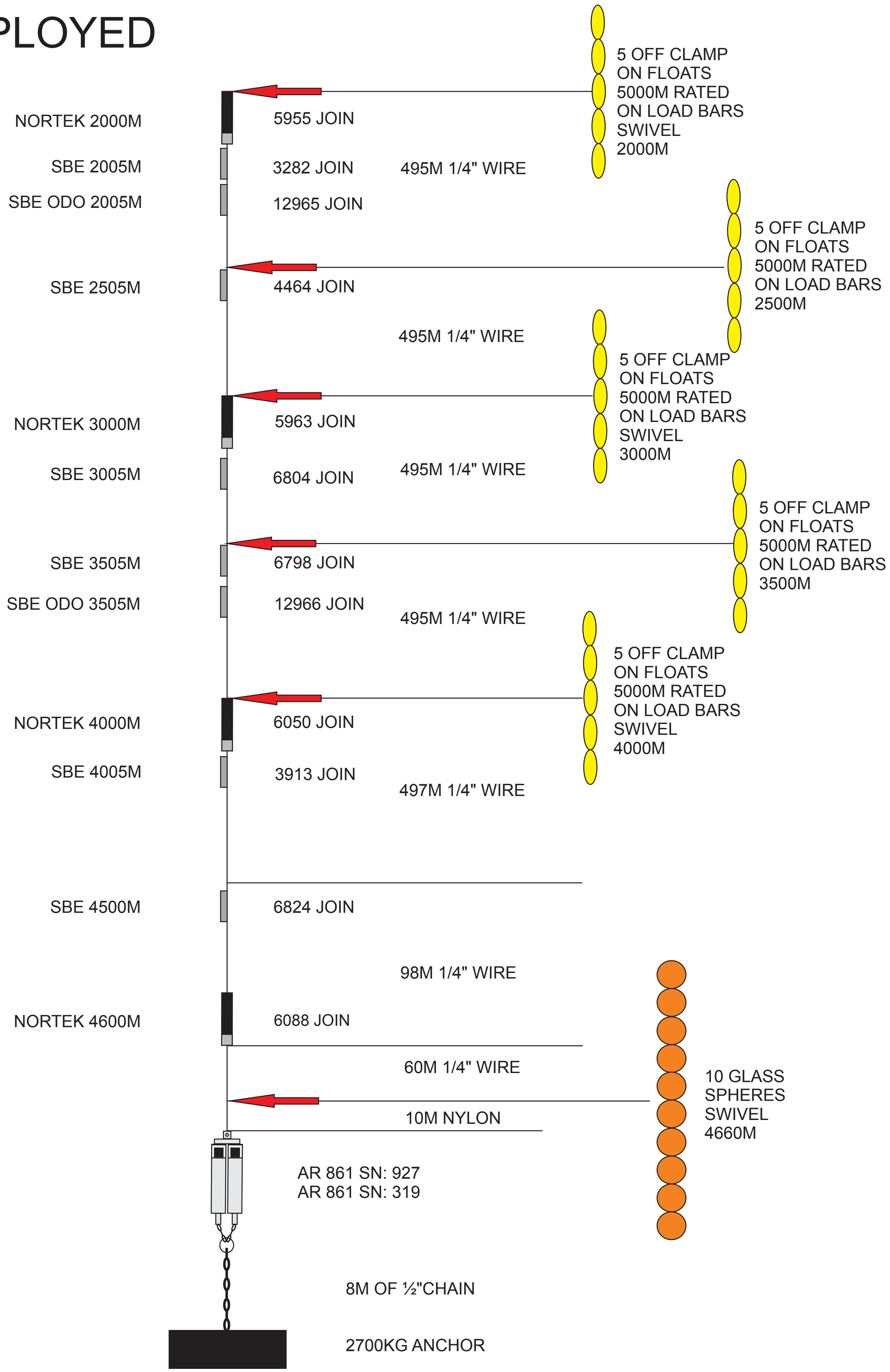
WB 6
AS DEPLOYED
2015



WB 4
AS DEPLOYED
2015



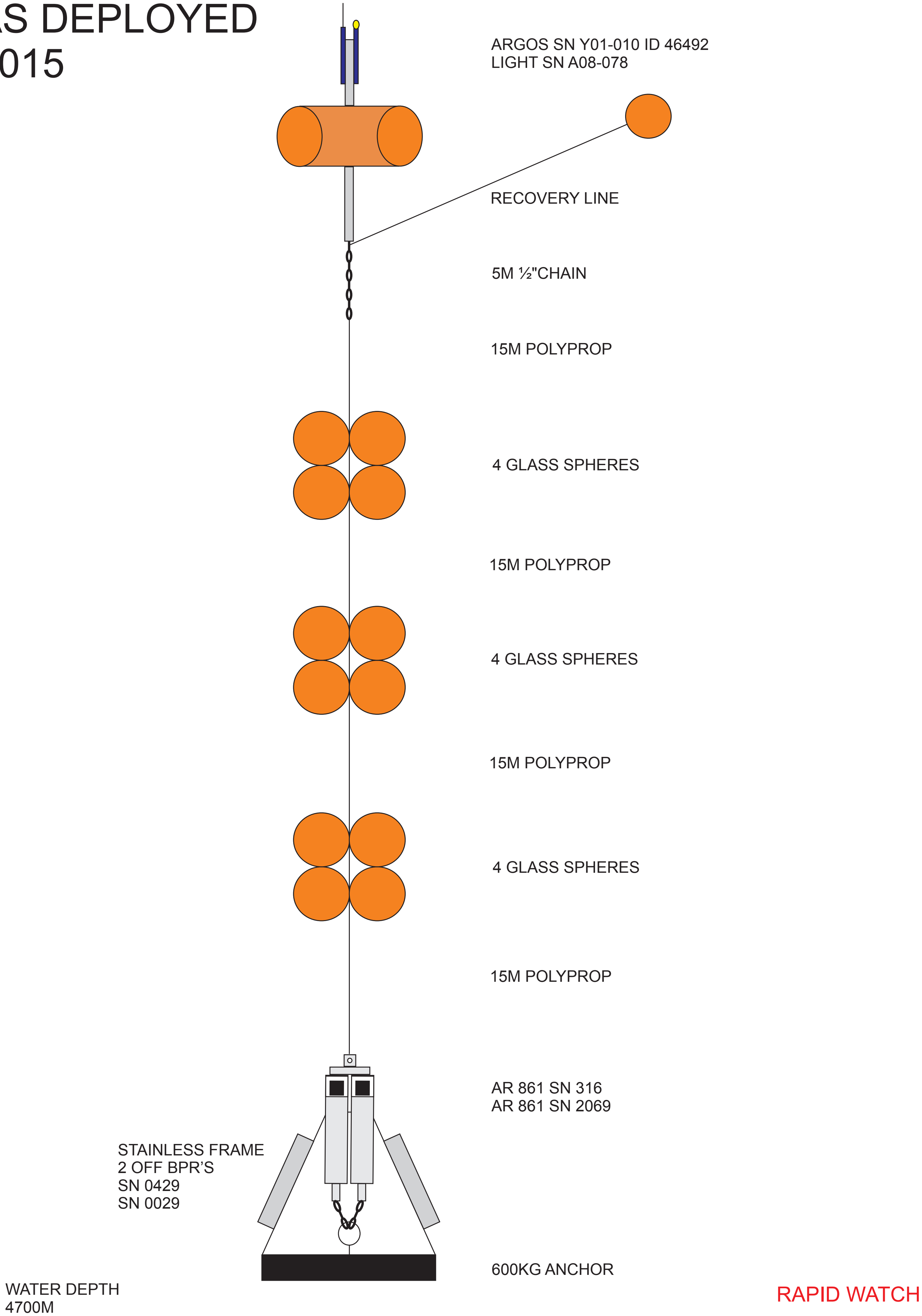
WB 4
AS DEPLOYED
2015



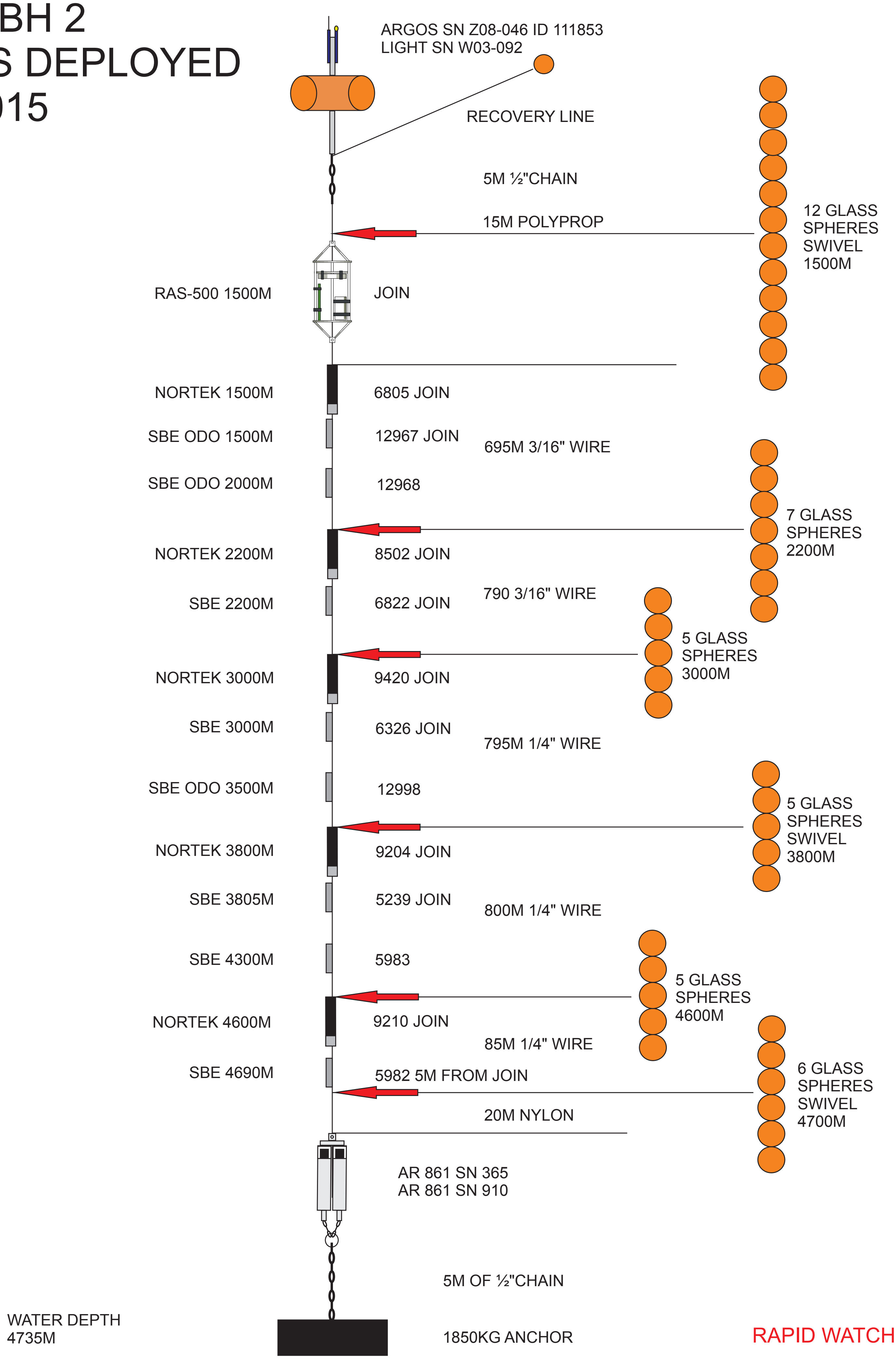
WATER DEPTH
4687M

RAPID WATCH

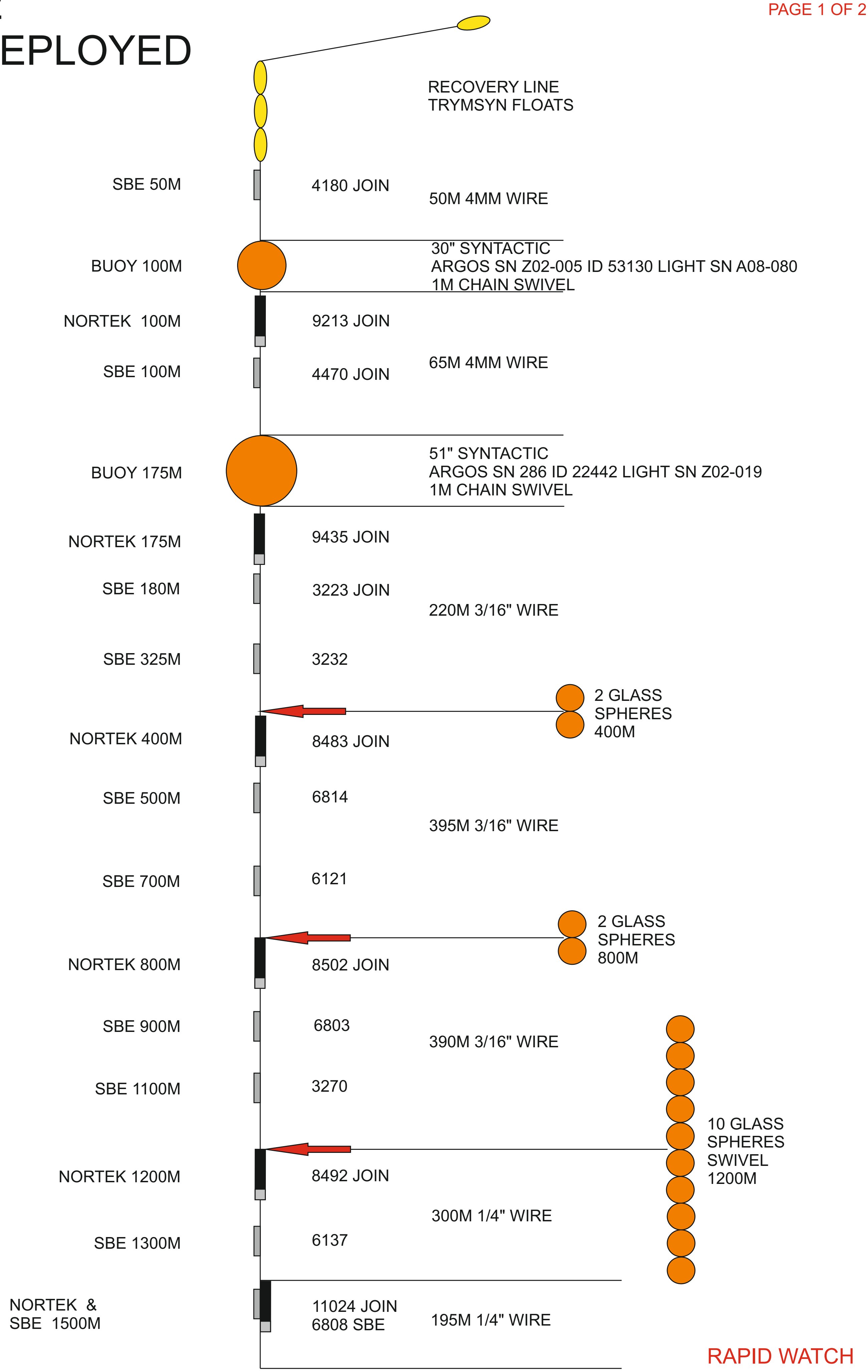
WB4L11
AS DEPLOYED
2015



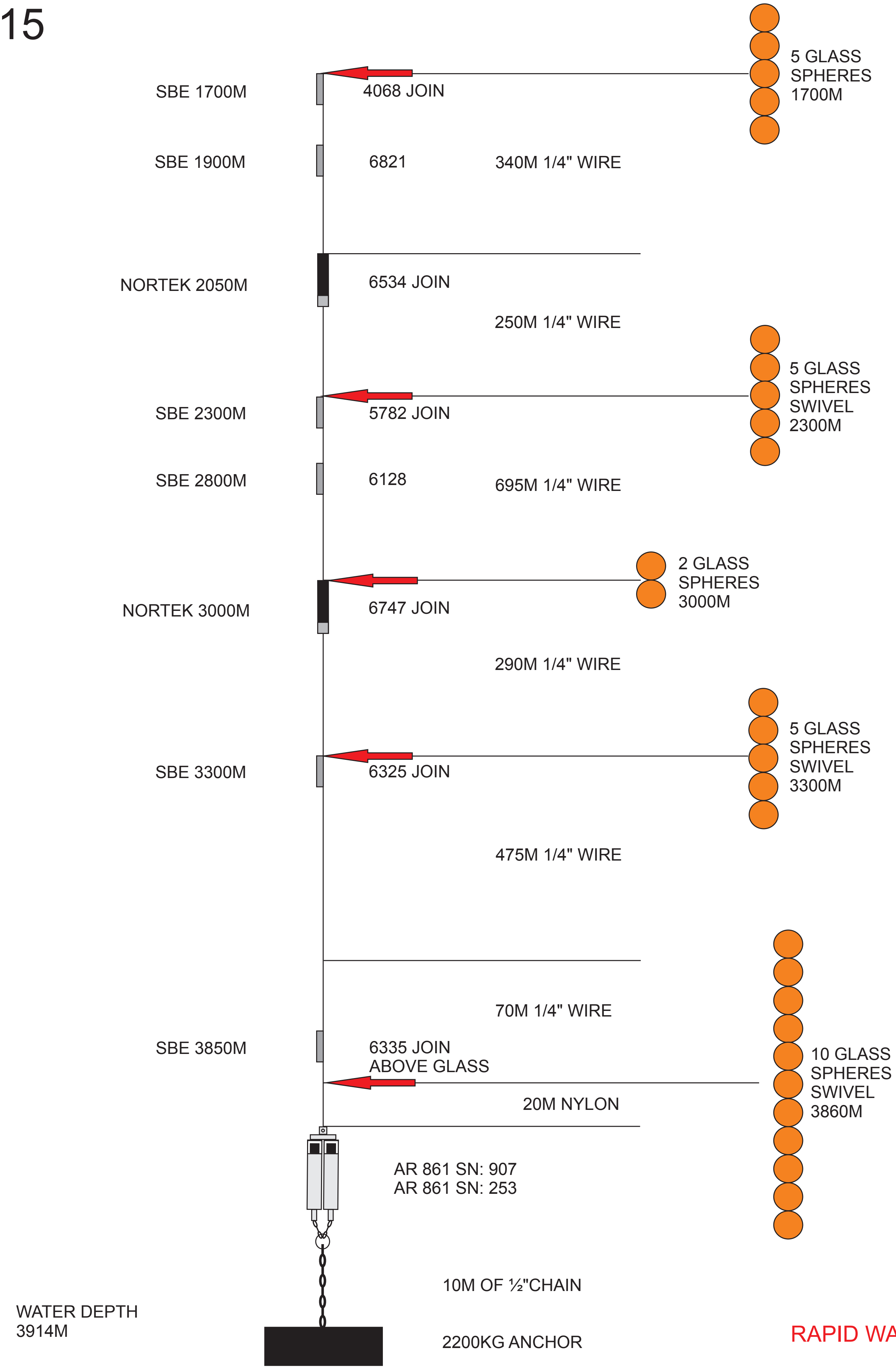
WBH 2
AS DEPLOYED
2015



WB 2
AS DEPLOYED
2015

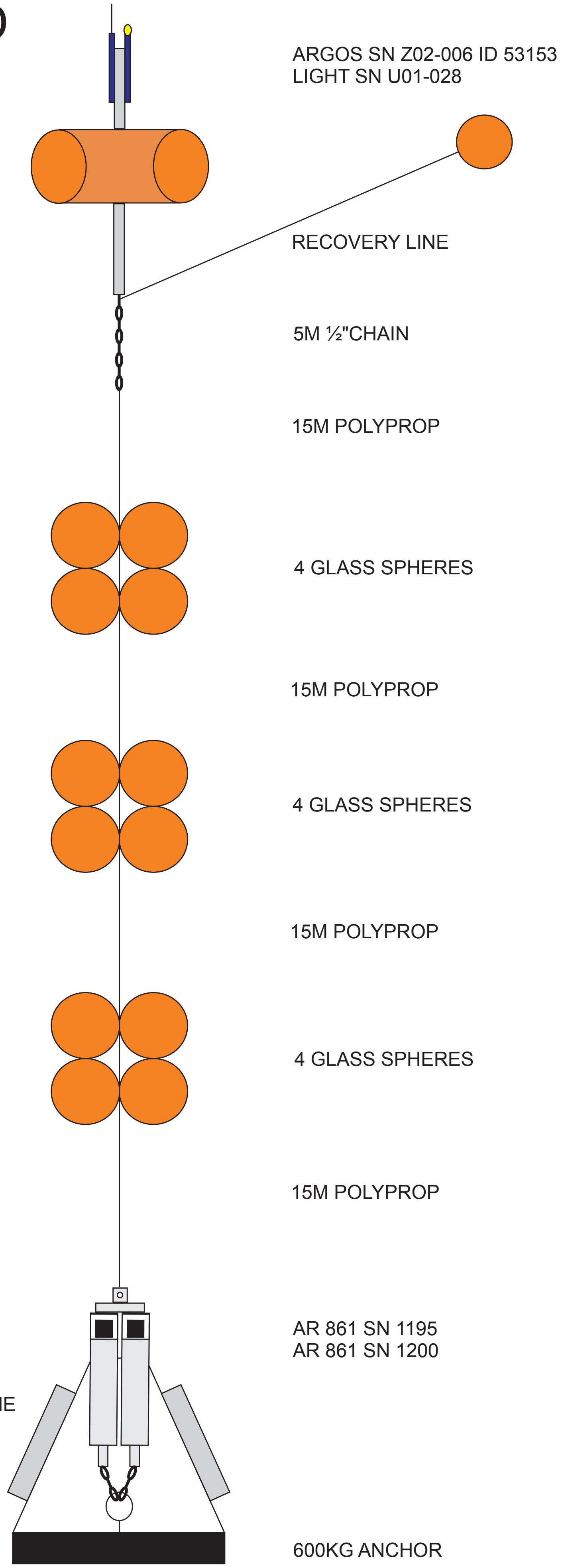


WB 2
AS DEPLOYED
2015



RAPID WATCH

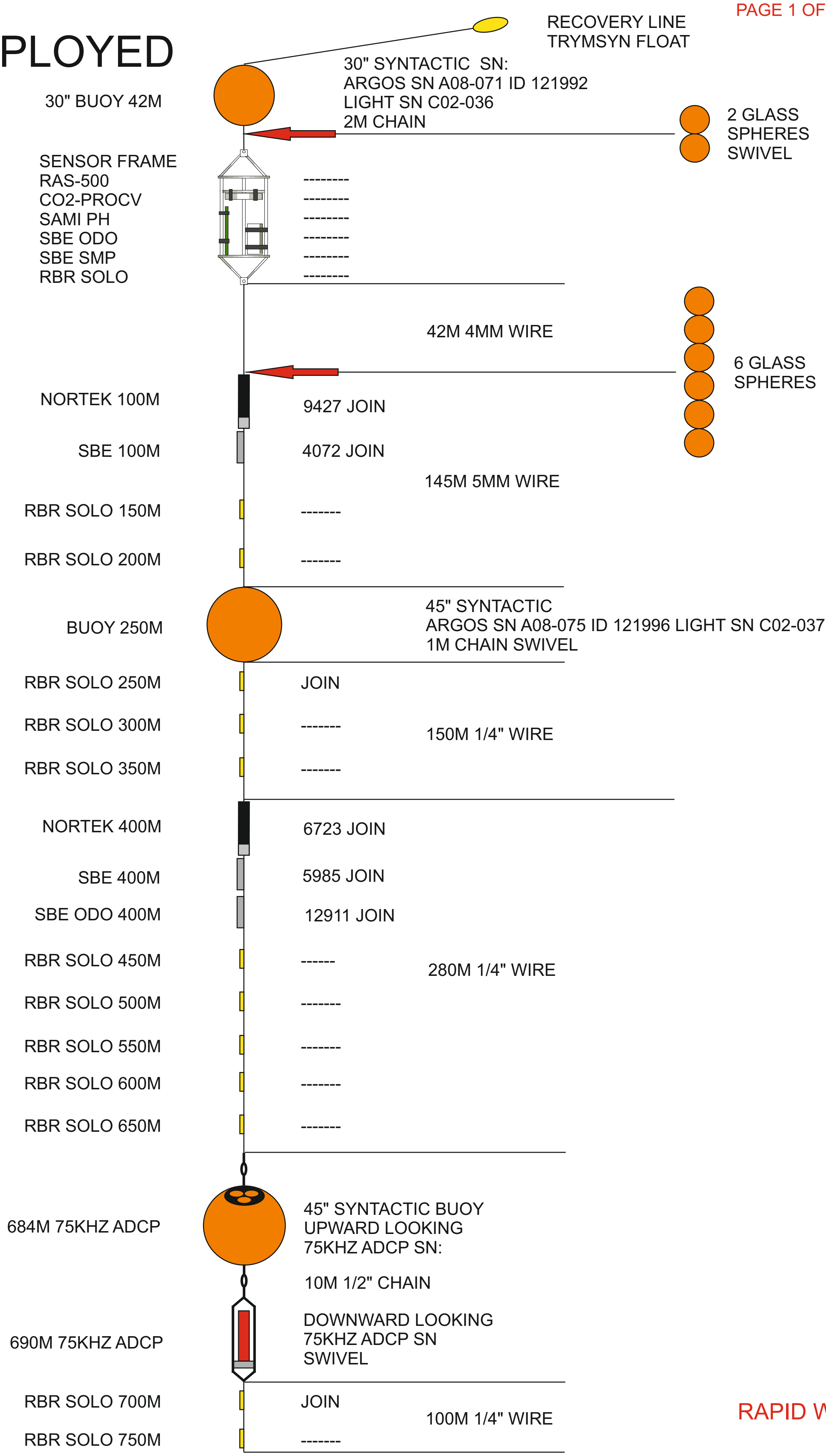
WB2L11
AS DEPLOYED
2015



WATER DEPTH
3890M

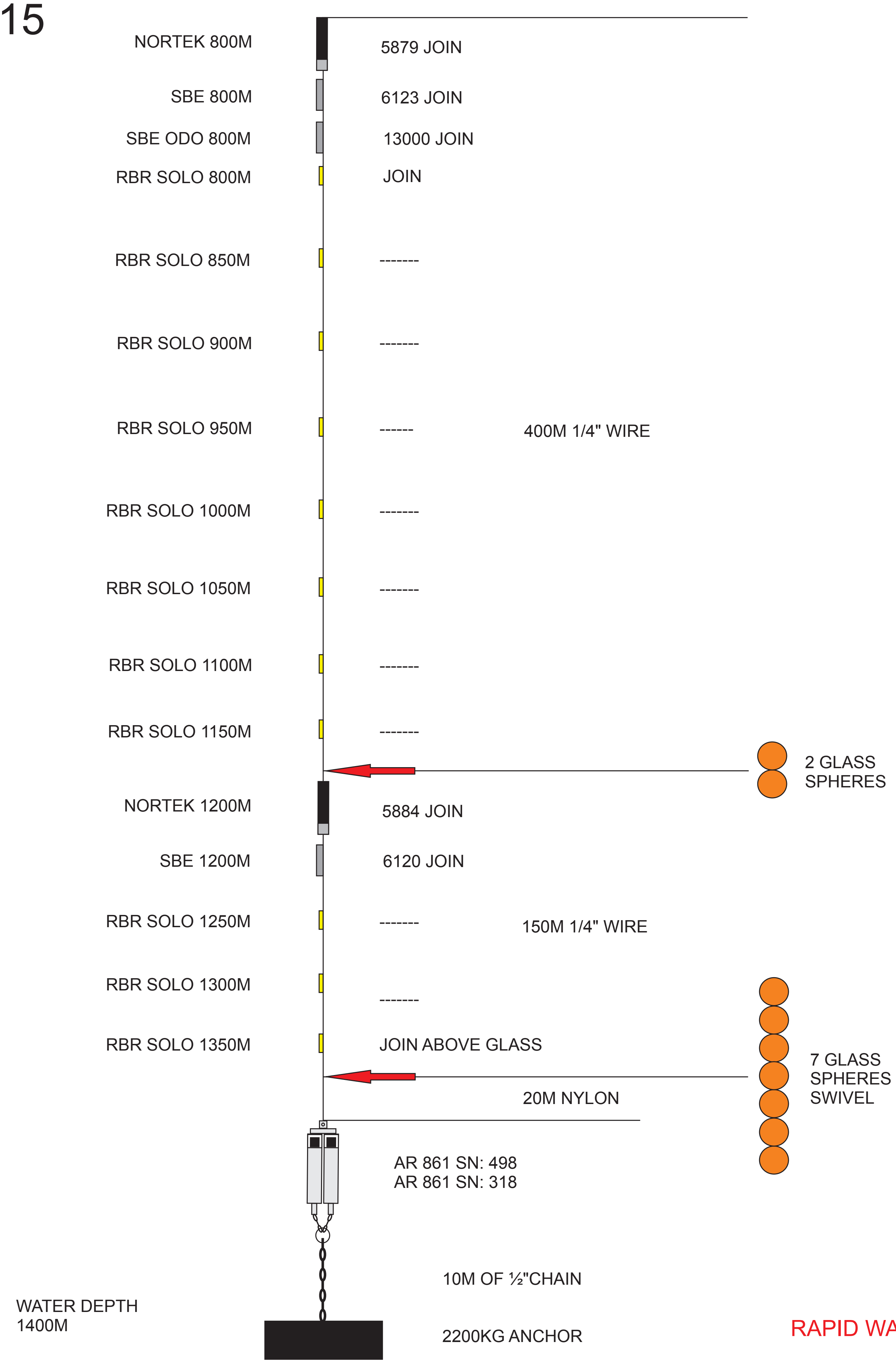
RAPID WATCH

WB 1
AS DEPLOYED
2015



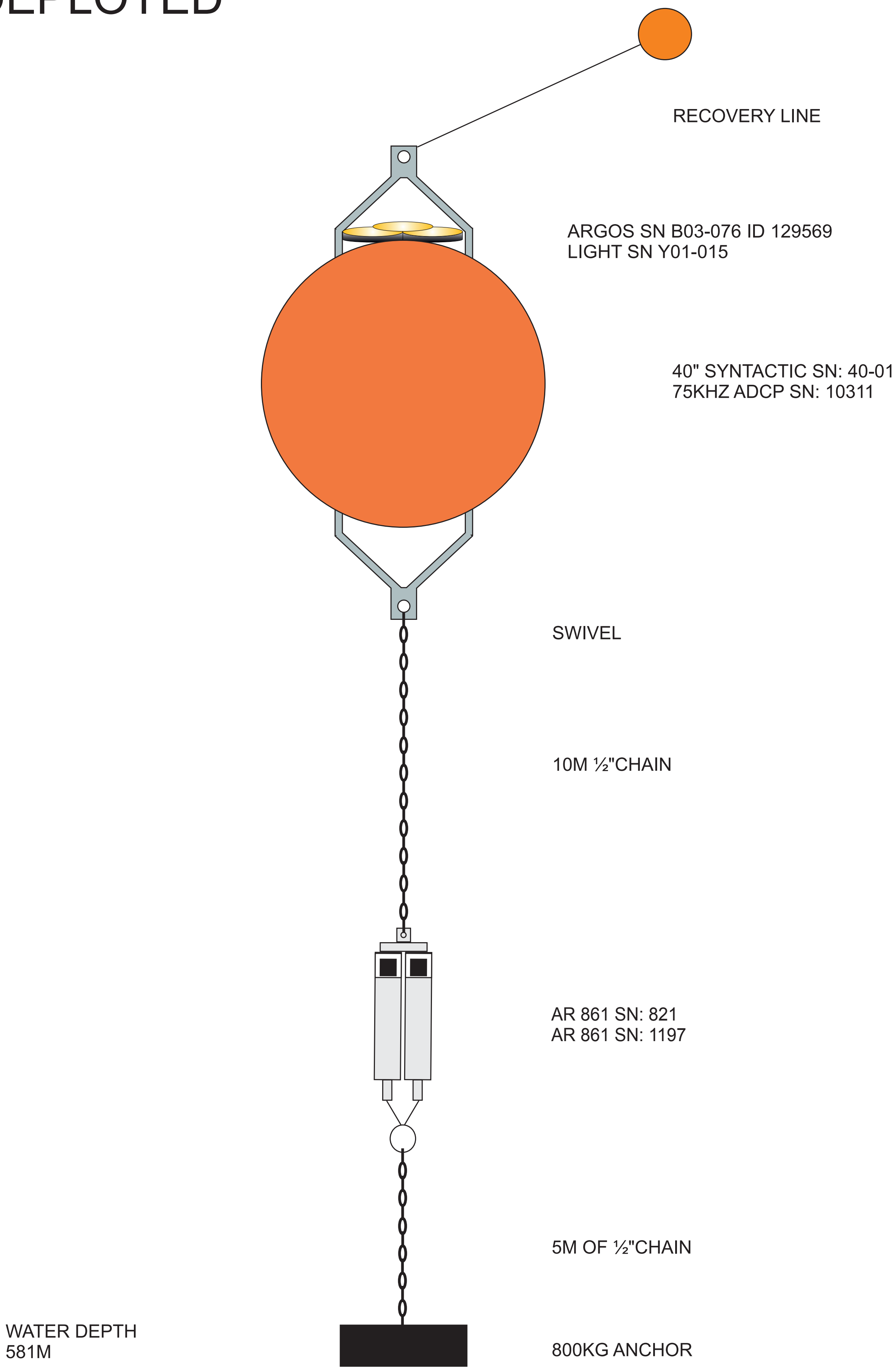
RAPID WATCH

WB 1
AS DEPLOYED
2015



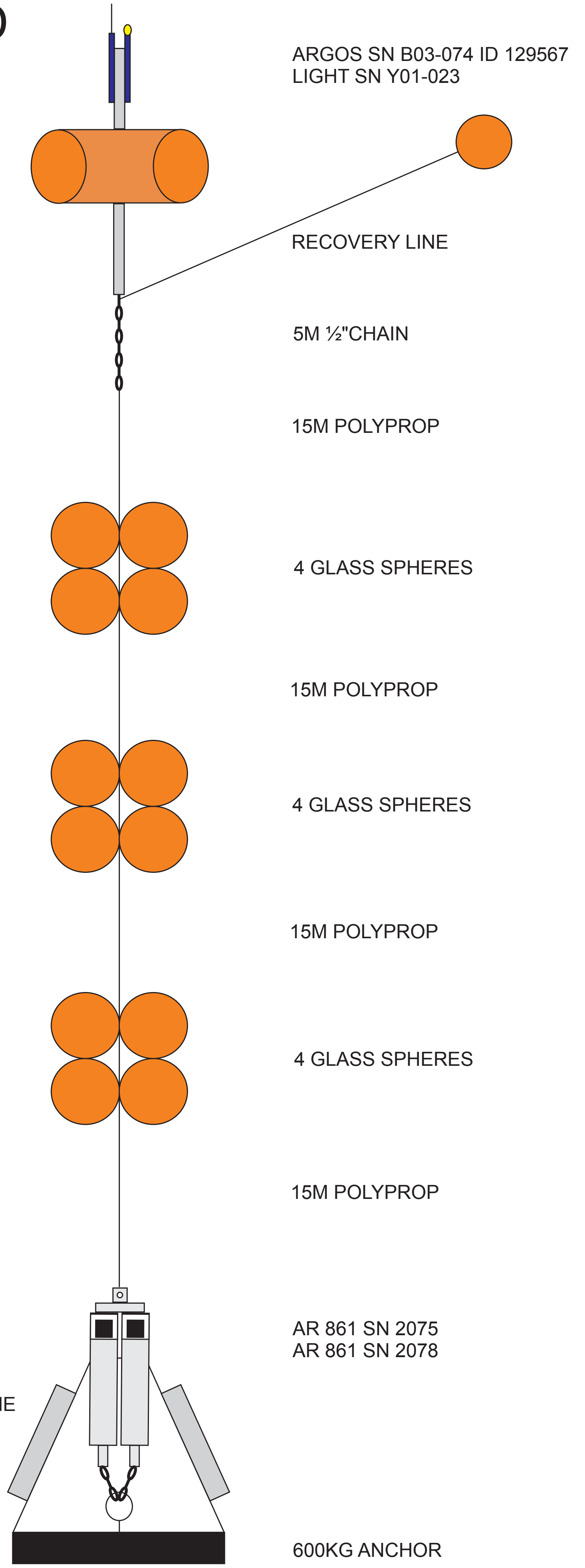
RAPID WATCH

WB ADCP
AS DEPLOYED
2015



RAPID WATCH

WBAL6
AS DEPLOYED
2015



WATER DEPTH
500M

RAPID WATCH

Appendix B: Instrument record lengths

Mooring	Nominal depth (m)	Inst. code	Serial number	Mean pressure (dbar)	Start date	End date	No. records	Comments
ebh3_10_201431	50	337	5778	39.6	30/05/2014	27/10/2015	12351	
	100	337	4725	89.8	30/05/2014	27/10/2015	12351	
	175	337	3932	163.9	30/05/2014	27/10/2015	12351	
	250	337	7723	241.2	30/05/2014	27/10/2015	12351	
