AR69-03 Cruise Report

Photo: Croy Carlin (WHOI)

Cruise Summary

Vessel: R/V Neil Armstrong
Cruise ID: AR69-03
Chief Scientist: Fiamma Straneo (SIO-UCSD)
Ports: Reykjavik, Iceland to Nuuk, Greenland
Dates: August 19, 2022 – September 24, 2022

1. Introduction and Objectives

The Overturning in the Subpolar North Atlantic Program (OSNAP) is an international program designed to measure the transport of heat, mass, and freshwater in the subpolar North Atlantic and the associated Atlantic Meridional Overturning Circulation (AMOC), and to investigate the AMOC's variability link to dense water formation variability (Figure 1). It includes contributions from scientists in the U.K., Germany, Netherlands, Canada, France and the U.S. One key component of this program are moored arrays maintained across two lines that cut across the subpolar North Atlantic flow: OSNAP West, from the Labrador coast to the southern tip of Greenland, and OSNAP East from the southern tip of Greenland, across the Reykjanes Ridge, and extending all the way to Scotland. This report summarizes operations carried out aboard the R/V *Neil Armstrong* during cruise 69-03 in August/September of 2022. This is the fifth US led cruise in this area primarily dedicated to the servicing of moorings SE and SW of Cape Farewell, respectively in the Irminger and Labrador Seas, and to the collection of hydrographic and velocity data to provide context to the moored measurements.

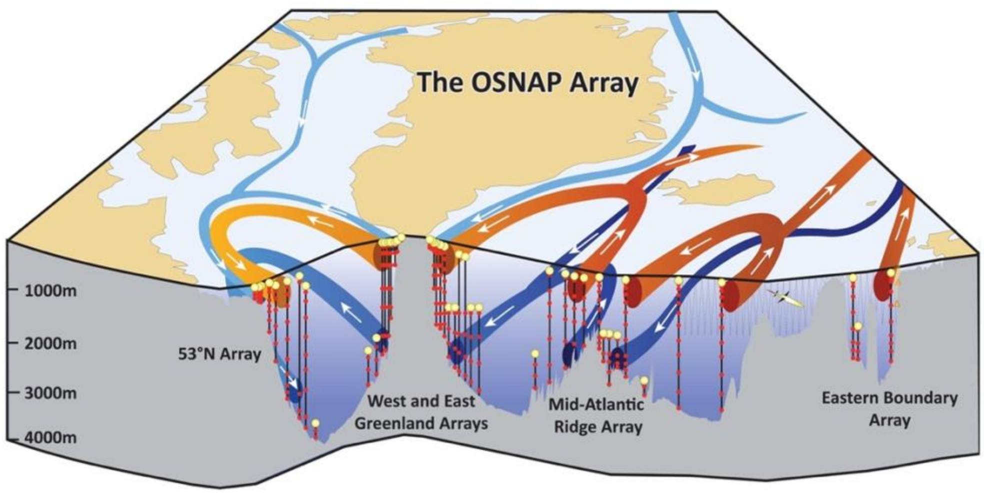

Figure 1: Schematic representation of the OSNAP observing system across the western and eastern OSNAP lines showing the different moored arrays. This report focuses on a cruise that serviced the West and East Greenland Arrays. (Figure from Lozier et al. 2017, Science).

In addition to the OSNAP objectives, this cruise also supported the collection of data for a complementary biogeochemistry program, GOH-SNAP (Gases in the Overturning and Horizontal circulation of the Subpolar North Atlantic Program, Lead PI Jaime Palter, URI) which has added O_2 sensors to the O-SNAP array to quantify O_2 export from the Labrador and Irminger Seas. The data will also be used to empirically model carbon concentrations, and estimate carbon export. Additionally, air-sea gas exchange will be calculated and compared against analogous observations in the convective interior of the Labrador Sea. Oxygenation of Labrador Sea Water prevents large-scale hypoxia from developing anywhere in the Atlantic, and anthropogenic CO_2 storage in the basin is the highest in the global ocean. The assumption that, in the Atlantic, O_2 and CO_2 uptake and their variability are tired to the dynamics of heat loss and the overturning circulation pervades the literature, but has never been evaluated on the basis of direct observations. The goal of the 2022 cruise for GOHSNAP is to recover and redeploy the O_2 sensors, collect both CTD and bottle oxygen measurements in order to calibrate the mooring data, and collect DIC/TA samples to aid in the estimation of carbon export. This was one of several GOHSNAP cruises that serviced moorings and collected associated data this summer. Finally, a number of surface drifters and Argo floats were deployed during the cruise as part of an NSF-funded project aimed at tracing the meltwater pathways around Greenland (Lead PI N. Foukal, WHOI).

Scientific Objectives

1. Recover and re-deploy 20 (18 US and 2 German) moorings carrying temperature, salinity, velocity, oxygen and pCO2 sensors that constitute part of the OSNAP West and East lines and specifically the Labrador Sea and Cape Farewell arrays.

2. To complete a hydrographic survey across the Irminger Sea, to be used in the transport and overturning calculations within the OSNAP program.

3. To collect samples of oxygen, dissolved inorganic carbon (DIC), total alkalinity, nutrients and delta-O18 as part of the OSNAP and GOHSNAP (Lead PI Jaime Palter, URI) programs.

4. To deploy 12 surface drifters and 3 Argo floats as part of an NSF-funded project aimed at studying the east and west Greenland boundary currents (Lead PI. Nick Foukal, WHOI).

5. To carry out surveys of opportunity, in between the mooring recovery and deployment operations, to investigate aspects of the circulation around Greenland that can further our understanding of the transport and water mass transformation in the subpolar North Atlantic.

Figure 2 Scientific party and crew from AR69-03 (Photo J. Holte, SIO)

Table 1: Scientific Party and Crew

	Last Name	First Name	Institution	Position
	Straneo	Fiamma	SIO-UCSD	Chief Scientist
	Holte	James	SIO-UCSD	Scientist
	Kemp	John	WHOI	Mooring Tech (lead)
	Irons	Ethan	WHOI	Mooring Tech
	Davies	Andrew	WHOI	Mooring Tech/Instruments
	Torres	Dan	WHOI	ADCP
	Aaron	Mau	SIO (ODF)	CTD/Salt Analysis
	Slater	Donald	Univ. Edinburg, UK	Scientist
	Lindeman	Margaret	SIO-UCSD	Postdoc
	Sanchez	Robert	SIO-UCSD	Graduate Student
	Nelson	Monica	SIO-UCSD	Graduate Student
	Roth	Aurora	SIO-UCSD	Graduate Student
	Brigham	Matt	SIO-UCSD	Graduate Student
	Yoder	Meg	Boston College, MA	Graduate Student
	Abib	Nicole	U. Oregon, OR	Graduate Student
	Coquereau	Arthur	WHOI	Visiting Graduate Student
	Nagao	Hiroki	WHOI	Graduate Student
	Sheasley	Kent	WHOI	Master
	Baird	Kelson	WHOI	Chief Mate
	Manka	Chris	WHOI	Second Mate
	Stamatiou	Lia	WHOI	Third Mate
	Cheung	Emily	WHOI	SSSG
	Carlin	Croy	WHOI	SSSG
	Liarikos	Pete	WHOI	Boatswain
	Fitz	Leo	WHOI	Able-Bodied Seaman
	Foley	Keenan	WHOI	Able-Bodied Seaman
	Hogan	Chrissy	WHOI	Able-Bodied Seaman

	LeBlanc	Olivia	WHOI	Ordinary Seaman
	Alexander	Nicholas	WHOI	Chief Engineer
	Bentley	William	WHOI	First Engineer
	Cardoso	Isaac	WHOI	Second Assistant Engineer
	Grant	Max	WHOI	Third Assistant Engineer
	Covert	Kyle	WHOI	Oiler
	Pansano	Dean	WHOI	Oiler
	Alvarez	John	WHOI	Oiler
	Hallsted	Steve	WHOI	Electrician
	Witte	Eric	WHOI	Chief Steward
	Jones	Brian	WHOI	Cook
	Leong	Thomas	WHOI	Mess Attendant

2. Cruise Synopsis

The cruise departed Reykjavik harbor on August 19 at 11:00 UTC. This was one day later than planned because the large crane on the ship needed a part that a machine shop in Reykjavik had to manufacture, after which is was mounted and then the crane load tested. Loading of the ship occurred via a shore crane. This delay also allowed time to fix an oil leak from the Lebus winch. A low pressure system offshore of Iceland caused strong winds while we were in port, to the extent that the container terminal was shut down, so unsurprisingly strong winds and swells meet us as we leave the harbor and steam over the Reykjanes Ridge towards the start of the Irminger Sea section. We attempt a first test CTD cast on August 20 once we are outside of the Icelandic EEZ and waters are deeper than 1000m. The crane that deploys the Rosette has some issues on this first test cast and the package has to be recovered via manual commands. The CTD cable got kinked as a result and it ends up being re-terminated. Around 16:00 UTC the system is fixed and we successfully complete the first test cast. On August 21 we start the CTD section across the Irminger Sea, weather has improved. On August 22 we steam through a second low pressure system with 30 knot winds and 4 m waves coming from multiple directions. We continue the CTD section. Several of the casts carry moored instrumentation (acoustic releases and/or microcats) for testing and calibration casts. We pass the OOI mooring region on August 23 and sample relatively close to some of the OOI moorings. By August 24 we have started preparation for the instrumentation for the Cape Farewell mooring array which we tackle at the end of the line. We finish the Irminger Sea section (Figure 3) as far into the coast as the bridge is willing to go given the fog and presence of icebergs near the coast. We complete the first set of drifter and float deployments.

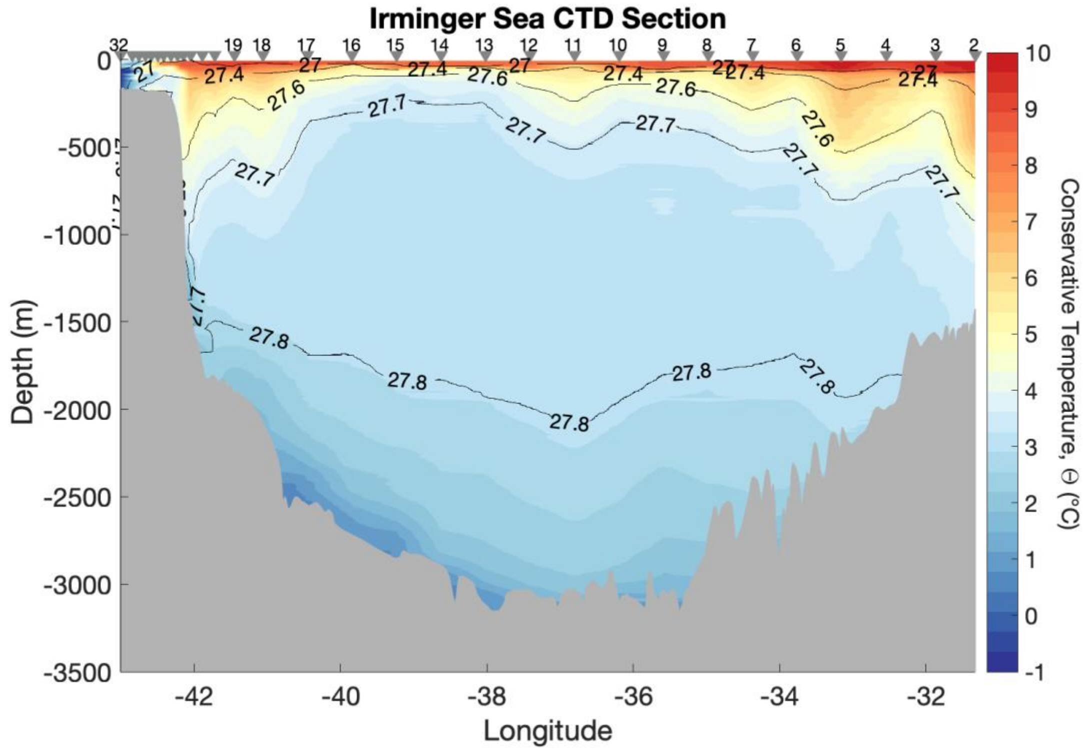

Figure 3: Irminger Sea Hydrographic Section (potential density isopycnals overlaid). Inverted triangles indicate CTD station number (Figure by Aurora Roth, SIO).

Cape Farewell moorings CF1, CF2, CF3 and CF4 are successfully recovered on August 25 (see Figure 4 for cruise track and Figure 5 for station location). After this we head to a bay at the entrance of Prince Christian Sound (PCS) to find calm waters for servicing the tripods and moorings. During the nights when no mooring work is happening we exit the bay to complete surveys of Lindenow Trough (Kangerlussuatsiaq Trough). The tripod and CF4 servicing ends the morning of August 27 and we head to deploy CF1, CF2, CF3. We deploy CF4 the following day, August 28, after completing a second survey of Lindenow Trough. The weather is getting worst and the forecast shows that a barrier wind event is developing along the SE Greenland coast. Since the weather is not workable for mooring operations we head north to survey a second trough along the coast. We steam through the worst of the wind event with the anemometer recording over 40 knots (some say up to 50 knots) and significant waves. The going is slow about 4-5 knots speed over ground. Along the way we deploy a few expendable probes. By August 29 we reach Tingmiarmiut Trough and start surveying this region. The weather has improved here but is still rough further south, at the moorings location. August 30 is a spectacular day with views of the SE Greenland mountains and icebergs moving down the coast. At night we steam back to the mooring sites. More surface drifters and floats are deployed along this coast.

We recover CF5 and CF6 on August 31 and then stay in the area overnight to do calibration casts. CF5 is redeployed on September 1st and CF7 is recovered that same day. CF7 is the mooring that lost it large subsurface floating in November when it went drifting and was eventually picked up by the Icelandic coastguard in March. By September 3rd we have completed the deployment of the CF moorings and head into PCS to cross over to the SW Greenland side and the Labrador Sea (LS) moored array.

Recovery of the LS moorings starts with LS4 on September 4. We typically recover and then redeploy moorings at the rate of one or two a day. At night we collect CTD data long the moored line and complete calibration casts for all the recovered and to-be-deployed instruments. Eventually we go down to one mooring operation a day since the moorings are taking longer. Also the Lebus winch is having some issues with oil leaking. At times during the night we head back inshore to survey Narsaq Trough which is just north of the mooring line on the shelf. LS6 is deployed on September 6 and LS8 on September 11. At this point we decided to stay offshore and recover and re-deploy the two moorings from GEOMAR since it looks like the weather will turn bad in a few days and we may not have the opportunity of getting back out where the GEOMAR moorings are. These take a while to recover in part because the acoustic release/deck box system do not seem to work well when the releases are deeper than 2000m. DSOW3 and DSOW4 are recovered on September 12 and re-deployed on September 13, after which we sail onshore to recover the tripods on the shelf.

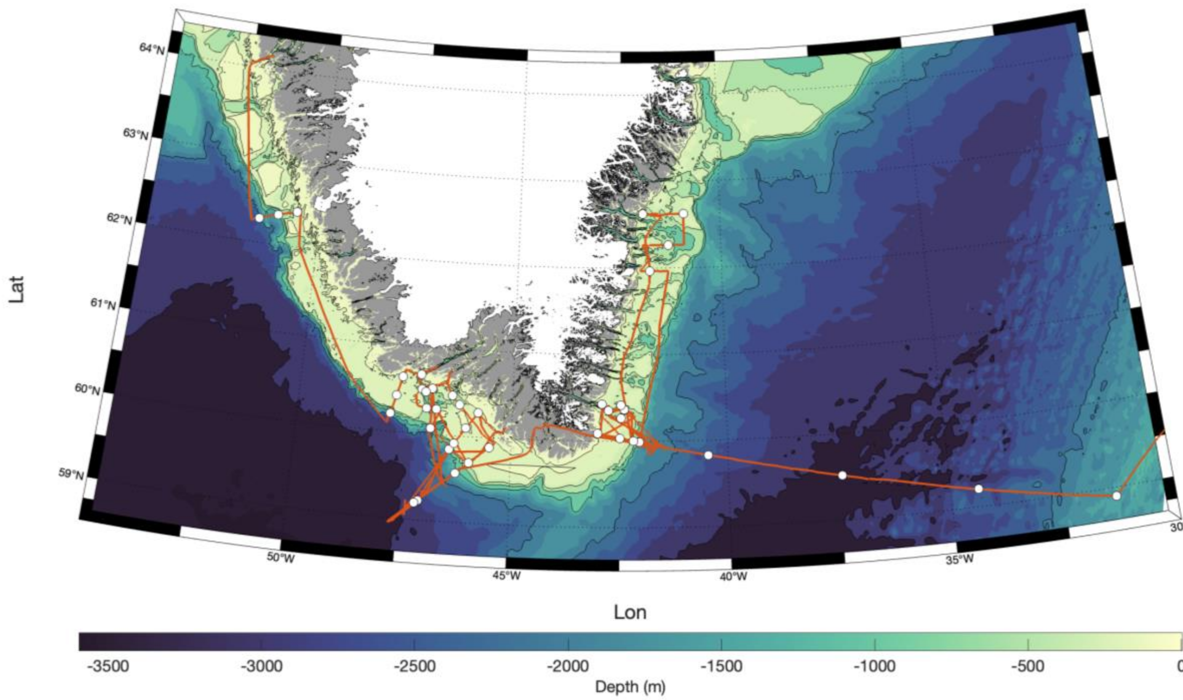

Figure 4: Ship track for the OSNAP 2022 AR69-03 cruise within the study region. One in every 5 CTD stations shown as white circles. (Figure by Nicole Abib, UOregon)

We recover all six (!) tripods on September 14, starting from the inshore-most one (LSi). We spend the night surveying Narsaq Trough and doing calibration casts. On September 15 early morning we head into a bay near the town of Narsaq for tripod refurbishment. The crane is not usable (again) which slows down the tripod operations. The mooring crew end up using the A-frame and tuggers to lift and then slide the tripods and anchors on deck which slows down the operations. They manage to get three done before we need to deploy them so that they can get to work on the remaining three. We steam away the night of September 16 and deploy LSi, LS1 and LS2 on September 17 in marginal weather conditions. We continue surveys upstream of Narsaq Trough during the night and head to a second bay, this one close to Nanortalik, the morning of September 18 for refurbishment of the three remaining tripods. We spend the day and following night there with the mooring crew working on the tripods. We set off at 13:00 local on September 19 to head for the deployment sites of LS1, LS2 and LS3. Deployment of the last mooring LS3 is at 19:00 local time.

