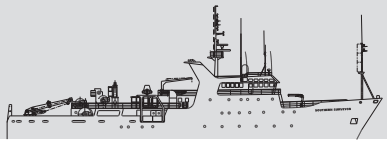


MARINE
NATIONAL FACILITY

2012 program

RV Southern Surveyor

CSIRO

voyagesummaryss2012_v03

ss2012_v03

Voyage: Integrated Marine Observing System (IMOS) Facility 3. Southern Ocean Time Series (SOTS) moorings for climate and carbon cycle studies southwest of Tasmania (47°S, 140°E).

Voyage Period

Start: 12/07/2012
End: 25/07/2012
Port of departure: Hobart, Tasmania, Australia
Port of return: Hobart, Tasmania, Australia

Responsible laboratory

ACE CRC

PB 80, Hobart, 7001

Australia

Chief Scientist

Dr. Tom Trull

CSIRO-UTAS-ACECRC

Scientific Objectives

The overall scientific objective is to obtain frequent measurements of surface and deep ocean properties that control the transfer of heat, mass, and CO_2 from the atmosphere to the upper ocean. The flux of heat and mass is a measure of the ocean-atmosphere interaction that controls climate variability and water mass formation on a range of scales. CO_2 it transported from the surface waters down to the ocean interior in the form of sinking particles. This "biological pump" drives carbon sequestration from the atmosphere, and writes the sedimentary record. The controls on its intensity are complex and involve processes that vary on daily, weekly, seasonal, and interannual timescales. Obtaining observations with the necessary frequency is not possible from ships. For this reason the NCRIS/EIF IMOS Southern Ocean Time Series Facility seeks to obtain this information using automated sensor measurements and sample collections. This voyage will deploy the Southern Ocean Flux Station (SOFS-3) mooring, the Pulse Biogeochemistry mooring (Pulse-9) and the SAZ sediment trap mooring (SAZ47-15) to obtain in-air and in-sea measurements to better understand the exchange of heat, moisture, and gases between the ocean and atmosphere.

Task List

and results in italics

1. deploy the SOFS-3 mooring to make meteorological and upper ocean measurements of physical and chemical properties important to air-sea exchange of heat, water, momentum, and dissolved gases (oxygen and CO_2).

   Completed – successfully deployed on 15 July 2012

2. deploy the Pulse-9 mooring to make upper ocean measurements of properties that control carbon uptake and export to the ocean interior, including temperature, salinity, mixed layer depth, light, oxygen, total dissolved gases, phytoplankton fluorescence, particle backscatter, and dissolved nitrate, and collect 24 paired water samples later study of nutrients and phytoplankton identification.

   Completed – successfully deployed on 17 July 2012

3. deploy the SAZ-15 deep ocean sediment trap mooring that collects samples in the deep sea (below 1000m) to quantify the transfer of particulate carbon and other materials to the ocean interior.

   Completed – successfully deployed on 18 July 2012

4. recover the SAZ-14 mooring

   Completed – successfully recovered on 22 July 2012

5. recover the Pulse-8 mooring

   Completed – successfully recovered on 20 July 2012

6. recover the SOFS-2 mooring

   Completed – successfully recovered on 23 July 2012

7. carry out underway and CTD measurements for comparison to the moored instruments.

   Completed – T,S,Fluo acquired underway by MNF, and cross-calibration with Pulse-9 and Pulse – 8 oxygen sensors carried out onboard. 3 CTDs to 1250m depth completed.

8. Undertake swath mapping of the mooring sites to inform ongoing deployments

   Completed - by MNF team member Sascha Frydman

9. Deploy a Continuous Plankton Recorder (CPR) during the out and back transit legs, and a drop net at the mooring site to 100m depth for comparison to the CPR results.

   Completed - CPR run on out and back legs. 4 drop nets completed to 90m depth.

10. Deploy the CSIRO DAR011 SST radiometer for validation of the VIIRS satellite data

    Completed

11. *Possibly deploy autonomous profiling floats and an ocean glider to obtain spatially distributed measurements of T,S, O_2, phytoplankton fluorescence and particle backscatter in the vicinity of the moorings, depending on their availability.*

    Not completed – recent losses of gliders and short life-times of floats have caused us to halt deployments until the equipment is improved.

Voyage Narrative

(narrative times are local – UTC+10 hours)

Mobilisation was undertaking on Mon, Tues, and Weds. prior to sailing Thurs morning. Mobilisation was slowed by problems with the coring winch. But in any case 2 full mobilisation days were required to spool on the 3 moorings and load the large volume of equipment. Two full mobilisation days will be requested for future voyages.

Thursday 12th July departure day: 3 members of the SOTS team waited ashore while 3 CSIRO staff (Mark Lewis, Tim Ryan, and Ryan Downey) carried out acoustic sounder calibrations while the ship was anchored in the lower Derwent off Opossum Bay. About 1500 this work was completed and these staff were taken ashore by workboat and the 3 SOTS personnel were loaded. While on anchor a test CTD and a test movement of the SOFS-3 anchor were both carried out successfully.

Friday 13th July we carried out oxygen sensor intercalibration among the shipboard CTD, Pulse, and SOFS sensors, while in transit to the mooring site, with 5 Winkler oxygen samples also collected.

Saturday 14th July was a calm (10-20 knots) and occasionally sunny day and we began deck set-up in darkness at 0600 ~8.5 nm east-southeast of the drop site and completed SOFS-3 deployment at about 1500 about 1nm shy of the target site, followed by a CTD to 1250m and a zooplankton netdrop to 90m before nightfall. The evening was spent triangulating the SOFS – 3 mooring anchor drop position.

SOFS-3 Deployed 14 July 2012			
Anchor Target Site	46 º 39.865'S	142 º 03.767'E	4650m
Anchor Drop Site:	46 º 40.256'S	142 º 05.314'E	4642m
Anchor Triangulated Site:	46 º 40.377'S	142 º 05.706'E	4695m
Distance from Drop to Triangulated site: 0.29 nmiles			
Distance from Drop to Target site: 1.13 nmiles			
Watch Circle Radius: 2.1nm			
Surface Light: Amber flash, 6s frequency (two redundant light systems)			

Sunday and Monday (July 16-17) weather prevented over the side deployments, but we collected meteorological data near the SOFS-3 mooring ship-buoy consisting of repeated slow ~2-hour upwind legs approaching the buoy.

Tuesday 17th July setup for the Pulse-9 deployment began at 0600 in rain and unexpected south easterlies. We nonetheless ran west-northwest to start deployment in anticipation of a shift to north westerlies later in the day. This made for somewhat less than ideal conditions with following winds which slowed the deployment, but all went well. After anchor drop we craned down gear for the next SAZ-15 deployment, undertook a net drop and CTD 20 to 1250m, and triangulated the position of the Pulse-9 deployment.

Pulse-9 Deployed 16 July 2012			
Anchor Target Site	46 º 51.303'S	142 º 22.328'E	4350m
Anchor Drop Site:	46 º 50.738'S	142 º 23.139'E	4350.25m
Anchor Triangulated Site:	46 º 50.959'S	142 º 23.913'E	4330m
Distance from Drop to Triangulated site: 1.06 nmiles			
Distance from Drop to Target site: 1.47 nmiles			
Watch Circle Radius: 1.1nm			
Surface Light: White flash, 3s frequency			

Wednesday 18th July we began the SAZ-15 deployment at 6am, in 2-3m seas and 10-15 knots, headed west 7 miles from the drop point. The deployment proceeded smoothly and was completed in strengthening winds shortly after midday. We then proceeded to the SAZ-14 site to evaluate the possibility of attempting its recovery. The combination of strengthening winds, declining daylight, fatigue, and sufficient remaining days to allow for the preferred early morning start convinced us to hold off. We then completed our 3rd net drop and began triangulation of the SAZ-15 anchor landing. Overnight we carried out Swath bathymetric mapping.