	325	337	6830	335.1	30/05/2014	27/10/2015	12351	
	400	337	4717	415.0	30/05/2014	27/10/2015	12351	
	500	310	303	520.2	30/05/2014	27/10/2015	12351	No conductivity
	500	337	4721	497.3	30/05/2014	27/10/2015	12351	
	600	337	5774	592.9	30/05/2014	27/10/2015	12351	
	700	337	3228	699.8	30/05/2014	27/10/2015	12351	
	800	310	305	502.3	30/05/2014	02/07/2014	699	No data after 21 days. Probably battery failure
	800	337	3269	808.3	30/05/2014	27/10/2015	12351	
	950	337	3233	958.8	30/05/2014	27/10/2015	12351	
	1000	310	383	1014.3	30/05/2014	27/10/2015	12311	
	1100	337	5789	1116.9	30/05/2014	27/10/2015	12351	
	1200	337	3221	1221.0	30/05/2014	27/10/2015	12351	
	1300	366	322	1345.4	30/05/2014	27/10/2015	12352	Questionable high currents.
	1400	337	3206	1418.0	30/05/2014	27/10/2015	12351	
ebh4_11_201433	100	337	3904	96.7	31/05/2014	27/10/2015	12337	
	175	337	3905	169.3	31/05/2014	27/10/2015	12337	
	250	337	6802	256.5	31/05/2014	27/10/2015	12337	
	325	337	3232	323.7	31/05/2014	27/10/2015	12337	
	400	337	6810	396.8	31/05/2014	27/10/2015	12337	0.3dbar pressure drift over deployment period
	500	337	3891	499.9	31/05/2014	27/10/2015	12337	
	600	337	6838	608.6	31/05/2014	27/10/2015	12337	
	700	337	3901	706.0	31/05/2014	27/10/2015	12337	