Having finished the mooring work we complete a section thorugh Narsaq Trough ending up in Bradefjord close to Narsaq on the afternoon of Sep 20. After fog in the early morning the weather turns nice and it is sunny and flat while we are in the fjord. We do a single CTD cast 10 miles inside the fjord then head back out for a section just upstream of Cape Desolation. The forecast calls for 30 (gusts to 40) knot winds and 12 'seas. We work out from the coast at Cape Desolation amongst rocks and islands to complete the section offshore. Quite windy and wavy as we emerge from the shadow of the cape. On the morning of September 21, having completed the Cape Desolation section, we steam north for about 16 hours to the last section. We start that early in the morning of September 22. Forecast is for 30 knot southerly winds intensifying throughout Friday. We finish this last section around midnight as seas have picked up and wind gusts are well over 40 knots. Cast 214!

We head towards Nuuk after the last cast since the forecast is for poor weather conditions on September 23, our last working day. We reach the area of Nuuk around 11 am and sit in a bay across from the main basin. Waves are gone but wind gusts to 60 knots.

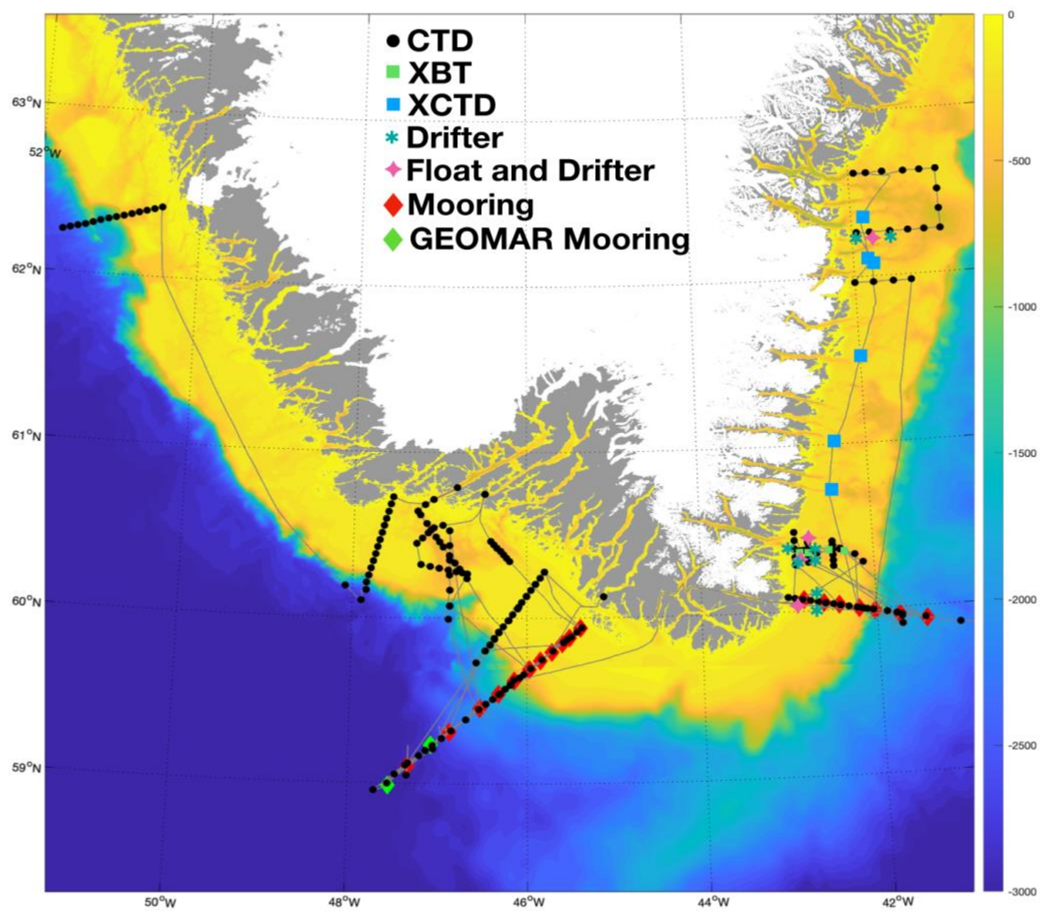

Figure 5: AR69-03 Cruise Locations for moorings and other measurements (see legend). (Figure by Jamie Holte, SIO)

3.CTD Measurements and Water Sampling

Contributing author: Aaron Mau

During OSNAP32, a total of 214 CTD casts were completed using a 24-place Niskin rosette with 10 L bottles (Figure 6). This included 20 casts for sensor calibrations “caldips”. All data was acquired using an SBE911+ CTD and deck unit at 24 Hz, with visualizations and carousel control provided by SeaSave v7.26.7.107 software running on a networked Windows workstation. Cast data was initiated after a 10 meter soak and return to the surface, allowing the pumps to turn on. Bottom approaches were determined initially by the *Armstrong*’s Kongsberg EM122 multibeam sonar and were further constrained during the downcast with real-time altimeter data attached to the rosette package. Data acquisition was terminated and deck unit was powered off prior to the CTD package leaving the water at the surface for recovery. Overall performance of the rosette and CTD was excellent with events recorded in the *AR69_03_CTD_Calibration_Report.pdf* document.

3.1 CTD Package

The CTD pressure housing was a SBE9 accompanied by a SBE11 V1 deck box for data acquisition. The SBE32 carousel had a custom-made bridle to guarantee an optimal angle of the niskin lanyards to the carousel latches. The primary sensor line consisted of an SBE3 temperature sensor, SBE4C conductivity sensor, and a SBE43 oxygen membrane sensor. The secondary line consisted of one SBE3 and SBE4C. Each line was fitted with a SBE5 pump. The CTD was oriented in a vertical orientation at the center of the rosette below the carousel, with the intakes to sensor lines oriented downwards. Auxiliary sensors consisted of a Valeport 500 altimeter, WETLabs ECO fluorometer and nephelometric turbidity unit (FLNTU) sensor, WETLabs C-Star transmissometer, WETLabs CDOM fluorometer, and a Biospherical Instruments underwater PAR sensor (for some casts). External to the CTD package were two LADCPs, described in their own section of this report.

Table 2: Sensors and equipment on Rosette

Equipment	Model	S/N	Cal Date	Stations
Rosette	24-place	-	-	001 – 214
Carousel	SBE 32	-	-	001 – 214
CTD	SBE 9	0383	15 July 2021	001 – 214
Primary Temperature	SBE 3	4491	30 July 2021	001 – 214
Primary Conductivity	SBE 4C	3009	30 July 2021	001 – 214
Primary Pump	SBE 5T	4880	-	001 – 214
Oxygen	SBE 43	1960	31 July 2021	001 – 214
Secondary Temperature	SBE 3	4492	30 July 2021	001 – 214

Secondary Conductivity	SBE 4C	3521	29 July 2021	001 – 214
Secondary Pump	SBE 5T	4938	-	001 – 214
Altimeter	Valeport 500	46506	2018	001 – 214
ECO Fluorometer	FLNTURTD	0969	9 May 2019	001 – 214
Turbidity sensor	FLNTURTD	0969	9 May 2019	001 – 214
Transmissometer	C-Star	1116DR	22 May 2019	001 – 214
CDOM Fluorometer	FLCDRTD	1964	18 November 2016	001 – 214
PAR sensor	QSP200L	4550	14 May 2014	001 - 214

3.2 Niskin Subsampling

Up to 20 niskin bottles could be closed during a single cast, with 4 spaces occupied for upward and downward facing LADCPs. Once the rosette was secured, LADCP cables were reattached to download data and niskin bottles could be subsampled. Subsampling consisted of dissolved oxygen, DIC, $\delta^{18}O$, nutrients, and salinity in that order. Detailed descriptions of subsampling are available in their respective sections of this report.

4.3 CTD Calibrations and Post Processing

Immediately following a cast, raw .HEX data were passed into a WHOI batch routine to run a series of SeaBird processing steps outlined in *AR69_03_CTD_Calibration_Report.pdf*. The data scans were converted to ASCII from .HEX, sensor lines were lag corrected, despiked and smoothed, and averaged into 2 decibar bins. The product at the end of these steps were .ASC, .CNV, .ROS, and .BTL ASCII files where downcast data could be easily accessed by the science party.

Raw .HEX CTD conductivity and oxygen data was fit to bottle reference data using SIO/ODF software “ctdcal” v. 0.1.3b. Data fitting and processing with ctdcal is further described in *AR69_03_CTD_Calibration_Report.pdf*, with the intent of running comparable subroutines to those of previous OSNAP cruises.

Figure 6 Niskin rosette with additional bottles removed to view CTD plumbing and carousel (Photo F. Straneo, SIO).

3.4 Biogeochemical and isotope water sampling

3.4.1 Nutrients

Contributing Authors: Monica Nelson, Matt Brigham

835 water samples for nutrient analysis (nitrate+nitrite, nitrite, phosphate, and silicate) were collected during the Irminger section, CF and LS mooring sections, and trough surveys. Samples were taken roughly every second station. Samples depths were chosen based on the downcast at each station targeting the surface, Chla maximum (based on the fluorescence profile), local O_2 maxima and minima, distinct water masses, near bottom, and bottom. Samples were filtered in 20mL plastic scintillation vials using Whatman .45 µm pp filters as soon as possible after collection from the rosette (within 30 minutes) and stored in a -80^{o}C freezer. Samples will be analyzed by the Oceanographic Data Facility at Scripps Institution of Oceanography using a Seal Analytical continuous-flow AutoAnalyzer3 (see ODF website for more information).

3.4.2 Oxygen Isotopes ($\delta^{18}O$)

Contributing Authors: Monica Nelson, Matt Brigham

630 water samples for oxygen isotope analysis were primarily collected during the CF and LS mooring sections, and trough surveys, where we expected to observe meltwater. Isotope samples

were also collected at two stations along the Irminger section - near the OOI Irminger Sea array and on the Reykjanes. Vertical sample resolution varied with location and were typically co-located with nutrient samples. Sampling was surface-intensified, as we do not expect to see a meltwater signal at depth. Depths were chosen to target water masses based on the downcast at each station. Samples were collected in 20 mL glass (samples #1-400) or plastic (samples #401-630) scintillation vials with polyseal cone caps. Vials were inspected to ensure no bubbles were present and caps were secured with Parafilm before storing samples at room temperature.

3.4.3 Oxygen

Contributing author: Meg Yoder
Oxygen titrations (Winklers) were performed onboard by Meg Yoder (yoderma@bc.edu). Oxygen samples were taken in duplicate or triplicate at multiple depths on [# of casts] casts to calibrate the CTD dissolved oxygen sensor and mooring sensor data.

On deck sampling
Oxygen samples were taken from Niskins prior to any other sampling. Flasks were rinsed, overflowed several times, preserved with manganous chloride ($MnCl_2$, 3M) and sodium hydroxide-sodium iodide (NaI, 4M; NaOH, 8M) and shaken vigorously 20 times. All samples were re-shaken and then capped with DI water in the lab twenty minutes after sampling.

Analysis
The titration system was standardized on ship at the beginning and end of the cruise using OSIL potassium iodate 0.1667 M standard. Each day prior to running samples, previously calibrated potassium iodate standards were run to confirm the integrity of the system. The titration system used David (Roo) Nicholson's Winkler titration software. Samples were acidified with sulfuric acid (5M) and titrated within 24 hours using sodium thiosulfate (0.2M).

CTD dissolved oxygen sensor
The CTD rosette included an SBE 43 oxygen sensor, which is a fast-response sensor that provides high resolution profiles, but which must be calibrated with Winkler oxygen data to account for drift from the original factory calibration

3.4.4 DIC and TA

Contributing author: Meg Yoder
Joint DIC/TA samples were taken at mooring calibration oxygen depths, at and surrounding pCO_2 sensor depths, and at additional locations of scientific interest including the [Irminger Sea hydrographic section, is there a name for this?]. 178 total samples were collected on 24 casts.

Sampling and Storage
Combined dissolved inorganic carbon (DIC) and total alkalinity (TA) samples were collected from Niskins immediately after oxygen. Ground glass borosilicate bottles were rinsed three times and overflowed several times to fill. Samples were immediately brought into the lab and poisoned with 100 µL saturated mercuric chloride solution, then sealed bottles using Apiezion M-grease.

Analysis
DIC/TA samples will be analyzed in Boston College's Marine Biogeochemistry Lab, overseen by Hilary Palevsky (palevsky@bc.edu, GOHSNAP co-PI). DIC samples will be run on an Apollo SciTech Dissolved Inorganic Carbon AS-C6L Analyzer and TA samples will be run on an Apollo SciTech Alkalinity Titrator AS-ALK2 using certified reference materials supplied by Andrew Dickson.

4. Moorings

4.1 Mooring Operations

Mooring operations involved the recovery and re-deployment (turn around) of 20 moorings constituting part of the West Greenland and East Greenland arrays (Figure 5). These include 7 Cape Farewell Array Moorings (SIO), 13 Labrador Sea Moorings (11 WHOI and 2 GEOMAR). Of these 9 are tripod moorings, designed for observing the properties and the circulation on the ~200 m deep continental shelves, two are 500m tall bottom-focused moorings to map the Deep Western Boundary Current in the Labrador Sea (the GEOMAR moorings) and the remainder are subsurface moorings that extend to about 100 m from the surface with the addition, in some cases, of a tethered instrument at 50m (designed to avoid dragging by icebergs or fishing operations). Table 3 list the recovered and Table 4 the deployed moorings, while the mooring diagrams can be found in Appendix A. The mooring locations are shown both in Fig 5 and in Fig 7.

Most of the mooring deployments and recovery made use of a Lebus double-capstan winch system provided by the UNOLS West Coast winch pool. This system allows separate wire reels to be loaded into an auxiliary system so that they can be fed to the main double capstan winch without having to spool all the wires under tension onto the winch beforehand (as is commonly done with other winches). This system worked well though it periodically leaked oil. A new part was fabricated in Reykjavik to address this problem but it started leaving again during the cruise and in the final mooring deployments the Lebus was only used for the wire spools. A second TSE winch was utilized in tandem with the Lebus.

Moorings were deployed top flotation first while being spooled out, instruments attached progressively, with the ship steaming into the current or the wind to keep the mooring streaming off the transom. The operation started far enough away from the planned drop location to provide enough time to string the mooring out before anchor deployment at the planned location. The deployment coordinates were corrected to be the A-frame position. All subsurface moorings deployed (except for the GEOMAR moorings, whose release system did not allow for range below 2000m, and the tripods - see later) were surveyed after deployment and the surveyed location is reported on the mooring logs. This is regarded as the most accurate mooring position. The GEOMAR moorings were deployed with no survey because their release/deck box system did not give stable ranges when the releases were deeper than 2000m. The tripods were lowered to the seafloor using a lowering release system and the trawl wire and winch – and then released within a few meters of the seafloor. This guarantees that they land flat and, also, gives a very accurate deployment position.

Recovery occurred by releasing the mooring with the vessel positioned upstream of the mooring – so that if it surfaces at anchor location it will come up on the starboard side some 300-500m in front of the ship. Moorings were hooked with a grapnel hook connected to the leader line on the Lebus winch fed through a block mounted on the A-frame and recovered progressively through the A-frame. Instruments were sequentially recovered in top to bottom order.

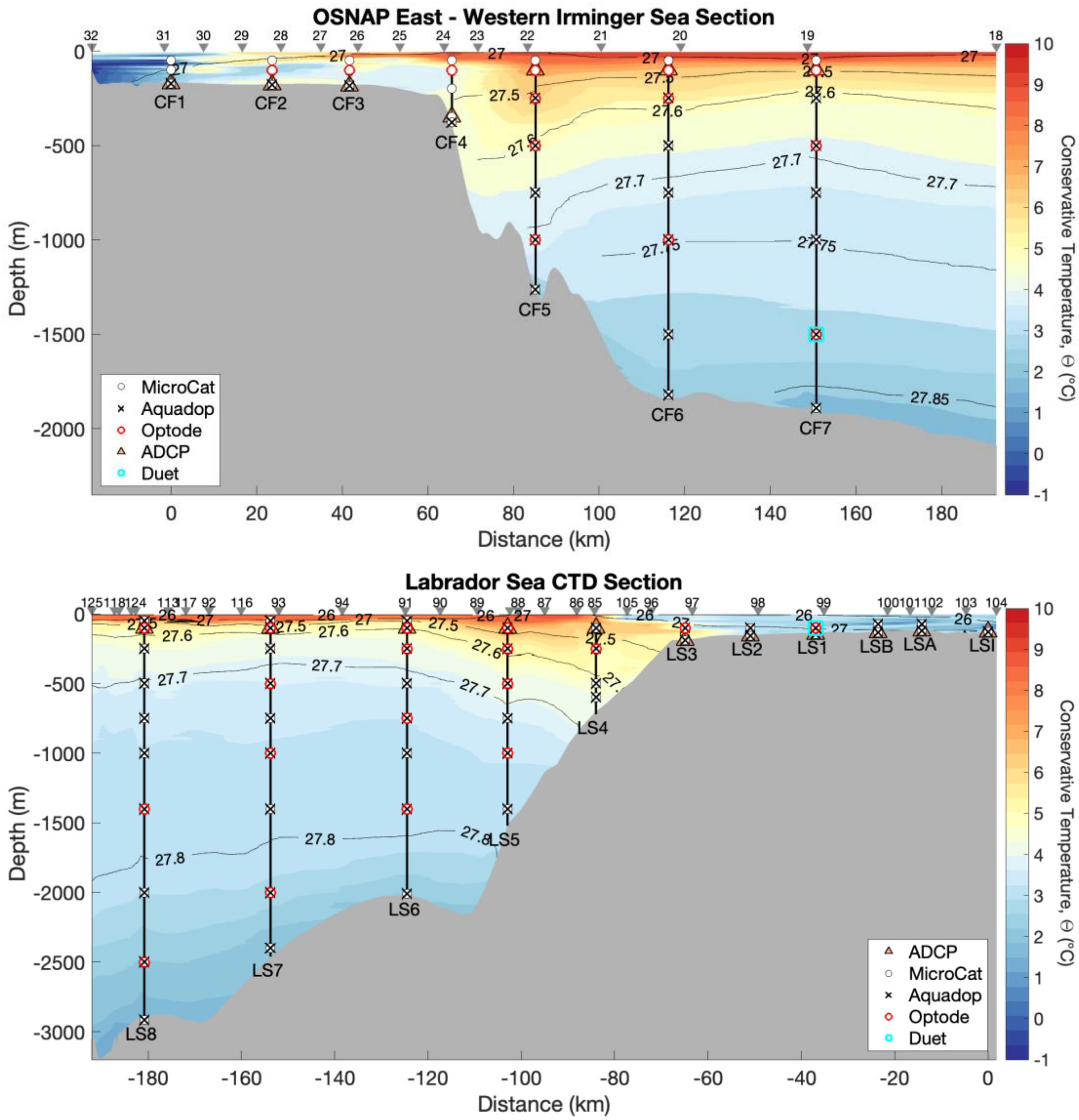

Figure 7. Cape Farewell Mooring locations and instrumentation overlaid on Conservative Temperature section obtained from hydrography during the cruise. Isopycnals are overlaid as thin black lines. Labrador Sea Mooring locations and instrumentation overlaid on Conservative Temperature section obtained from hydrography during the cruise. Isopycnals are overlaid as thin black lines (Figure by Aurora Roth, SIO).