SAZ47-15			
Anchor Target Site	46 º 50.000'S	141 º 39.000'E	4600m
Anchor Drop Site:	46 º 50.036'S	141 º 40.300'E	4602m
Anchor Triangulated Site:	46 º 50.229'S	141 º 40.710'E	4591m
Distance from Drop to Triangulated site: 0.63 nmiles			
Distance from Drop to Target site: 1.65 nmiles			

Thurday 19th July winds and seas were rough and we were unable to work.

Friday 20th July winds and seas were abating and we decided to proceed with the Pulse-8 recovery. Two attempts to communicate with Release 35505 failed, but Release 35506 responded immediately and confirmed release at ~09:30 local. At this time the surface float was very close to being directly above the anchor. The first floats surfaced quickly, but the lower two float packs did not. We did a full circle of the mooring looking for them while ranging on the releases (both responded at this point). The range remained at greater than 2nm as we transited the circle without spotting it on the surface. We suspected that floats had imploded and thus the releases were hanging below the rest of the mooring. We approached the floating surface polybraid (section between the damper and the string of pearls) and grappled it with the hand-held CO_2-powered line thrower at 13:36 local. After steaming to windward to bring the mooring behind us we began a very difficult recovery due to two major tangles.

The first to come on board was a wuzzle of polybraid and 3 float packs from the stiff section of the mooring – specifically the top 6 yellow floats mixed with their adjacent chain of pearls, and two 8 packs from lower in the section, with another 8 pack floating behind the ship on a bight of wire, as well as the spectra leading down to the releases and the braid leading to the damper and the top section of the mooring. Resolving this required the use of the Gilson winches, the coring winch as a mobile stopper, the H-bit as a fixed stopper, and the net drum to wind in the lower section of polybraid after cutting it at the recovered bight. We next recovered the 8-pack of floats on the wire bight, and then went after the damper on its bight but this entangled another set of floats. After much movement of stoppers, rearrangement of winches, etc., we eventually recovered all equipment, including the acoustic releases suspended below an 8-pack of floats that had ruptured completely and blown holes in all the hard-hats. All gear was on deck by 17:15 local (5 hours after the initial grappling), and after tea we spooled it off by ~10:45 pm. The mooring showed signs of significant wear and tear. The anodes on the lower danlino were completely gone, along

with one shackle so that one bungy was attached only to the top danlino. The split pin on the bottom of the damper was corroded almost but not completely away. Other shackles had threads corroded to the point where only the split pins were retaining the nuts. The RAS instrument pack came up with some signs of malfunction (the fluorometer wiper was open and the ECOPAR wiper while closed, moved to half-open when the pack was jarred heavily on deck, and revealed green discoloration of the white sensor face by copper corrosion spread by the wiper). Interrogation of the SBE 16+ CTD the next day revealed battery depletion in April, after about 6 months, far sooner than expected from the power budgets which allowed for ~15 months. Biofouling of the RAS was moderate with ~50 gooseneck barnacles per face and twice that many on the bottom, and a brown scum on the outside and grey scum on the inside on the water sampler frame. Samples of these 3 materials were taken and frozen. Biofouling of the surface float included a higher abundance of barnacles and a ~1mm thick brown scum (but freeboard on the float was essentially the same as when deployed).

Saturday 21st July winds and seas were rough through midday and we were unable to undertake mooring work. Cross calibration of the ship CTD O_2 sensors and the recovered Pulse-8 RAS sensors was undertaken using the underway TS-thermosalinograph supply, with 4 Winkler oxygen samples also collected.

Sunday 22nd July we recovered SAZ-14 with winds still about 20knots and confused 3-4 m seas. Rolling made deck work difficult at times but the mooring was recovered without incident, and only one tangle which caused us to bring the acoustic releases onboard before the final float pack. The 3 McLane traps had all functionally correctly, as did the IRS trap (except for not opening its indented rotating sphere at the end of the mission). A final CTD for O_2 analysis tests was carried out in the evening, followed by a 4th net drop after midnight which captured 3 large pyrosomes, as well as abundant krill and copepods.

Monday 23 July we recovered SOFS-2 in 20-25 knot winds and 3-4m seas. Only one release (34623) was interrogated and released. The deep float group came up ~50 minutes after it was released, with one group of 8 floats destroyed by implosion. The total 52-float group was brought on deck together. During winding of the synthetic line onto the netdrum, loud noises coming from the starboard cheek striking the stanchion (in response to flaring or bearing movement) was a concern and slowed the operation, and the wire section was recovered to the coring winch. After recovering the 300m wire shot above the ADCP the mooring was released with a section of chain attached to increase its stability. The pick-up line release flap opened when activated but the release line did not exit, so we craned floats to the half-height on the top deck to clear the trawl deck and prepare for recovery. We approached with the mooring on the starboard side, and attached a line using a snap-hook on a pole, to start the recovery. Unfortunately as the mooring bumped along against the ship hull, the pick-up line was jostled free, and was pulled into the propeller and severed. This did not affect the mooring, but may require underwater examination to determine if any of the Kevlar line was caught around the shaft. Following completion of the SOFS-2 recovery began the transit back to Hobart at ~1700 local, and deployed the CPR at ~2100 after some respooling of the towed body winch.

CTD Deployments

CTD deployment files 03-18 and 21 were time-series on deck for sensor comparison with Pulse-9 and Pulse-8, respectively.

CTD deployments 19, 20, and 22 were carried out to 1250m depth, with Niskin bottle sampling at 12 depths for dissolved oxygen, DIC, alkalinity, salinity and nutrients. Mounted sensors measured temperature, conductivity, dissolved oxygen, photosynthetically available radiation, phytoplankton fluorescence, and beam transmission.

CPR Deployments

Deployment 1:	Outside mechanism 185, Inside Mechanism 0
Launch:	UTC 12/07/2012 08:44 43° 22.023′ S 147° 27.645′ E
Recover:	UTC 14/0702012 20:00 46° 39.4′ S 142° 04.2′ E
Deployment 2:	Outside mechanism 185, Inside Mechanism 2
Launch:	UTC 23/07/2012 10:40 46° 31.4′ S 142° 19.0′ E
Recover:	UTC 24/07/2012 10:30 43° 59.4′ S 146° 34.5′ E

We arrived back in Hobart at 0830 on Wednesday. 25 July.

Summary

The voyage was successful in achieving all scientific goals. The crew and science party performed superbly despite occasionally difficult and tedious seas. Mooring durability remains a significant issue.