	800	337	5783	811.6	31/05/2014	27/10/2015	12337	
	900	366	281	Flooded.				
	1000	337	6807	1004.2	31/05/2014	27/10/2015	12337	
ebh4L4_4_201238	1009	465	37	1032.2	02/11/2012	27/10/2015	26136	
	1009	465	53	1030.7	02/11/2012	27/10/2015	26136	Pressure jump of 0.1dbar after 02/Aug/2015
ebh2_10_201430	1600	337	4795	1613.5	30/05/2014	28/10/2015	12391	
	1800	337	3234	1826.5	30/05/2014	28/10/2015	12390	
	1900	310	445	1930.3	30/05/2014	28/10/2015	12383	
	2000	337	4714	2036.6	30/05/2014	28/10/2015	12391	
ebh1L9_9_201231	3015	465	400	3068.2	18/10/2012	29/10/2015	26546	
	3015	465	389	3067.6	18/10/2012	29/10/2015	26546	
ebh1_10_201428	2500	337	4475	2542.4	29/05/2014	29/10/2015	12429	
	2900	310	448	2969.4	29/05/2014	28/11/2014	4379	Short record. Battery failure
	3000	337	3229	3070.9	29/05/2014	29/10/2015	12429	
ebhi_10_201427	3500	337	5486	3494.1	26/05/2014	31/10/2015	12547	
	4000	337	4716	4031.9	26/05/2014	31/10/2015	12547	
	4400	310	449	4472.5	26/05/2014	15/10/2015	12523	Temperature 9.4°C too high.
	4500	337	6116	4571.3	26/05/2014	31/10/2015	12547	
eb1L9_9_201236	Mooring not recovered							
eb1_12_201425	50	337	4723	51.6	24/05/2014	02/11/2015	12643	
	100	337	4724	105.4	24/05/2014	02/11/2015	12643	
	175	337	4722	177.4	24/05/2014	02/11/2015	12643	
	250	337	6826	256.5	24/05/2014	02/11/2015	12643	
	325	337	3231	333.7	24/05/2014	02/11/2015	12643	
	400	337	4071	408.2	24/05/2014	02/11/2015	12643	
	600	337	4070	610.1	24/05/2014	02/11/2015	12643	
	800	337	6331	809.1	24/05/2014	02/11/2015	12643	
	1000	337	5485	1013.5	24/05/2014	02/11/2015	12643	
	1200	337	5770	1219.3	24/05/2014	02/11/2015	12643	
	1500	310	302	1533.2	24/05/2014	02/11/2015	12638	
	1600	337	6322	1631.4	24/05/2014	02/11/2015	12643	
	2000	337	5784	2045.1	24/05/2014	02/11/2015	12643	

	2500	337	6127	2533.7	24/05/2014	02/11/2015	12643	
	3000	337	6804	3051.6	24/05/2014	02/11/2015	12643	
	3500	337	4464	3557.1	24/05/2014	02/11/2015	12643	
	4000	337	6801	4117.3	24/05/2014	02/11/2015	12643	125dbar increase from mid august 2015.
	4500	337	4184	4608.7	24/05/2014	02/11/2015	12643	
	4990	310	395	4944.9	24/05/2014	03/12/2014	3917	Short record. Badly corrupted file. Battery failure.
	5000	337	5246	5097.1	24/05/2014	02/11/2015	12643	
mar3L8_8_201241	5100	465	029	5280.5	13/11/2012	07/11/2015	26144	
	5100	465	031	Low pressure flood				
mar3_10_201422	2000	377	4471	2012.0	18/05/2014	07/11/2015	12912	
	2500	377	3282	2484.4	18/05/2014	07/11/2015	12912	
	3000	377	6117	3007.6	18/05/2014	07/11/2015	12912	
	3500	377	5981	3520.9	18/05/2014	07/11/2015	12912	
	4000	377	5239	4040.2	18/05/2014	07/11/2015	12912	
	4500	377	5938	4564.6	18/05/2014	07/11/2015	12912	
	4995	377	5982	5081.7	18/05/2014	07/11/2015	12912	
	5000	302	35612574	5117.2	18/05/2014	07/11/2015	12912	
mar1_10_201420	50	337	4472	56.6	15/05/2014	11/11/2015	13079	
	100	337	4470	100.6	15/05/2014	11/11/2015	13079	
	175	337	4180	190.8	15/05/2014	11/11/2015	13079	
	250	337	3223	265.6	15/05/2014	11/11/2015	13079	
	325	337	4072	341.9	15/05/2014	11/11/2015	13079	
	400	337	4549	417.6	15/05/2014	11/11/2015	13079	
	600	337	6814	623.4	15/05/2014	11/11/2015	13079	
	800	337	4068	814.8	15/05/2014	11/11/2015	13079	
	1000	337	3239	1016.7	15/05/2014	11/11/2015	13079	
	1200	337	3270	1218.0	15/05/2014	11/11/2015	13079	
	1500	310	301	1539.5	15/05/2014	11/11/2015	13079	
	1600	337	6808	1629.8	15/05/2014	11/11/2015	13079	
	2000	337	5247	2057.0	15/05/2014	11/11/2015	13079	
	2500	337	5782	2564.7	15/05/2014	11/11/2015	13079	
	3000	337	5767	3082.2	15/05/2014	11/11/2015	13079	

	3500	337	3219	3605.2	15/05/2014	11/11/2015	13079	
	4000	337	6335	4112.3	15/05/2014	11/11/2015	13079	
	4500	337	6326	4638.2	15/05/2014	11/11/2015	13079	
	5000	337	6325	5161.0	15/05/2014	11/11/2015	13079	
	5000	302	35612571	0.3	15/05/2014	11/11/2015	13079	Pressure sensor fault: reads 0.366 dbar
mar1L8_8_201244	5200	465	59	5326.2	10/11/2012	11/11/2015	26318	
	5200	465	80	5326.0	10/11/2012	11/11/2015	26306	
mar2_10_201421	3750	337	4461	3852.1	15/05/2014	12/11/2015	13094	
	4250	337	6824	4378.5	15/05/2014	12/11/2015	13094	
	4750	337	6822	4891.1	15/05/2014	12/11/2015	13094	
	5170	337	6821	5284.7	15/05/2014	12/11/2015	13094	
	5185	302	35612572	5294.5	15/05/2014	12/11/2015	13095	
mar0_7_201418	4800	337	6121	4748.6	13/05/2014	13/11/2015	13174	
	4980	337	6123	4941.2	13/05/2014	13/11/2015	13174	
	5162	337	6137	5136.2	13/05/2014	13/11/2015	13174	
	5340	337	6120	5320.8	13/05/2014	13/11/2015	13174	
	5460	302	35612568	5421.7	13/05/2014	13/11/2015	13175	Pressure sensor fault June 1st 2015. Battery cover heavily pitted.
	5532	337	6803	No data. Instrument not set up.				
wb6_8_201417	4800	337	5985	4845.1	08/05/2014	15/11/2015	13343	
	4975	337	5243	5034.9	08/05/2014	15/11/2015	13342	
	5150	337	6320	5229.3	08/05/2014	15/11/2015	13342	
	5325	337	6128	5414.3	08/05/2014	15/11/2015	13342	
	5400	370	5896	Low pressure flood on deployment.				
	5490	337	3919	5587.5	08/05/2014	15/11/2015	13342	
	5494	465	0056	5608.8	09/05/2014	15/11/2015	13327	
	5494	465	0055	5609.7	09/05/2014	15/11/2015	13314	
wb4_11_201409	50	337	6125	45.6	01/05/2014	18/10/2015	12803	Stopped mid-October 2015. Depleted battery.
	50	335	10545	44.1	01/05/2014	22/11/2015	3418	
	100	370	9409	85.8	01/05/2014	22/11/2015	27346	
	105	337	6129	87.3	01/05/2014	22/11/2015	13673	

	250	337	6327	240.1	01/05/2014	22/11/2015	13673	
	400	370	9420	392.9	01/05/2014	22/11/2015	27346	
	405	335	10544	394.9	01/05/2014	22/11/2015	3418	
	405	337	3933	393.5	01/05/2014	22/11/2015	13673	
	600	337	7363	594.7	01/05/2014	22/11/2015	13673	
	800	370	9427	807.1	01/05/2014	22/11/2015	27346	
	805	337	5786	794.0	01/05/2014	22/11/2015	13673	
	805	335	10547	796.7	01/05/2014	22/11/2015	3418	
	1000	337	4307	998.6	01/05/2014	22/11/2015	13673	
	1200	370	9433	1224.6	01/05/2014	22/11/2015	27346	
	1205	337	5762	1202.0	01/05/2014	22/11/2015	13673	
	1500	370	9439	1511.4	01/05/2014	22/11/2015	27346	
	1500	335	10555	1503.0	01/05/2014	22/11/2015	3418	
	1600	337	5773	1599.4	01/05/2014	22/11/2015	13673	
	2000	370	9444	2005.0	01/05/2014	22/11/2015	27346	
	2005	337	3931	2007.7	01/05/2014	22/11/2015	13673	
	2005	335	10556	2008.3	01/05/2014	22/11/2015	3418	
	2500	337	5779	2517.5	01/05/2014	22/11/2015	13673	
	3000	370	6119	3076.3	01/05/2014	22/11/2015	27346	
	3005	337	6820	3032.1	01/05/2014	22/11/2015	13673	
	3505	337	6806	3534.8	01/05/2014	22/11/2015	13673	
	3505	335	10546	3545.3	01/05/2014	22/11/2015	3418	
	4000	370	5879	4084.9	01/05/2014	22/11/2015	27346	
	4005	337	5768	4058.7	01/05/2014	22/11/2015	13673	
	4500	337	4305	4564.8	01/05/2014	22/11/2015	13673	
	4600	370	5884	4710.8	01/05/2014	22/11/2015	27346	
wb4L9_9_201249	4700	365	54	4782.2	19/11/2012	23/11/2015	26386	
	4700	365	4	4785.2	19/11/2012	23/11/2015	26380	
wbh2_8_201416	1500	370	5590	1552.4	05/05/2014	23/11/2015	27224	
	1500	335	10520	1546.9	05/05/2014	23/11/2015	3403	
	2000	335	10542	2062.9	05/05/2014	23/11/2015	3403	
	2200	370	5899	2272.0	05/05/2014	23/11/2015	27224	

	2200	337	5763	2255.2	05/05/2014	23/11/2015	13613	
	3000	370	6049	3069.8	05/05/2014	23/11/2015	27224	
	3000	337	6124	3058.6	05/05/2014	23/11/2015	13613	
	3500	335	10543	3561.3	05/05/2014	23/11/2015	3403	
	3800	370	9406	3877.4	05/05/2014	23/11/2015	27224	
	3800	337	6333	3867.4	05/05/2014	23/11/2015	13612	
	4300	337	5780	4373.7	05/05/2014	23/11/2015	13613	
	4610	370	6083	4713.2	05/05/2014	23/11/2015	4713.2	
	4690	337	3934	4761.5	05/05/2014	23/11/2015	13612	
wb2L9_9_201252	3890	365	002		21/11/2012	06/04/2014	12000	Short record. Pressure sensor failure.
	3890	365	060	3950.7	21/11/2012	24/11/2015	26352	
wbadcp_11_201413	566	581	5817	600.8	04/05/2014	24/11/2015	13676	
wb1_11_201415	50	335	10517	43.7	04/05/2014	29/11/2015	13774	
	100	370	7553	92.0	04/05/2014	29/11/2015	27549	
	100	337	6115	92.3	04/05/2014	29/11/2015	13774	
	400	370	9266	390.1	04/05/2014	29/11/2015	27549	
	400	337	3911	391.9	04/05/2014	29/11/2015	13774	
	400	335	10518	495.8	04/05/2014	29/11/2015	13774	Known pressure offset. Refer to JC103 cruise report
	800	370	5885	801.1	04/05/2014	29/11/2015	27549	
	800	337	3486	789.4	04/05/2014	29/11/2015	13774	
	800	335	10519	795.3	04/05/2014	29/11/2015	13774	
	1200	370	9402	1187.9	04/05/2014	29/11/2015	27549	
	1200	337	3483	1191.7	04/05/2014	29/11/2015	13774	
wb2_12_201412	50	337	6126	73.2	03/05/2014	28/10/2015	12946	Short record. Battery failure
	100	370	5897	119.9	03/05/2014	29/11/2015	27604	
	100	337	6321	117.3	03/05/2014	29/11/2015	13802	Conductivity offset of 8 mS/cm after 24/07/2015
	175	370	5890	192.0	03/05/2014	29/11/2015	27546	
	175	337	7468	190.9	03/05/2014	29/11/2015	13802	
	325	337	6828	341.5	03/05/2014	29/11/2015	13802	
	400	370	5967	419.1	03/05/2014	29/11/2015	27604	
	500	337	3902	518.6	03/05/2014	29/11/2015	13802	
	700	337	6840	716.4	03/05/2014	29/11/2015	13802	

	800	370	6132	825.7	03/05/2014	29/11/2015	27604	
	900	337	5785	917.2	03/05/2014	29/11/2015	13802	
	1100	337	4306	1120.8	03/05/2014	29/11/2015	13802	
	1200	370	6176	1236.5	03/05/2014	29/11/2015	27604	
	1300	337	5240	1323.7	03/05/2014	29/11/2015	13802	
	1500	370	6516	1535.3	03/05/2014	29/11/2015	27604	
	1500	337	3928	1533.2	03/05/2014	29/11/2015	13802	
	1700	337	3209	1734.0	03/05/2014	29/11/2015	13802	
	1900	337	5787	1936.0	03/05/2014	29/11/2015	13802	
	2050	370	6743	2089.2	03/05/2014	29/11/2015	27604	Roll sensor faulty
	2300	337	3248	2331.6	03/05/2014	29/11/2015	13802	
	2800	337	6825	2848.0	03/05/2014	29/11/2015	13802	
	3000	370	6751	3066.9	03/05/2014	29/11/2015	27604	
	3300	337	3910	3345.7	03/05/2014	29/11/2015	13802	
	3850	337	6323	3908.5	03/05/2014	29/11/2015	13802	

Table B.1: Summary of instrument record lengths

Appendix C: Cal-dip details

CAST NO. , MICROCAT S/N

CAST01, 3257, 3893, 6817, 6818, 5766, 5244[1], 5238, 3266, 3212, 3216[2], 3890, 5242[3], 5765, 6816, 6813[4]
[1]Cond > 0.03 mS/cm offset at 3500 m.
[2]Not stopped. Rebatteried and redipped.
[3]Cond > 0.05 mS/cm offset at 3500 m.
[4]Press > 10 dbar offset throughout

CAST02, 3912, 6833, 5484[1], 5245, 3252, 3213, 3249, 3207, 3244, 6815[2], 3271, 3214, 3220, 3251
[1]Cond > 0.03 mS/cm offset at 3500 m
[2]Press > 10 dbar offset throughout

CAST03, 6827, 6832, 6831, 6823, 3244, 6332, 5772, 5241[1], 3916, 3907, 3265, 3215[2], 3256, 6812[3], 3281, 11744, 11424, 7681
[1]Temp cold by 0.01°C
[2]Cond ~ 0.03 mS/cm, just within range
[3]Press > 20 dbar at 3500 dbar target (bad throughout)

CAST04, 12832, 12833, 12834, 12835, 12900, 12901, 12902, 12907, 12908, 12910, 7470, 7362, 4799, 5979, 5984, 6113[1], 6112[2], 5777
*All oxygen microcats (S/N 12XXX) had large offsets from the CTD but were together
[1]Press > 6 dbar, moved to less sensitive location and paired with an ODO
[2]Press > 10 dbar, moved to less sensitive location and paired with an ODO

CAST06, 3206, 3221, 3222, 3224, 3253, 3255, 3484, 3904, 3905, 4717[1], 4721, 5776, 6114[2], 6118, 6122, 6834, 6839, 6841
[1]Cond > 0.04 mS/cm offset
[2]Press > 14 dbar offset

CAST07, 3228, 3229, 3232[1], 3233[2], 3234, 3269, 3891[3], 3901, 4475, 4714, 4795[4], 5774[5], 5783, 5789, 6802, 6807[6], 6810, 6838
[1]No data, requires redip
[2]Out by 6 dbar around 1200 dbar (target) but only 2 dbar at shallower depths, reallocated
[3]Cond ~ 0.03 mS/cm out at all depths, Press 30 dbar offset at depth
[4]Press ~ 10 dbar out at 1000 m
[5]No data, requires redip
[6]Press ~ 10 dbar offset at shallower depths

CAST09, 6836, 6829, 6811, 6799, 3900, 5778[1], 4725[2], 3932, 7723, 6830[3], 5774[4], 5486[5], 4719, 6116, 3247, 6800, 3259, 3225
[1]Cond off by 0.037 mS/cm. Paine pressure sensor
[2]Press off by 20-30 dbar at depth, good shallow
[3]Press off by 7.5 dbar at 600 m, good deeper
[4,5]Paine pressure sensors

CAST10, 3231, 4070, 4071, 4184[1], 4464, 4722[2], 4723, 4724, 5485[3], 5770, 5784, 6127, 6322, 6331[4], 6801, 6804, 6826, 13243, 5246[5]
[1]Press off by 10 dbar at 4500 dbar. Offset throughout
[2]Cond off by 0.025
[3]Paine pressure sensor
[4]Press out by 7 dbar at 5500 dbar, Paine sensor

CAST13, 3232, 4471, 3282, 6117, 5981, 5239, 6798, 3913, 3223, 4549[1], 6814[2], 3270, 6808, 5247[3]
[1]Bad pressure, Paine sensor
[2]Press bad near surface, good around 2000 dbar
[3]Bad pressure, Paine sensor. Bad cond > 0.03 mS/cm at bottom

CAST14, 12962, 12963, 12964[1], 12965, 12966[2], 12967, 12968, 12998, 12999, 13000, 4072, 4068, 3239
*All oxygen microcats (S/N 1????) had large offsets from the CTD but together
[1]Conductivity out by 0.05 mS/cm at deepest bottle
[2]Oxygen slow response, not visible in conductivity i.e. not consistent with a pump issue

CAST15, 5983, 5982, 3268[1], 6326[2], 6325, 6824, 6822, 6821, 6137, 6120[3], 6803, 6121, 6123, 6335, 4472[4], 4470, 4180, 5782
[1]Pump dodgy at start, slow response in shallow pressure
[2,3]Press 5 dbar out at deployment depth, marginal
[4]Cond out by 0.05 at deepest dip

CAST17, 5985, 5243, 6320[1], 6128, 3919, 5767, 3219[2], 4461
[1]Press out by 6 dbar
[2]Press out by a 76 dbar. Cond off by 0.035 mS/cm (could be related to large pressure error)

CAST19, 6125[1], 6129[2], 6327, 3933, 7363, 5786, 4307, 5762[3], 5773, 3931[4], 5779, 6820, 6806[5], 5768, 4305
[1,2]Cond out by 0.03 mS/cm
[3]Press out by 6 dbar
[4]Press out by approximately 5 dbar
[5]Press out by 7 dbar

CAST20, 12911, 10545[1], 10544, 10547, 10555, 10556, 10546
[1]Cond out by 0.04 mS/cm

CAST21, 5763[1], 6124, 6333, 5780, 3934
[1]Press out by 6 dbar

CAST23, 10542, 10520, 10543[1], 10517[2], 10518[3], 10519, 3911, 3483, 6126, 6321[4], 7468[5], 6828, 3902[6], 6840, 5785, 4306
[1]Press 1000 dbar out
[2]Cond 0.05 mS/cm out at depth
[3]Oxygen 10 umol/kg out at depth
[4]Cond 4.4 mS/cm out!
[5]Cond out by 0.03 mS/cm
[6]Press out 15 dbar