All moorings surfaced after release with a few caveats. CF7 had lost its top flotation in November 2021, and was eventually recovered by the Icelandic Coastguard in March 2022 (after a failed attempt of recovery from a Greenlandic vessel in November 2021). We were able to recover the remaining portion of the mooring thanks to the backup flotation. Upon inspection, it looked like all of the instruments in this recovery were jolted at one point to the extent that all of the Aquadopps shifted inside their frames and slammed into them. In at least one case this led to a bent connector pin and damage inside the instrument and we were only able to communicate with the instrument by changing the end cap. This jolt also resulted in the loss of one microcat and one optode which must have slid out of their clamps since we recovered the clamps. The jolt appeared to be worst for the surface-most instruments. Likely the jolt happened when the sphere was ripped away and the wire parted. Several things including a missing part of wire rope (and the 250m instrument cage) as well as the bending of the lower metal attachment point of the sphere suggests that this was due to fishing gear getting stuck and pulled upon until it ripped the mooring apart.

The GEOMAR releases did not respond to the enable or release command and therefore both releases were enabled and released to maximize chances of surfacing. One of the GEOMAR moorings surfaced relatively far from the ship in fog and we eventually found it thanks to the Argo Xeos beacon which turned on and reported position via email. The German moorings came back in a tangle due to the buoyant glass balls being distributed throughout the mooring. The result was a tangle of glass balls, instruments and chain. In one case this is thought to have resulted in shearing off the endcap of a microcat and in its flooding. LS3 did not initially release, even if both releases confirmed release, but eventually surfaced about 1 hour after the initial release as the mooring team was getting ready to drag for it. Finally, a few of the Aquadopp Current meters deployed on the LS moorings flooded, and a few (both on LS and CF showed signs of limited amount of water infiltration – i.e. there were salt crystals deposited on the instrument).

Table 3: Recovered Moorings

AR69-03 OSNAP Mooring Recoveries

OSNAP EAST					
Name	**Latitude**	**Longitude**	**Date**	**Release Time**	**Time Recovered**
CF1	60 04.075	42 49.626	25 Aug	09:51	10:08
CF2	60 02.761	42 36.200	25 Aug	11:24	11:30
CF3	60 01.743	42 25.892	25 Aug	12:42	13:01
CF4	60 00.107	42 12.417	25 Aug	14:15	14:30
CF5	59 58.986	42 02.060	31 Aug	10:10	10:25
CF6	59 57.404	41 44.228	31 Aug	14:24	14:50
CF7	59 55.576	41 25.885	1 Sep	16:30	17:00

OSNAP WEST					
Name	**Latitude**	**Longitude**	**Date**	**Release Time**	**Time Recovered**
LS4	59 37.559	46 09.063	4 Sep	15:46	15:54
LS5	59 32.618	46 19.814	5 Sep	14:01	14:24
LS6	59 27.140	46 31.575	7 Sep	10:13	12:06

LS7	59 18.559	46 51.968	9 Sep	09:59	10:12
LS8	59 06.579	47 19.894	11 Sep	08:18	08:31
DSOW3	58 59.329	47 33.092	12 Sep	10:25	12:27
DSOW4	59 13.59	47 04.86	12 Sep	15:45	16:36
LSI	59 56.280	45 23.244	14 Sep	08:13	08:22
LSA	59 52.843	45 30.996	14 Sep	09:04	09:20
LSB	59 50.700	45 36.090	14 Sep	10:03	10:14
LS1	59 47.598	45 43.226	14 Sep	10:56	11:07
LS2	59 44.585	45 50.740	14 Sep	11:50	11:59
LS3	59 41.358	45 58.239	14 Sep	12:48	14:19

Table 4: Deployed Moorings

AR69-03 OSNAP Mooring Deployments						
OSNAP EAST						
Name	**Latitude**	**Longitude**	**Bottom depth**	**Date**	**Anchor Drop Time**	**Position Method**
CF1	60 04.208	42 49.527	170	27 Aug	12:37	stern referenced
CF2	60 02.853	42 35.975	178	27 Aug	14:33	stern referenced
CF3	60 01.851	42 25.708	184	27 Aug	15:54	stern referenced
CF4	60 00.302	42 12.340	384	28 Aug	11:26	surveyed position
CF5	59 59.087	42 01.563	1260	1 Sep	13:09	surveyed position
CF6	59 57.277	41 44.648	1829	2 Sep	13:11	surveyed position
CF7	59 55.367	41 26.020	1901	3 Sep	12:54	surveyed position

OSNAP WEST						
Name	**Latitude**	**Longitude**	**Bottom depth**	**Date**	**Anchor Drop Time**	**Position Method**
LS4	59 37.318	46 08.631	738	5 Sep	11:44	surveyed position
LS5	59 32.512	46 19.361	1501	6 Sep	16:24	surveyed position
LS6	59 27.437	46 32.210	2033	8 Sep	16:46	surveyed position
LS7	59 18.715	46 52.418	2463	10 Sep	14:20	surveyed position
LS8	59 06.314	47 20.141	2935	11 Sep	18:50	surveyed position
DSOW3	59 00.590	47 33.630	3104	13 Sep	12:04	stern referenced
DSOW4	59 13.005	47 04.741	2939	13 Sep	16:31	stern referenced
LSI	59 56.281	45 23.240	130	17 Sep	10:24	stern referenced
LSA	59 52.840	45 30.990	121	17 Sep	12:05	stern referenced
LSB	59 50.700	45 36.090	134	17 Sep	13:21	stern referenced
LS1	59 47.598	45 43.222	144	19 Sep	18:19	stern referenced
LS2	59 44.588	45 50.732	157	19 Sep	19:34	stern referenced
LS3	59 41.360	45 58.240	191	19 Sep	20:56	stern referenced

4.2 Calibration Casts

Approximately 20 'caldips' (calibration casts) were conducted to calibrate instruments either recovered from moorings or to be deployed on moorings, mostly microcats and optodes though 8 Aquadopp Current Meters were also pressure-calibrated for the GEOMAR Moorings. Calibration casts involve strapping instruments on the Rosette by using hose clamps and straps mounted on the Rosette (see Figure 8). Instruments were programmed to sample at 6-10 seconds rate and 'soaked' on the upcast for 10 minutes at various depths to obtain a relatively constant value for calibration. In total, we calibrated 23 Optodes, 173 Microcats and 8 Current meters during the cruise.

Figure 8 Microcats mounted on the Rosette for calibration casts (Photo F. Straneo, SIO).

5. Underway Measurements

Thermosalinograph

Values of surface temperature and salinity were continuously monitored using a Sea-Bird TSG system (including SBE45 and SBE48 temperature sensors and SBE45 salinity sensor) installed in the Armstrong's seawater intake line.

Shipboard ADCP

Underway vessel-mounted ADCP data were collected throughout the cruise using two independent systems: a 150 kHz Ocean Surveyor (OS150) and a 38 kHz Ocean Surveyor (OS38) both from Teledyne RD Instruments. UHDAS data acquisition software from University of Hawaii was used to collect raw ADCP data from each instrument. The OS150 was set up to collect 50 8-meter bins of data every ping in narrowband mode. The OS38 was set up to collect 80 16-meter bins of data every ping in narrowband mode. Raw single ping data were processed on board using the CODAS shipboard ADCP processing software developed at University of Hawaii's School of Earth Science and Technology. Single ping data were averaged and edited to remove ship motion from the measured velocity. Final processed data resulted in absolute velocity profiles at 5-minute sample intervals throughout the cruise. The data were then de-tided using the same tidal models used for the LADCP data.

6. Surface Drifter and Float

Contributing author: Arthur Coquereau (arthur.coquereau@whoi.edu)

12 surface drifters and 4 Argo floats were successfully deployed in the East Greenland Coastal Current for the second consecutive summer, as part of the Greenland FreshWater Experiment (PI: Nick Foukal, WHOI). The objective of the project is to investigate the fate and pathways of fresh water around the southern tip of Greenland.

12 Surface Velocity Program Salinity (SVPS) drifters were deployed in 4 batches of 3 drifters at different spots on the inner shelf. They are drogued at 15 m depth and will follow the surface current and measure the salinity of the surface water as well as the temperature. In addition, 4 SOLO-2 (ALTO) Argo floats were deployed on the shelf, one per batch of surface drifters. The floats are programmed to sample the upper 100 m of the water column. Drifters were deployed by launching the float, cable and tether off the stern's transom while the ship was underway at 3 knots. Argo floats were deployed by releasing the box into the water and then waiting for the saltwater switch to activate.

Figure 9. Drifter deployment from the stern of the R/V Armstrong (Photo F. Straneo, SIO).

Table 5 – Drifter Deployment

DRIFTE R	LIN E	SERIAL #	DATE	TIME UTC	DEPLOY. LON	DEPLOY. LAT
1	1	WHOI_NF-SVPS-0013	8/25/2022	5:01	42°40.215'W	60°3.219'N
2	1	WHOI_NF-SVPS-0014	8/25/2022	7:22	42°50.192'W	60°3.474'N
3	1	WHOI_NF-SVPS-0015	8/25/2022	10:58	42°41.346'W	60°3.024'N
4	2	WHOI_NF-SVPS-0016	8/26/2022	23:08	42°54.617'W	60°22.778'N
5	2	WHOI_NF-SVPS-0017	8/27/2022	0:26	42°48.507'W	60°22.066'N
6	2	WHOI_NF-SVPS-0018	8/27/2022	0:52	42°41.896'W	60°21.988'N
7	3	WHOI_NF-SVPS-0019	8/30/2022	13:04	41°32.297'W	62°16.003'N
8	3	WHOI_NF-SVPS-0020	8/30/2022	14:37	41°47.788'W	62°15.369'N
9	3	WHOI_NF-SVPS-0021	8/30/2022	15:43	41°56.112'W	62°15.557'N
10	4	WHOI_NF-SVPS-0022	9/2/2022	22:10	42°51.148'W	60°21.909'N
11	4	WHOI_NF-SVPS-0023	9/2/2022	23:18	42°45.430'W	60°24.646'N
12	4	WHOI_NF-SVPS-0024	9/3/2022	2:05	42°45.321'W	60°19.247'N

Table 6 – Float Deployment

FLOAT	LINE	SERIAL #	DATE	TIME UTC	DEPLOY. LON	DEPLOY. LAT
1	1	11340	8/25/2022	7:18	42°50.475'W	60°3.528'N
2	2	11339	8/27/2022	0:23	42°48.581'W	60°22.015'N
3	3	11342	8/30/2022	14:29	41°47.223'W	62°15.483'N
4	4	11338	9/2/2022	23:13	42°45.564'W	60°24.769'N

7. Expendable Probes

A limited number of expendable probes (XBT, temperature only; XCTD, temperature and conductivity) where used to collect profiles to complement hydrography without stopping the vessel. These were Sippican/Lockheed Martin XBT and XCTD-1 probes that were launched off the stern using the ship's deck unit and launcher. A total of 10 probes were launched (see Table below and map for location).

Table 6– Expendable Probes

	XCTD XBT s/n	Date (2022)	Time (UTC)	Latitude (N)	Longitude (W)	Depth (m) MB	Comments
1	1272626	8/27	23:39	60° 21.933’	42° 49.983’	621	XBT
2	1272730	8/27	23:59	60° 21.481’	42° 44.764’	526	XBT
3	1272725	8/28	01:56	60° 22.14’	42° 30.881’	584	XBT
4	1272729	8/28	03:24	60° 21.154’	42° 18.780’	583	XBT
5	19029262	8/28	20:02	60° 43.444’	42° 28.377’	507	XCTD
6	16060018	8/28	23:22	61° 1.0’	42° 22.8’	600	XCTD
7	16060013	8/29	05:52	61° 31.035’	42° 0.063’	380	XCTD
8	19029265	8/29	12:54	62° 5.95’	41° 48.72’	592	XCTD
9	19029263	8/29	15:32	62° 22.297’	41° 50.858’	700	XCTD
10	19029266	8/30	17:07	62° 5.510’	41° 47.562’	400	XCTD

8. Shipboard ADCP/Lowered ADCP Measurements

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Lowered ADCP

A lowered ADCP (LADCP) system was used to measure full ocean depth profiles of velocity at each CTD station. The LADCP system consisted of one downward-facing and one upward-facing 300 kHz ADCP (both from Teledyne RD Instruments). The ADCPs were synchronized to ping out of phase with each other in order to minimize instrument interference. Each instrument was set to collect single pings in beam coordinates. Data from each LADCP cast were edited and combined with CTD, GPS, and shipboard ADCP data, and processed using software from Lamont-Doherty Earth Observatory resulting in a profile of absolute velocity at each station. The absolute velocity profiles were then corrected for magnetic declination using a magnetic declination model from NOAA/NODC. The profiles were subsequently de-tided using tidal models developed at Oregon State University’s College of Earth, Ocean, and Atmospheric Sciences. A high-resolution (1/60th degree) regional model was used to de-tide the stations.

9. Compliance with consent to perform research in foreign waters

In accordance with the provisions specified in the cruise prospectus and application for Greenlandic research clearance, a report summarizing the results of the research conducted on the AR69-03 cruise will be provided to Danish and Greenlandic authorities within 6 months of the termination of the cruise.

10. Acknowledgements

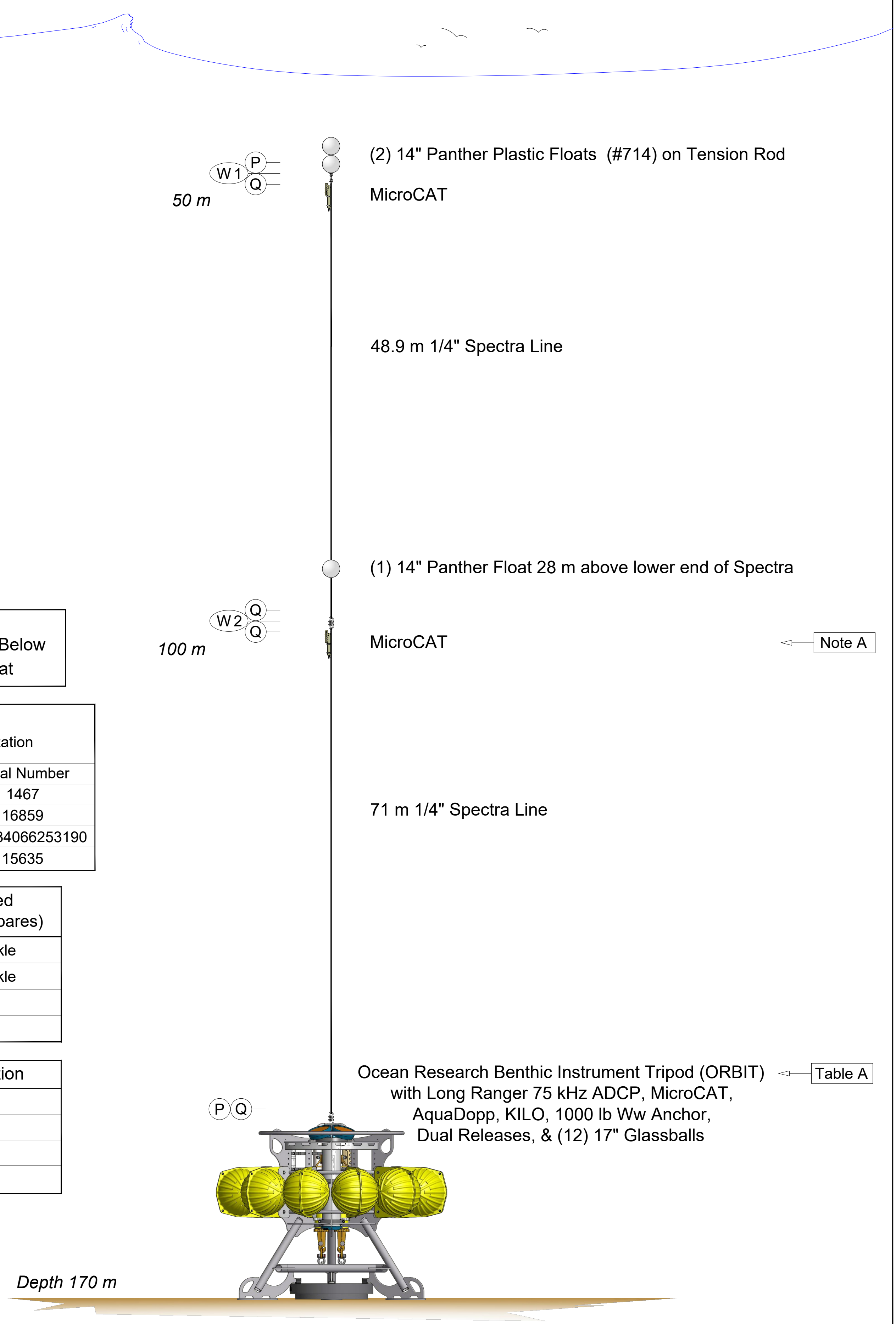
The success of this cruise was made possible by the exceptional support and able assistance provided by Captain Sheasley and his crew. Support for the scientific research was provided by the U.S. National Science Foundation under grants OCE 1948482 and 1948505.