Principal investigators

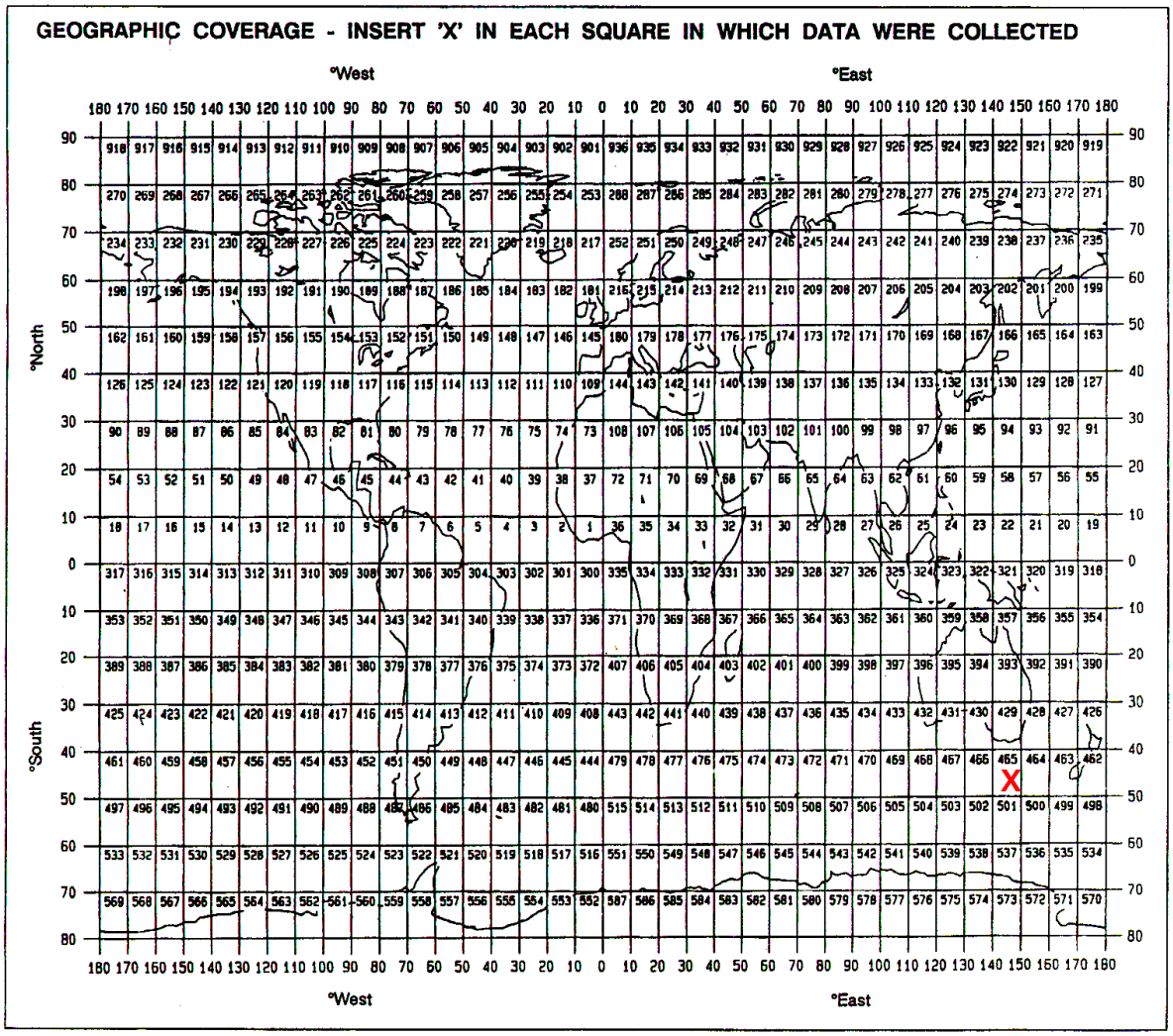
Eric Schulz, BOM-CAWCR, E.Schulz@bom.gov.au

Tom Trull, ACE CRC – UTAS – CMAR-CAWCR, Tom.Trull@utas.edu.au

Marsden Squares

Move a red "x" into squares in which data was collected

X



MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS									
This section should be used for reporting moorings, bottom mounted gear and drifting systems (both surface and deep) deployed and/or recovered during the voyage. Separate entries should be made for each location (only deployment positions need be given for drifting systems). This section may also be used to report data collected at fixed locations which are returned to routinely in order to construct 'long time series'.									
Item No	PI See page above.	APPROXIMATE POSITION						DATA TYPE enter code(s) from list on last page.	DESCRIPTION
		LATITUDE			LONGITUDE				Identify, as appropriate, the nature of the instrumentation the parameters (to be) measured, the number of instruments and their depths, whether deployed and/or recovered, dates of deployments and/or recovery, and any identifiers given to the site.
		deg	min	N/S	deg	min	E/W		
1	A	46	40.377	S	142	5.706	E	M02, M06, M90, H71, D01, H90, H17, H21	Deployed SOFS-3 anchored meteorological mooring with large surface tower buoy. Surface buoy moves within a 'watch circle' of 2.1 nmile and has a light that flashes amber every 6 seconds. Recovered SOFS-2 deployed 24 November 2011.
2	B	46	50.959	S	142	23.913	E	H90	Deployed Pulse-9 anchored biogeochemistry mooring with small surface float (1m diameter, 80cm freeboard). Surface buoy moves within a 'watch circle' of 1.1 nmile and has a light that flashes white every 3 seconds. Recovered Pulse-8 deployed 3 Aug 2011.
3	B	46	50.299	S	141	40.710	E	H90	Deployed SAZ47-15 anchored sediment trap subsurface mooring. Recovered SAZ47-14 deployed 4 Aug 2011

SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN
Except for the data already described above under 'Moorings, Bottom Mounted Gear and Drifting Systems', this section should include a summary of all data collected on the voyage, whether they be measurements (e.g. temperature, salinity values) or samples (e.g. cores, net hauls). Separate entries should be made for each distinct and coherent set of measurements or samples. Different modes of data collection (e.g. vertical profiles as opposed to underway measurements) should be clearly distinguished, as should measurements/sampling techniques that imply distinctly different accuracy's or spatial/temporal resolutions. Thus, for example, separate entries would be created for i) XBT drops, ii) water bottle stations, iii) CTD casts, iv) towed CTD, v) towed undulating CTD profiler, vi) surface water intake measurements, etc. Each data set entry should start on a new line – it's description may extend over several lines if necessary. NO, UNITS: for each data set, enter the estimated amount of data collected expressed in terms of the number of 'stations'; miles' of track; 'days' of recording; 'cores' taken; net 'hauls'; balloon 'ascents'; or whatever unit is most appropriate to the data. The amount should be entered under 'NO' and the counting unit should be identified in plain text under 'UNITS'.