CAST25, 5240, 3928, 3209, 5787, 3248, 6825, 3910, 6323, 6115, 3486

Appendix D: Mooring deployment tracks and trilaterated seabed locations of selected moorings

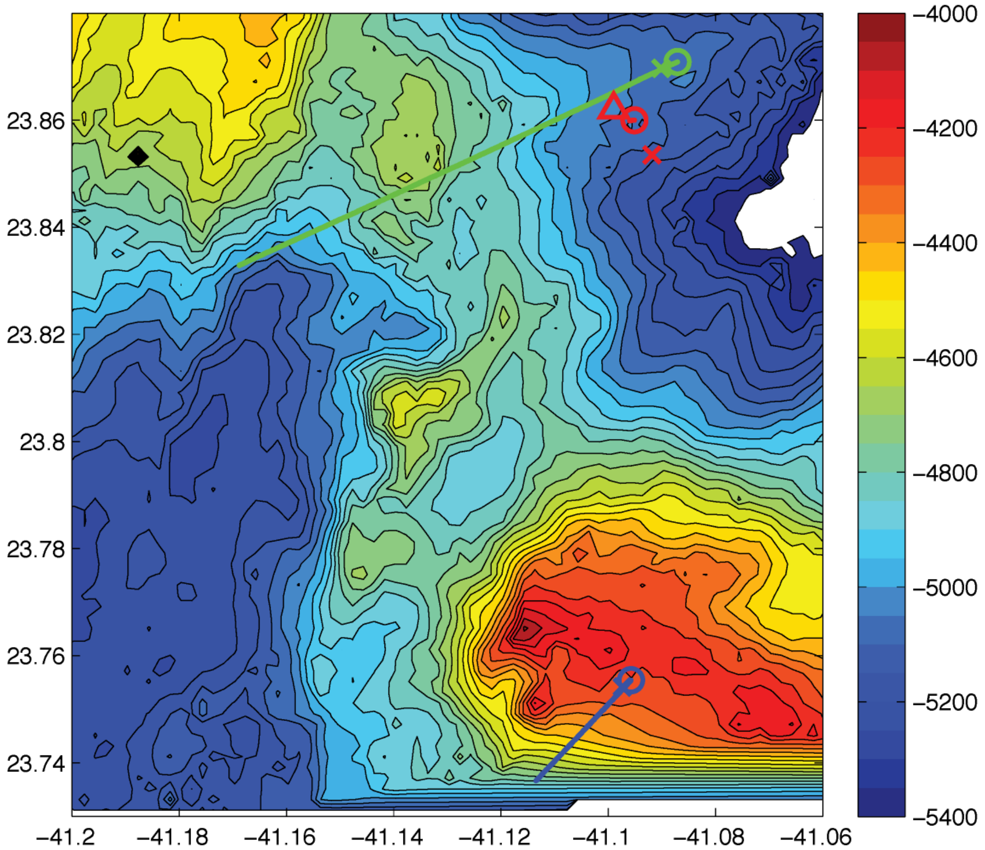


Figure D.1: Deployment track and anchor seabed positions of MAR3 (green), NOG (blue) and MAR3L10 (red). MAR3L9 deployed in 2014 also shown (red triangle). X = trilaterated anchor position and O = anchor drop position. Depth shown in metres.

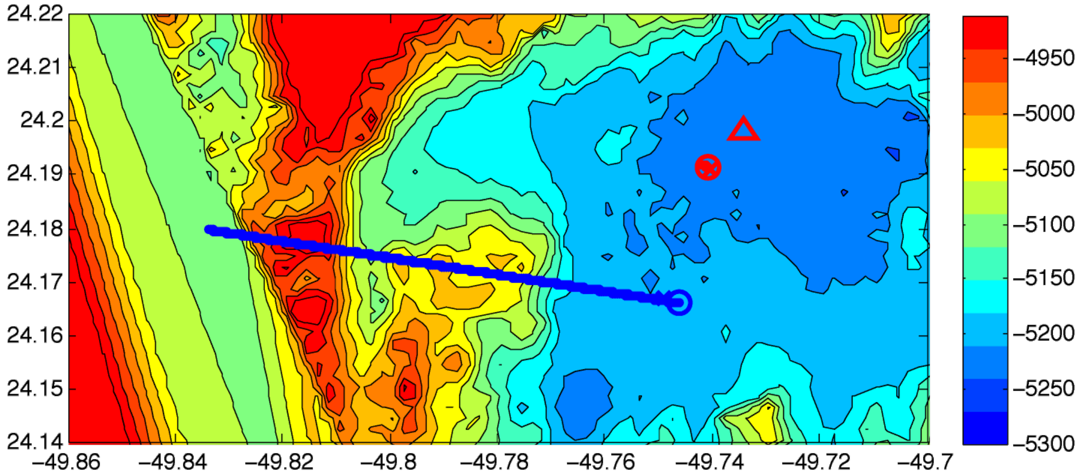


Figure D.2: Deployment track and anchor seabed positions of MAR1 (blue) and MAR1L10 (red). Also shown is MAR1L9 deployed in 2014 (red triangle). X = trilaterated anchor position and O = anchor drop position. Depth shown in metres.

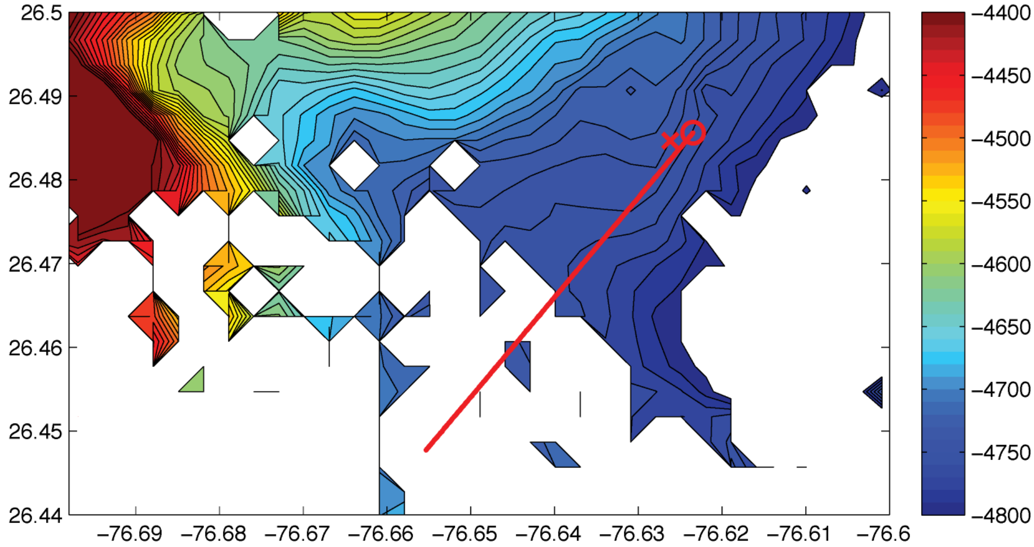


Figure D.3: Deployment track and anchor seabed positions of WBH2 (red). X = trilaterated anchor position and O = anchor drop position. Depth shown in metres.

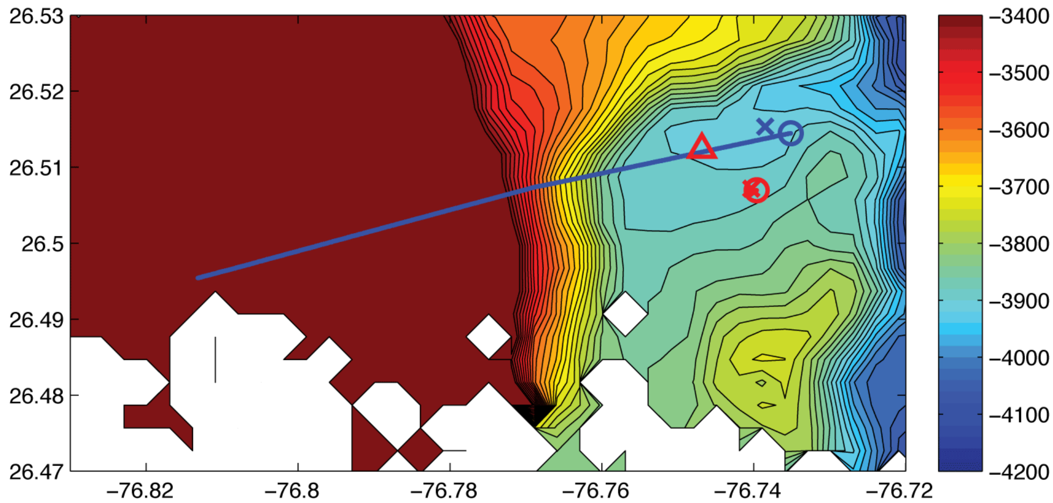


Figure D.4: Deployment track and anchor seabed positions of WB2 (blue) and WB2L11 (red). Also shown is WB2L10 deployed in 2014 (red triangle). X = trilaterated anchor position and O = anchor drop position. Depth shown in metres.

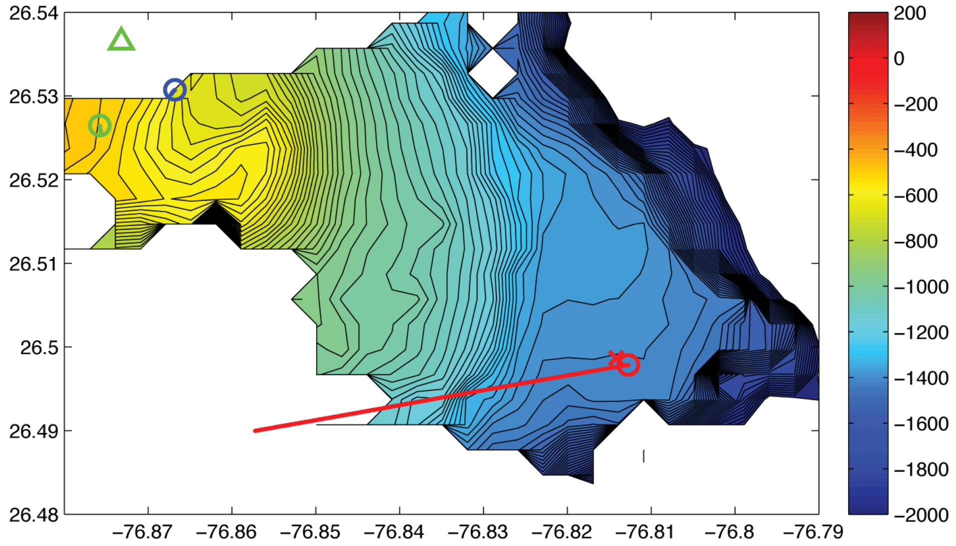


Figure D.5: Deployment track and anchor seabed positions of WB1 (red), WBADCP (blue) and WBAL6 (green). Also shown is WBAL5 deployed in 2014 (green triangle). X = trilaterated anchor position and O = anchor drop position. Depth shown in metres.

Appendix E: Mooring recovery and deployment logsheets

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH4** Cruise **DY039**

NB: all times recorded in GMT

Date 27/10/2015 **Site arrival time** 1518

Time of first ranging 1515

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	Grappled @ 15:44	15:44
Billings Float	n/a		15:50
with Light	U01-026 ✓		
and Argos Beacon	C02-039 ✓	BEACON ID: 300234061660230	
4 x 17" glass	n/a		15:53
MicroCAT	3904 ✓	Weed coverage (70%)	15:53
MicroCAT	3905 ✓	Weed coverage	16:02
3 x 17" glass	n/a		16:04
MicroCAT	6802 ✓		16:06
MicroCAT	3232 ✓		16:08
2 x 17" glass	n/a	Tangled with microcat	16:11
MicroCAT	6810 ✓		16:11
MicroCAT	3891 ✓		16:18
2 x 17" glass	n/a	Fishing net (small)	16:21
MicroCAT	6838 ✓		16:23
MicroCAT	3901 ✓		16:26
2 x 17" glass	n/a		16:29
MicroCAT	5783 ✓		16:32
Sontek	D298 ✓		16:36
MicroCAT	6807 ✓		16:40
6 x 17" glass	n/a		16:42
Swivel	n/a		
Acoustic Release 1	253	[redacted]	
Acoustic Release 2	1536		
700 KG ANCHOR	n/a		

Ascent Rate 50 m/min

Ranging

~50 m/min

Time	Range 1	Range 2	Command/comment
151512			Echo sounders ON
151630	1135	1138	[redacted]
151700	8809	209	
151830	1166	1167.	"
152300	1176	1176	" , Release OK
152330	1146	1139	" "
152400	1110	1103	" "
			Spotted by bridge
			immediately
			All up @ 1536

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring **EBH4L4** Cruise **DY039**

NB: all times recorded in GMT

Date 27 Oct 2015 **Site arrival time** 1719

Time of first ranging 1722

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	Grappled @ 1756	1757
Billings Float	n/a		1803
with Light	A08-087 ✓		
and Argos Beacon	Y01-028 ✓	Beacon iD: 46501	
4 x 17" glass	n/a		"
4 x 17" glass	n/a		1813
4 x 17" glass	n/a		1817
BPR	0037 ✓	lots of fouling on lower line	1821
BPR	0053 ✓		"
Acoustic Release #1	1242 ✓	[redacted]	"
Acoustic Release #2	908 ✓		"

Ascent Rate 70 m/min eta 1745

Ranging

Time	Range 1	Range 2	Command/comment
172200	1621	83	[redacted]
172330	105	1109	"
172400	211	1109	"
172430	6084	1109	[redacted]
172500	251	"	"
172830	1109	1109	[redacted] RELEASE OK
172930	1040	1037	" "

14 MC

10:04
10:10

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH3** Cruise **DY039**

NB: all times recorded in GMT

Date 27/10/15 **Site arrival time** 09:00

Time of first ranging 09:02

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	SURFACED 09:09	
Billings Float	n/a		9:45
with Light	Z08-049		
and ~~Argos~~ Iridium Beacon	C02-048	Beacon ID:300234061662230 ✓	
4x17" glass	n/a		9:47
Swivel	n/a		9:50
MicroCAT	5778 ✓	Heavy fouling	9:50
MicroCAT	4725 ✓	" "	9:52:46
MicroCAT	3932 ✓	Heavy fouling	9:55:23
MicroCAT	7723 ✓		9:57:49
3x17" glass	n/a	Tangled.	10:01
MicroCAT	6830 ✓		10:02
MicroCAT	4717 ✓	missing guard	10:04
5x 17" glass	n/a		10:15
Swivel	n/a		
RCM11	303 ✓		10:08
MicroCAT	4721 ✓		10:05
MicroCAT	5774 ✓		10:18:59
4 x 17" glass	n/a	Tangled.	10:22:17
MicroCAT	3228 ✓		10:22:17
RCM11	305 ✓		10:32:48
MicroCAT	3269 ✓		10:32:48
3 x 17" glass	n/a		10:37:07
MicroCAT	3233 ✓	No locking sleeve.	10:39:58
RCM11	383 ✓		10:41:51
MicroCAT	5789 ✓		10:45:36
3 x 17" glass	n/a ✓	Tangled (with MC) 3221.	10:48:59
MicroCAT	3221 ✓		10:48:59
Sontek	D322 ✓		10:54:27
MicroCAT	3206 ✓	Heavy fouling	10:58:26
4 x 17" glass	n/a	Heavy fouling	10:59:10
Swivel	n/a		10:59:10
Acoustic Release 1	1535 ✓	opened.	10:59:10
Acoustic Release 2	930 ✓		10:59:10
500 kg Anchor	n/a		

Ascent Rate ____________

Ranging

Time	Range 1	Range 2	Command/comment
09:03:20	1544	1539	Arm +Arm
09:07:48	1543	1543	Arm + Rel OK
09:08:40	1488	1480	
09:09:40	147.3 X	1399	RANGES < WATER DEPTH

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring **EBH2** Cruise **DY039**

NB: all times recorded in GMT

Date 28/OCT/2015 **Site arrival time** ________

Time of first ranging 16:16:30

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		17:01:48
Billings Float	n/a	Tangled.	17:02:00
with Light	N08-027		
and Argos Beacon	C08-047	Beacon ID: 300234061668230	17:
2 x 17" glass	n/a		17:04:58
Swivel	n/a		
MicroCAT	4795p		17:02
2 x 17" glass	n/a		17:14:59
MicroCAT	3234		17:15:46
RCM11	445		17:18:55
MicroCAT	4714		17:22:36
3 x 17" glass	n/a		17:22:46
Swivel	n/a		
Acoustic Release #1	1198	released.	17:22:46
Acoustic Release #2	1350		17:22:46
500kg Anchor	n/a		

Ascent Rate 65m/min

Ranging

Time	Range 1	Range 2	Command/comment
16:16:30	2101.6	2101.4	ok. 'range'
16:17:15	7196	2101.4	release ok.
16:18:15	2050.8	2043.3	57 m/min.
16:19:15	1986.8	~~1980~~ 1980.7	65 m/min.
16:43			at Surface

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring **EBH1** Cruise **DY039**

NB: all times recorded in GMT

Date 29/10/2015 **Site arrival time** 0920

Time of first ranging 0906

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1037
Billings Float	n/a		1049
with Light	T05-078 ✓		1049
and Argos Beacon	C02-049 ✓	Beacon ID: 300234061601230	1049
2 x 17" glass	n/a		1049
Swivel	n/a		1049
MicroCAT	4475 ✓		1051
2 x 17" glass	n/a		1100
RCM11	448 ✓		1106
MicroCAT	3229 ✓		1110
3 x 17" glass	n/a		1110
Swivel	n/a		
Acoustic Release #1	1202 ✓		1110
Acoustic Release #2	827 ✓		1110
500kg Anchor			

Ascent Rate 70 m/min

Ranging

Time	Range 1	Range 2	Command/comment
0906	1910	5578	Ranging
0906 17	3535	773	" sounders may
092000	2207	3117	have been on.
092036	2448	647	
092230	2895	3106	
092300	2367	2868	
092400	—	9528	
092450	4814	7185	
092510	—	11831	
092630	3110	11262	
092700	3109	3109	
092900	3112	3111	Release OK
093000	3056	3049	" "
093100	2984	2981	

42

70 ⟌ 3006 2

10:11 surface

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **EBH1L9** Cruise **DY039**

NB: all times recorded in GMT

Date 29/10/2015 **Site arrival time** overnight

Time of first ranging ____________

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	8:26:40	8:47:20
Billings Float	n/a		8:47:20
with Light	S01-185 ✓		
and Argos Beacon	A08-070 ✓	Beacon ID:121991	
3 x 17” glass	n/a	Tangled	8:47:00
3 x 17” glass	n/a		8:52:03
4 x 17” glass	n/a		8:53:30
BPR	400 ✓		8:56
BPR	389 ✓		8:56
Acoustic Release #1	265 ✓	[redacted] ✓	8:56
Acoustic Release #2	1 347	✓	8:56
300kg Anchor	n/a		

Ascent Rate 90 m/min eta 08.30.