Appendix A: CTD station table

CTD Number	Section	Date	Time (UT	Lat (degN	Lat (minN	Lon (degW	Lon (minW	Bottom dep	Water Samples	Comments
1	Test cast	20-Aug-22	16:40	60	35.392	27	42.01	1336	Salts, Nutrients, d18O, DO, DIC/TA	Test cast
2	Irminger section	21-Aug-22	9:57	58	53.684	31	19.764	1413	Salts, Nutrients, d18O, DO, DIC/TA	
3	Irminger section	21-Aug-22	13:12	58	57.037	31	52.013	1659	Salts, Nutrients, DO	
4	Irminger section	21-Aug-22	16:48	59	0.966	32	32.379	1920	Salts	
5	Irminger section	21-Aug-22	20:40	59	4.817	33	9.475	2219	Salts, Nutrients, DO, DIC/TA	
6	Irminger section	22-Aug-22	1:06	59	8.544	33	45.8	2392	Salts, Nutrients, DO, DIC/TA	
7	Irminger section	22-Aug-22	5:40	59	12.282	34	22.289	2385	Salts	
8	Irminger section	22-Aug-22	10:00	59	15.995	34	58.76	2988	Salts, Nutrients, DO, DIC/TA	Microcat cal-dip
9	Irminger section	22-Aug-22	16:30	59	19.751	35	36.016	3103	Salts	Microcat cal-dip
10	Irminger section	22-Aug-22	22:20	59	23.46	36	12.356	3092	Salts, Nutrients, DO, DIC/TA	
11	Irminger section	23-Aug-22	1:49	59	27.213	36	48.27	3111	Salts, DO	
12	Irminger section	23-Aug-22	6:39	59	30.983	37	24.747	3123	Salts, Nutrients, DO, DIC/TA	
13	Irminger section	23-Aug-22	10:52	59	34.747	38	1.248	3097	Salts, DO	Microcat cal-dip
14	Irminger section	23-Aug-22	16:40	59	38.575	38	37.785	2979	Salts, Nutrients, d18O, DO, DIC/TA	Microcat cal-dip, near OOI array
15	Irminger section	23-Aug-22	20:11	59	42.251	39	14.024	2850	Salts, DO	Near OOI array
16	Irminger section	23-Aug-22	23:21	59	45.949	39	50.446	2700	Salts, Nutrients, DO, DIC/TA	Near OOI array
17	Irminger section	24-Aug-22	4:31	59	49.649	40	27.05	2488	Salts, Nutrients, DO	
18	Irminger section	24-Aug-22	8:49	59	53.388	41	3.528	2122	Salts, DO	
19	Irminger section	24-Aug-22	11:43	59	55.817	41	27.011	1893	Salts, Nutrients, d18O, DO, DIC/TA	Microcat cal-dip
20	Irminger section	24-Aug-22	15:31	59	57.144	41	42.864	1821	Salts, Nutrients	
21	Irminger section	24-Aug-22	17:22	59	58.3	41	53.458	1394	Salts	
22	Irminger section	24-Aug-22	19:30	59	59.535	42	2.539	1174	Salts, Nutrients, d18O, DO, DIC/TA	Microcat cal-dip
23	Irminger section	24-Aug-22	9:39	60	0.072	42	9.001	939	Salts	Release test, no LADCP
24	Irminger section	24-Aug-22	23:05	60	0.521	42	13.355	278	Salts, Nutrients, d18O, DO, DIC/TA	
25	Irminger section	25-Aug-22	0:23	60	1.129	42	19.081	198	Salts	Microcat cal-dip
26	Irminger section	25-Aug-22	1:28	60	1.695	42	24.603	184	Salts, Nutrients, d18O, DO, DIC/TA	
27	Irminger section	25-Aug-22	2:50	60	2.216	42	29.506	179	Salts, Nutrients, d18O	
28	Irminger section	25-Aug-22	3:48	60	2.738	42	34.773	176	Salts	
29	Irminger section	25-Aug-22	4:41	60	3.279	42	39.942	180	Salts, Nutrients, d18O	Drifter deployment
30	Irminger section	25-Aug-22	5:41	60	3.793	42	45.135	179	Salts	Drifter deployment
31	Irminger section	25-Aug-22	6:40	60	4.359	42	50.432	176	Salts, Nutrients, d18O, DO, DIC/TA	Drifter and Argo deployment
	CF moorings	25-Aug-22								CF1 recovery
	CF moorings	25-Aug-22								CF2recovery
	CF moorings	25-Aug-22								CF3 recovery
	CF moorings	25-Aug-22								CF4 recovery
32	CFsec	25-Aug-22	18:55	60	5.31	43	0.4	164	Salts, Nutrients, d18O, DO, DIC/TA	PAR sensor on
33	CFsec	25-Aug-22	20:14	60	4.82	42	55.784	170	Salts, Nutrients, d18O	Release test, no LADCP. PAR sensor on.
34	CFsec	25-Aug-22	21:25	60	4.356	42	50.595	174	Salts	Microcat cal-dip. PAR sensor on.
35	CFsec	25-Aug-22	23:00	60	2.707	42	34.961	177	Salts	PAR sensor on
36	Cfsec	25-Aug-22	23:58	60	1.703	42	24.788	184	Salts, DO	PAR sensor on
37	CFsec	26-Aug-22	1:11	60	0.285	42	10.818	696	Salts, Nutrients, d18O	Food waste disposal of during upcast
38	CFsec	26-Aug-22	2:48	59	59.86	42	6.631	991	Salts, Nutrients, DO	Microcat and Optode cal-dip
39	LTsec1	26-Aug-22	22:26	60	22.698	42	54.565	608	Salts, Nutrients, d18O, DO	Drifter deployment
40	LTsec1	26-Aug-22	23:43	60	22.009	42	48.565	480	Salts, Nutrients	Drifted during cast
	LTsec1	27-Aug-22	0:26	60	22.066	42	48.507			Drifter and Argo deployment
	LTsec1	27-Aug-22	0:52	60	21.988	42	41.896			Drifter deployment
41	LTsec1	27-Aug-22	1:13	60	20.819	42	39.144	517	Salts, Nutrients, d18O, DO	Drifted out of trough during cast
42	LTsec1	27-Aug-22	3:06	60	21.921	42	23.218	529	Salts, Nutrients	
43	LTsec1	27-Aug-22	4:51	60	16.971	42	7.498	477	Salts, Nutrients, d18O, DO	
	CF moorings	27-Aug-22								CF1 deployment
	CF moorings	27-Aug-22								CF2 deployment
	CF moorings	27-Aug-22								CF3 deployment
44	LTsec2	27-Aug-22	18:37	60	16.908	42	54.23	212	Salts, Nutrients, d18O	
45	LTsec2	27-Aug-22	19:43	60	19.679	42	52.258	225	Salts, Nutrients, DO	PAR sensor on
46	LTsec2	27-Aug-22	20:38	60	22.751	42	54.42	626	Salts	PAR sensor on
47	LTsec2	27-Aug-22	21:38	60	25.75	42	54.327	143	Salts, Nutrients, DO	PAR sensor on
48	LTsec2	27-Aug-22	22:30	60	28.725	42	54.326	141	Salts, Nutrients, d18O	PAR sensor on. Spigots and valves on Niskins 1-5 not closed, not sampled
	LTsec3	27-Aug-22	22:39	60	21.93333	42	49.98333	621		XBT1
	LTsec3	27-Aug-22	23:59	60	21.4808	42	44.76405	526		XBT2
49	LTsec3	28-Aug-22	0:22	60	21.14	42	31.03	575	Salts, DO	
	LTsec3	28-Aug-22	1:56	60	22.14	42	30.6876	584		XBT3
50	LTsec3	28-Aug-22	2:34	60	22.186	42	23.015	504	Salts	
	LTsec3	28-Aug-22	3:24	60	21.154	42	18.78	583		XBT4
51	LTsec3	28-Aug-22	3:56	60	19.894	42	12.924	552	Salts, Nutrients, d18O, DO	
	CF moorings	28-Aug-22								CF4 deployment
	SE shelf, transit north	28-Aug-22	20:02	60	43.444	42	28.377	507		XCTD1
	SE shelf, transit north	28-Aug-22	23:22	61	1	42	22.8	600		XCTD2
	SE shelf, transit north	29-Aug-22	5:52	61	31.035	42	0.063	380		XCTD3
	SE shelf, transit north	29-Aug-22	13:00	62	5.95	41	48.72	592		XCTD4
	SE shelf, transit north	29-Aug-22	15:49	62	22.297	41	50.858	700		XCTD5
	SE shelf, transit north	29-Aug-22	17:07	62	5.51	41	47.562	400		XCTD6
52	TTsec1	29-Aug-22	20:00	62	37.482	41	55.921	780	Salts, Nutrients, d18O, DO	
53	TTsec1	29-Aug-22	21:30	62	37.448	41	46.79	502	Salts, Nutrients, d18O	PAR sensor on
54	TTsec1	29-Aug-22	22:56	62	37.632	41	34.606	261	Salts, Nutrients, d18O, DO	
55	TTsec1	30-Aug-22	0:42	62	37.477	41	19.011	309	Salts, Nutrients, d18O	
56	TTsec1	30-Aug-22	2:18	62	37.474	41	6.966	267	Salts, DO	
57	TTsec1/TTsec2	30-Aug-22	4:07	62	37.515	40	54.833	206	Salts, Nutrients, d18O	
58	TTsec2	30-Aug-22	5:31	62	30.124	40	54.877	277	Salts, Nutrients, d18O, DO	
59	TTsec2	30-Aug-22	6:52	62	23.02	40	54.877	578	Salts, Nutrients, d18O	
60	TTsec2/TTsec3	30-Aug-22	8:27	62	15.94	40	54.867	622	Salts, DO	
61	TTsec3	30-Aug-22	9:56	62	16.01	41	6.776	597	Salts, Nutrients, d18O	
62	TTsec3	30-Aug-22	11:19	62	16.024	41	18.737	376	Salts, DO	

63	TTsec3	30-Aug-22	12:33	62	15.983	41	32.021	277	Salts, Nutrients, d18O	
64	TTsec3	30-Aug-22	13:57	62	15.964	41	46.897	210	Salts, Nutrients, d18O, DO	
65	TTsec3	30-Aug-22	15:10	62	16.016	41	56.668	177	Salts, Nutrients, d18O	PAR sensor on. Near Mogens Glacier outlet
66	TTsec4	30-Aug-22	18:06	61	57.936	42	0.116	249	Salts, Nutrients, d18O	PAR sensor on
67	TTsec4	30-Aug-22	19:23	61	57.903	41	46.553	390	Salts, Nutrients, d18O	PAR sensor on. Drifted into deeper water during cast
68	TTsec4	30-Aug-22	20:56	61	57.732	41	31.983	252	Salts, Nutrients, d18O, DO	PAR sensor on
69	TTsec4	30-Aug-22	22:21	61	58.017	41	18.847	233	Salts, Nutrients, d18O, DO	
	CF moorings	31-Aug-22								CF5 recovery
	CF moorings	31-Aug-22								CF6 recovery
70	CF moorings	31-Aug-22	20:48	59	56.909	41	43.174	1818	Salts, DO	Optode cal-dip and Release test, no LADCP
71	CF moorings	31-Aug-22	23:38	59	53.583	41	42.982	1826	Salts	Microcat cal-dip
	CF moorings	1-Sep-22								CF5 deployment
	CF moorings	1-Sep-22								CF7 recovery
72	LTsec4	2-Sep-22	0:45	60	24.943	42	28.113	183	Salt, Nutrients, d18O	
73	LTsec4	2-Sep-22	1:32	60	23.442	42	28.084	445	Salts, DO	
74	LTsec4	2-Sep-22	2:26	60	21.949	42	28.049	570	Salts, Nutrients, d18O	
75	LTsec4	2-Sep-22	3:28	60	19.982	42	28.014	464	Salts, DO	
76	LTsec4	2-Sep-22	4:26	60	18.007	42	27.991	317	Salts	
77	LTsec4	2-Sep-22	5:14	60	16.007	42	27.988	209	Salts, Nutrients, d18O, DO	
	CF moorings	2-Sep-22								CF6 deploymenet
78	CF moorings	2-Sep-22	15:14	59	57.81	41	46.635	1820	Salts, DO	Optode cal-dip and Release test, no LADCP
79	LTsec5	2-Sep-22	21:33	60	21.998	42	50.45	623	Salts, DO	Drifter deployment
80	LTsec5	2-Sep-22	22:47	60	24.967	42	45.124	251	Salts, Nutrients, d18O	Drifter and Argo deployment. LADCP battery failure.
81	LTsec5	2-Sep-22	23:49	60	22.86	42	44.82	173	Salts, DO	No LADCP
82	LTsec5	3-Sep-22	0:32	60	21.332	42	45.116	461	Salts, Nutrients, d18O	No LADCP
83	LTsec5	3-Sep-22	1:37	60	19.595	42	45.072	373	Salts, DO	Drifter deployment. No LADCP. Drifted during cast.
84	LTsec5	3-Sep-22	2:24	60	17.66	42	45.188	256	Salts, Nutrients, d18O	No LADCP
	CF moorings	3-Sep-22								CF7 deployment
85	LSsec1	4-Sep-22	14:39	59	37.696	46	8.798	714	Salts, Nutrients, d18O, DO, DIC/TA	Near LS4
	LS moorings	4-Sep-22								LS4 recovery
86	LSsec1	4-Sep-22	19:10	59	35.738	46	10.952	880	Salts, DO	Redid cast due to CTD malfunction
87	LSsec1	4-Sep-22	20:39	59	34.353	46	14.827	1140	Salts, Nutrients, d18O	
88	LSsec1	4-Sep-22	22:05	59	32.68	46	18.123	1451	Salts, DO, DIC/TA	Near LS5
89	LSsec1	4-Sep-22	23:57	59	30.617	46	23.254	2127	Salts, Nutrients, d18O	
90	LSsec1	5-Sep-22	2:08	59	28.912	46	27.969	2114	Salts, DO	
91	LSsec1	5-Sep-22	4:11	59	26.953	46	32.596	2020	Salts, Nutrients, d18O, DO, DIC/TA	Near LS6, Optode cal-dip
	LS moorings	5-Sep-22								LS4 deployment
	LS moorings	5-Sep-22								LS5 recovery
92	LSsec1	5-Sep-22	21:26	59	13.794	47	3.674	2918	Salts, DO	Near DSOW4. Microcat and Optode cal-dip, release test. No LADCP
93	LSsec1	6-Sep-22	1:28	59	19.225	46	51.35	2419	Salts, Nutrients, d18O, DO, DIC/TA	
94	LSsec1	6-Sep-22	4:14	59	23.166	46	41.387	2126	Salts, DO	
95	LSsec1	6-Sep-22	10:29	59	32.385	46	19.075	1497	Salts	Near LS5, Microcat cal-dip
	LS moorings	6-Sep-22								LS5 deployment
96	LSsec1	6-Sep-22	19:17	59	39.631	46	2.124	344	Salts, Nutrients, d18O	
97	LSsec1	6-Sep-22	20:22	59	41.786	45	57.433	187	Salts, DO, DIC/TA	
98	LSsec1	6-Sep-22	21:35	59	44.959	45	49.898	156	Salts, Nutrients, d18O	
99	LSsec1	6-Sep-22	22:35	59	48.065	45	42.297	145	Salts, DO, DIC/TA	
100	LSsec1	6-Sep-22	23:39	59	51.151	45	34.965	130	Salts, Nutrients, d18O	
101	LSsec1	7-Sep-22	0:24	59	52.194	45	32.395	120	Salts	
102	LSsec1	7-Sep-22	1:01	59	53.133	45	29.849	119	Salts, Nutrients, d18O	
103	LSsec1	7-Sep-22	1:48	59	54.847	45	25.856	134	Salts, DO	
104	LSsec1	7-Sep-22	2:31	59	56.45	45	22.262	130	Salts, Nutrients, d18O	
105	LSsec1	7-Sep-22	6:07	59	38.443	46	5.036	105	Salts, Nutrients, d18O, DO	
	LS moorings	7-Sep-22								LS6 recovery
106	NTsec1	7-Sep-22	19:11	59	59.58	46	53.674	2095	Salts, Nutrients, d18O, DO	Optode cal-dip
107	NTsec1	7-Sep-22	22:11	60	4.476	46	53.191	1784	Salts, Nutrients, d18O	
108	NTsec1	8-Sep-22	0:11	60	10.16	46	52.98	391	Salts	Niskin 3 misfired
109	NTsec1	8-Sep-22	1:15	60	15.62	46	53.302	547	Salts, Nutrients, d18O	
110	NTsec1	8-Sep-22	2:38	60	20.976	46	53.298	550	Salts	
111	NTsec1	8-Sep-22	3:51	60	26.286	46	53.398	466	Salts, Nutrients, d18O	
112	NTsec1	8-Sep-22	5:12	60	31.669	46	53.466	157	Salts, Nutrients, d18O	
	LS moorings	8-Sep-22								LS6 deployment
113	LSsec1	8-Sep-22	21:18	59	10.035	47	12.564	2883	Salts, Nutrients, d18O	GEOMAR microcat and aquadopp cal-dip. Release test, No LADCP.
114	LSsec1	9-Sep-22	0:52	59	6.408	47	21.638	2945	Salts, DO, DIC/TA	
115	LSsec1	9-Sep-22	4:06	58	59.961	47	33.527	3108	Salts, Nutrients, d18O, DO, DIC/TA	
	LS moorings	9-Sep-22								LS7 recovery
116	LSsec1	9-Sep-22	15:45	59	16.326	46	57.608	2681	Salts, Nutrients, d18O	
117	LSsec1	9-Sep-22	19:14	59	11.907	47	8.37	2921	Salts, Nutrients, DO, DIC/TA	
118	LSsec1	9-Sep-22	23:59	59	3.23	47	28.672	3042	Salts, Nutrients	
	LS moorings	10-Sep-22								LS7 deployment
119	LSsec2	10-Sep-22	18:09	59	43.87	46	34.587	1949	Salts, Nutrients, d18O	
120	LSsec2	10-Sep-22	20:20	59	48.683	46	28.757	1444	Salts, DO	
121	LSsec2	10-Sep-22	22:20	59	52.827	46	22.286	650	Salts, Nutrients, d18O	
122	LSsec2	10-Sep-22	23:49	59	50.438	46	25.187	1225	Salts	
	LS moorings	11-Sep-22								LS8 recovery
123	LSsec1	11-Sep-22	11:29	59	2.972	47	20.884	2980	Salts, DO	Optode cal-dip
	LS moorings	11-Sep-22								LS8 deployment
124	LSsec1	11-Sep-22	21:02	59	7.362	47	20.081	2922	Salts	Microcat cal-dip
125	LSsec1	12-Sep-22	1:19	58	57.438	47	42.512	2968	Salts, Nutrients, DO	
	LS moorings	12-Sep-22								DSOW3 recovery
	LS moorings	12-Sep-22								DSOW4 recovery
126	LSsec1	12-Sep-22	20:28	59	12.538	47	3.4332	2928	Salts, DO	Microcat, Aquadopp and Optode cal-dip
	LS moorings	13-Sep-22								DSOW3 deployment
	LS moorings	13-Sep-22								DSOW4 deployment
127	LSsec2	13-Sep-22	21:53	59	55.036	46	19.317	147	Salts, DO	10m/min in upper 50m
128	LSsec2	13-Sep-22	22:58	59	59.182	46	12.352	130	Salts, Nutrients, d18O	10m/min in upper 50m
129	LSsec2	14-Sep-22	0:00	60	3.612	46	6.197	117	Salts, DO	10m/min in upper 50m
130	LSsec2	14-Sep-22	1:05	60	7.862	46	0.133	97	Salts, Nutrients, d18O	10m/min in upper 50m. Oxygen sensor fouled near surface.
131	LSsec2	14-Sep-22	2:08	60	12.313	45	53.976	118	Salts	10m/min in upper 50m