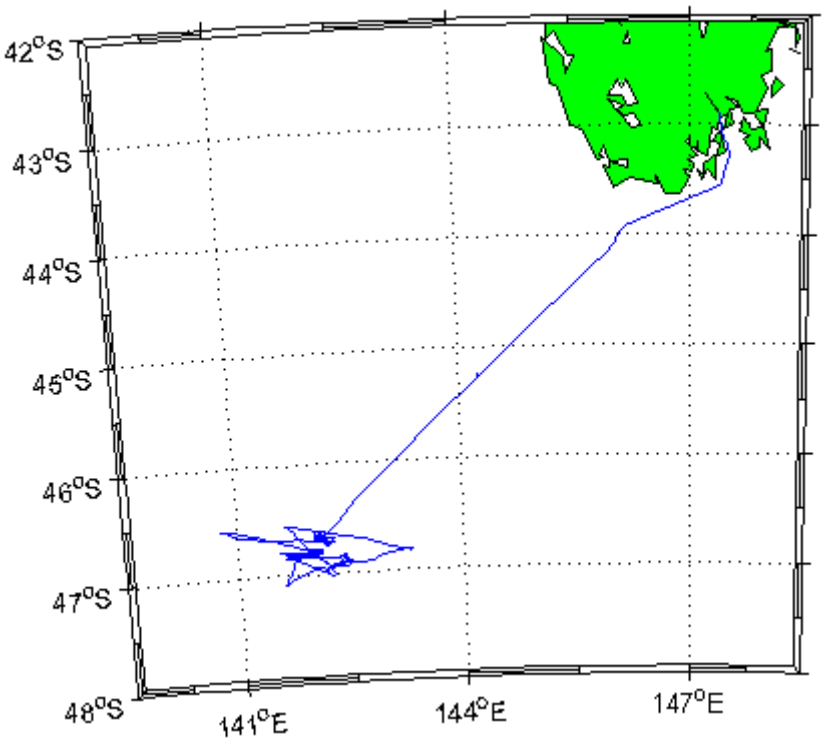
Item No.	PI see page above	NO see above	UNITS see above	DATA TYPE Enter code(s) from list on last page	DESCRIPTION Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e.g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.
1	B	1	cast	H10	3 CTD casts to 1250m, sampled at 12 depths for analyses of nutrients, salinity, DIC, alkalinity, dissolved oxygen
2	A	700	miles	H71	Continuous monitoring of underway seawater supply for temperature, salinity for study of physical heat and mass flux
3	A	700	miles	M02	Continuous monitoring of incoming short and long-wave radiation for heat fluxes
4	A	700	miles	M06	Continuous monitoring of routine meteorological observations (wind, ait temperature, humidity and pressure) for heat, mass and momentum fluxes
5	A	700	miles	M90	Continuous monitoring of precipitation for mass fluxes
6	B	4	drops	B03	Freefalling dropnet that collects from surface to 90m depth, where is is cinched shut by the deployment line. Net diameter 60cm and mesh 100 microns.
7	B	700	miles	B03	Towed continuous plankton recorder

CURATION REPORT

Item No.	DESCRIPTION For each data-set or sample collected identify the arrangements made for its lodgement and or curation. The description should identify the Organisational Unit that will house and curate the data and or sample, the names of national / international repositories. Where a physical sample is to become part of a collection this should be stated and the collection named. Where physical samples are to be returned to a laboratory for further study the laboratory should be named as should the method of preservation and the proposed duration for which the sample is to be retained.
1	Water samples collected from the CTD and underway system are returned to CSIRO Marine and Atmospheric Research for gas and salinity measurements and then discarded following quarantine protocols.
2	Continuous Plankton Recorder and Dropnet samples are preserved with formaldehyde and provided to the IMOS SOOP Facility, CSIRO Marine and Atmospheric research.

Track chart

Ship Track for SS2012 V03



General ocean area(s)

Southern Ocean – Indian Sector

Specific areas

Subantarctic Zone southwest of Tasmania

Personnel List

Scientific Participants

Name	Affiliation	Role
Tom Trull	ACE-UTAS-CMAR	Chief Scientist
Eric Schulz	BOM	Co-Chief Scientist
Mark Rosenberg	ACE-UTAS	Moorings
Stephen Bray	ACE-UTAS	Moorings
Peter Jansen	UTAS	Moorings
Jim LaDuke	CSIRO	Moorings
Ben Weeding	UTas	student
Jacqui Doran	UWA	student
Bruce Barker	MNF	Voyage Manager
Brett Muir	MNF	Electronics Support
Hiski Kippo	MNF	Computing Support
Sascha Frydman	MNF	Swath Mapping Support
Aaron Shorthouse	MNF	MNF Observer
Sue Reynolds	MNF	Hydrochemistry Support

Marine Crew

Name	Role
Michael Watson	Master
John Boyes	Chief Mate
Simon Smeaton	Second Mate
Fred Rostron	Chief Engineer
Mike Yorke-Barber	First Engineer
Bill Bourn	Second Engineer
Bob Dittko	Chief Cook
Darcy Chalker	Chief Steward
Rebecca Lee	Second Cook
Graham McDougall	CIR
Rod Langham	IR
Johnny Baker	IR
Jonathon Lumb	IR
Kel Lewis	IR
Tyron Grasso	Deck Cadet

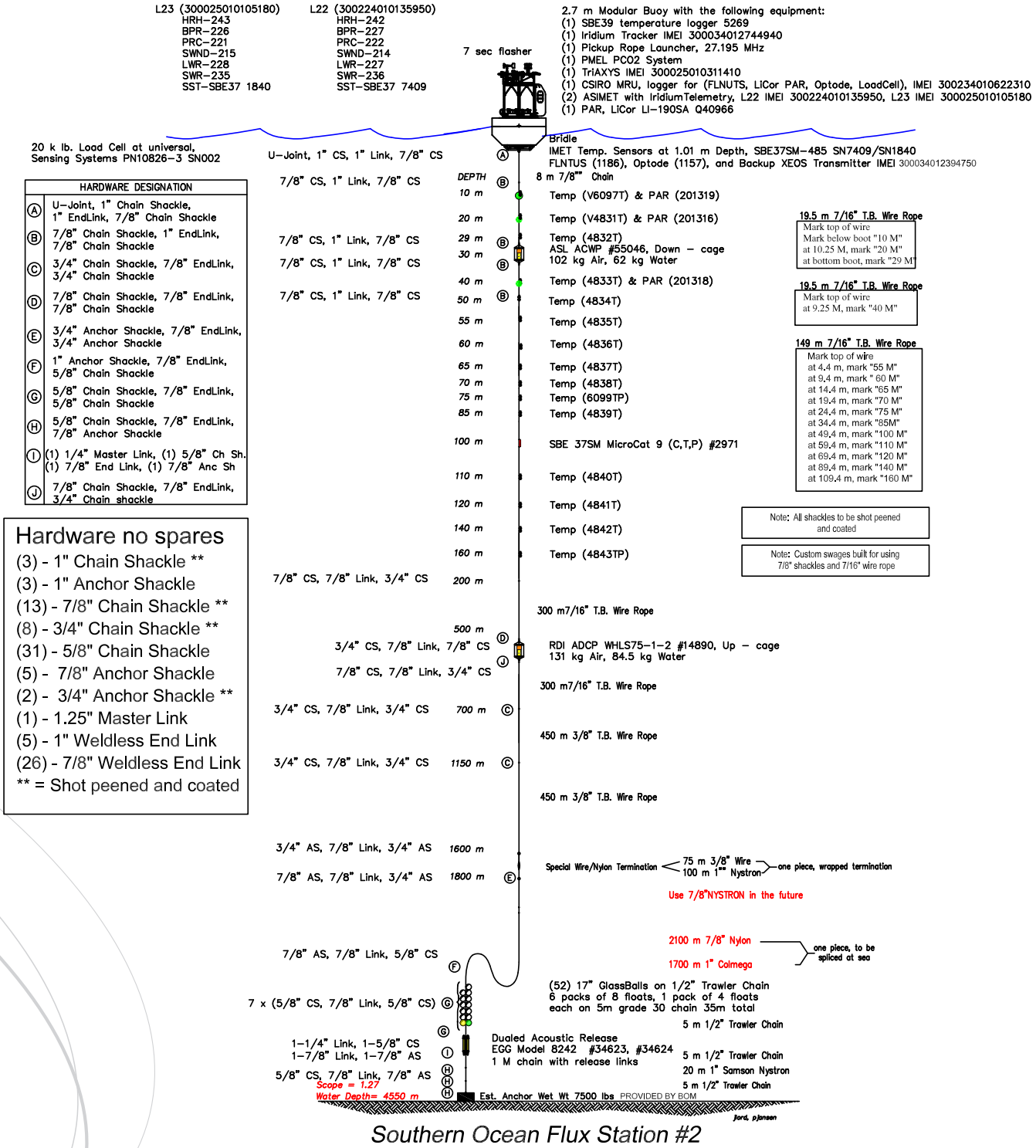
ACKNOWLEDGEMENTS

Thanks to the Master, Crew, MNF staff, and the onboard Science Team the voyage went very smoothly which is a testament to the skill and professionalism of all aboard.