Ranging

[redacted]

Time	Range 1	Range 2	Command/comment
075043	–	–	ranging
	3061	3061	
	3061	3061	
	1586	4542	
	3062	3060	
075330	3062	(2684)	Release OK.
075430	1198	2987	" "
075530	1039	2583	" "
075630	2824	2815	
075730	2735	2719	

3000 m

4|2700

30

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring EBHi

Cruise DY039

NB: all times recorded in GMT

Date 31/10/15

Site arrival time OVERNIGHT

Time of first ranging 07:15

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	8:16 surface.	8:43:27
Billings Float	n/a	TANGLED	8:44:16
with Light	X01-048 ✓		8:
and Argos Beacon	C02-038 ✓	Beacon ID:300234061669220	
2 x 17" glass	n/a		8:44:47
Swivel	n/a		
MicroCAT	5486 ✓		8:45:24
2 x 17" glass	n/a		9:02:48
MicroCAT	4719 ✓	TANGLED	9:12:20
RCM11	449 ✓		9:17:14
MicroCAT	6116 ✓		9:21:31
4 x 17" glass	n/a		9:22:16
Swivel	n/a		
Acoustic Release #1	~~821~~ ✓		9:22:35
Acoustic Release #2	1465 ✓		9:22:35
500Kg Anchor	n/a		

Ascent Rate ____________

Ranging

Time	Range 1	Range 2	Command/comment
07:15	—	5450	ARM + ARM SN 821
07:16:18	4531	3421	
07:17:20	2672	8545	
07:17:44	2015	10861	
07:18:22	1457	4709	ARM + ARM ~~1461~~ SN 1465
07:18:45	5763	5747	
07:19:11	—	1030	
07:19:41	4071	—	
07:20:21	2811	2424	
072228		4257	
072615		2349	821
072715	1905	3897	821
0728 00	3854	3846	821
073115	3311	3634	821

07:33:24	3508	2014	ARM + REL SN 1465 REL OK
07:34:30	3442	3434	ARM + REL
07:35:10	3402	3394	
07:35:56	3353	3348	
07:37:54	3241	3226	

FIRST RELEASE

ETA 08:24
TO SURFACE

X WRONG AS ESTIMATED WITH 500m MOORING INSTEAD OF 1000m.

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring EB1 Cruise DY039

NB: all times recorded in GMT

Date 2/11/15 **Site arrival time** 11:49

Time of first ranging 11:49

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	Grappled at 12:43	1244
3 x Mini-Trimsyns	n/a		12:51:28
MicroCAT	4723 ✓	fouling	12:51:29
24" syntactic float	n/a		12:56:48
with Light	Z02-023		
and ~~Argos Beacon~~ IRB.	C02-042	Beacon ID:300234061664230 J03J D2	
Swivel	n/a		
MicroCAT	4724 ✓		12:57:39
37" steel sphere	n/a	Tangled	13:05:09
with light	Y01-018 ✓		
and Argos Beacon	~~285~~-094	Beacon ID: ~~60211~~ 24027	
Swivel	n/a		
MicroCAT	4722 ✓		13:05:09
MicroCAT	6826 ✓		13:12:00
MicroCAT	3231 ✓		13:13:43
MicroCAT	4071 ✓		1:16:25
MicroCAT	4070 ✓		1:26:09
4 x 17" glass	n/a	Tangled	1:16:25
MicroCAT	6331 ✓	gaurd loose	1:31:04
4 x 17" glass	n/a	Tangled	1:31:01
MicroCAT	5485 ✓	lockingsleave is missing	1:47:36
MicroCAT	5770 ✓		1:43:11
4 x 17" glass	n/a		1:31:00
Swivel	n/a		
RCM11	302 ✓	tangled.	2:01:19
~~Sontek~~	~~D273~~		
4 x 17" glass	n/a		2:08:56
MicroCAT	6322 ✓	line is broken. 17:57:08	2:25:32
MicroCAT	5784 ✓		17:47:04
4 x 17" glass	n/a		17:38:25
Swivel	n/a		
MicroCAT	6127 ✓		17:32:59
MicroCAT	6804 ✓		17:20:50
4 x 17" glass	n/a	One glass imploded	17:10:40
Swivel	n/a		17:10:40
MicroCAT	4464 ✓		17:04:55

hooked bottom 8@ 1549

change the drum

4 x 17" glass	n/a	Tangled.	16:36:53
MicroCAT	6801	No blanking plug. Pins bent.	16:33:50
4 x 17" glass	n/a	Tangled. Wire stretched.	16:15:07
Swivel	n/a		
MicroCAT	4184	~~Tangled~~. Tangled.	16:14:50
RCM11	395		16:00:42
MicroCAT	5246		16:00:42
8 x 17" glass	n/a		1556
Swivel	n/a		
Acoustic Release #1	1197		"
Acoustic Release #2	319		"
1450Kg Anchor			

Ascent Rate ____________

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring **EB1L9** Cruise **DY039**

NB: all times recorded in GMT

Date 02/11/2015 **Site arrival time** overnight

Time of first ranging ___________

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		
Billings Float	n/a		
with Light	Y01-020		
and Argos Beacon	X02-056	Beacon ID: 93792	
3 x 17" glass	n/a		
3 x 17" glass	n/a		
3 x 17" glass	n/a		
BPR	392		
BPR	420		
Acoustic Release #1	1353	[redacted]	
Acoustic Release #2	368	[redacted]	
300 kg Anchor	n/a		

Ascent Rate ___________

Ranging

Time	Range 1	Range 2	Command/comment
075450	2949	8656	[redacted]
" 5530	4806	5116	"
" 5630	—	4437	[redacted]
" 5730	5596	10710	"
" 5810	1625	4917	"
5900	4451	1584	"
080000	1696	6308	[redacted]
08 0100	4625	4451	"
" " 50	10086	1694	"
101820	1694	5139	[redacted]
" 1845	2526	1417	
" 1900	4501	3423	
" 1925	5172	—	
" 2000	5139	4913	"
102100	—	—	[redacted] Release no answer.
" 2200	3389	10382	Release OK
" 2300	5139	3775	" "
" 2400	2599	5140	" "
102940	205	177	" "
103000	269	541	" "
103030	5122	5122	" "
103130	5122	5121	" "
103230	—	—	[redacted] Range
103330	—	6201	

BOW THRUSTER FIXING

[redacted]

10 3408		7408	
10 3454	5121	3275	[redacted], release ok
" 3534	5122	5122	
10 3612	—	—	[redacted], release
" " 56	—	3974	—
" 3731	—	—	—
" 3825	5121	5122	Release OK
" 3923	5122	5122	diagnostic, vert 5 V
" 4042	5123	5122	" 8.2 V
104130	—	—	[redacted], rel
104230	10377	—	
" 4315	—	—	
" 4400	—	7309	Release OK
" 4450	—	2424	—
" 4557	5122	5123	
" 5241	"	"	Release OK
" 5820	"	"	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR3** Cruise **DY039**

NB: all times recorded in GMT

Date 7/Nov/2015 **Site arrival time** 1718

Time of first ranging 1718

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled	18:25
Billings float	n/a	tangled	18:31
with Light	A08-081 ✓		
and Iridium Beacon	C02-043 ✓	Beacon ID: 300234001667220	
2 x 17" glass	n/a	tangled	18:32
Swivel	n/a	tangled	18:32
MicroCAT	4471 ✓	tangled	18:32
2 x 17" glass	n/a		18:38
2 x 17" glass	n/a		18:48
MicroCAT	3282 ✓		18:49
2 x 17" glass	n/a	tangled.	19:03
Swivel	n/a		
MicroCAT	6117 ✓	tangled	19:03
2 x 17" glass	n/a	tangled	19:21
MicroCAT	5981 ✓	tangled	19:21
3 x 17" glass	n/a	tangled	19:37
MicroCAT	5239 ✓	tangled.	19:37
3 x 17" glass	n/a	tangle wound on, tight on d.b.	2006
Swivel	n/a		
MicroCAT	5983		2005
MicroCAT	5982		2020
7 x 17" glass	n/a		2023
Swivel	n/a		"
S4	35612574 ✓		"
Acoustic Release #1	1200 ✓		20:26
Acoustic Release #2	498 ✓	Released	20:26
700kgn Anchor	n/a		

Ascent Rate __________

Ranging

Time	Range 1	Range 2	Command/comment
17:18:00	1611.5	5053.4	
	5054.6	5051.8	
17:19:15	5052.4	4554.3	release ok.
17:20:04	~~1457.7~~	~~3837.7~~	—
17:20:45	4952.2	~~6548.8~~	
17:21:45	—	~~8467~~	
17:22:45	4075.7	1535.2	
17:23:15	4740	—	
17:48	on	surface.	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR3L8** Cruise **DY039**

NB: all times recorded in GMT

Date 7/NOV/2015 **Site arrival time** 15:00

Time of first ranging 15:08

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled at 16:30	
Billings Float	n/a	" " Tangled	16:35:54
with Light	Z02-021 ✓	"	
and Argos Beacon	Y01-010 ✓	Beacon DI: 46492 ✓	
~~3~~ 4 x 17" glass	n/a	Tangled	16:35:54
~~3~~ 4 x 17" glass	n/a	Tangled	16:35:54
~~3~~ 4 x 17" glass	n/a		16:39:11
BPR	0029 ✓		16:45:28
BPR	0031 ✓		16:45:28
Acoustic Release #1	927 ✓	ARM: [redacted] REL: [redacted]	
Acoustic Release #2	907 ✓	" [redacted] " [redacted]	
300KG Anchor	n/a		

Ascent Rate ____________

Ranging

Time	Range 1	Range 2	Command/comment
144400	–	–	[redacted] RANGING
" 4520	2432	–	" "
" 46 "	1655	–	[redacted] "
" 4700	–	9230	" "
" 48 "	850	9206	
" 4910	–	–	
" 5020	–	–	[redacted]
150650	–	12660	
" 0740	–	–	[redacted]
" 08 "	5234	5233	"
" 0930	5235	5233	Release OK
" 1030	5177	5163	" "
" 1130	5097	5086	" "

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **NOG** Cruise **DY039**

NB: all times recorded in GMT

Date 9/11/15 **Site arrival time** OVERNIGHT

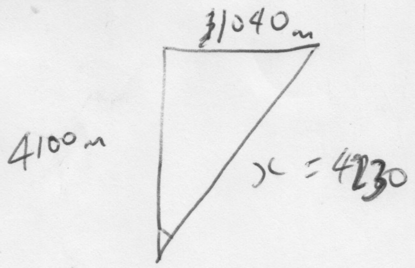
Time of first ranging ___________

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled at 18:06	
Billings Float	n/a	Tangled	1811
with Light	T05-079 ✓	"	
12 x 17" glass	n/a	"	1811
Swivel	n/a		
Sediment Trap	11262-06 ✓		1826
Nortek	~~8430~~ 8421		1830 B
Nortek	~~8421~~ 8430?	~~Came up first~~	1838 B
Sediment Trap	~~12168-03~~	11804-01	1835
10 x 17" glass	n/a	Tangled	1907
MicroCAT	9477 ✓		1917
Acoustic Release #1	318 ✓		1917
850kg Anchor	n/a		

Ascent Rate ___________

Ranging

Time	Range 1	Range 2	Command/comment
09:14:50	/	/	Arm + Arm 14CE
09:15:40	11062	1200	
09:16:10	/	10821	
092300	1001	123	
" " 20	2467	1781	
" 2450	106	54	
" 2630	361	—	
	2502	8345	
	—	7552	
	—	454	
	8443	6732	
	/	2508	
093320	—	—	Release
094000	2077?	4429	" UTC
094100	—	—	
" 4200	—	—	
" 4300	—	—	
" 4500	—	—	
" 5000	—	—	
09:52:00	/	—	
09:53:30	/	/	
09:55:00	/	/	
09:58:00	/	/	
09:59:00	/	/	
10:01:00	/	/	
112558	—	—	
112640	—	—	
12:08:15	/	/	
12:03:35	/	/	
12:41:50	/	/	
42:30	/		



RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR2** Cruise **DY039**

NB: all times recorded in GMT

Date 12/11/15 **Site arrival time** OVERNIGHT

Time of first ranging 10:05
REL AT 10:08

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	ON SURFACE 11:00 grappled at 11:25	
Billings float	n/a		11:31
with Light	H01-009 ✓		11:31
and Argos Beacon	Z02-006 ✓	Beacon ID: 53153	11:31
3 x 17" glass	n/a	Tangled	11:32
Swivel	n/a	"	11:32
MicroCAT	4461 ✓	"	11:32
5 x 17" glass	n/a	Tangled	11:50
Swivel	n/a		11:50
MicroCAT	6824 ✓	Locking shield missing	11:49
MicroCAT	6822 ✓		12:06
MicroCAT	6821 ✓		12:16
7 x 17" glass	n/a		12:17
Swivel	n/a		
S4	35612572 ✓		12:18
Acoustic Release #1	910 ✓		12:18
Acoustic Release #2	316		12:18
500 KG Anchor	n/a		

Ascent Rate 88 m/min.

Ranging

Time	Range 1	Range 2	Command/comment
10:05:50	1524	—	ARM + ARM SN 316
	—	5188	
10:06:50	—	—	
10:07:30	—	5187	ARM + ARM 910
10:08:02	—	5188	
~~10:09:00~~			ARM + REL SN 910
10:09:00	—	5189	RELEASE OK
10:10:00	—	12853	
10:11:00	—	12612	
10:12:05	4920	4905	ARM + ARM SN 316
10:13:05	—	—	
10:14:05	—	—	
10:16:05	—	—	
10:17:05	—	4462	ARM + ARM SN 910
10:18:05	—	4382	

443 + 5 MINS $\simeq$ 88 m/MIN

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR1** Cruise **DY039**

NB: all times recorded in GMT

Date 11/Nov/2015 **Site arrival time** 14-05

Time of first ranging ____________

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	ON SURFACE 14:16 grappled @ 15:12,	15:12
3 x Mini-Trimsyn	n/a		15:17:14
MicroCAT	4472 ✓	fouling ; guard loose	15:17:14
24" syntactic float	n/a	tangled long line	15:22:18
with Light	A08-078 ✓	15:23: line Broken.	〃
and Iridium Beacon	C02-052 ✓	Beacon ID: 300234061662220	〃
Swivel	n/a		
MicroCAT	4470 ✓	light fouling ; guard loose.	15:22:56
37" Steel Sphere	n/a	grappled at 15:43	15:48:06
with Light	W03-091 ✓		〃
and Argos Beacon	304 ✓	Beacon ID: 82895	〃
Swivel	n/a		
MicroCAT	4180 ✓	light fouling	15:53:52
MicroCAT	3223 ✓		15:56:18
MicroCAT	4072 ✓		15:58:22
MicroCAT	4549 ✓		16:01:10
MicroCAT	6814 ✓		16:05
8 x 17" glass	n/a	ON SURFACE 14:26	16:11
Swivel	n/a		
MicroCAT	4068 ✓		16:11
MicroCAT	3239 ✓		16:19
MicroCAT	3270 ✓		16:25
RCM11	301 ✓		16:33
MicroCAT	6808 ✓		16:37
8 x 17" glass	n/a	ON SURFACE 14:44	16:44
Swivel	n/a		〃
MicroCAT	5247 ✓		16:52
4 x 17" glass	n/a	on surface 15:11	17:07
Swivel	n/a		
MicroCAT	5782 ✓		17:08
4 x 17" glass	n/a		17:23
Swivel	n/a	Drum change	
MicroCAT	5767 ✓		17:35
4 x 17" glass	n/a		17:48
Swivel	n/a		17:48
MicroCAT	3219 ✓		17:50
4 x 17" glass	n/a	Imploded 3 of them	18:06:00

Swivel	n/a		
MicroCAT	6335 ✓		18:08
MicroCAT	6326 ✓		18:21:35
5 x 17" glass	n/a	Tangled	18:27:57
Swivel	n/a		
MicroCAT	6325 ✓		18:38:10.
SA	35612571 ✓		18:38:10
9x 17" glass	n/a	2 imploded glasses.	18:43:00
Swivel	n/a		
Acoustic Release 1	917 ✓		18:44:
Acoustic Release 2	370 ✓		
1800Kg Anchor	n/a		

~~Swivel~~	~~n/a~~
~~MicroCAT~~	~~3225~~
~~MicroCAT~~	~~4468~~
~~5 x 17" glass~~	~~n/a~~
~~Swivel~~	~~n/a~~
~~S4~~	~~35612565~~
~~MicroCAT~~	~~6798~~
~~9 x 17" glass~~	~~n/a~~
~~Swivel~~	~~n/a~~
~~Acoustic Release #1~~	~~1200~~
~~Acoustic Release #2~~	~~319~~

~~Ascent Rate~~ ~~________~~

Ranging

Time	Range 1	Range 2	Command/comment
14:11:32	207	1137	
14:12:00	—	5195	
14:13:30	—	5195	
14:14:20	—	5193	relesse ok.
14:15:10	5145	5132	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **MAR1L8** Cruise **DY039**

NB: all times recorded in GMT

Date 11/11/15 **Site arrival time** 18:55

Time of first ranging 18:56

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled	20:11:59
Billings Float	n/a	tangled	~~20~~:16:48
with Light	U01-028 ✓		
and Argos Beacon	A08-078 ✓	Beacon ID: 121997	
3 x 17" glass	n/a	tangled	20:16:46
3 x 17" glass	n/a		20:19:20
3 x 17" glass	n/a		20:21
BPR	0059 ✓		20:23:24
BPR	0080 ✓		20:23:24
Acoustic Release #1	822 ✓		20:23:24
Acoustic Release #2	1203 ✓		20:23:24
300kg Anchor	n/a		

Ascent Rate 76 m/min. ETA 20:05

Ranging

Time	Range 1	Range 2	Command/comment
18:56:15	—	6046	ARM+ARM SN 822
18:56:55	6046	6045	
18:57:50	6045	6045	ARM+REL OK. SN 822
18:58:50	5996	5984	
18:59:50	5930	5920	
			on surface at: 19:59.

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring **MAR0** Cruise **DY039**

NB: all times recorded in GMT

Date 13/NOV/2015 **Site arrival time** ________

Time of first ranging 17:54

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	grappled at 19:17	19:22:30
Billings Float	n/a	SURFACED LAST ~ 19:08	19:24:
with Light	W03-092 ✓	Big tangled	
and Argos Beacon	Z08-042 ✓	Beacon ID: 111849	
2 x 17" glass	n/a	SURFACED THIRD.	19:24
Swivel	n/a		
MicroCAT	6121 ✓	Both 177m Sections tangled.	19:24:35
MicroCAT	6123 ✓	Tangled.	19:50
3 x 17" glass	n/a	SURFACED 2ND, tangled	19:56
Swivel	n/a		
MicroCAT	6137 ✓	tangled	19:56
MicroCAT	6120 ✓	Tangled	19:35
S4	35612568 ✓	Tangled. white powder stuck to underside of S4	19:43
MicroCAT	6803 ✓	tangled	19:54
31" Syntactic	31-09	SURFACED ~ 19:06	19:55
34' Syntactic	34-02		19:50
Acoustic Release #1	281		19:49
Acoustic Release #2	819		19:49
600Kg Anchor	n/a		

Ascent Rate ____________

Ranging

Time	Range 1	Range 2	Command/comment
175430	—	—	[redacted]
" 5515	—	—	"
" 5615	2154	—	[redacted]
" 5700	—	—	"
180605	—	—	[redacted]
" " 49	—	—	"
" 0742	—	—	"
" 0842	5408	5408	[redacted]
" 0925	5410	—	", Release } no release ok
" 1010	5345	5330	"
" 11 ~~25~~10	—	12539	
18 1210	—	—	
18 1810	4427	4413	

45345
4422
8|9023
113

RAPID-WATCH MOORING LOGSHEET RECOVERY

Mooring **WB6** Cruise **DY039**

NB: all times recorded in GMT

Date 18/11/15 **Site arrival time** OVERNIGHT

Time of first ranging 1704

ITEM	SER NO	COMMENT	TIME
Recover Line	n/a	grappled 1918	1923
Billings float	n/a	tangled	19:27
Argos	Y01-012 ✓	Beacon ID: 46494	
Light	X01-050 ✓		
3 x 17" glass	n/a		19:29
Swivel			"
SBE MicroCAT	5985 ✓		19:29
SBE MicroCAT	5243 ✓		19:35.
2 x 17" glass	n/a		19:40
SBE MicroCAT	6320 ✓		19:40
SBE MicroCAT	6128 ✓		19:49
Nortek	5896 ✓		19:52.
SBE MicroCAT	3919 ✓		19:56
31" SYNTACTIC	n/a	Tangled both of them	19:58
34" SYNTACTIC	n/a	" " "	19:58
Swivel			
BPR #1	0056 ✓	tangled	19:58
BPR #2	0055 ✓	tangled	19:58
Acoustic Release #1	1201	tangled	19:58
Acoustic Release #2	364	tangled	19:58
600Kg Anchor	n/a	tangled	

shackle caught on storage drum, bent bar.