132	LSsec2	14-Sep-22	3:07	60	16.754	45	47.783	183	Salts, Nutrients, d18O	10m/min in upper 50m
	LS moorings	14-Sep-22								LSI recovery
	LS moorings	14-Sep-22								LSA recovery
	LS moorings	14-Sep-22								LSB recovery
	LS moorings	14-Sep-22								LS1 recovery
	LS moorings	14-Sep-22								LS2 recovery
	LS moorings	14-Sep-22								LS3 recovery. Several release attempts
133	NTsec2	14-Sep-22	18:23	60	4.426	46	52.906	1781	Salts, DO	LS tripod Microcat and Optode cal-dips
134	NTsec2	14-Sep-22	21:57	60	16.05	46	40.98	90	Salts, Nutrients, d18O	Microcat cal-dip
135	NTsec2	14-Sep-22	23:04	60	16.825	46	48.749	456	Salts, DO	
136	NTsec2	15-Sep-22	0:08	60	17.377	46	54.419	556	Salts, Nutrients, d18O	Microcat cal-dip
137	NTsec2	15-Sep-22	1:46	60	18.016	47	0.56	466	Salts, DO	
138	NTsec2	15-Sep-22	2:45	60	18.674	47	6.749	228	Salts	
139	NTsec2	15-Sep-22	3:37	60	19.331	47	13.041	118	Salts, Nutrients, d18O	
140	NTsec3	15-Sep-22	4:55	60	26.976	47	16.613	140	Salts, Nutrients, d18O	
141	NTsec3	15-Sep-22	5:47	60	28.907	47	12.228	141	Salts	
142	NTsec3	15-Sep-22	6:38	60	30.816	47	8.308	582	Salts, Nutrients, d18O, DO, DIC/TA	
143	NTsec3	15-Sep-22	8:12	60	32.669	47	4.443	429	Salts	
144	NTsec3	15-Sep-22	9:26	60	33.606	46	58.18	101	Salts, Nutrients, d18O	Microcat cal-dip
145	Hiding spot 1	16-Sep-22	10:15	60	44.929	46	29.033	333	Salts	Release test, no LADCP
146	Hiding spot 1	16-Sep-22	11:46	60	44.955	46	29.003			Release test, no LADCP
147	NTsec4	16-Sep-22	20:23	60	27.869	46	24.828	154	Salts	
148	NTsec4	16-Sep-22	21:09	60	26.648	46	22.787	149	Salts	
149	NTsec4	16-Sep-22	21:53	60	25.435	46	20.785	354	Salts, DO	
150	NTsec4	16-Sep-22	22:47	60	24.303	46	18.073	406	Salts, Nutrients, d18O	
151	NTsec4	17-Sep-22	0:00	60	23.122	46	16.141	425	Salts	
152	NTsec4	17-Sep-22	0:59	60	21.858	46	14.071	307	Salts	
153	NTsec4	17-Sep-22	1:56	60	20.583	46	11.836	123	Salts	
	LS moorings	17-Sep-22								LSI deployment
	LS moorings	17-Sep-22								LSA deployment
	LS moorings	17-Sep-22								LSB deployment
154	LSsec3	17-Sep-22	16:21	59	48.428	46	28.683	1430	Salts, DO	
155	LSsec3	17-Sep-22	17:57	59	50.591	46	25.555	1284	Salts	
156	LSsec3	17-Sep-22	19:24	59	52.485	46	22.062	595	Salts, Nutrients, d18O	
157	LSsec3	17-Sep-22	20:28	59	55.023	46	19.268	146	Salts	
158	LSsec3	17-Sep-22	21:19	59	57.033	46	16.257	135	Salts	
159	LSsec3	17-Sep-22	22:00	59	59.125	46	12.852	130	Salts, Nutrients, d18O	
160	LSsec3	17-Sep-22	22:53	60	1.314	46	9.743	129	Salts	
161	LSsec3	17-Sep-22	23:58	60	4.044	46	5.519	112	Salts, DO	
162	LSsec3	18-Sep-22	0:43	60	5.817	46	3.666	106	Salts, Nutrients, d18O	
163	LSsec3	18-Sep-22	1:34	60	7.989	46	0.333	98	Salts	
164	LSsec3	18-Sep-22	2:17	60	10.137	45	57.163	152	Salts	
165	LSsec3	18-Sep-22	3:02	60	12.354	45	54.014	121	Salts, Nutrients, d18O	
166	LSsec3	18-Sep-22	3:48	60	14.526	45	50.784	147	Salts	
167	LSsec3	18-Sep-22	4:32	60	16.73	45	47.804	184	Salts, Nutrients, d18O	
168	Hiding spot 2	18-Sep-22	15:37	60	7.606	45	7.193	271		Release test, no LADCP
169	Hiding spot 2	18-Sep-22	16:49	60	7.606	45	7.193	271		Release test, no LADCP
	LS moorings	19-Sep-22								LS1 deployment
	LS moorings	19-Sep-22								LS2 deployment
	LS moorings	19-Sep-22								LS3 deployment
170	NTsec5	20-Sep-22	0:56	60	14.376	46	41.185	110	Salts	
171	NTsec5	20-Sep-22	1:38	60	16.415	46	44.492	197	Salts	
172	NTsec5	20-Sep-22	2:24	60	17.815	46	46.384	429	Salts	
173	NTsec5	20-Sep-22	3:21	60	19.979	46	49.621	544	Salts, DO	
174	NTsec5	20-Sep-22	4:26	60	22.662	46	53.401	174	Salts	
175	NTsec5	20-Sep-22	5:31	60	25.75	46	57.783	516	Salts	
176	NTsec5	20-Sep-22	6:27	60	27.557	47	0.283	621	Salts	
177	NTsec5	20-Sep-22	7:25	60	29.341	47	2.583	684	Salts	
178	NTsec5	20-Sep-22	8:33	60	31.962	47	6.467	519	Salts	
179	NTsec5	20-Sep-22	9:35	60	34.216	47	9.367	350	Salts, Nutrients, d18O	
180	NTsec5	20-Sep-22	10:39	60	37.292	47	13.855	672	Salts	
181	NTsec5	20-Sep-22	11:38	60	38.627	47	15.677	608	Salts, Nutrients, d18O	
182	NTsec5	20-Sep-22	12:54	60	41.052	47	10.569	610	Salts	
183	NTsec5	20-Sep-22	14:08	60	42.946	47	4.722	674	Salts, Nutrients, d18O	
184	NTsec5	20-Sep-22	16:19	60	47.351	46	48.367	669	Salts, Nutrients, d18O	In Ikersuaq fjord. PAR sensor on
185	LSsec4	20-Sep-22	19:50	60	43.677	47	32.908	120	Salts, Nutrients, d18O	PAR sensor on
186	LSsec4	20-Sep-22	20:40	60	41.051	47	34.479	119	Salts	PAR sensor on
187	LSsec4	20-Sep-22	21:23	60	38.407	47	35.994	110	Salts, Nutrients, d18O	PAR sensor on
188	LSsec4	20-Sep-22	22:06	60	35.718	47	37.601	166	Salts	PAR sensor on
189	LSsec4	20-Sep-22	22:52	60	33.281	47	38.925	126		
190	LSsec4	20-Sep-22	23:37	60	30.684	47	40.366	143	Salts, Nutrients, d18O	High winds
191	LSsec4	21-Sep-22	0:39	60	28.099	47	41.797	133		High winds
192	LSsec4	21-Sep-22	1:24	60	25.58	47	43.203	155		High winds
193	LSsec4	21-Sep-22	2:15	60	22.972	47	44.519	146	Salts, Nutrients, d18O	High winds
194	LSsec4	21-Sep-22	3:17	60	20.395	47	45.981	133		High winds
195	LSsec4	21-Sep-22	4:01	60	17.826	47	47.497	193		High winds
196	LSsec4	21-Sep-22	4:51	60	15.18	47	48.957	1217	Salts, Nutrients, d18O	High winds
197	LSsec4	21-Sep-22	6:41	60	12.606	47	50.432	2115	Salts, DO	High winds
198	LSsec4	21-Sep-22	9:12	60	9.913	47	50.542	2574	Salts	High winds
199	LSsec4	21-Sep-22	11:38	60	6.176	47	53.87	2790	Salts, Nutrients, d18O	
200	SW transit north	21-Sep-22	14:35	60	11.438	48	5.471	2600		Celebration cast - stopped at 150 m
201	LSsec5	22-Sep-22	5:03	62	25.253	50	28.603	145	Salts, Nutrients, d18O	
202	LSsec5	22-Sep-22	5:55	62	24.45	50	34.254	315	Salts	
203	LSsec5	22-Sep-22	7:02	62	23.741	50	39.979	206	Salts	
204	LSsec5	22-Sep-22	7:51	62	22.925	50	45.438	543	Salts	
205	LSsec5	22-Sep-22	8:55	62	22.055	50	50.822	510	Salts, Nutrients, d18O, DO	
206	LSsec5	22-Sep-22	10:06	62	21.385	50	56.508	435	Salts	
207	LSsec5	22-Sep-22	11:03	62	20.654	51	2.117	1105	Salts	
208	LSsec5	22-Sep-22	12:26	62	19.978	51	7.668	1318	Salts	
209	LSsec5	22-Sep-22	13:57	62	19.125	51	13.486	1641	Salts, Nutrients, d18O	
210	LSsec5	22-Sep-22	16:05	62	18.272	51	18.913	905	Salts, DO	
211	LSsec5	22-Sep-22	17:22	62	17.375	51	24.416	1765	Salts	
212	LSsec5	22-Sep-22	19:10	62	16.709	51	29.912	2230	Salts	Niskin 7 misfired. High winds
213	LSsec5	22-Sep-22	2120	62	16.033	51	35.455	2395	Salts, Nutrients, d18O	High winds
214	LSsec5	23-Sep-22	0:21	62	15.288	51	40.901	2430	Salts	High winds



Note A
Clamp RBR Virtuoso Below
100 meter Microcat

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	1467
MicroCat	16859
XEOS Kilo	300234066253190
Aqua Dopp	15635

Hardware Required
(per mooring without spares)

(4)	3/8" Anchor Shackle
(2)	1/2" Anchor Shackle
(1)	250 lb Weak Link
(1)	350 lb Weak Link

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W1	250 lb Weak Link
W2	350 lb Weak Link

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Straneo OSNAP Tripod Mooring CF-1
As Deployed 2020

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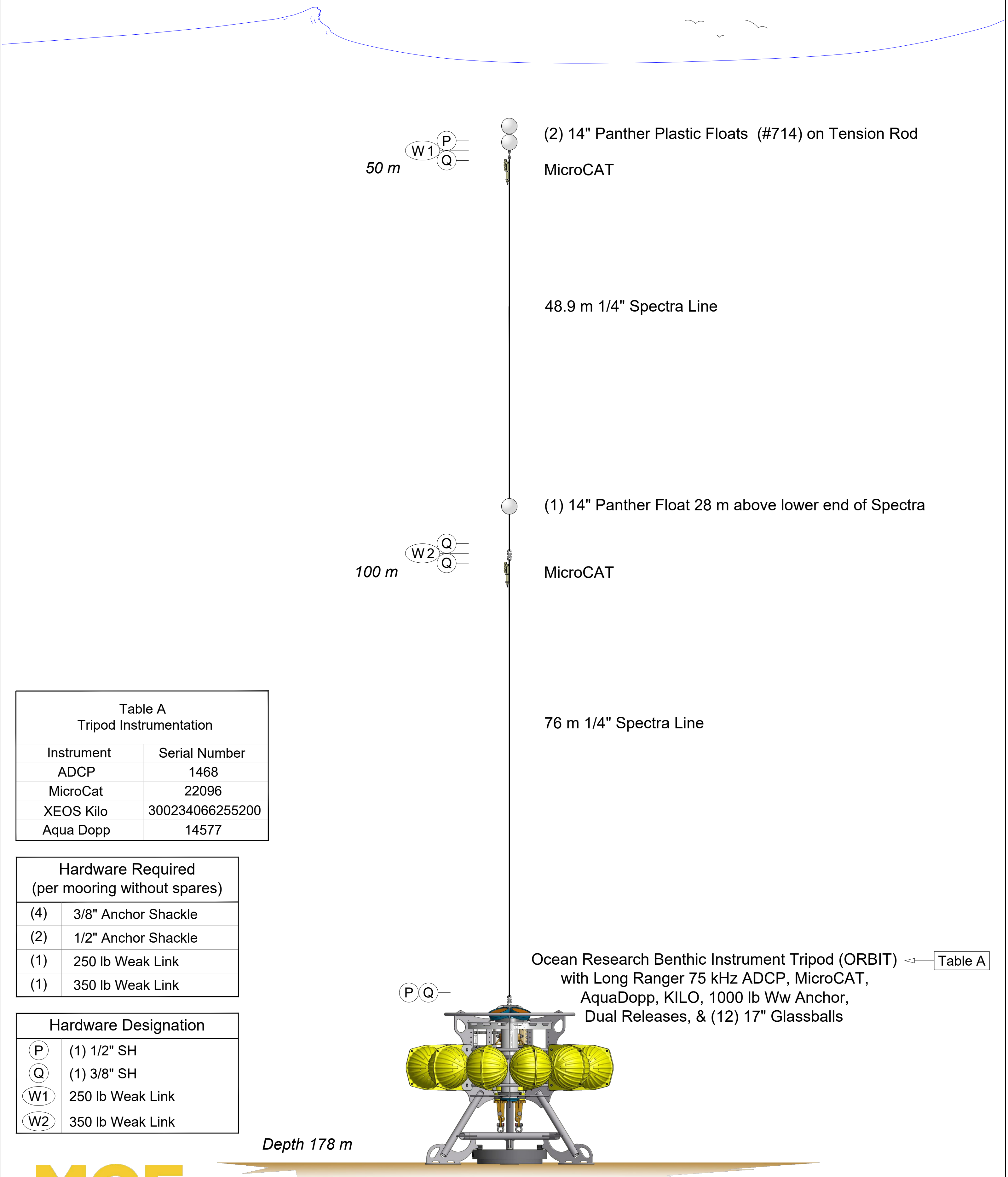

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	1468
MicroCat	22096
XEOS Kilo	300234066255200
Aqua Dopp	14577

Hardware Required
(per mooring without spares)

(4)	3/8" Anchor Shackle
(2)	1/2" Anchor Shackle
(1)	250 lb Weak Link
(1)	350 lb Weak Link

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W1	250 lb Weak Link
W2	350 lb Weak Link

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Straneo OSNAP Tripod Mooring CF-2
As Deployed 2020

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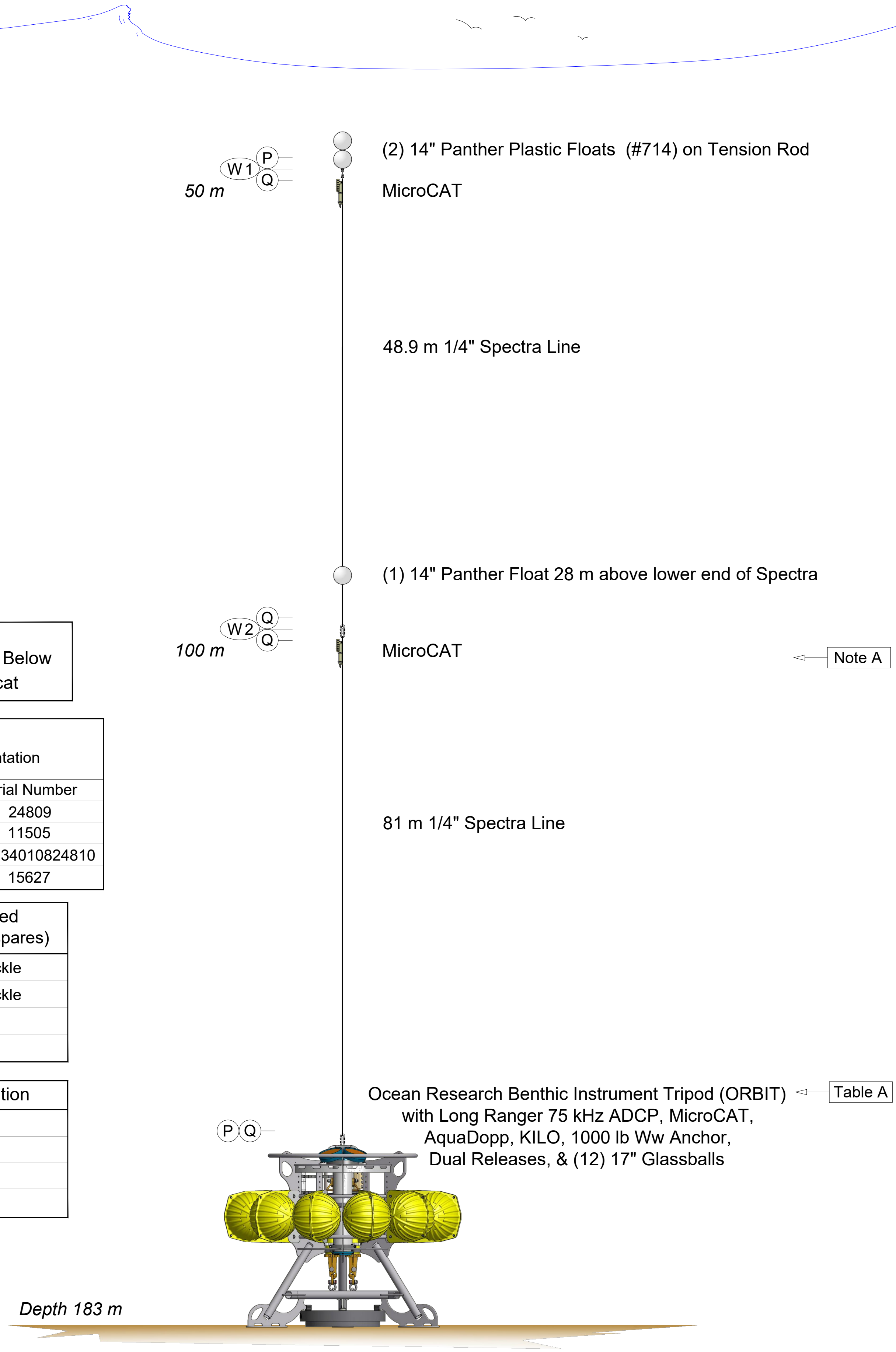