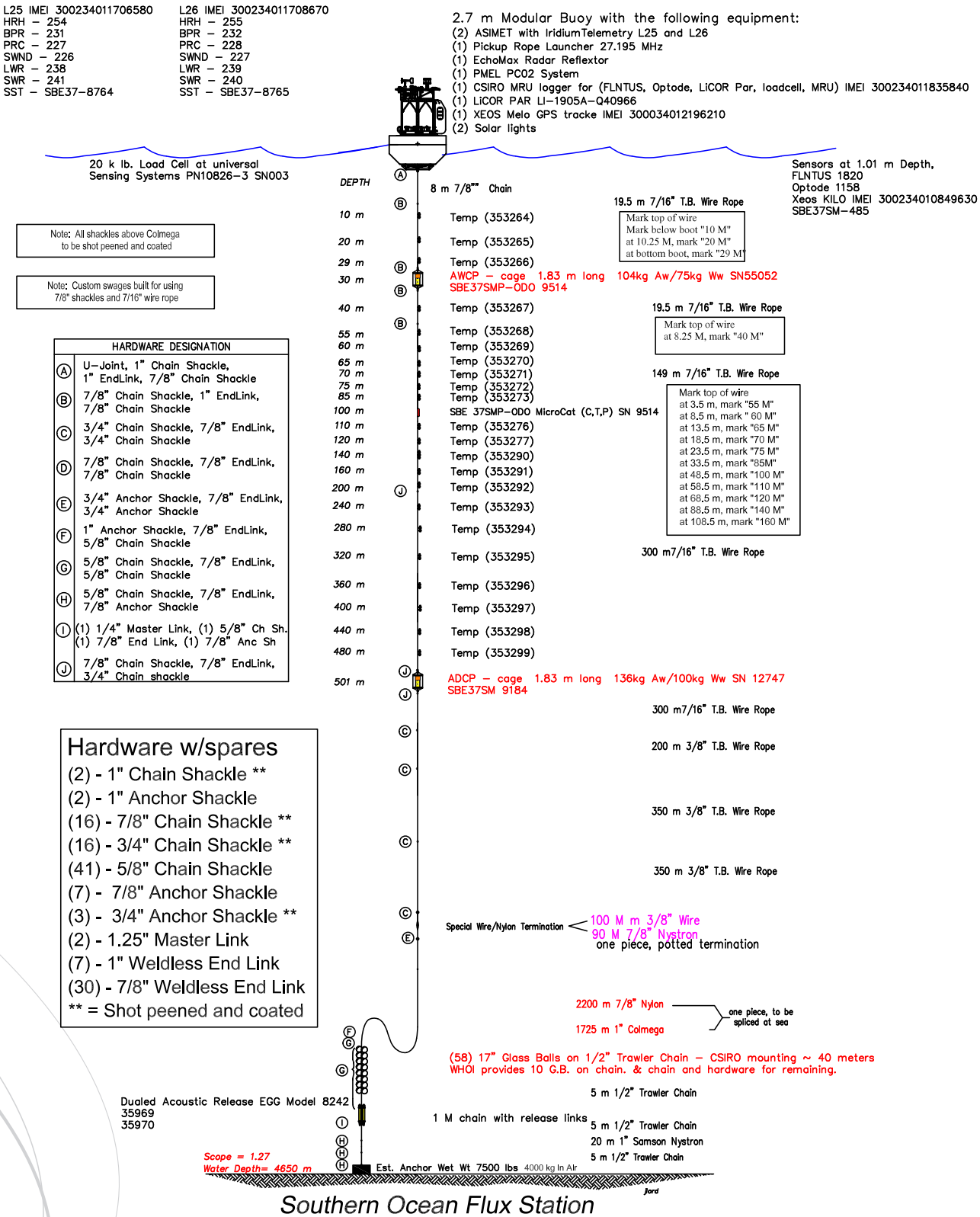
Chief Scientist

Tom Trull
25 July 2012

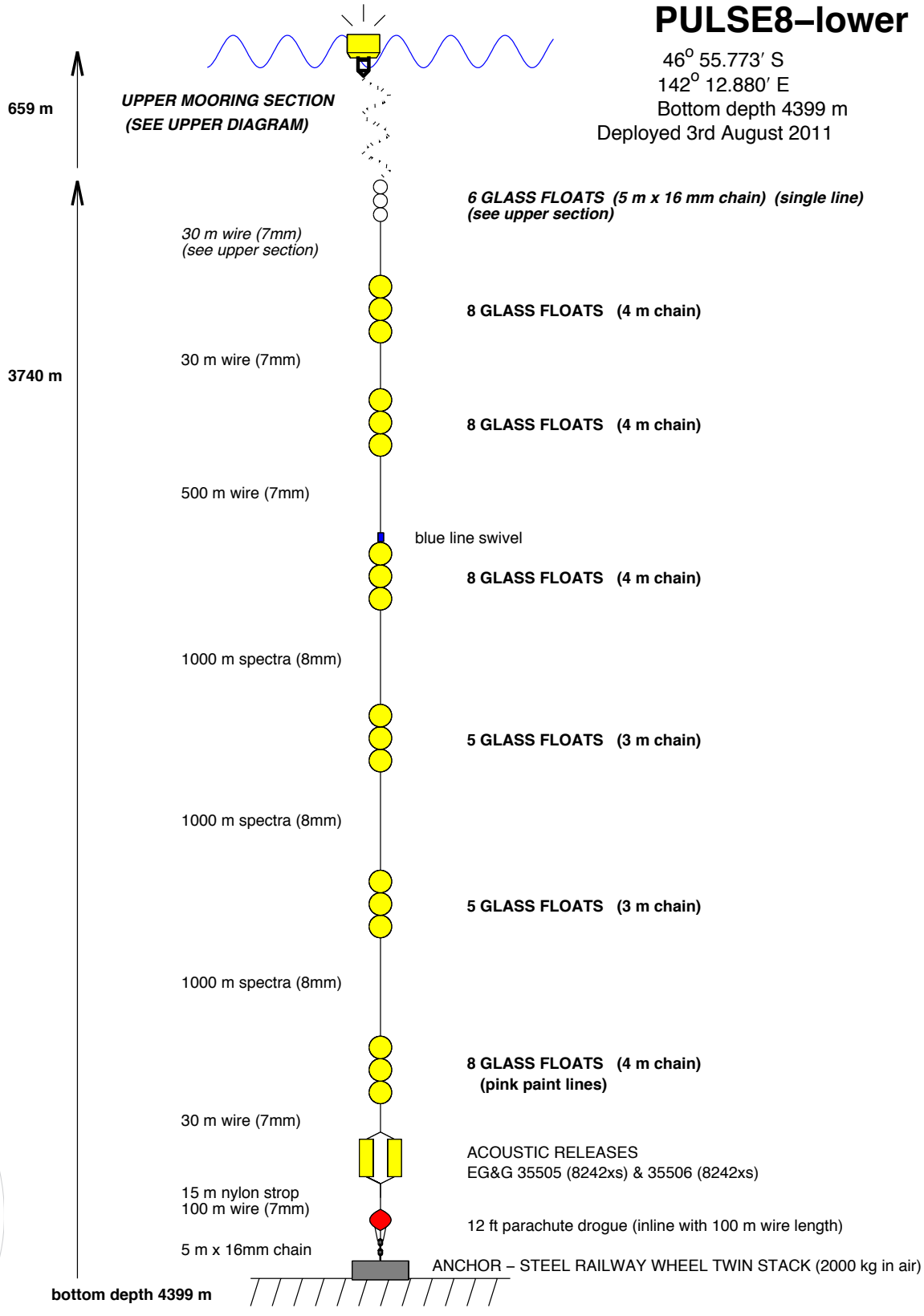
SOFS-2 mooring diagram – as recovered

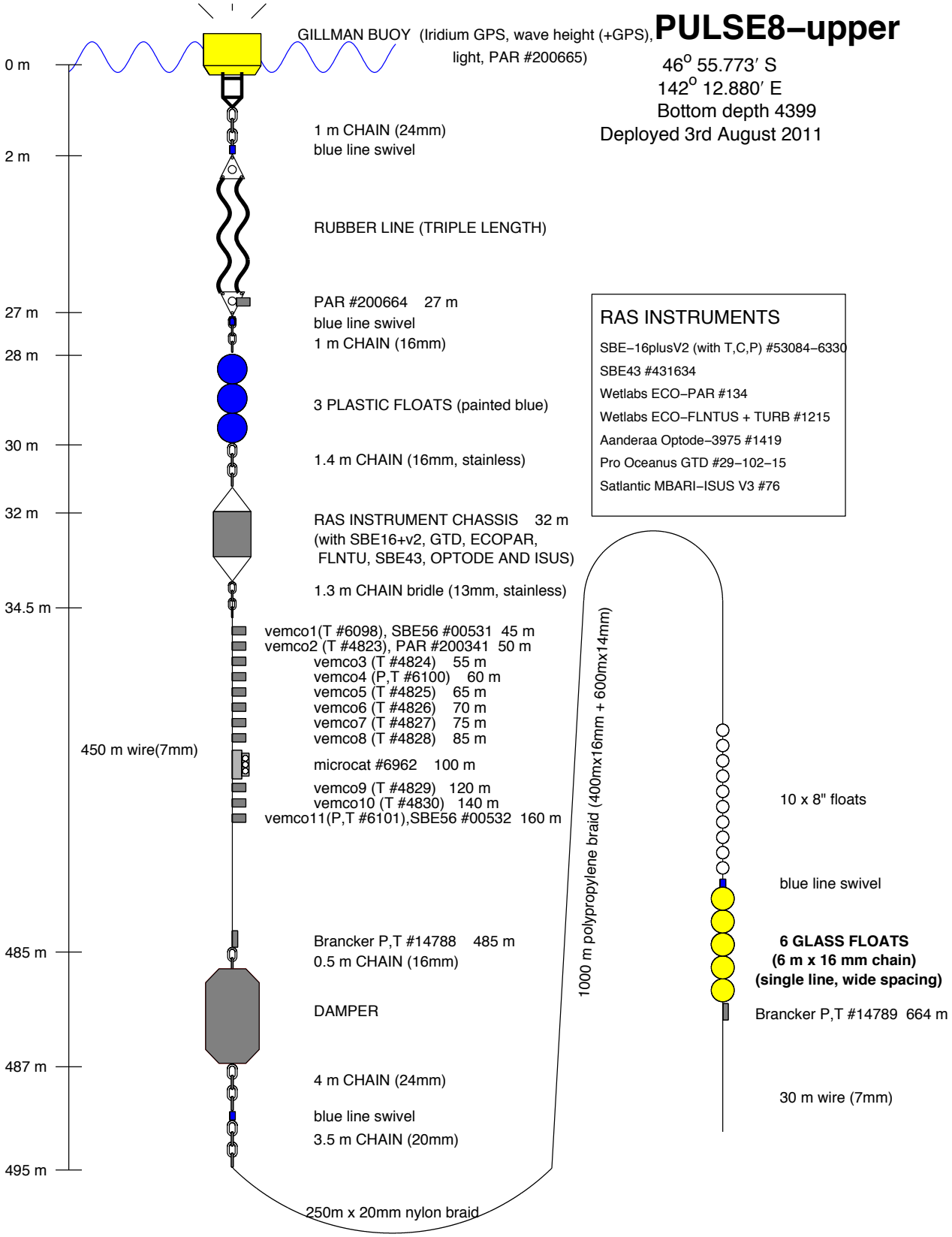


SOFS-3 mooring diagram – as deployed

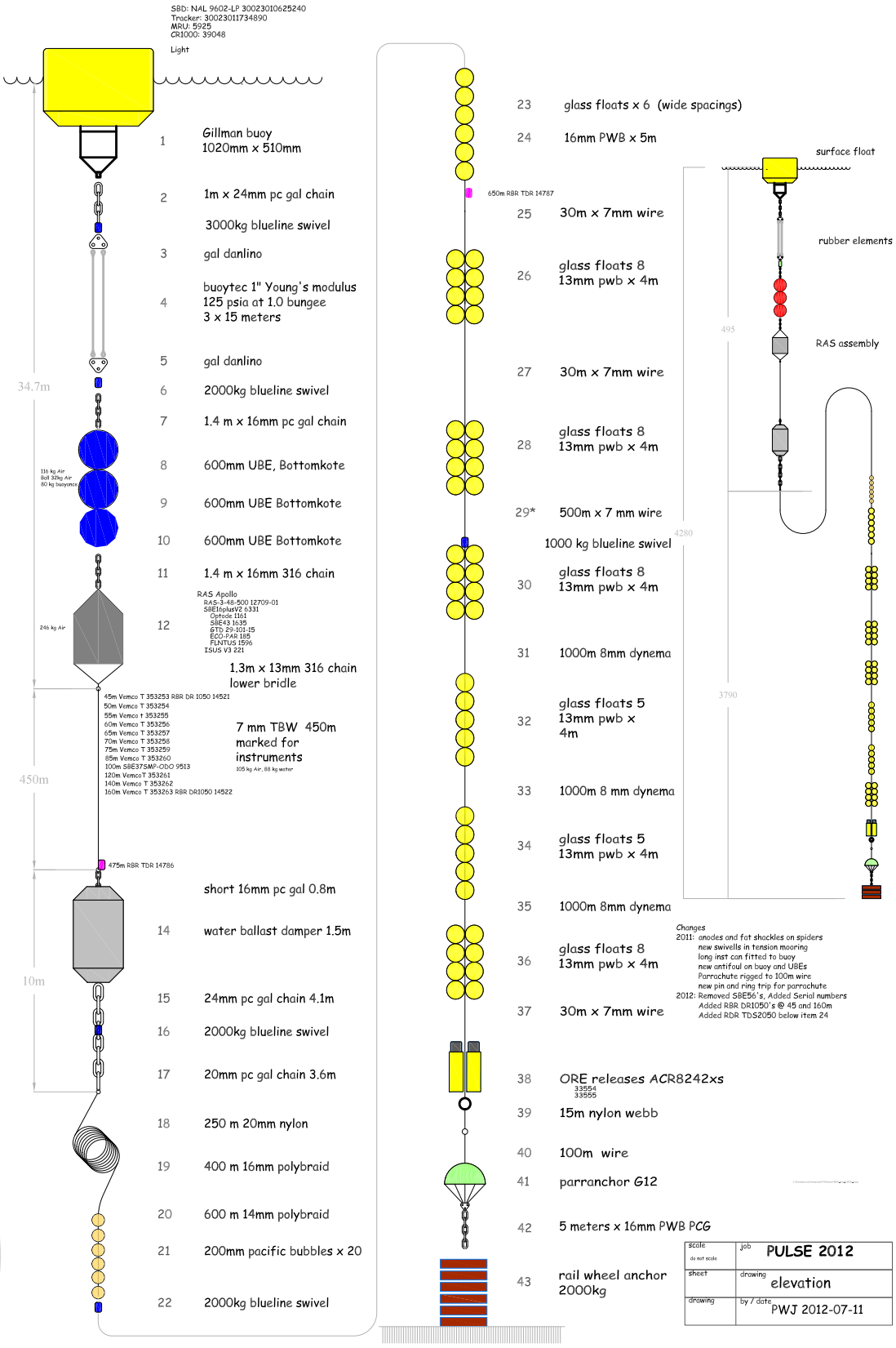


Pulse-8 mooring diagram – as recovered

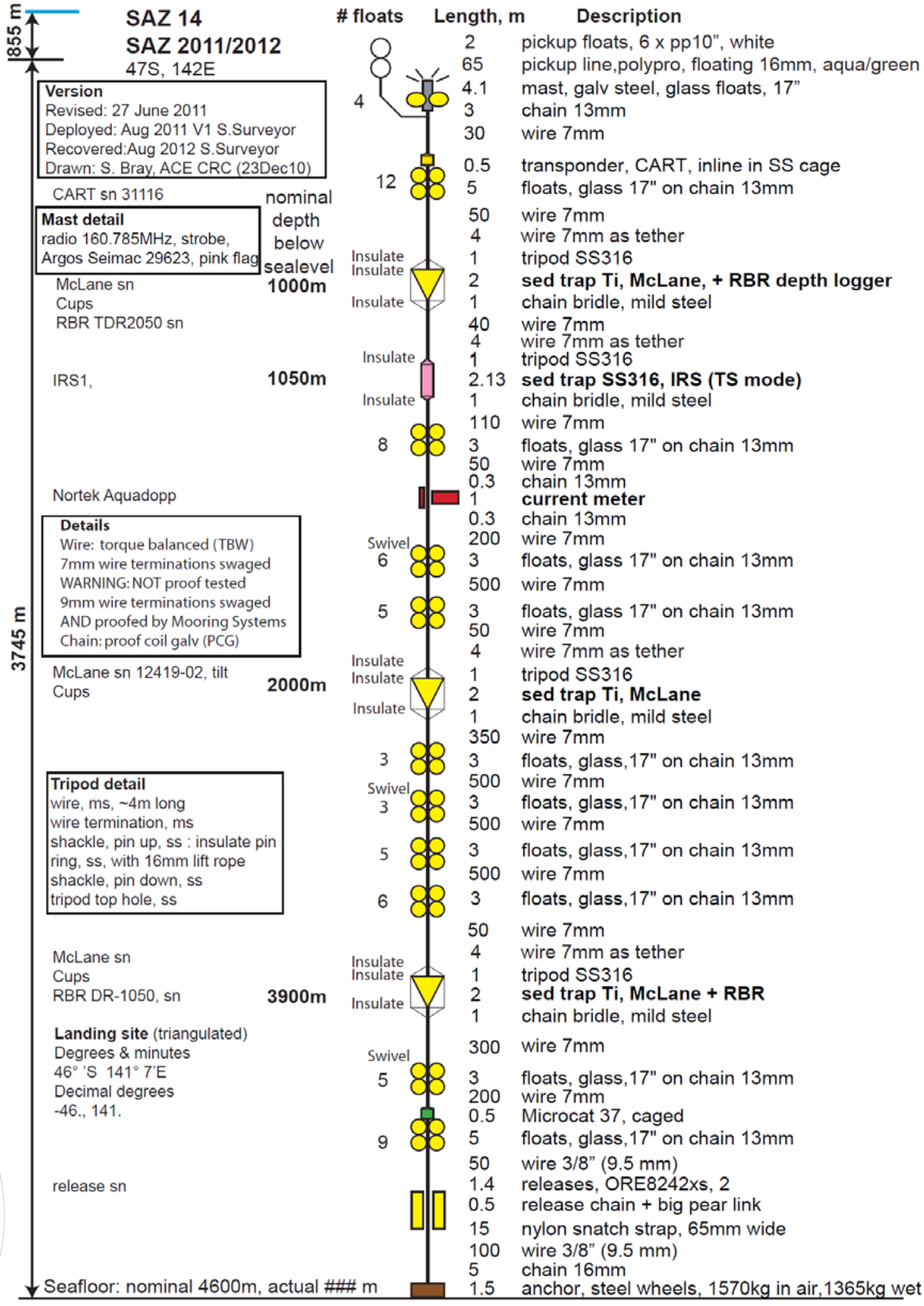



PULSE8–upper
46° 55.773′ S
142° 12.880′ E
Bottom depth 4399
Deployed 3rd August 2011
GILLMAN BUOY (Iridium GPS, wave height (+GPS), light, PAR #200665)
0 m
2 m
1 m CHAIN (24mm)
blue line swivel