Ascent Rate ~100 m/min

Time at end of recovery 1958

both syntactics tangled together on recovery.
both releases released
corrosion on base of lander frame.

deck unit 026

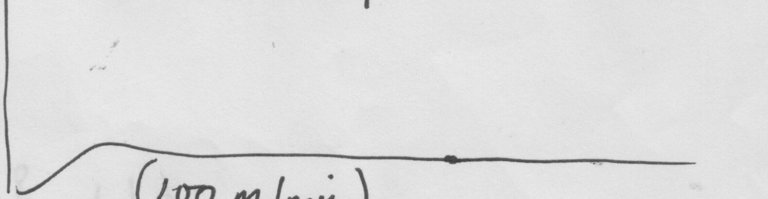
715 00
200

Ranging

Time	Range 1	Range 2	Command/comment
10:53:40	/	/	Arm + Arm SN 364 Hull transducer
10:54:30	/	/	
10:55:20	/	/	
10:56:40	/	/	Arm + Arm SN 1201 Hull Xducer
10:57:30	/	/	
170430	–	–	ARM: [redacted] Audible response on headphones
170510	–	–	ARM: [redacted]
" 0645	–	–	
170830	–	–	[redacted], release, no response
170920	–	–	
171030	–	–	
171130	–	–	
171240	–	–	[redacted], no response
171445	5410	1584	" lowered transducer further
171545	5411	–	[redacted]
171700	–	–	
171830	–	5412	added more rope
172210	5376	–	[redacted], Release
172310	5378	–	Heard response but not registered
172410	–	–	
172510	–	–	
172610	–	–	[redacted]
172710	–	–	
172810	–	–	[redacted]
172850	–	–	
" 2930	–	–	audible response ~~@~~
" 3432	–	–	@ 7 seconds
" 3515	–	–	no change in this
" 3600	–	–	interval
" 3654	5378	–	
" 3738	–	–	
" 39 –	–	–	
17 3933	–	–	[redacted]
" 4030	–	–	
" 4624	–	–	
" 4724	–	–	more rope out

17:54:40	3352	~~582~~	realease ok
175503	–	–	
" 5546	–	–	
" 5620	–	–	
" 5749	–	–	
180116	–	–	

182700, 7 sec response



(100 m/min)

extrap from 5378−3352 ≈ 2000 m in 20 min, eta 1825

180510	–	–	181305	–	–
180630	–	–	181406	[redacted]	–
181030	–	–	" " 50	"	–
181115	–	–	181537	[redacted]	
181216	–	–			

release ok

1950, 1942
32 50

Notes

18:51 3 x GLASS AT SURFACE

18:52 BILLINGS AT SURFACE

18:53 ~~2x GLASS AT SURFACE~~

PICKUP AT SURFACE

18:54 2x GLASS AT SURFACE

18:56 1ST SYNTACTIC ON SURFACE.

2ND SYNTACTIC NOT BREAKING SURFACE

↳ AS PREDICTED

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB4** Cruise **DY039**

NB: all times recorded in GMT

Date 22/Nov/2015 **Site arrival time** overnight

Time of first ranging 11:40

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a ✓	Grappled @ 1243	
3 TRYMSYN floats	n/a ✓		1259
MicroCAT	6125 ✓	Fouling	1259
MicroCAT-ODO	10545 ✓	Fouling	1259
32" syntactic	n/a ✓		1307
with Argos beacon	B03-078 ✓	Beacon ID: 129571 No aerial	
and light	C02-037 ✓		
Swivel	n/a ✓		
Nortek	9409 ✓	fouling	1311
MicroCAT	6129 ✓	Fouling	1312
49" syntactic	n/a ✓		1321
with Argos beacon	Z08-046 ✓	Beacon ID: 111853	
and light	C02-036 ✓		
Swivel	n/a ✓		
MicroCAT	6327 ✓	Locking shield missing	1323
Nortek	9420 ✓		1328
MicroCAT	3933 ✓		1328
MicroCAT-ODO	10544 ✓		1328
MicroCAT	7363 ✓	Locking shield missing	1335
DST Tilt	361 ✓		1335
Nortek	9427 ✓		1342
MicroCAT	5786 ✓		1341
MicroCAT-ODO	10547 ✓		1342
MicroCAT	4307 ✓		1348
DST Tilt	363 ✓		1349
10 x Orange CF-16s	n/a		1357
Swivel	n/a		
Nortek	9433 ✓	Tangled with floats	1358
MicroCAT	5762 ✓	Tangled with floats - Guard slightly bent	1358
DST Tilt	366 ✓		1407
Nortek	9439 ✓		1411
MicroCAT-ODO	10555 ✓		1411
5 x yellow CF-16s	n/a ✓		1416
MicroCAT	5773 ✓		1417
DST Tilt	367 ✓		14:23:59
5 x yellow CF-16s	n/a		14:29
Swivel	n/a		14:

Nortek	9444 ✓		14:29
MicroCAT	3931 ✓		14:32
MicroCAT-ODO	10556 ✓		14:32
DST Tilt	368 ✓		14:40
5 x yellow CF-16s	n/a ✓	Tangled, change of drum	14:48
MicroCAT	5779 ✓		14:47
5 x yellow CF-16s	n/a ✓		15:13
Swivel	n/a		
Nortek	6119 ✓		15:13
MicroCAT	6820 ✓		15:15
5 x yellow CF-16s	n/a ✓		15:29
Swivel	n/a		
MicroCAT	6806 ✓		15:30
MicroCAT-ODO	10546 ✓		15:30
5 x yellow CF-16s	n/a ✓		15:45
Nortek	5879 ✓		1546
MicroCAT	5768 ✓		1548
MicroCAT	4305 ✓	Lower clamp missing End cap loose → slid down wire	1601
Nortek	5884 ✓		1604
10 x glass	n/a ✓	4-5 implosions	1608
Swivel	n/a		
Acoustic Release 1	1731 ✓		1610
Acoustic Release 2	1463 ✓		1610
2700KG Anchor	n/a		

Ascent Rate ____________

Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command/comment
11:40:00	1069 X	789 X	[redacted] ARM + ARM
11:40:25	960 X	74[illegible] X	
11:40:45	4652	4653	
11:41:25	4652	4652	[redacted] ARM + REL NOT CONFIRMED
11:42:30	—	—	
11:43:30	—	—	
11:44:40	—	—	[redacted] ARM + ARM
11:45:20	4283	4272	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB4L9** Cruise **DY039**

NB: all times recorded in GMT

Date 23/NOV/2015 **Site arrival time** overnight

Time of first ranging 11:04:50

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	grappled at 12:21	
Billings float	n/a	Tangled.	12:27
LIGHT	Z02-019 ✓		
ARGOS	Z02-005 ✓	Beacon ID: 53130	
4 x 17" glass	n/a		12:29
4 x 17" glass	n/a		12:29
4 x 17" glass	n/a		12:35
BPR #1	0054 ✓		12:39
BPR #2	0004 ✓		12:39
Acoustic Release #1	322	Corrosion on frame.	12:39
Acoustic Release #2	256		12:39
600Kg Anchor	n/a		

Ascent Rate 81 m/min

Time at end of recovery 12:39.

Ranging

Time	Range 1	Range 2	Command/comment
11:04:50	~~4938~~	4681	[redacted] ARM + CMD
11:05:30	4680.6	4680	
11:06:15	10790	4681	~~release~~ [redacted] ARM + CMD
11:07:00	4681	4681	[redacted] release 04.
11:08:00	4618	4606	" "
11:09:00	4537	4525	~~Surface~~
			surfaced at 12:04.
			billings float ~~on~~ surfaced last.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBH2** Cruise **DY039**

NB: all times recorded in GMT

Date 23/NOV/2015 **Site arrival time** 1933

Time of first ranging 1922

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	grapelled 20:28:25	20:28:25 20:31:24
Billings float	n/a	tangled	20:32:40
Light	B11-019		
Iridium Beacon	C02-041 ✓	Beacon ID: 300234061665220	
10x 17" glass	n/a	ON SURFACE 20:00 tangled	20:34:40
Swivel	n/a	~~tan~~	
Nortek	5590 ✓	tangled	20:34:40
MicroCAT-ODO	10520 ✓	tangled with billings float	20:32:40
MicroCAT-ODO	10542 ✓		20:52:59
7 x 17" glass	n/a	ON SURFACE ~20:1? ; tangled	20:57:49
Nortek	5899 ✓	tangled	20:57:49
MicroCAT	5763 ✓	guard loose tangled three screws missing	20:57:49
5 x 17" glass	n/a		21:23:30
Nortek	6049 ✓		21:23:30
MicroCAT	6124 ✓		21:23:46
MicroCAT-ODO	10543 ✓		21:39
5 x 17" glass	n/a		21:48
Swivel	n/a		"
Nortek	9406 ✓		2148
MicroCAT	6333 ✓	hanging over edge during nortek recovery	2150
MicroCAT	5780 ✓		2208
5 x 17" glass	n/a	2x imploded	2216
Nortek	6083 ✓		"
MicroCAT	3934 ✓		2221
6x 17" glass	n/a		2222
Acoustic Release #1	1733 ✓	ARM: [redacted]	"
Acoustic Release #2	918 ✓	" : [redacted]	"
1800Kg Anchor	n/a		—

Ascent Rate 80 m/min

Time at end of recovery 2222

2154 stopped due to seeler storage drum bar coming out

2156 started again

2200 same issue

2214 lovely sunset

Ranging

Time	Range 1	Range 2	Command/comment
192210	4755	11719	[redacted]
192300	3509	—	"
192340	—	—	"
192500	—	7755	[redacted]
192600	4597	4850	"
192700	2560	826	"
192800	7407	4778	"
193000	1552	1767	"
" 2220	3136	4715	"
" 3320	1582	—	
193900	—	—	[redacted] ARM + ARM
193950	—	—	
1940:45	4720	4719	[redacted] ARM + ARM
19:41:30	4719	4720	ARM + REL NOT CONFIRMED
19:42:30	4645	4634	
19:43:30	4565	4553	
			On surface at 20:00

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB2** Cruise **DY039**

NB: all times recorded in GMT

Date 29/NOV/2015 **Site arrival time** ________

Time of first ranging 18:21

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a		19:30
3 x Trymsyn floats	n/a	LONG LINE ON FLOATS.	19:39
MicroCAT	6126 ✓	fishing line behind guard	19:39
30" SYNTACTIC		✓ fishing line tangled on it	19:46
Iridium	C02-044 ✓	Beacon ID: 300234061666	
Light	A08-084 ✓		
swivel	n/a		
Nortek	5897 ✓	tangled with fishing line	19:46
MicroCAT	6321 ✓	" " "	19:47
51" syntactic	n/a	tangled with fishing line, nortek, SBE	19:57
ARGOS	286 ✓	Beacon ID: 22442	
Light	A08-085 ✓		
swivel	n/a		
Nortek	5890 ✓	tangled	19:57
MicroCAT	7468 ✓	tangled	19:57
MicroCAT	6828 ✓		20:12:53
2 x 17" glass	n/a		20:15
Nortek	5967 ✓		20:15
MicroCAT	3902 ✓	Damage on it, scrappings, endcap missing	20:19
DST Tilt	352	No number on it.	20:22
MicroCAT	6840 ✓	No cap	20:25
2 x 17" glass	n/a		20:28
Nortek	6132 ✓		20:28
MicroCAT	5785 ✓	no end cap.	20:33
DST Tilt	358 ✓		20:36
MicroCAT	4306 ✓		20:40
10 x 17" glass	n/a		20:43
Swivel	n/a		
Nortek	6176 ✓		20:43
MicroCAT	5240 ✓		20:50
DST Tilt	362 ✓		20:52
Nortek	6516 ✓		20:57
MicroCAT	3928 ✓		20:56
5 x 17" glass	n/a ✓		21:04
MicroCAT	3209 ✓		21:06
MicroCAT	5787 ✓		21:11

start of
21:21 → change of drum
21:29 : end of drum change.

DST Tilt	364 ✓		21:15
Nortek	6743 ✓		21:16
5 x 17" glass	n/a		21:37
Swivel	n/a		
MicroCAT	3248 ✓		21:38
MicroCAT	6825 ✓		2152
DST Tilt	370 ✓		2153
2 x 17" glass	n/a ✓		2159
Nortek	6751 ✓		2200
5 x 17" glass	n/a ✓	Tangle	2210
MicroCAT	3910 ✓		2210
MicroCAT	6323 ✓		2226
10 x 17" glass	n/a		2227
Swivel	n/a		2229
Acoustic Release #1	325		"
Acoustic Release #2	1405		"
200 kg Anchor	n/a		—

Ascent Rate ________
Time at end of recovery 2230

[redacted]

Ranging

Time	Range 1	Range 2	Command/comment
182100	1512	2431	AS APPROACHING ARM + ARM [redacted]
182205	2749	2572	
182300	3663	3925	
182320	3405	2732	
182405	11184	3906	ARM + ARM [redacted] STOPPED
182435	1912	1409	
182500	9254	1493	
182540	2407	2853	
182655	1108	1006	
182750	5733	6632	[redacted]
182815	5818	8738	
183315	3087	1681	[redacted] SUPERDOWN
183410	3875	3875	
183500	3876	3875	ARM + REL REL OK
183600	10029	3754	
183645	1868	3691	

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB2L9** Cruise **DY039**

NB: all times recorded in GMT

Date 24/11/15 **Site arrival time** 16:13

Time of first ranging 16:16

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	grabelted 17:21	17:33:37
Billings float	n/a		17:27:22
ARGOS	A08-074 ✓	Beacon ID: 121995 no aerial	
LIGHT	A08-082 ✓		
4 x 17" glass	n/a	tangled.	17:24:30
4 x 17" glass	n/a	tangled.	17:26:50
4 x 17" glass	n/a		17:31:08
BPR	0002 ✓		17:35:01
BPR	0060 ✓		17:35:01
Acoustic Release #1	928 ✓		17:35:01
Acoustic Release #2	920 ✓		17:35:01
600 kg Anchor	n/a		

Ascent Rate 82 m/min

Time at end of recovery 17:35

Ranging

Time	Range 1	Range 2	Command/comment
16:00:00	1673	3659	WHILST APPROACHING AT 11 KTS.
160130	2280	6425	
160420	8208	8717	4 KTS. ½ MILE AWAY
160500	4538	1505	
160550	8091	3231	1.5 KTS.
16:06 20	767	1831	
16:16:00	$\boxed{3969}$	1956	SURFACED
161625	237	$\boxed{3969}$	
161710	3970	3969	
161745	3970	3970	ARM + REL REL OK.
161845	3905	3895	
161945	3823	3813	ETA 17:05
			Surface at 17:02

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB1** Cruise **DY039**

NB: all times recorded in GMT

Date 29/NOV/2015 **Site arrival time** 16:04

Time of first ranging 16:04

ITEM	SER NO	COMMENT	TIME	
Recovery Line	n/a	Single Trymsyn missing		
3 Trymsyn floats	n/a	Grappled at 16:36 Fouling	~~[illegible]~~	16:48
MicroCAT-ODO	10517 ✓	Fouling Shells in guard	16:48	
30" SYNTACTIC	n/a	ON SURFACE 16:06 Fouling	16:53	
IRIDIUM	C02-040 ✓	Beacon ID: 300234061660210	"	
Light	Z08-051 ✓		"	
Swivel	n/a			
Nortek	6753	Fouling Shells + weed Worm onions	16:55	
MicroCAT	6115 ✓	Fouling	16:55	
45" syntactic	n/a		17:02	
ARGOS	253 ✓	Beacon ID: 42745	"	
LIGHT	Z08-05~~5~~2		"	
Swivel	n/a			
Nortek	9266 ✓		17:08	
MicroCAT	3911 ✓		17:08	
MicroCAT-ODO	10518 ✓	Missing locking shield	17:08	
7 x 17" glass	n/a	Tangled	17:32	Winch stopped 17:19
Swivel	n/a			
Nortek	5885 ✓	17:32	~~17:17~~	Restart at 17:30
MicroCAT	3486 ✓	Locking shield missing 17:32	17:32	
MicroCAT-ODO	10519 ✓	17:32	17:32	
2 x 17" glass	n/a		17:46	
Nortek	9402 ✓		17:46	
MicroCAT	3483 ✓		17:48	
6 x 17" glass	n/a		17:52	
Swivel	n/a		17:52	
Acoustic release #1	1461 ✓		17:52	
Acoustic release #2	324 ✓		17:52	
1800 kg Anchor	n/a		~~[illegible]~~	

Ascent Rate ____________

Time at end of recovery 17:52

Ranging

Time	Range 1	Range 2	Command/comment
144006	7873	1883	ARM + ARM [redacted] @ CTD.
144030	1882	1882	
144130	3855	1876	ARM + DIAG [redacted] @ CTD V 8.2V VERTICAL
~~16~~			
155451	1647	1645.	[redacted] ARM + ARM
160400	1488	1487	ARM + REL [redacted] REL OK
160430	1448	1435	
160500	1388	1376	~~AL~~

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBADCP** Cruise **DY039**

surfaced 1914

NB: all times recorded in GMT

Date 24/11/2015 **Site arrival time** 1905

Time of first ranging 1854

ITEM	SER NO	COMMENT	TIME
Recovery Line	n/a	grappled 1927	1927
ADCP in float	n/a		1932
with Iridium beacon	C02-045	Beacon ID: 300234061661040	"
and light	A08-083		"
Swivel	n/a		"
Acoustic Release #1	1352		1936
Acoustic Release #2	1349		"
800 kg Anchor	n/a		—

~~$650^2 + 600^2$~~ ^{2}

Ascent Rate 60 m/min

Time at end of recovery 1936

Ranging

Time	Range 1	Range 2	Command/comment
185400	—	818	[redacted], still steaming
185500	774	771	"
190530	899	904	"
190630	904	904	", Release OK
190700	881	11406	—
190800	841	840	Release OK

RAPID-WATCH MOORING LOGSHEET　　　　**DEPLOYMENT**

Mooring **EBH4**　　　　Cruise **DY039**

NB: all times recorded in GMT

Date 28/OCT/2015　　　　**Site arrival time** 9:41:10

Setup distance 1.24 N miles

Start time 8:27:11　　　　**End time** 9:41:10

Start Position

Latitude 278294　　**Longitude** ~~[illegible]~~ -13.5427

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		8:27:11
McLane-12"	n/a		
Billings 3 sphere	n/a		8:27:39
with Light		401-	
~~Argos~~ or Iridium Beacon	C02-039	Beacon ID = 300234061660230	
4 x 17" glass	n/a		8:28:15
SBE37 SMP	3257		8:29:30
SBE37 SMP	3893		8:33:09
3 x 17" glass	n/a		8:38:15
SBE37 SMP	6817		8:39:12
SBE37 SMP	6818		8:41:53
2 x 17" glass	n/a		8:45:32
SBE37 SMP	5766		8:46:32
SBE37 SMP	6332		8:51:20
2 x 17" glass	n/a		8:55:40
SBE37 SMP	5238		8:56:34
SBE37 SMP	3266		8:59:45
2 x 17" glass	n/a		9:04:03
SBE37 SMP	3212		9:05:07
SBE37 SMP	3216		9:10:58
~~Swivel-SS~~	n/a		
6 x 17" glass	n/a		9:14:22
Acoustic Release #1	2072	Record codes below	9:18:36
Acoustic Release #2	2071	Record codes below	9:18:36
700kg Anchor	n/a		~~9:30:30~~

9:41:10

Scmll
$\boxed{516}$ sn →
$\boxed{9:04}$ time :04

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 27.8518　　**Longitude** ~~[illegible]~~ -13.5405

Uncorrected water depth 1057.2 (at anchor launch)

Corrected water depth 1060.6 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET DEPLOYMENT

Mooring EBH4L

Cruise DY039

NB: all times recorded in GMT

Date 28/10/15

Site arrival time 1020

Setup distance –

Start time 1021

End time 1028

Start Position

Latitude 27.8752 **Longitude** -13.5129

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	Fouling	1021
McLane-12"	n/a		1021
Billings 4 sphere	n/a		1022
with Light	Y01-016		1022
Argos or Iridium Beacon	Y01-028	Beacon ID =	1022
4 x 17" glass	n/a		1023
4 x 17" glass	n/a		1024
4 x 17" glass	n/a		1025
SBE26/53	n/a 396		1028:20secs
SBE26/53	397		"
Acoustic Release #1 (tripod)	2065	Record codes below	"
Acoustic Release #2 (tripod)	2068	Record codes below	"
600kg Anchor	n/a		1028:20secs.