Note A
Clamp RBR Virtuoso Below
100 meter Microcat

Table A Tripod Instrumentation	
Instrument	Serial Number
ADCP	24809
MicroCat	11505
XEOS Kilo	300234010824810
Aqua Dopp	15627

Hardware Required (per mooring without spares)	
(4)	3/8" Anchor Shackle
(2)	1/2" Anchor Shackle
(1)	250 lb Weak Link
(1)	350 lb Weak Link

Hardware Designation	
P	(1) 1/2" SH
Q	(1) 3/8" SH
W1	250 lb Weak Link
W2	350 lb Weak Link

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Straneo OSNAP Tripod Mooring CF-3
As Deployed 2020

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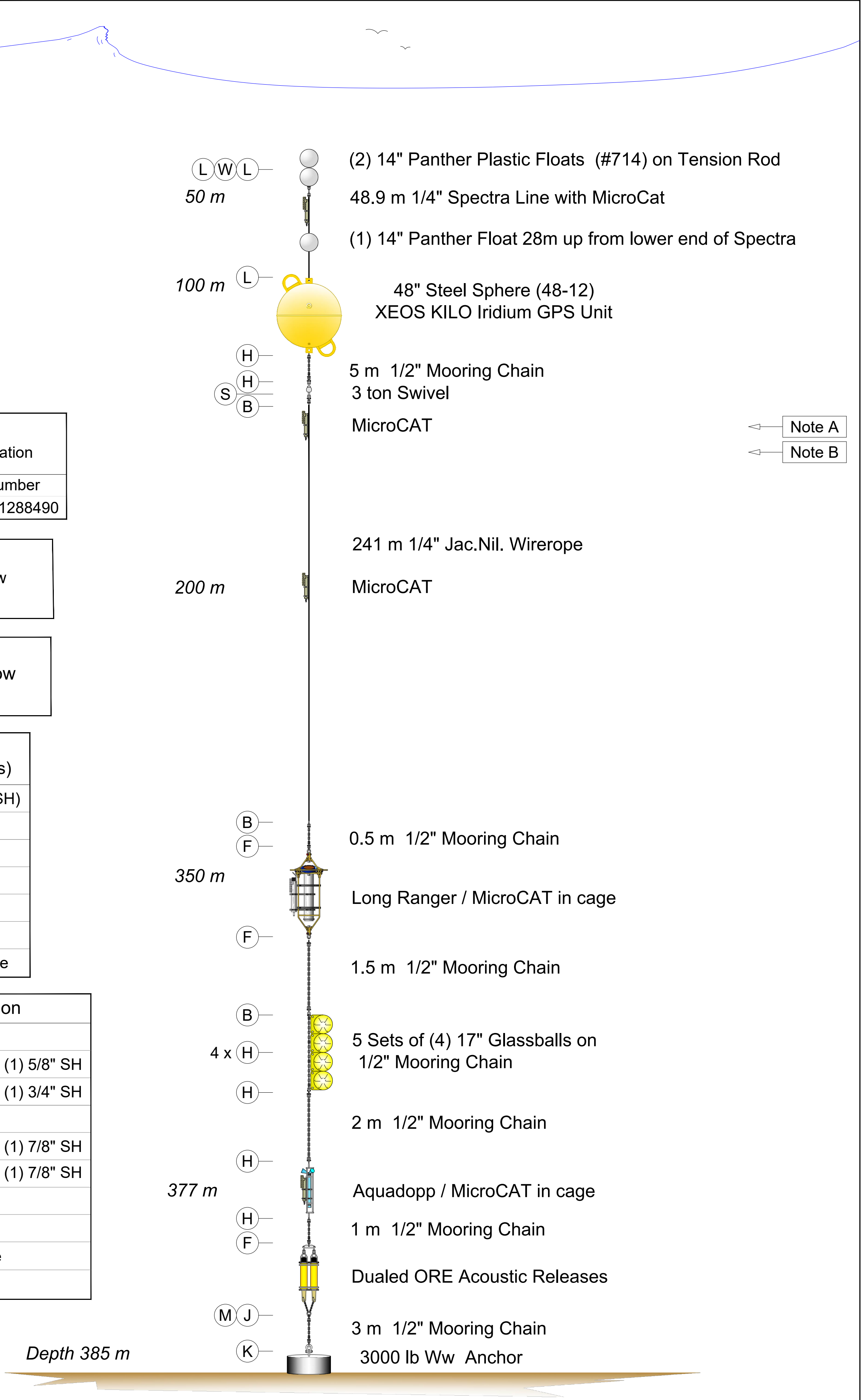

Table A 48 inch Sphere Instrumentation	
Instrument	Serial Number
XEOS Kilo	300234011288490

Note A
Clamp MicroCat 1 m Below
Upper Termination

Note B
Clamp RBR Virtuoso Below
100 meter MicroCat

Hardware Required (per mooring without spares)	
(6)	1/2" Anchor Shackle (SH)
(27)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(18)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
L	(1) 1/2" SH
S	3 ton Swivel with Anode
W	350 lb Weak Link

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Straneo OSNAP Mooring CF-4
As Deployed 2020

Woods Hole Oceanographic Institution	
designed by John Kemp, drawn by Jim Ryder	
file: OSNAP Straneo 2020	date: 01/04/2022

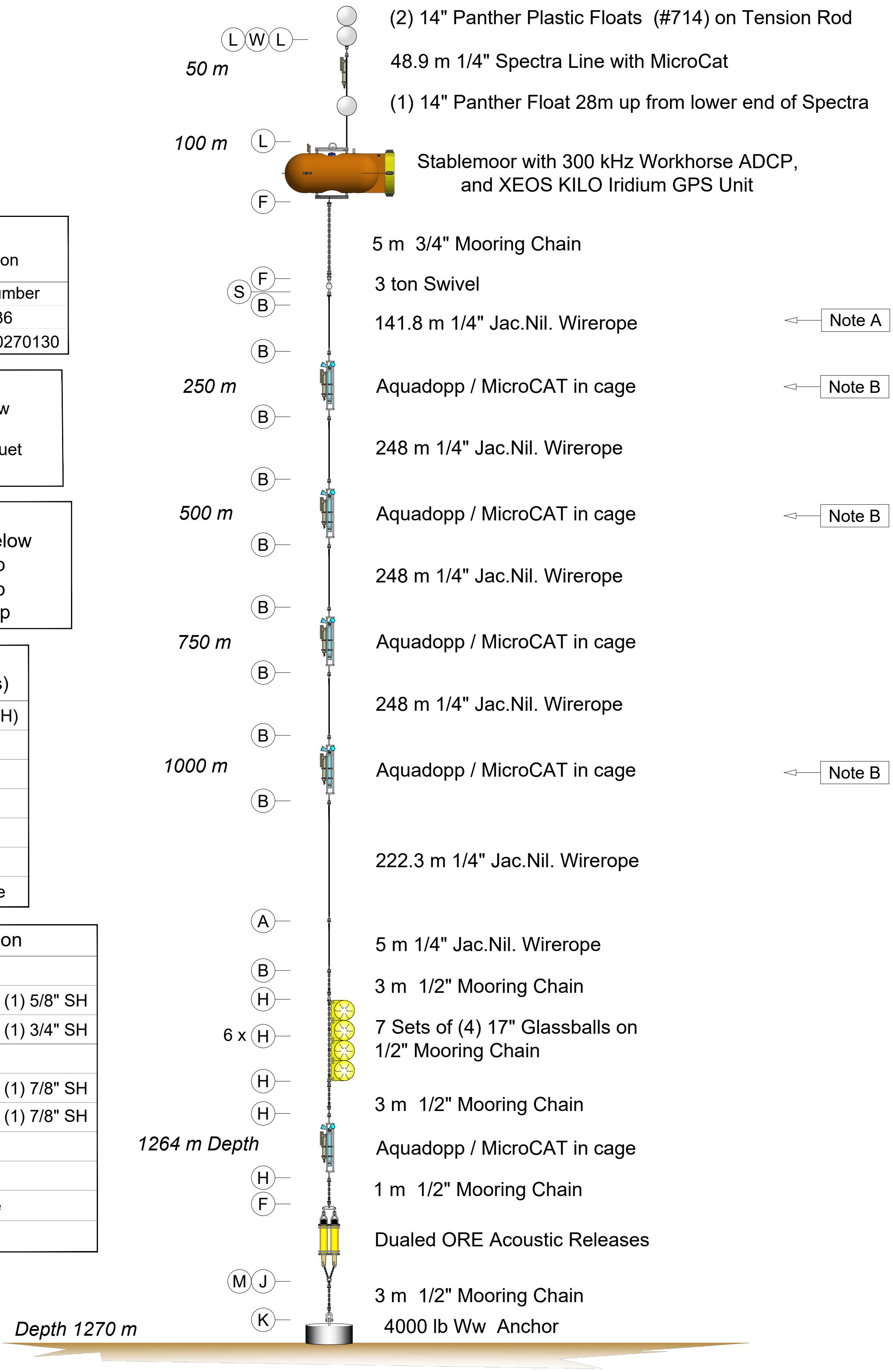
Table A Stablemoor Instrumentation	
Instrument	Serial Number
ADCP	20636
XEOS Kilo	300234060270130

Note A
Clamp MicroCat 1 m Below
Upper Termination
Clamp RBR Virtuoso and Duet
Below MicroCat

Note B
Clamp RBR Virtuoso Below
250 meter Aquadopp
500 meter Aquadopp
1000 meter Aquadopp

Hardware Required (per mooring without spares)	
(15)	1/2" Anchor Shackle (SH)
(36)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(27)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
L	(1) 1/2" SH
S	3 ton Swivel with Anode
W	350 lb Weak Link



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Straneo OSNAP Mooring CF-5
AS Deployed 2020

Woods Hole Oceanographic Institution	
designed by John Kemp, drawn by Jim Ryder	
file: OSNAP Straneo 2020	date: 01/04/2022

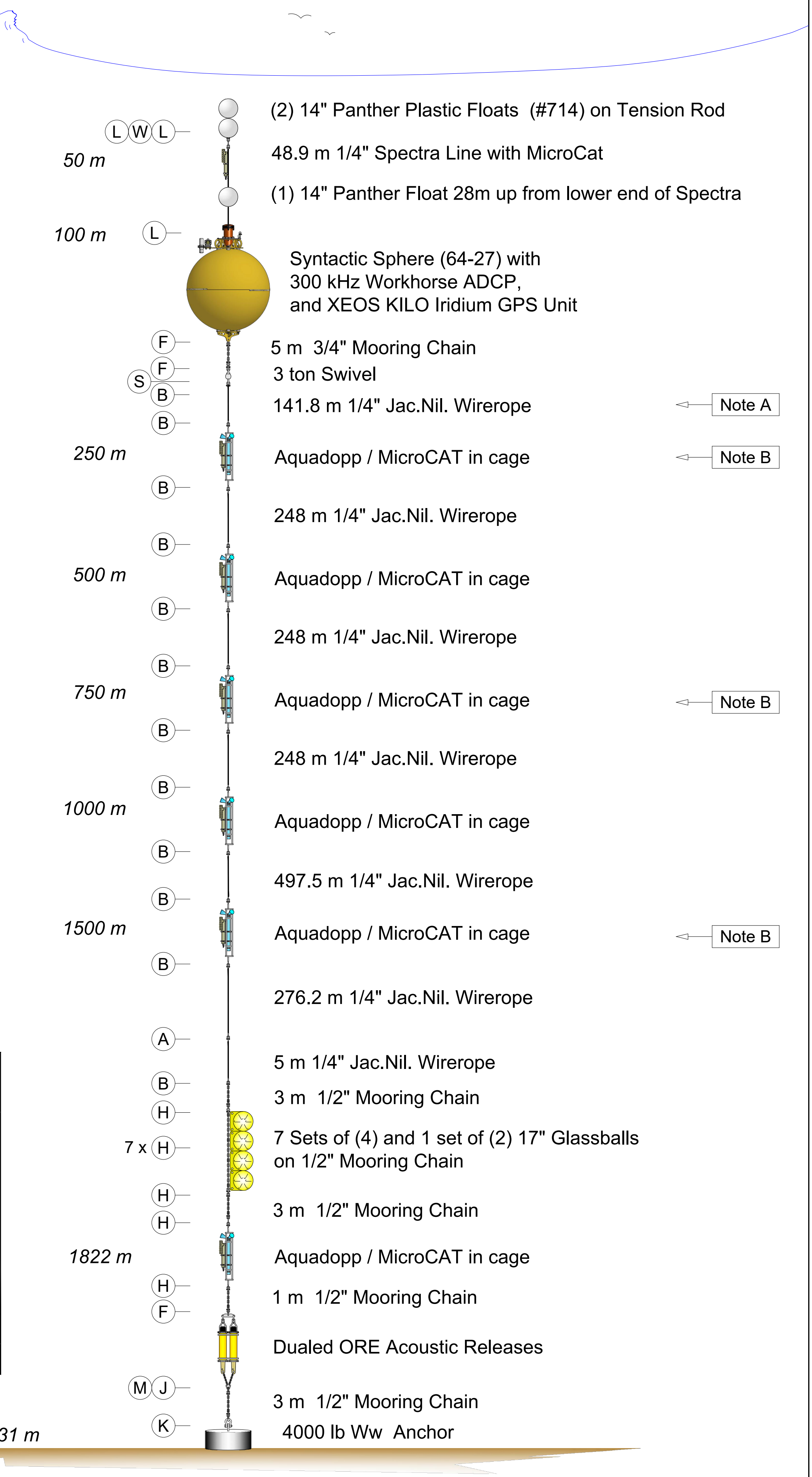

Table A 64 inch Sphere Instrumentation	
Instrument	Serial Number
ADCP	15448
XEOS Kilo	300234010825820

Note A
Clamp MicroCat 1 m Below
Upper Termination
Clamp RBR Virtuoso and Duet
Below MicroCat

Note B
Clamp RBR Virtuoso Below
250 meter Aquadopp
750 meter Aquadopp
1500 meter Aquadopp

Hardware Required (per mooring without spares)	
(17)	1/2" Anchor Shackle (SH)
(41)	5/8" Anchor Shackle
(2)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(30)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
L	(1) 1/2" SH
S	3 ton Swivel with Anode
W	350 lb Weak Link

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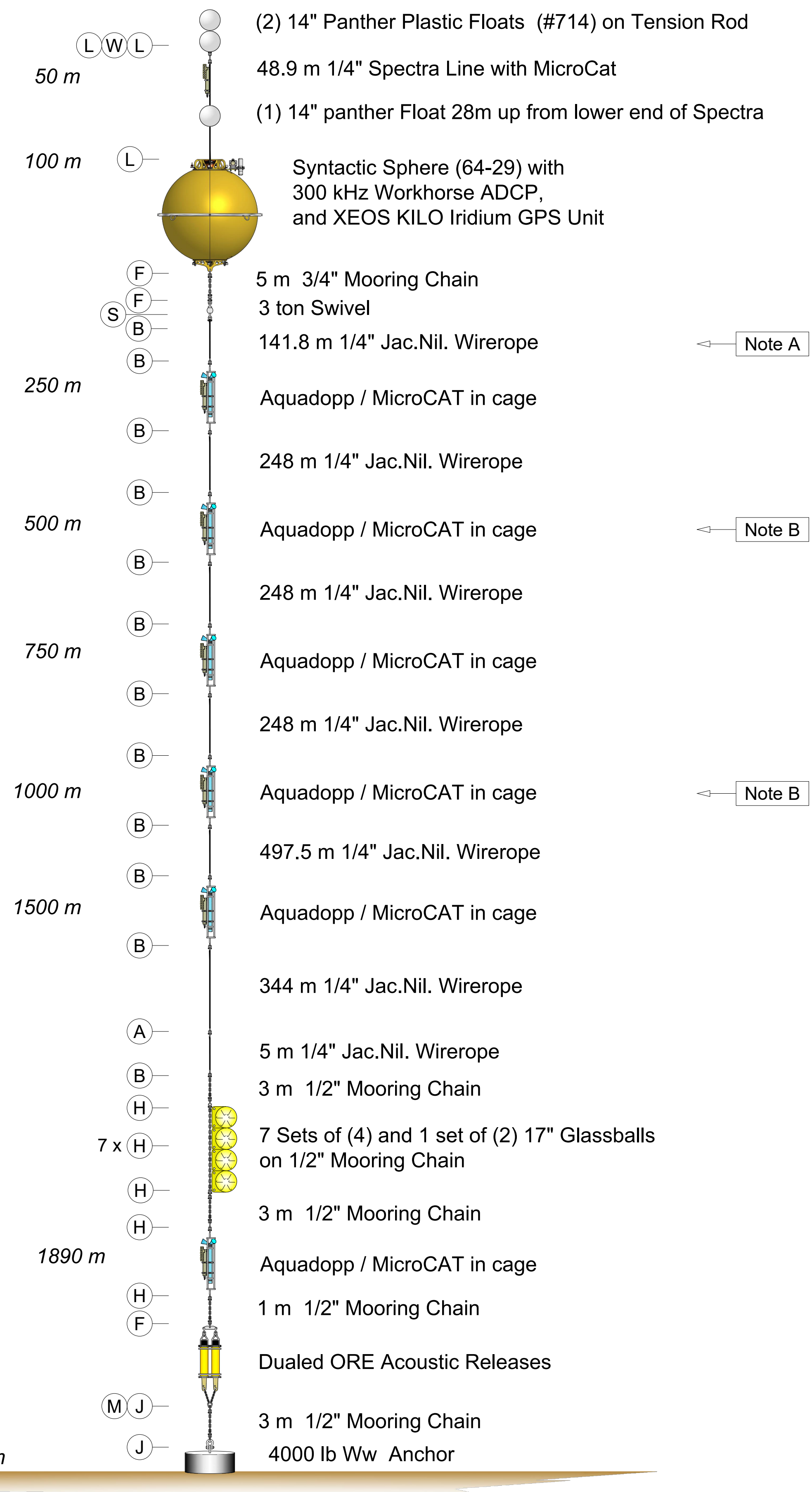
Straneo OSNAP Mooring CF-6
As Deployed 2020

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder
file: OSNAP Straneo 2020 | date: 01/04/2022



Depth 1899 m

Table A 64 inch Sphere Instrumentation	
Instrument	Serial Number
ADCP	21230
XEOS Kilo	300234066257210

Note A
Clamp MicroCat 1 m Below
Upper Termination
Clamp RBR Virtuoso and Duet
Below MicroCat