RUBBER LINE (TRIPLE LENGTH)
27 m
PAR #200664 27 m
blue line swivel
1 m CHAIN (16mm)
28 m
3 PLASTIC FLOATS (painted blue)
30 m
1.4 m CHAIN (16mm, stainless)
32 m
RAS INSTRUMENT CHASSIS 32 m
(with SBE16+v2, GTD, ECOPAR, FLNTU, SBE43, OPTODE AND ISUS)
1.3 m CHAIN bridle (13mm, stainless)
34.5 m
vemco1(T #6098), SBE56 #00531 45 m
vemco2 (T #4823), PAR #200341 50 m
vemco3 (T #4824) 55 m
vemco4 (P,T #6100) 60 m
vemco5 (T #4825) 65 m
vemco6 (T #4826) 70 m
vemco7 (T #4827) 75 m
vemco8 (T #4828) 85 m
450 m wire(7mm)
microcat #6962 100 m
vemco9 (T #4829) 120 m
vemco10 (T #4830) 140 m
vemco11(P,T #6101),SBE56 #00532 160 m
485 m
Brancker P,T #14788 485 m
0.5 m CHAIN (16mm)
DAMPER
487 m
4 m CHAIN (24mm)
blue line swivel
3.5 m CHAIN (20mm)
495 m
250m x 20mm nylon braid
1000 m polypropylene braid (400mx16mm + 600mx14mm)
10 x 8" floats
blue line swivel
6 GLASS FLOATS
(6 m x 16 mm chain)
(single line, wide spacing)
Brancker P,T #14789 664 m
30 m wire (7mm)
RAS INSTRUMENTS
SBE–16plusV2 (with T,C,P) #53084–6330
SBE43 #431634
Wetlabs ECO–PAR #134
Wetlabs ECO–FLNTUS + TURB #1215
Aanderaa Optode–3975 #1419
Pro Oceanus GTD #29–102–15
Satlantic MBARI–ISUS V3 #76