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 27.8760 **Longitude** -13.5123

Uncorrected water depth 1014 (at anchor launch)
Corrected water depth 1017 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET DEPLOYMENT

Mooring **EBH3** Cruise **DY039**

NB: all times recorded in GMT

Date 27/OCT/2015 **Site arrival time** 12:33

Setup distance 2600m

Start time 12:33 **End time** 13:59

Start Position

Latitude 27.8242 **Longitude** -13.7315°

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		12:33
McLane-12''	n/a		
Billings 3 sphere	n/a		12:38
with Light		Z 08-049	
~~Argos or~~ Iridium Beacon		Beacon ID = IMEI:300234061662230	
4 x 17" glass	n/a		12:38
SBE37 SMP	3890		12:38
SBE37 SMP	6832		12:43
SBE37 SMP	5765		12:46
SBE37 SMP	6816		12:49
3 x 17" glass	n/a		12:53
SBE37 SMP	3244		12:54
SBE37 SMP	3912		12:57
5 x 17" glass	n/a		13:02
~~Nortek~~ RCM11	443		13:02
SBE37 SMP	6833		13:03
SBE37 SMP	5772		13:06
4 x 17" glass	n/a		13:11
SBE37 SMP	5245		13:12
~~Nortek~~ RCM11	428		13:16
SBE37 SMP	3252		13:17
3 x 17" glass	n/a		13:21
SBE37 SMP	3213		13:24
~~Nortek~~ RCM11	426		13:27
SBE37 SMP	3249		13:31
3 x 17" glass	n/a		13:37
SBE37 SMP	3207		13:37
~~Nortek~~ RCM11	518		13:41
SBE37 SMP	3907		13:45
Swivel-SS	n/a		
4 x 17" glass	n/a		13:57
Acoustic Release #1	2067	Record codes below 0B7C 0B55	
Acoustic Release #2	824	Record codes below 1686 1055	
1200kg Anchor	n/a		13:59

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]

Argos beacon #1 ID __________
Argos beacon #2 ID __________

Anchor Drop Position
Latitude 27.8058. **Longitude** -13.7490

Uncorrected water depth 1419.6 (at anchor launch)
Corrected water depth 1421.6 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET DEPLOYMENT

Mooring **EBH2**

Cruise **DY039**

NB: all times recorded in GMT

Date 28/10/2015

Site arrival time 1730

Setup distance 0.25 nm

Start time 1814

End time 1823

Start Position

Latitude 27.6130 **Longitude** -14.2151

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1814
McLane 12"	n/a		1815
3 x Billings sphere	n/a	slightly fouled	
with Light	on, flashing	501-189	
Argos or Iridium Beacon	on	Beacon ID = Y01-013, 46498	
2 x 17" glass	n/a		
SBE37 SMP	3265		1816
2 x 17" glass	n/a		
SBE37 SMP	3271		1819
RCM-11	519		1821
SBE37 SMP	3214		1822
Swivel-SS	n/a		
4 x 17" glass	n/a		
Acoustic Release #1	2073	Record codes below & Small bang	1823
Acoustic Release #2	2066	Record codes below against ship	
500kg Anchor	n/a		1823:31

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]

Argos beacon #1 ID ____________

Argos beacon #2 ID ____________

Anchor Drop Position

Latitude 27.6145 **Longitude** -14.2117

Uncorrected water depth 2016.4699 (at anchor launch)

Corrected water depth ~~[illegible]~~ (at anchor launch)

2016.5

RAPID-WATCH MOORING LOGSHEET DEPLOYMENT

Mooring EBH1

Cruise DY039

NB: all times recorded in GMT

Date 29/OCT/2015

Site arrival time ________

Setup distance 0.250 N miles

Start time 12:09:55

End time 12:22:47

Start Position

Latitude 27.22051 **Longitude** -15.42638

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		12:09:55
1 x 17" glass	n/a		12:09:55
MicroCAT			
3 x Billings sphere	n/a		12:10:30
with Light	T05-078		
~~Argos or~~ Iridium Beacon	202-049	Beacon ID = #300234061661230	
2 x 17" glass	n/a		12:11:15
SBE37 SMP	3220		12:11:30
2 x 17" glass			12:16:46
RCM11	444		12:19:59
SBE37 SMP	3251		12:21:09
Swivel-SS	n/a		
4 x 17" glass	n/a		12:21:25
Acoustic Release #1	2077	Record codes below	12:21:47
Acoustic Release #2	2074	Record codes below	12:21:47
500kg Anchor	n/a		12:21:47

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]

Argos beacon #1 ID ________

Argos beacon #2 ID ________

Anchor Drop Position

Latitude +27.22291 **Longitude** -15.42175

Uncorrected water depth 3036.87 (at anchor launch)

Corrected water depth 3040.2 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET DEPLOYMENT

Mooring EBH1L Cruise DY039

NB: all times recorded in GMT

Date 29/OCT/2015 **Site arrival time** ________

Setup distance 0 N miles

Start time 12:46:18 **End time** 12:49:45

Start Position

Latitude 27.21681 **Longitude** -15.43422

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		12:46:18
McLane-12"	n/a		
Billings 4 sphere	n/a	3 sphere billings.	12:46:31
with Light	N08-027		
Argos or ~~Iridium Beacon~~	A08-070	Beacon ID =	
4 x 17" glass	n/a		12:47:14
4 x 17" glass	n/a		12:47:49
4 x 17" glass	n/a		12:48:41
SBE26/53	n/a 399		12:49:45
SBE26/53	398		12:49:45
Acoustic Release #1 (tripod)	2079	Record codes below	12:49:45
Acoustic Release #2 (tripod)	2076	Record codes below	12:49:45
600kg Anchor	n/a		12:49:45

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 27.21669 **Longitude** -15.43205

Uncorrected water depth 3043.5 ~~3046.11~~ (at anchor launch)

Corrected water depth 3046.9 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EBHi** Cruise **DY039**

NB: all times recorded in GMT

Date 31/OCT/2015 **Site arrival time** 10:00

Setup distance 1 mile

Start time 10:26:31 **End time** 11:37:26

Start Position

Latitude 24.9273 **Longitude** -21.2833

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:26:31
McLane-12"	n/a		
Mk3 49" Telemetry Buoy	n/a		10:26:31
with Light	W03-089.		
~~Argos~~ or Iridium Beacon	C02-047	Beacon ID = 300234061668230	
Swivel-Tele	n/a		
SBE37 IMP	7470		10:26:31
2 x 17" glass	n/a		10:56:50
SBE37 IMP	7362.		10:56:50
2 x 17" glass	n/a		10:12:39
Nortek	12700	facing down	10:12:44
SBE37 IMP	4799		11:16:45
Swivel-SS			
4 x 17" glass	n/a		~~11:19:05~~ 11:21:15
Acoustic Release #1	320	Record codes below	~~[illegible]~~ 11:37:26
Acoustic Release #2	361	Record codes below	~~11:23:10~~ 11:37:26
600kg Anchor	n/a		~~11:23:10~~ 8

11:37:26

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

Anchor Drop Position

Latitude 24.9340 **Longitude** -21.2645

Uncorrected water depth 4469.5 (at anchor launch)

Corrected water depth 4495.9 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET DEPLOYMENT

Mooring EB1 Cruise DY039

NB: all times recorded in GMT

Date 3/Nov/2015 **Site arrival time** ________

Setup distance 5 N miles

Start time 10:01:36 **End time** 14:46:40

Start Position

Latitude 23.7376 **Longitude** -24.2466

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:01:36
Mini-Trimsyn	n/a		
24.5" syntactic float	n/a		10:01:36
with Light		~~#S01-182, B03-077~~ X01-048	
Iridium ~~Argos~~ or ~~Iridium Beacon~~		Beacon ID = ~~C02-038~~ '300234061669220	
5 x 17" glass	n/a		10:02:53
RAS RAS-500	13278-05		10:13:49
Contros pCO2	1114-001		10:13:49
SeaFET	004		10:13:49
Swivel-SS	n/a		10:13:49
MC-SMP-ODO	~~1744 SMP~~	12906 / ODO ~~SMP 6827~~ ✓	10:13:49
SBE37 IMP	6827 ✓		10:13:49
SBE37 IMP	11744 ✓		10:17:02
37" McLa. SS			10:25:27
with Light	S01-182	#S01-182, ~~B03-077~~	
Argos or ~~Iridium Beacon~~	B03-077	Beacon ID =	
Swivel-SS	n/a		
SBE37 SMP	6831		10:25:59
SBE37 SMP	6823		10:28:45
SBE37 SMP	6841		10:31:29
SBE37 SMP	6839		10:35:40
MC-SMP-ODO	12832		10:35:40
4 x 17" glass	n/a		10:40:15
SBE37 SMP	7681		10:43:40
4 x 17" glass	n/a		10:50:13
SBE37 SMP	6112		10:51:53
MC-SMP-ODO	12833		10:51:53
SBE37 SMP	3916		10:58:00
4 x 17" glass	n/a		11:03:00
SBE37 SMP	6122		11:05:46
MC-SMP-ODO	12834		11:15:05
~~SONTEK~~ RCM 11	451		11:17:45
4 x 17" glass	n/a		11:20:11
SBE37 SMP	3206		11:22:38
MC-SMP-ODO	12835		11:34:05

SBE37 SMP	6113		11:34:05
5 x 17" glass	n/a		11:43:34
SBE37 SMP	3215		11:40:38
SBE37 SMP	3256		12:03:01
5 x 17" glass	n/a		12:12:18
MC-SMP-ODO	12900		12:19:02
SBE37 SMP	5777		12:19:02
4 x 17" glass	n/a	2.5 MILES TO RUN.	12:31:00
SBE37 SMP	3224		12:34
4 x 17" glass	n/a		1249
SBE37 SMP	3253		1250
~~SONTEK~~ RCM11	450		13:05:52
SBE37 SMP	3222		13:07:26
Swivel-Ti	n/a		
8 x 17" glass	n/a		13:13:51
Acoustic Release #1	1534	Record codes below	13:25:41
Acoustic Release #2	825	Record codes below	13:25:41
1500kg Anchor	n/a		14:46:40

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

[redacted]

Anchor Drop Position
Latitude 23.7577 **Longitude** -24.1544

Uncorrected water depth 5038.2 (at anchor launch)
Corrected water depth 5080.3 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **EB1L** Cruise **DY039**

NB: all times recorded in GMT

Date 3/Nov/2015 **Site arrival time** 15:25

Setup distance none

Start time 15:33 **End time** 15:37:08

Start Position

Latitude 23.80011 **Longitude** -24.12026

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		15:33
~~McLane 12"~~ billings	n/a	lght: x01- Argos: B03-075	15:33
4glass ~~31" syntactic float~~	n/a		15:34
~~with Light~~			
4glass ~~Argos or Iridium Beacon~~		~~Beacon ID =~~	15:35
~~34" syntactic float~~	n/a		
4glass ~~with Light~~			15:35
~~Argos or Iridium Beacon~~		~~Beacon ID =~~	
SBE26/53	~~[illegible]~~ 058		
SBE26/53	394		
Acoustic Release #1 (tripod)	2070	Record codes below	
Acoustic Release #2 (tripod)	497	Record codes below	
300kg Anchor	n/a		15:37:08

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

Anchor Drop Position
Latitude 23.80011 **Longitude** -24.11899

Uncorrected water depth 5055.5 (at anchor launch)
Corrected water depth 5098.2 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR3** Cruise **DY039**

NB: all times recorded in GMT

Date 8/NOV/2015 **Site arrival time** overnight

Setup distance 5 N miles

Start time 10:57 **End time** 15:14

Start Position

Latitude 23·8330°N **Longitude** 41·1687°W

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		10:57
3 x Mini-Trimsyn	n/a		10:58
SBE37 IMP	3281		10:58
24.5" syntactic float	n/a		
with Light			11:04
and ~~Argos~~ IR Beacon		Beacon ID = 300234061663230	
SBE37 IMP	3904		11:04
37" McLa. SS			11:10
with Light	202-023		
and Argos Beacon	094	Beacon ID = 24027	
Swivel-SS	n/a		
SBE37 IMP	11424		11:11
SBE37 IMP	3905		11:14
SBE37 IMP	3233		11:17
SBE37 IMP	6810		11:20
SBE37 IMP	4721		11:26
10 x 17" glass	n/a		11:34:27
SBE37 IMP	3228		11:35:33
SBE37 IMP	6834		11:41:06
SBE37 IMP	3221		11:46
~~SONTEK~~ RCM 11	507		11:56
SBE37 IMP	4795		11:59
9 x 17" glass	n/a		12:07:58
Swivel-Ti	n/a		
SBE37 IMP	3255		12:14
4 x 17" glass	n/a		12:28:28
SBE37 IMP	4475		12:30:58
4 x 17" glass	n/a	DRUM CHANGE	12:59:33
SBE37 IMP	5984		13:00:41
4 x 17" glass	n/a		13:10:38
SBE37 ~~IMP~~ SMP	5776	13:16:28	13:15:20
4 x 17" glass	n/a		13:32:14
SBE37 IMP	5979		13:32:14
SBE37 IMP	6118	Pilot whales spotted	13 45
4 x 17" glass	n/a		13 53

SBE37 IMP	3484		1401
S4	35612565		1405
7 x 17" glass	n/a		~~[illegible]~~ 1407
Swivel-Ti	n/a		
Acoustic Release #1	251	Record codes below	14:16
Acoustic Release #2	1351	Record codes below	"
1800kg Anchor	n/a		151352

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Iridium **~~Argos~~ beacon #1 ID** 300234061663230
Argos beacon #2 ID 24027

Anchor Drop Position
Latitude 23.8712°N **Longitude** 41.0868° W

Uncorrected water depth 5016 m (at anchor launch)
Corrected water depth 5058 m (at anchor launch)

@ 1413, eta, 1515
@ 1416, prep for towing

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR3L** Cruise **DY039**

NB: all times recorded in GMT

Date 8/11/2015 **Site arrival time** 1550

Setup distance –

Start time 1551 **End time** 1556

Start Position

Latitude 23.8600°N **Longitude** 41.0959°W

ITEM	SER NO	COMMENT	TIME	
Recovery line	n/a		1551	
McLane-12"	n/a			
Billings 4 sphere	n/a		1552	
with Light	A08-081	Turned on and working		
Argos or Iridium Beacon		Beacon ID =		
4 x 17" glass	n/a		1552	
4 x 17" glass	n/a		1553	
4 x 17" glass	n/a		" "	
SBE26/53	~~n/a~~ 0036		1554	52
SBE26/53	0053		" "	
Acoustic Release #1 (tripod)	922	Record codes below	" "	
Acoustic Release #2 (tripod)	1346	Record codes below	" "	
600kg Anchor	n/a		" "	

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

Anchor Drop Position

Latitude 23.8601°N **Longitude** 41.0948°W

Uncorrected water depth 4998 m (at anchor launch)
Corrected water depth 5039 m (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **NOG** Cruise **DY039**

NB: all times recorded in GMT

Date 9/Nov/2015 **Site arrival time** 13:00

Setup distance 1.5 N miles

Start time 14:18 **End time** 15:39:08

Start Position

Latitude 23.7368 **Longitude** -41.11338

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		14:18:27
Billings Float	n/a		14:19:24
with Light	W03-94		
12 x 17" glass	n/a		14:21:49
Swivel	n/a		
Sediment Trap	11804-05		14:26
Nortek	6765		14:26
Nortek	9956		14:31
Sediment Trap	11262-02		14:31
10 x 17" glass	n/a		15:02
MicroCAT	13243		15:08
Acoustic Release #1	1906 and 1535		15:10:58
850kg Anchor	n/a		15:39:08

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 23.75554 **Longitude** -41.09567

Uncorrected water depth 4239.0 (at anchor launch)

Corrected water depth 4260.2 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR1** Cruise **DY039**

NB: all times recorded in GMT

Date 12/Nov/2015 **Site arrival time** 13:00

Setup distance 4.75 Nmiles

Start time 13:39 **End time** 17:54:03

Start Position

Latitude 24.17968 **Longitude** -49.83356

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		13:39:03
Mini-Trimsyn	n/a		13:39:03
24.5" syntactic float	n/a		13:39:03
with Light	Y01-021	Y01-	
Argos or Iridium Beacon	C02-050	Beacon ID = 300234061666220	
8 x 17" glass	n/a	13:43:20	13:39:57
RAS-500	13278-03		13:46:55
Contros pCO2	4R-020		"
SeaFET	002		"
Swivel-SS	n/a		"
MC-SMP-ODO	12905		"
SBE37 IMP	7723	in RAS	"
SBE37 IMP	6116		13:50:20
37" McLa. SS	n/a		13:54:29
with Light	T05-076		
Argos or Iridium Beacon	274	Beacon ID =	
Swivel-SS	n/a		
SBE37 IMP	3269		13:58:19
SBE37 IMP	n/a 6802		14:00:50
SBE37 IMP	n/a 5789		14:03:35
MC-SMP-ODO	12901		14:07:36
SBE37 IMP	n/a 4719		14:07:36
SBE37 IMP	n/a 6838		14:13:10
9 x 17" glass	n/a		14:20:40
MC-SMP-ODO	n/a 12902		14:23:47
SBE37 IMP	3901		14:23:47
SBE37 IMP	5783		14:29:37
SBE37 IMP	n/a 3229		14:35:38
RCM-11	n/a 515		14:46:10
MC-SMP-ODO	12907		14:46:10
SBE37 IMP	3234		14:49:29
12 x 17" glass	n/a		1458
Swivel-Ti	n/a		
MC-SMP-ODO	12908		15:05
SBE37 IMP	4714		15:05

SBE37IMP	
SER NO	4719
time	

* We do not remember the exact order of these two

8 x 17" glass	n/a		15:21:10
SBE37 IMP	6836		15:22:10
SBE37 IMP	6829		15:35:30
3 x 17" glass	n/a		15:49:28
MC-SMP-ODO	12910		15:51:
SBE37 IMP	3932		15:51:
4 x 17" glass	n/a		16:05
SBE37 IMP	6811		16:06
SBE37 IMP	6799		16:20
4 x 17" glass	n/a		16:28
SBE37 IMP	3900		16:36
S4	35612576		16:40
9 x 17" glass	n/a		16:45
Swivel-Ti	n/a		16:45
Acoustic Release #1	0930	Record codes below	16:53
Acoustic Release #2	1202	Record codes below	16:53
2100kg Anchor	n/a		17:54:03

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

[redacted]

} Label scratched off.