Note B
Clamp RBR Virtuoso Below
500 meter Aquadopp
1000 meter Aquadopp

Hardware Required (per mooring without spares)	
(17)	1/2" Anchor Shackle (SH)
(41)	5/8" Anchor Shackle
(2)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(30)	5/8" Sling Link (SL)
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
L	(1) 1/2" SH
S	3 ton Swivel with Anode
W	350 lb Weak Link

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Straneo OSNAP Mooring CF-7
As Deployed 2020

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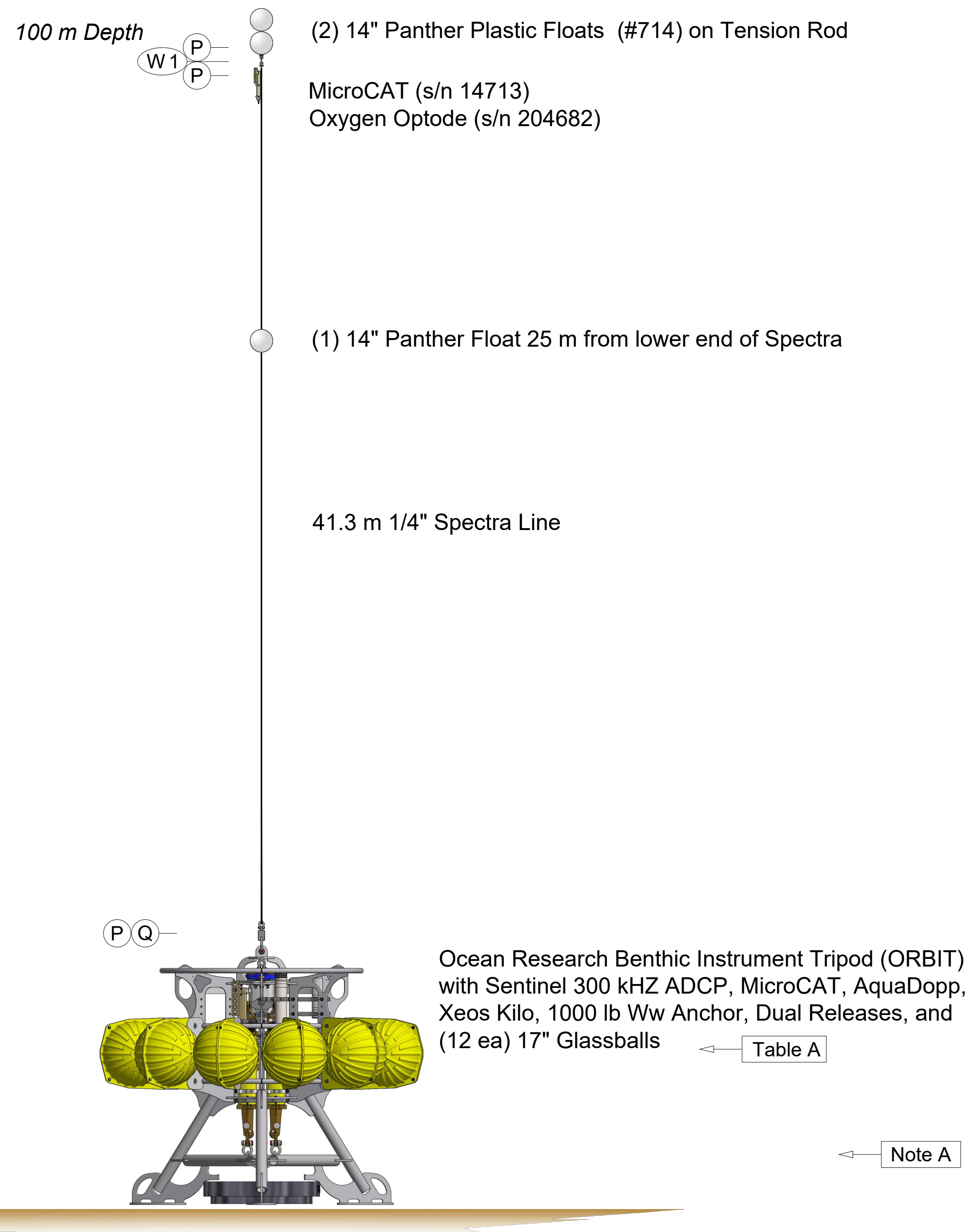
designed by John Kemp, drawn by Jim Ryder	
file: OSNAP Straneo 2020	date: 01/04/2022



Note A
Dualing Chain has 5 Links
1/2" Trawler Chain

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	17123
MicroCat	14619
Aqua Dopp	12440
XEOS Kilo	300234068729110

Hardware Required
(per mooring without spares)

(1)	3/8" Anchor Shackle
(3)	1/2" Anchor Shackle
(1)	250 lb Weak Link

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W 1	250 lb Weak Link

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Pickart OSNAP Mooring LS-1
As Deployed 2020

Woods Hole Oceanographic Institution
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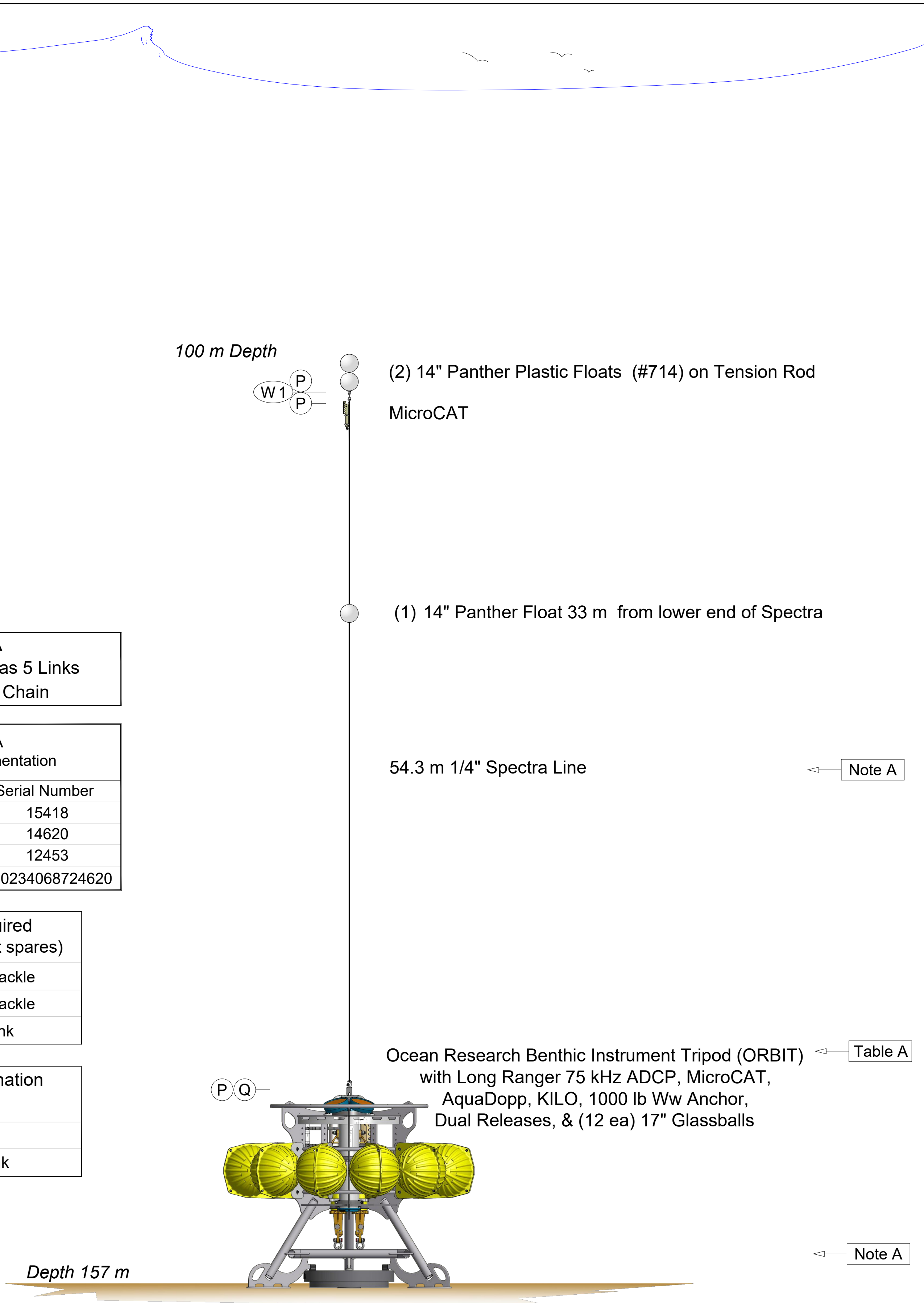
file: OSNAP Pickart 2020 | date: 01/04/2022



Note A
Dualing Chain has 5 Links
1/2" Trawler Chain

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	15418
MicroCat	14620
Aqua Dopp	12453
XEOS Kilo	300234068724620

Hardware Required
(per mooring without spares)

(1)	3/8" Anchor Shackle
(3)	1/2" Anchor Shackle
(1)	250 lb Weak Link

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W 1	250 lb Weak Link

Pickart OSNAP Mooring LS-2
As Deployed 2020

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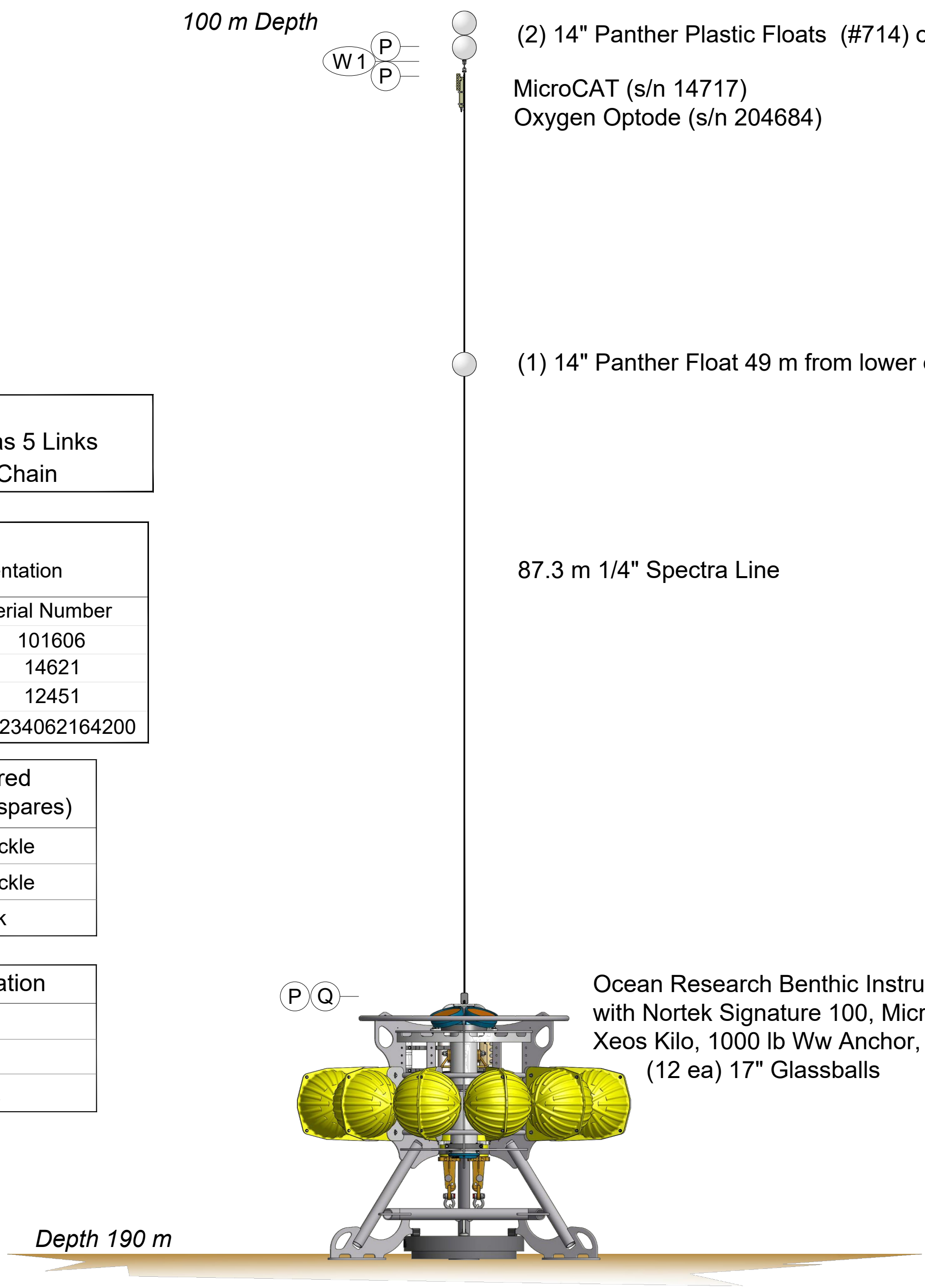
file: OSNAP Pickart 2020 | date: 01/04/2022



Note A
Dualing Chain has 5 Links
1/2" Trawler Chain

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	101606
MicroCat	14621
Aqua Dopp	12451
XEOS Kilo	300234062164200

Hardware Required
(per mooring without spares)

(1)	3/8" Anchor Shackle
(3)	1/2" Anchor Shackle
(1)	250 lb Weak Link

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W 1	250 lb Weak Link

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Pickart OSNAP Mooring LS-3
As Deployed 2020

Woods Hole Oceanographic Institution	
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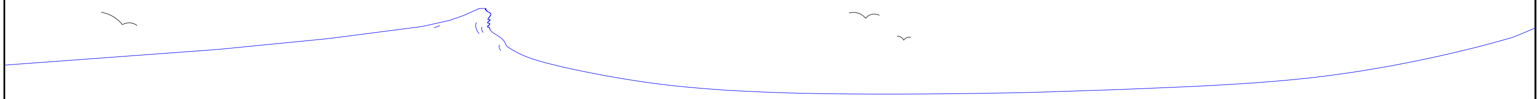
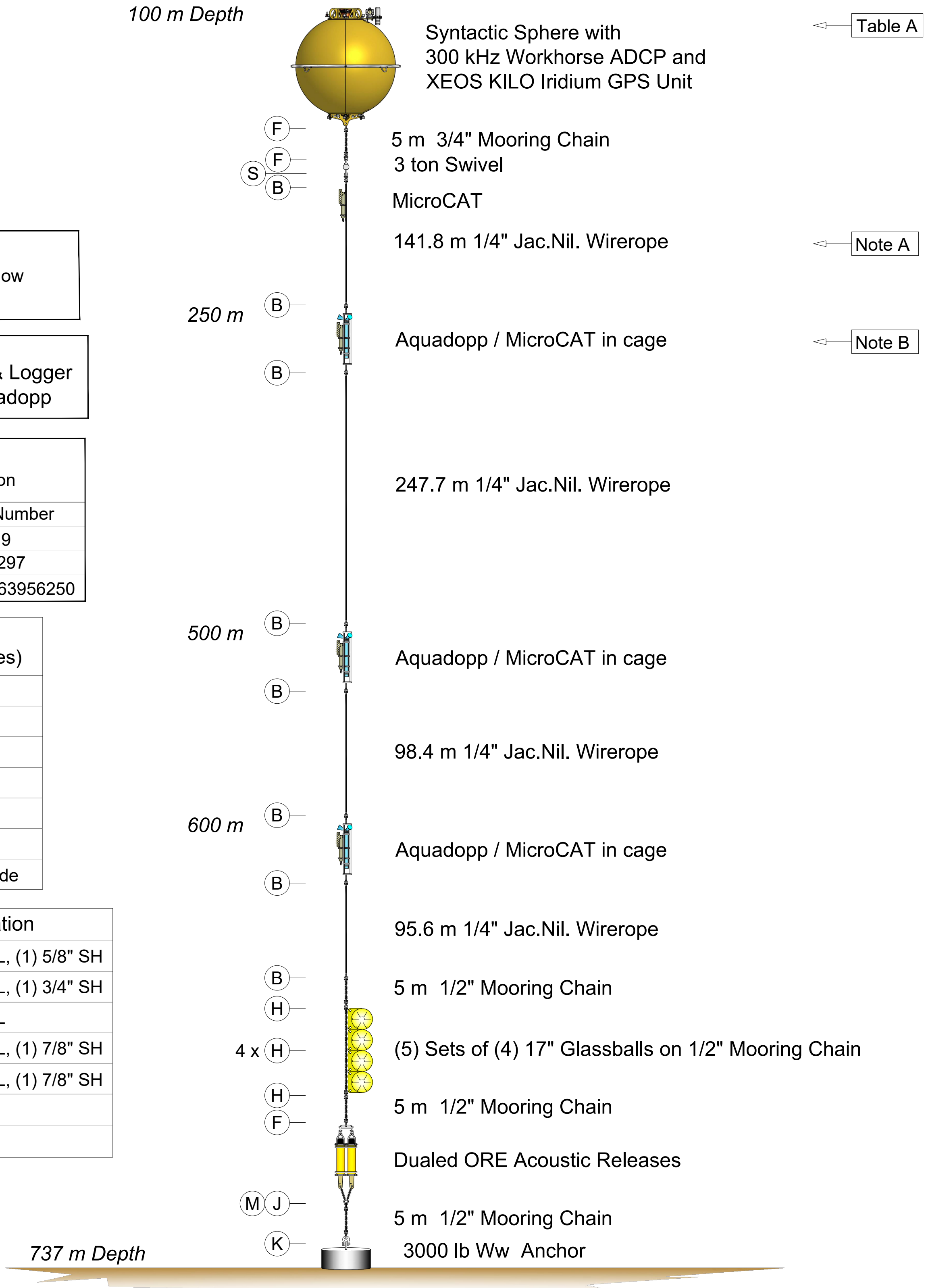
file: OSNAP Pickart 2020	date: 01/04/2022





Note A
Clamp MicroCat 1 m Below
Upper Termination

Note B
Clamp Oxygen Optode & Logger
Below 250 meter Aquadopp

Table A Sphere Instrumentation	
Instrument	Serial Number
64" Sphere	19
ADCP	14297
XEOS Kilo	300234063956250

Hardware Required (per mooring without spares)	
(8)	1/2" Anchor Shackle
(26)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(20)	5/8" Sling Link
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	Master Link
S	Swivel

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Pickart OSNAP Mooring LS-4
As Deployed 2020