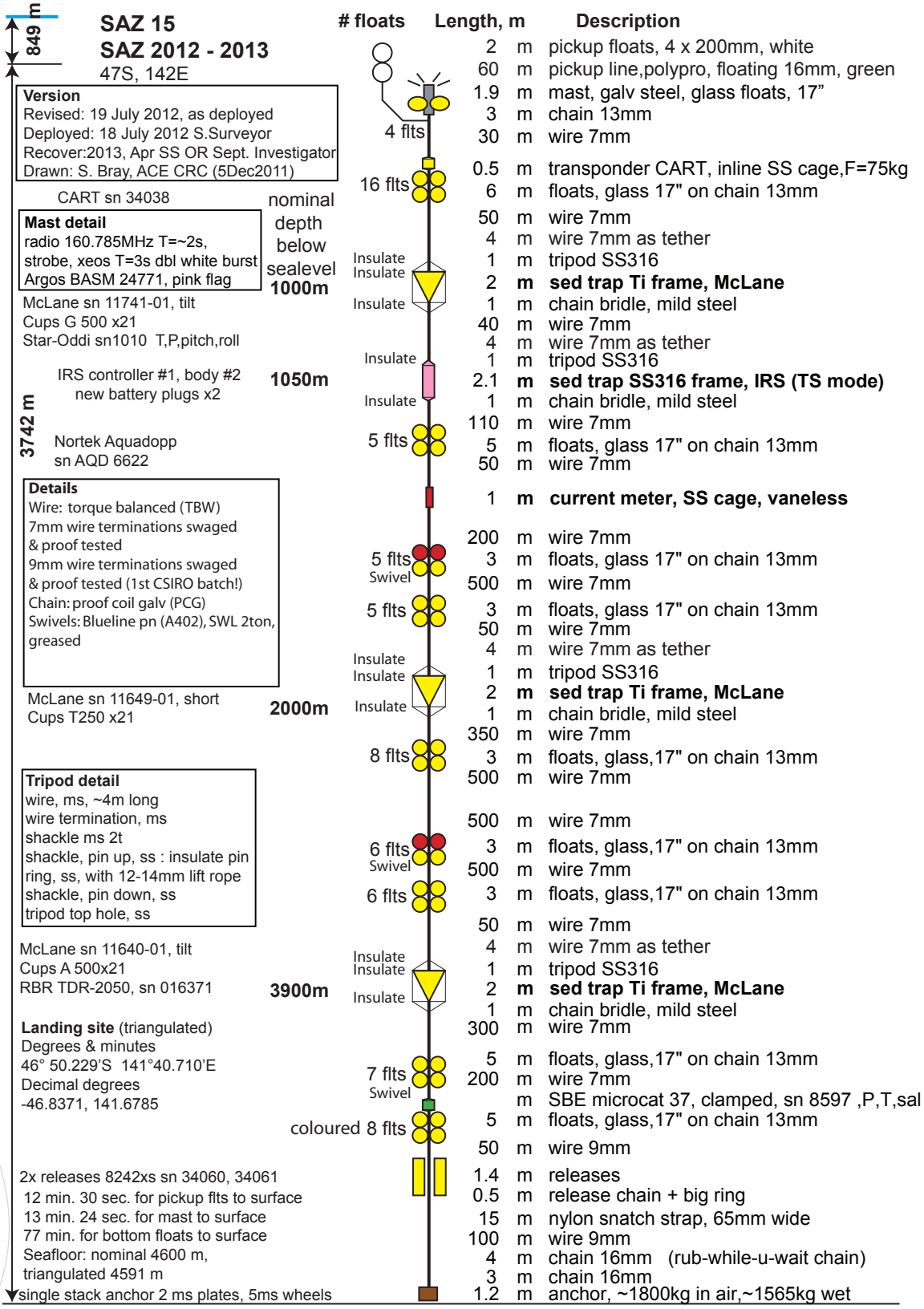
Pulse-9 mooring diagram – as deployed



SAZ-14 mooring diagram – as recovered



SAZ-15 mooring diagram – as deployed



# floats	Length, m		Description
	2	m	pickup floats, 4 x 200mm, white
	60	m	pickup line,polypro, floating 16mm, green
	1.9	m	mast, galv steel, glass floats, 17"
	3	m	chain 13mm
4 flts	30	m	wire 7mm
	0.5	m	transponder CART, inline SS cage,F=75kg
16 flts	6	m	floats, glass 17" on chain 13mm
	50	m	wire 7mm
	4	m	wire 7mm as tether
Insulate	1	m	tripod SS316
Insulate	2	**m**	**sed trap Ti frame, McLane**
Insulate	1	m	chain bridle, mild steel
	40	m	wire 7mm
	4	m	wire 7mm as tether
Insulate	1	m	tripod SS316
	2.1	**m**	**sed trap SS316 frame, IRS (TS mode)**
Insulate	1	m	chain bridle, mild steel
	110	m	wire 7mm
5 flts	5	m	floats, glass 17" on chain 13mm
	50	m	wire 7mm
	1	**m**	**current meter, SS cage, vaneless**
	200	m	wire 7mm
5 flts	3	m	floats, glass 17" on chain 13mm
Swivel	500	m	wire 7mm
5 flts	3	m	floats, glass 17" on chain 13mm
	50	m	wire 7mm
	4	m	wire 7mm as tether
Insulate	1	m	tripod SS316
Insulate	2	**m**	**sed trap Ti frame, McLane**
Insulate	1	m	chain bridle, mild steel
	350	m	wire 7mm
8 flts	3	m	floats, glass,17" on chain 13mm
	500	m	wire 7mm
	500	m	wire 7mm
6 flts	3	m	floats, glass,17" on chain 13mm
Swivel	500	m	wire 7mm
6 flts	3	m	floats, glass,17" on chain 13mm
	50	m	wire 7mm
	4	m	wire 7mm as tether
Insulate	1	m	tripod SS316
Insulate	2	**m**	**sed trap Ti frame, McLane**
Insulate	1	m	chain bridle, mild steel
	300	m	wire 7mm
7 flts	5	m	floats, glass,17" on chain 13mm
Swivel	200	m	wire 7mm
		m	SBE microcat 37, clamped, sn 8597 ,P,T,sal
coloured 8 flts	5	m	floats, glass,17" on chain 13mm
	50	m	wire 9mm
	1.4	m	releases
	0.5	m	release chain + big ring
	15	m	nylon snatch strap, 65mm wide
	100	m	wire 9mm
	4	m	chain 16mm (rub-while-u-wait chain)
	3	m	chain 16mm
	1.2	m	anchor, ~1800kg in air,~1565kg wet