Argos beacon #1 ID ____________
Argos beacon #2 ID ____________

Anchor Drop Position
Latitude 24.16603 **Longitude** -49.74612

Uncorrected water depth 5162.419 (at anchor launch)
Corrected water depth 5212.3 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR1L** Cruise **DY039**

NB: all times recorded in GMT

Date 12/NOV/2015 **Site arrival time** 18:30

Setup distance —

Start time 18:39 **End time** 18:43:54

Start Position

Latitude 24.19186 **Longitude** −49.74207

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		18:39
~~McLane 12"~~	n/a		18:40
~~31" syntactic float~~	n/a		
with Light	X01-052		
Argos or Iridium Beacon	503156	Beacon ID = 300234061667230	
~~34" syntactic float~~	n/a		18:41
~~with Light~~			18:42
~~Argos or Iridium Beacon~~		~~Beacon ID =~~	18:42
SBE26/53	012		
SBE26/53	037		
Acoustic Release #1 (tripod)	1536	Record codes below	
Acoustic Release #2 (tripod)	1462	Record codes below	
300kg Anchor	n/a		18:43:54

3 float billings

glass

4 glass

4 glass.

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 24.19139 **Longitude** −49.74052

Uncorrected water depth 5172.0 (at anchor launch)

Corrected water depth 5222.2 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **MAR0** Cruise **DY039**

NB: all times recorded in GMT

Date 13/NOV/2015 **Site arrival time** 21:00

Setup distance ~~at target position~~ 0.25

Start time 21:28 **End time** 21:47:30

Start Position

Latitude 25.14266 **Longitude** -52.01712

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		21:26
~~McLane-12"~~	~~n/a~~		21:27
Billings ~~3~~ sphere	n/a	strobe dissapeared at 21:52	
with Light	W03-096		
~~Argos or~~ Iridium Beacon	J0346B	Beacon ID = 300234061667220	
4 ~~2~~ x 17" glass	n/a		21:28
SBE37 SMP	3247		21:28
SBE37 SMP	6800		21:32
1 ~~3 x 17" glass~~	n/a		
SBE37 SMP	3259		21:34
SBE37 SMP	6830		21:37
S4	35612571		21:39
SBE37 SMP	3225		21:41
~~31" Syntactic buoy~~			
~~with Light~~			
~~Argos or Iridium Beacon~~		~~Beacon ID~~ =	
34" Syntactic buoy			
with Light			21:43
Argos or Iridium Beacon		Beacon ID =	
Acoustic Release #1	1198	Record codes below	21:45
Acoustic Release #2	924	Record codes below	21:45
500kg Anchor	n/a		21:47:30

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 25.14076 **Longitude** -52.02221

Uncorrected water depth 5405.5 (at anchor launch)

Corrected water depth 5463.7 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB6** Cruise **DY039**

NB: all times recorded in GMT

Date 19. Nov **Site arrival time** ________

Setup distance ~

Start time 20:48:19 **End time** ~~20~~21:05:20

Start Position

Latitude 26.49472 **Longitude** -70.52~~4~~80

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		20:48:19
McLane-12"	n/a		20:48:19
Billings 3 sphere	n/a		20:50:40
with Light	Z02-021		
Argos or Iridium Beacon	C02-052	Beacon ID = 300234061162220	
3 x 17" glass	n/a		
SBE37 SMP	6801		20:50:50
SBE37 SMP	6127		20:53:43
2 x 17" glass	~~n/a~~		
SBE37 SMP	6826		20:56:04
SBE37 SMP	5770		20:58:26
Nortek	8120		20:59:34
SBE37 SMP	63822		21:00:50
31" syntactic float			21:01:35
with Light			~~21:03:30~~
Argos or Iridium Beacon		Beacon ID =	
34" syntactic float			21:03:30
with Light			
Argos or Iridium Beacon		Beacon ID =	
SBE26/53	0080		21:05:20
SBE26/53	0059		21:0520
Acoustic Release #1 (tripod)	354	Record codes below	21:05:20
Acoustic Release #2 (tripod)	1354	Record codes below	21:05:20
600kg Anchor	n/a		21:05:20

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 26.4949 **Longitude** -70.5242

Uncorrected water depth 5436.95 (at anchor launch)
Corrected water depth 5496.40 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB4** Cruise **DY039**

NB: all times recorded in GMT

Date 22/Nov/2015 **Site arrival time** 17:17

Setup distance 4.5 Nmiles

Start time 17:28:00 **End time** 21:52:33

Start Position

Latitude 26.5544 **Longitude** -75.7194

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1728
4 x Mini-Trimsyn	n/a		1728
SBE37 SMP	4723		1728
MC-SMP-ODO	12999		1728
32" syntactic float	n/a	With ADCP	1733
with Light			
Argos or ~~Iridium Beacon~~		Beacon ID =	
Swivel-Ti	n/a		
Nortek	5490		1733
SBE37 SMP	4724		1733
ADCP		in 32" syntactic ↑	1733
49" ~~Steel~~ SYNTACTIC Sphere			1743
with Light			
Argos or ~~Iridium Beacon~~		Beacon ID =	
Swivel-Ti	n/a		
SBE37 SMP	5743		1744
Nortek	5611		1751
SBE37 SMP	4070		1751
MC-SMP-ODO	12962		1751
SBE37 SMP	4071		1757
Nortek	~~5831~~	5889 Problem attching	1810
SBE37 SMP	5784		1810
MC-SMP-ODO	12963		1810
SBE37 SMP	6117		1816
* 12 ~~10~~ x CF-16s orange	n/a	18:23 x4 / Finish 18:45	1843
Nortek	5831		1847
SBE37 SMP	5981		1848
Nortek	5893		1901
MC-SMP-ODO	12964		1901
5 x CF-16s yellow	n/a		1908
SBE37 SMP	4471		1911
5 x CF-16s yellow	n/a		1924
Swivel-Ti	n/a		↓
Nortek	5935		1926
SBE37 SMP	3282		1928

* Problem joining floats used two yellow and 10 red

MC-SMP-ODO	12965		1928
5 x CF-16s yellow	n/a		19:44:32
SBE37 SMP	n/a 4464		19:46:50
5 x CF-16s yellow	n/a		20:00:00
Swivel-Ti	n/a		
Nortek	5963		20:04:41
SBE37 SMP	6804		20:05:26
5 x CF-16s yellow	n/a		20:22:18
SBE37 SMP	n/a 6798		20:24:27
MC-SMP-ODO	12966		20:24:27
5 x CF-16s yellow	n/a		20:41:49
Nortek	6050		20:41:58
SBE37 SMP	3913.		20:42:54
SBE37 SMP	6824	mark is above the join.	20:54:20
Nortek	6088		21:02:04
Swivel-Ti	n/a		
10 x17" glass	n/a		21:09:20
Acoustic Release #1	927	Record codes below	21:15:57
Acoustic Release #2	319	Record codes below	21:15:57
2700kg Anchor	n/a		21:52:33

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

Anchor Drop Position
Latitude 26.4738 **Longitude** -75.7021

Uncorrected water depth 4655.6 (at anchor launch)
Corrected water depth 4691.3 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB4L** Cruise **DY039**

NB: all times recorded in GMT

Date 23/NOV/2015 **Site arrival time** 13:50

Setup distance none

Start time 13:03 **End time** 13:07:42

Start Position

Latitude 26.4744 **Longitude** -75.70672

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		13:03
McLane-12"	n/a		
Billings ~~4~~ 13 sphere	n/a		13:04
with Light	A08-078		
Argos or ~~Iridium Beacon~~	Y01-010	Beacon ID = 46492	
4 x 17" glass	n/a		13:05
4 x 17" glass	n/a		13:06
4 x 17" glass	n/a		13:06
SBE26/53	~~n/a~~ 429		
SBE26/53	29		
Acoustic Release #1 (tripod)	2069	Record codes below	13:07:42
Acoustic Release #2 (tripod)	316	Record codes below	
600kg Anchor	n/a		

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Argos beacon #1 ID ~~OB7E~~ 46492
Argos beacon #2 ID

Anchor Drop Position
Latitude ~~26.47518~~ 26.47518 **Longitude** -75.70667

Uncorrected water depth 4658.8 (at anchor launch)
Corrected water depth 4694.6 (at anchor launch)

BOTH RELEASES TALKING ON TRILATERATION
SN 316 SLIGHTLY LESS RELIABLE RANGES THOUGH

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBH2** Cruise **DY039**
NB: all times recorded in GMT
Date 24/Nov/2015 **Site arrival time** overnight
Setup distance 2.5 N miles
Start time 12:41 **End time** 14:58
Start Position
Latitude 26.46712 **Longitude** -75.70722

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		12:41
Billings Float	n/a		12:41
with Light	W03-092		
and Beacon	Z08-046	Beacon ID = 111853	
6 x 17" glass	n/a		12:42
6 x 17" glass	n/a		12:42
RAS-500	13278-02		12:51
Nortek	6805		12:51
MC-SMP-ODO	12967		12:51
MC-SMP-ODO	12968		13:05
7 x 17" glass	n/a		13 13
~~6 x 17" glass~~	~~n/a~~		
Nortek	8502		1313
SBE37 SMP	6822		1314
5 x 17" glass	n/a		1335
Nortek	9420		1336
SBE37 SMP	6326		1337
MC-SMP-ODO	12998		1350
5 x 17" glass	n/a		1401
Nortek	9204		1402
SBE37 SMP	5239		1402
SBE37 SMP	5983		1416
5 x 17" glass	n/a		1426
Nortek	9210		1426
SBE37 SMP	5982		1430
6 x 17" glass	n/a		1435
Acoustic Release #1	910	Record codes below	1440
Acoustic Release #2	365	Record codes below	1440
1850kg Anchor	n/a		1458

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code
Argos beacon #1 ID 111853

Argos beacon #2 ID ____________

Anchor Drop Position
Latitude 26.48657 Longitude -75.73485

Uncorrected water depth 4677.3 (at anchor launch)
Corrected water depth 4713.6 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB2** Cruise **DY039**

NB: all times recorded in GMT

Date 30 Nov 2015 **Site arrival time** Overnight

Setup distance 4 Nmiles

Start time 1200 **End time** ________

Start Position

Latitude ________________ **Longitude** ________________

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		1200
4 x Mini-Trimsyn	n/a		"
SBE37 SMP	4180		"
30" syntactic float	n/a		1205
with Light	A08-080		"
Argos or ~~Iridium~~ Beacon	Z02-005	Beacon ID = 53130	"
Swivel-SS	n/a		"
Nortek	9213		1207
SBE37 SMP	4470		1207
51" syntactic float			
with Light	Z02-019		1215
Argos ~~Argos or Iridium~~ Beacon	286	Beacon ID = 22442	
Swivel-Ti	n/a		
Nortek	9435		1215
SBE37 SMP	3223		1215
SBE37 SMP	3232		1220
2 x 17" glass	n/a		1224
Nortek	8483		1224
SBE37 SMP	6814	1228	~~1224~~
SBE37 SMP	6121		1234
2 x 17" glass	n/a		1238
Nortek	8052		1238
SBE37 SMP	6803		1241
SBE37 SMP	n/a 3270		1247
Swivel-Ti	n/a		
10 x 17" glass	n/a		1252
Nortek	8492		1254
SBE37 SMP	6137		1257
Nortek	11024		1304
SBE37 SMP	6808		1304
5 x 17" glass	n/a		
SBE37 SMP	4068		1312
SBE37 SMP	6821		1318
Nortek	6534		1323
Swivel-Ti	n/a		

	5 x 17" glass	n/a		1331
	SBE37 SMP	5782		1332
	SBE37 SMP	6128		1345
	2 x 17" glass	n/a		1351
	Nortek	6747		1351
	5 x 17" glass	n/a		1400
	SBE37 SMP	6325		1401
	SBE37 SMP	6335		1419
	Swivel-Ti	n/a		
	10 x 17"glass	n/a		1429
907	Acoustic Release #1	~~325~~		
~~2~~ 25~~8~~3	Acoustic Release #2	1~~40~~5	Record codes below	
	2200kg Anchor	n/a	Record codes below	

14:56:23

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code
[redacted]

Argos beacon #1 ID 53130
Argos beacon #2 ID 22442

Anchor Drop Position
Latitude 26 30-87 **Longitude** 76 44-09

Uncorrected water depth ____________ (at anchor launch)
Corrected water depth ____________ (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WB2L 11** Cruise **DY039**

NB: all times recorded in GMT

Date 24/NOV **Site arrival time** ______

Setup distance ______

Start time 17:54:45 **End time** 18:00:04

Start Position

Latitude 26.5064 **Longitude** -76.7405

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a	drop at 17:54:45	~~17:53:30~~
McLane-12"	n/a		
Billings 4 sphere	n/a		17:55:25
with Light			
Argos or Iridium Beacon	Z02-006	Beacon ID = 53153	
4 x 17" glass	n/a		17:56:09
4 x 17" glass	n/a		17:56:45
4 x 17" glass	n/a		17:58:52
SBE26/53	n/a 0055		18:00:04
SBE26/53	0430		18:00:04
Acoustic Release #1 (tripod)	1195	Record codes below	18:00:04
Acoustic Release #2 (tripod)	1200	Record codes below	18:00:04
600kg Anchor	n/a		18:00:04

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 26.5071 **Longitude** -76.7395

Uncorrected water depth 3858.1 (at anchor launch)
Corrected water depth 3877.3 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET DEPLOYMENT

Mooring **WB1**

Cruise **DY039**

NB: all times recorded in GMT

Date 20-11-15

Site arrival time ~1600

Setup distance 2.5 N miles

Start time 1609

End time 18.07

Start Position

Latitude 26.4899 **Longitude** -76.8573

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		16 09
Mini-Trimsyn	n/a		"
30" syntactic float	n/a		"
with Light	C02-036		"
and Argos Beacon	A08-071	Beacon ID = 121992	"
2 x 17" glass	n/a		16 10
RAS-500	13278-04		16 13
~~Contros~~ PH	003	Contros - 1114-003	"
~~SeaFET~~ MC-SMP	3239		"
Swivel-SS	n/a		"
MC-SMP-ODO	12903		"
RBR-SoloT	100277		"
6 x 17" glass			16:18
Nortek	9427		16:21
SBE37 SMP	~~4072~~	5985	16:26
RBR-SoloT	100279		16:33
RBR-SoloT	100263		16:36
45" syntactic float	n/a	Slipped off	16 42
with Light	C02-037		"
and Argos Beacon	A08-075	Beacon ID = 121996	"
RBR-SoloT	100257		"
RBR-SoloT	100262		16 44
RBR-SoloT	100260		1647
Nortek	6723		1650
SBE37 SMP	4072		"
MC-SMP-ODO	12911		"
RBR-SoloT	100274		1653
RBR-SoloT	100265		16 55
RBR-SoloT	100266		1656
RBR-SoloT	100275		1658
RBR-SoloT	100259		1700
ADCP+44" Sphere up looking			1708
75kHz ADCP down looking	15579	Dropped lightly, scraped on deck	1710
Swivel-Ti	n/a		"
RBR-SoloT	100269		1711

8XRBK

RBR-SoloT	100271		1713
Nortek	5879		1717
SBE37 SMP	6123		"
MC-SMP-ODO	13000		"
2 x 17" glass	n/a	Large	1734
Nortek	5884		"
SBE37 SMP	6120		17:35
Swivel-Ti	n/a		~~#~~
6 x 17" glass	n/a	3@1743 @	1744
Acoustic Release #1	498	Record codes below	1807
Acoustic Release #2	318	Record codes below	"
2200kg Anchor	n/a		180716

Release #1 arm code
Release #1 release code
Release #2 arm code
Release #2 release code [redacted]
Argos beacon #1 ID 121991
Argos beacon #2 ID 121996

Anchor Drop Position
Latitude 26.4979 **Longitude** -76.8126

Uncorrected water depth 1389.5 (at anchor launch)
Corrected water depth 1397.6 (at anchor launch)

8 x RBK

100273 @ 1717

100276 @ 171932 (start hauling)
100258 @ 172054 (stop ") 172129 (start hauling)
100267 @ 172240 (" ") ; 2314 (" ")
100272 @ " 2444 (" ") " 2501 (" ")
100264 @ " 2624 (" ") " 2659 " "
100255 @ " 2819 (" ") " 2852 " "
100268 @ ——— 173042 " "

100270 @ 173645 (" ") 173716 " "
100256 @ ——— 173920 " "
100278 @ 174040 " 4118

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBADCP** Cruise **DY039**

NB: all times recorded in GMT

Date 24/11/2015 **Site arrival time** 1905

Setup distance 0

Start time 2001 **End time** 2008

Start Position

Latitude 26.5303 **Longitude** -76.8672

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		2001
40" syntactic float	n/a		2003
with Light	Y01-015		"
Argos ~~Iridium~~ Beacon	B03-076	Beacon ID = 129569	"
ADCP	10311		"
Swivel-Ti	n/a		"
10m ½" chain			
Acoustic Release #1	821	Record codes below	2006
Acoustic Release #2	1197	Record codes below	"
5m ½" chain			"
800kg Anchor	n/a		200752

Release #1 arm code [redacted]

Release #1 release code

Release #2 arm code

Release #2 release code

Argos beacon #1 ID 129569

Argos beacon #2 ID n/a

Anchor Drop Position

Latitude 26.5309 **Longitude** -76.8667

Uncorrected water depth 583 (at anchor launch)

Corrected water depth 592 (at anchor launch)

RAPID-WATCH MOORING LOGSHEET **DEPLOYMENT**

Mooring **WBAL** Cruise **DY039**

NB: all times recorded in GMT

Date 24/11/2015 **Site arrival time** 2028

Setup distance 0

Start time 2028 **End time** 2033

Start Position

Latitude 26.52[illegible]59 **Longitude** -76.875[illegible]5

ITEM	SER NO	COMMENT	TIME
Recovery line	n/a		2028
Billing-12"	n/a		2029
Billings 3 sphere	n/a		
with Light	Y01-02	Both On.	
Argos or Iridium Beacon	B03-074	Beacon ID = 129567	
4 x 17" glass	n/a		2030
4 x 17" glass	n/a		2030
4 x 17" glass	n/a		2031
SBE26/53	0400		2032
SBE26/53	0427		"
Acoustic Release #1 (tripod)	2075	Record codes below	"
Acoustic Release #2 (tripod)	2078	Record codes below	"
1200kg Anchor	n/a		2032 58

Release #1 arm code [redacted]

Release #1 release code

Release #2 arm code

Release #2 release code

Argos beacon #1 ID 129567

Argos beacon #2 ID n/a.

Anchor Drop Position

Latitude 26.5268 **Longitude** -76.8756

Uncorrected water depth 492 (at anchor launch)

Corrected water depth 499 (at anchor launch)