Woods Hole Oceanographic Institution
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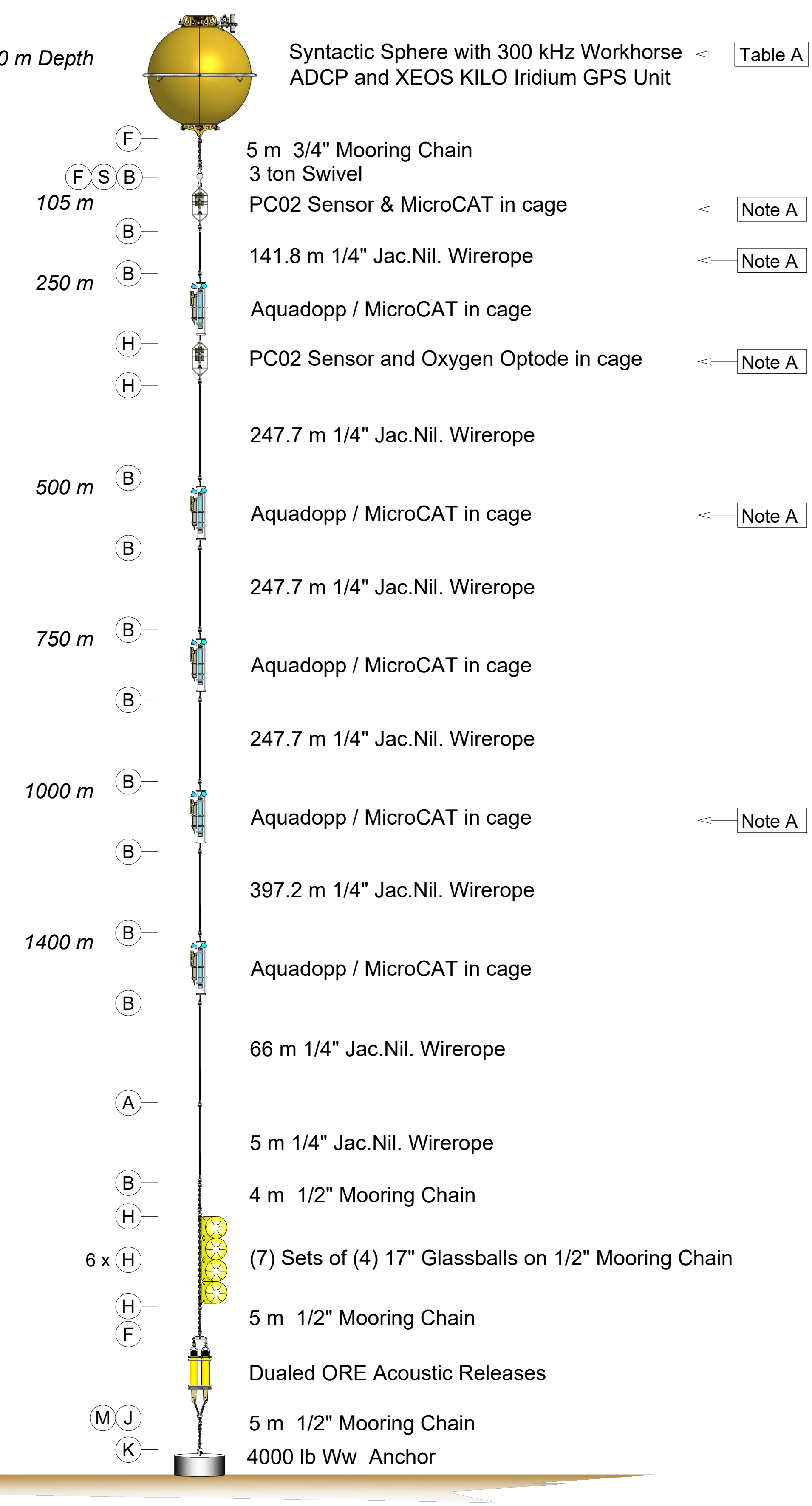
file: OSNAP Pickart 2020 | date: 01/04/2022



1501 m Depth

Note A
Clamp Oxygen Optode & Logger Below
105 meter PCO2 Cage (w/ RBR)
250 meter Aquadopp (w/ RBR)
500 meter Aquadopp
1000 meter Aquadopp

Table A
Sphere Instrumentation

Instrument	Serial Number
64" Sphere	16
ADCP	14445
XEOS Kilo	300234063169510

Hardware Required
(per mooring without spares)

(13)	1/2" Anchor Shackle
(39)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(29)	5/8" Sling Link
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
S	3 ton Swivel with Anode

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Pickart OSNAP Mooring LS-5
As Deployed 2020

Woods Hole Oceanographic Institution
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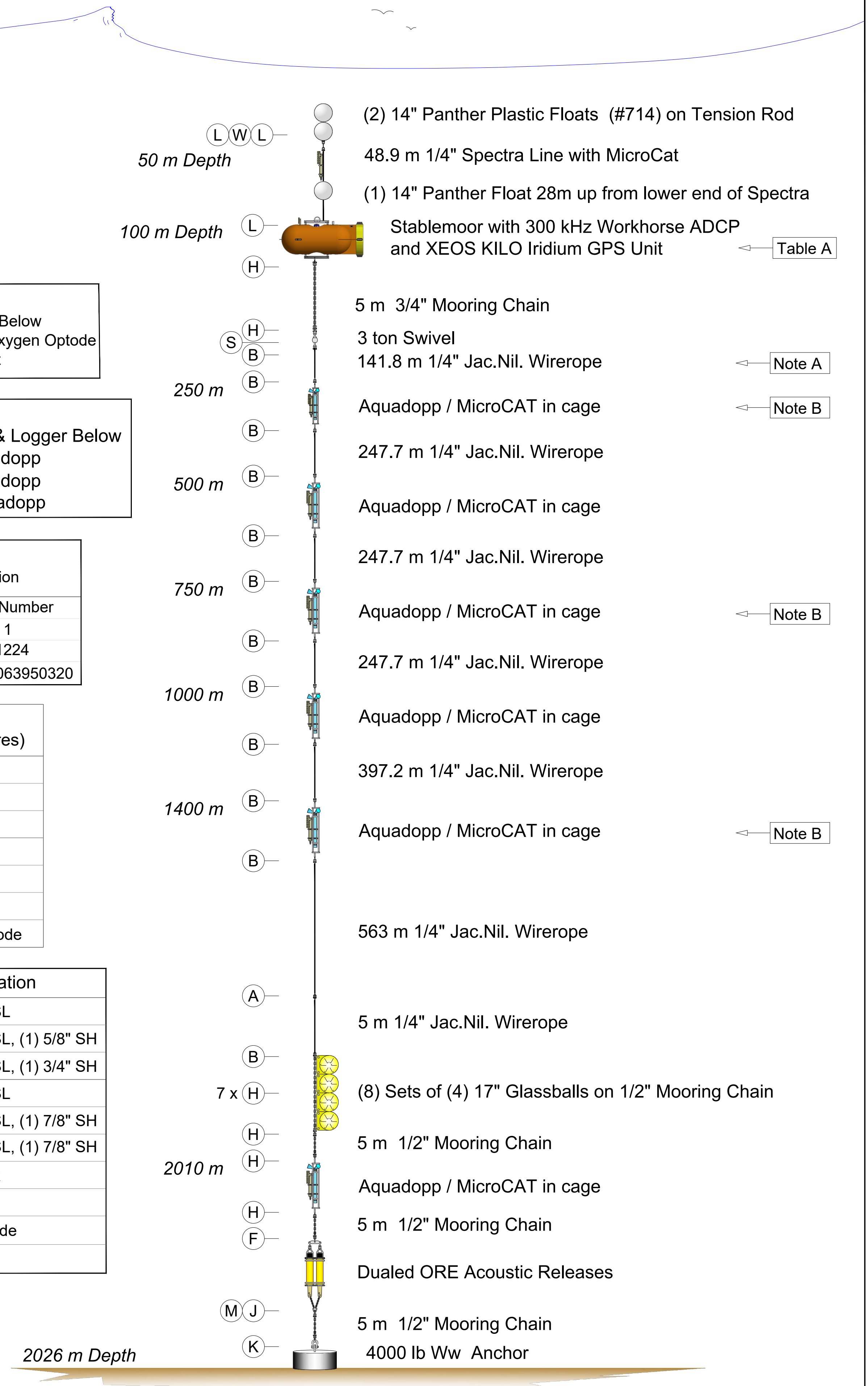
file: OSNAP Pickart 2020 | date: 01/04/2022



Note A
Clamp MicroCat 1 m Below Upper Termination. Clamp Oxygen Optode Below MicroCat

Note B
Clamp Oxygen Optode & Logger Below
250 meter Aquadopp
750 meter Aquadopp
1400 meter Aquadopp

Table A
Sphere Instrumentation

Instrument	Serial Number
Stablemoor	1
ADCP	21224
XEOS Kilo	300234063950320

Hardware Required
(per mooring without spares)

(17)	1/2" Anchor Shackle
(40)	5/8" Anchor Shackle
(1)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(29)	5/8" Sling Link
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
L	(1) 1/2" SH
S	3 ton Swivel with Anode
W	350 lb Weak Link

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Pickart OSNAP Mooring LS-6
As Deployed 2020

Woods Hole Oceanographic Institution	
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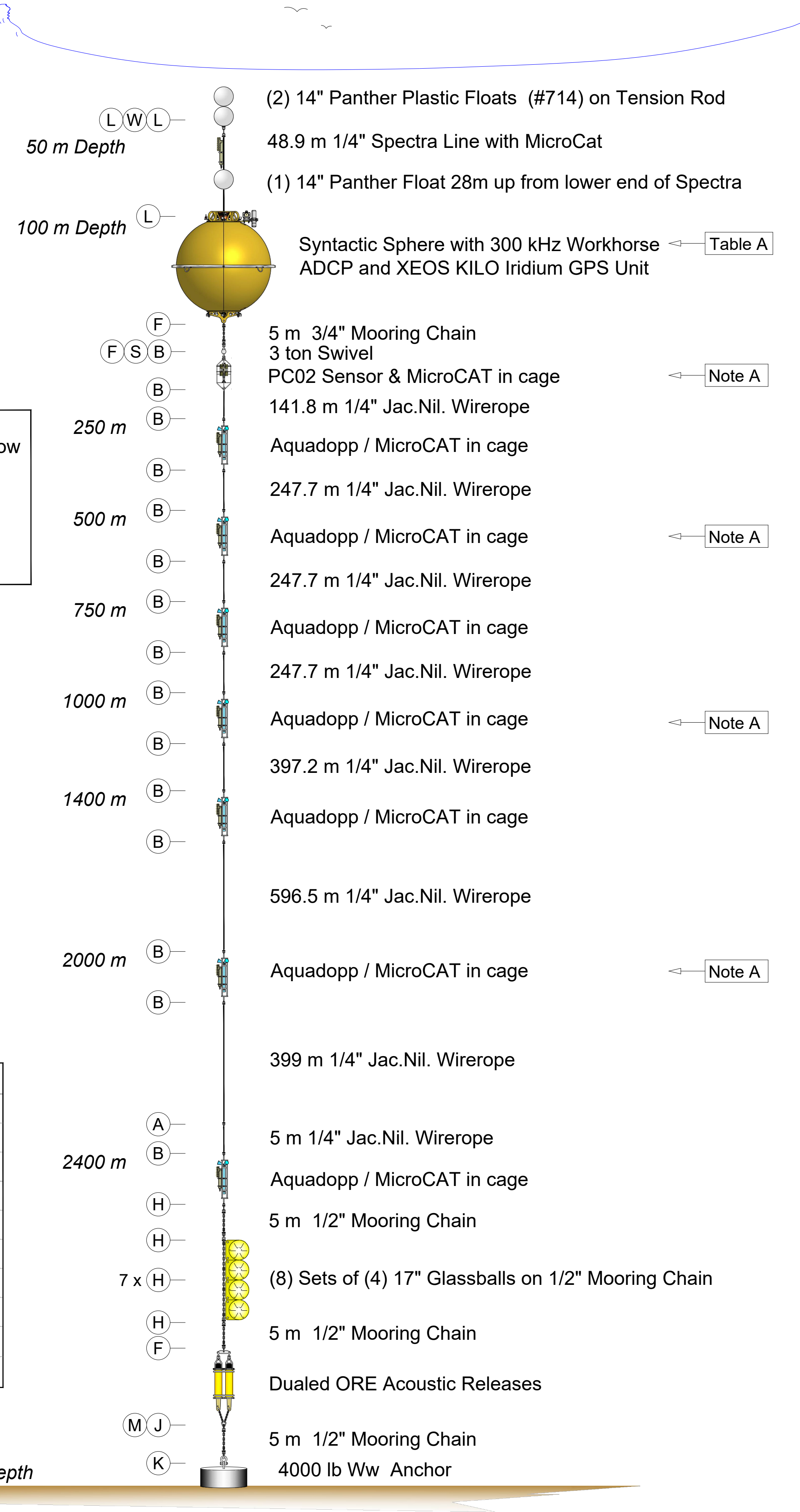
file: OSNAP Pickart 2020	date: 01/04/2022



2462 m Depth

Note A
Clamp Oxygen Optode & Logger Below
PCO2 Cage
141.8 m 1/4" Wirerope
500 meter Aquadopp
1000 meter Aquadopp
2000 meter Aquadopp

Table A Sphere Instrumentation	
Instrument	Serial Number
64" Sphere	17
ADCP	15356
XEOS Kilo	300234062167190

Hardware Required (per mooring without spares)	
(20)	1/2" Anchor Shackle
(41)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(32)	5/8" Sling Link
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation	
A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
L	(1) 1/2" SH
S	3 ton Swivel with Anode
W	350 lb Weak Link

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Pickart OSNAP Mooring LS-7
As Deployed 2020

Woods Hole Oceanographic Institution	
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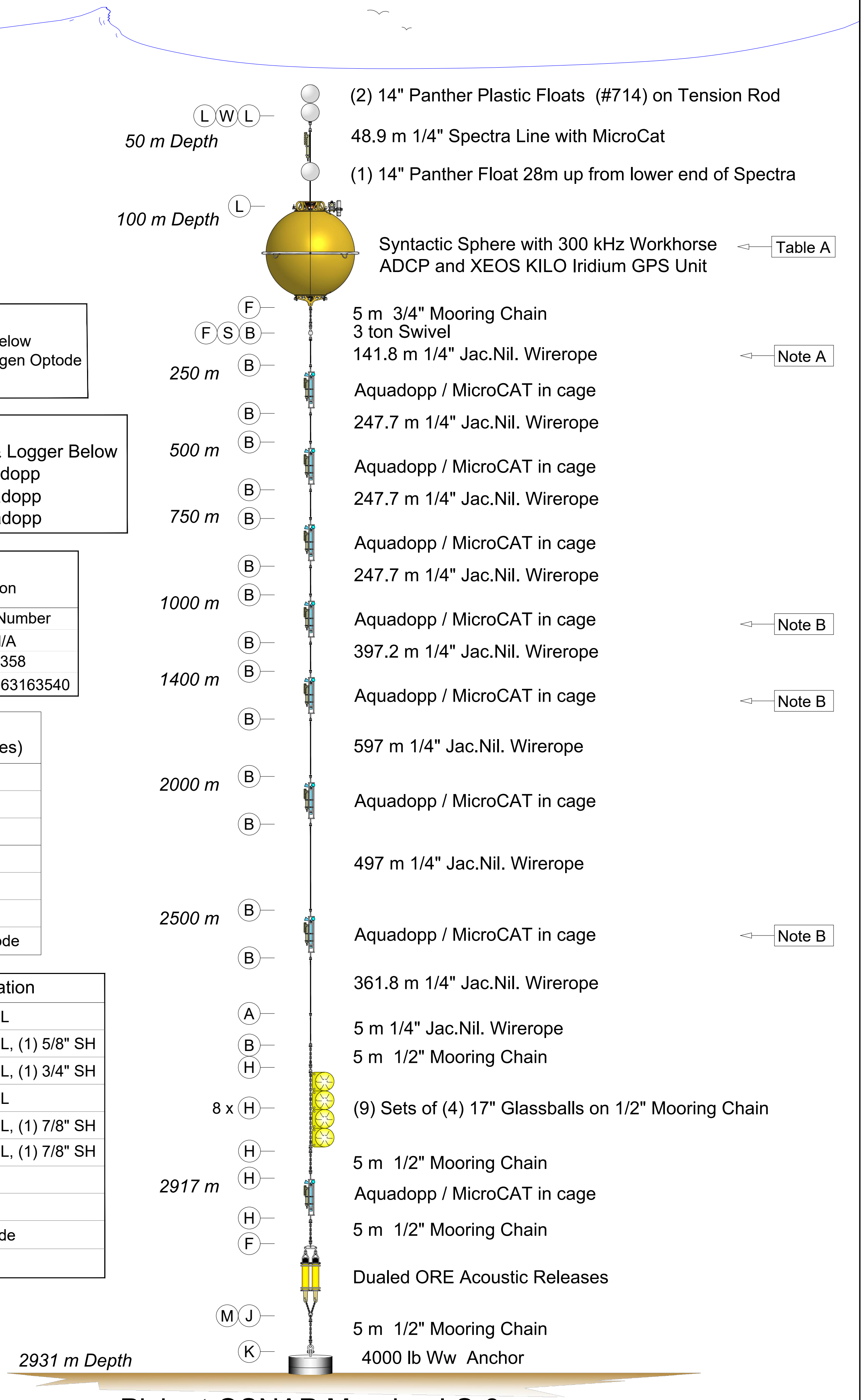
file: OSNAP Pickart 2020	date: 01/04/2022



Note A
Clamp MicroCat 1 m Below Upper Termination. Clamp Oygen Optode Below MicroCat

Note B
Clamp Oxygen Optode & Logger Below
1000 meter Aquadopp
1400 meter Aquadopp
2500 meter Aquadopp

Table A
Sphere Instrumentation

Instrument	Serial Number
64" Sphere	N/A
ADCP	15358
XEOS Kilo	300234063163540

Hardware Required
(per mooring without spares)

(21)	1/2" Anchor Shackle
(46)	5/8" Anchor Shackle
(3)	3/4" Anchor Shackle
(2)	7/8" Anchor Shackle
(35)	5/8" Sling Link
(1)	1-1/4" Master Link
(1)	3 ton Swivel with Anode

Hardware Designation

A	(2) 1/2" SH, (1) 5/8" SL
B	(1) 1/2" SH, (1) 5/8" SL, (1) 5/8" SH
F	(1) 5/8" SH, (1) 5/8" SL, (1) 3/4" SH
H	(2) 5/8" SH, (1) 5/8" SL
J	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
K	(2) 5/8" SH, (2) 5/8" SL, (1) 7/8" SH
M	(1) 1-1/4" Master Link
L	(1) 1/2" SH
S	3 ton Swivel with Anode
W	350 lb Weak Link

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Pickart OSNAP Mooring LS-8
As Deployed 2020

Woods Hole Oceanographic Institution	
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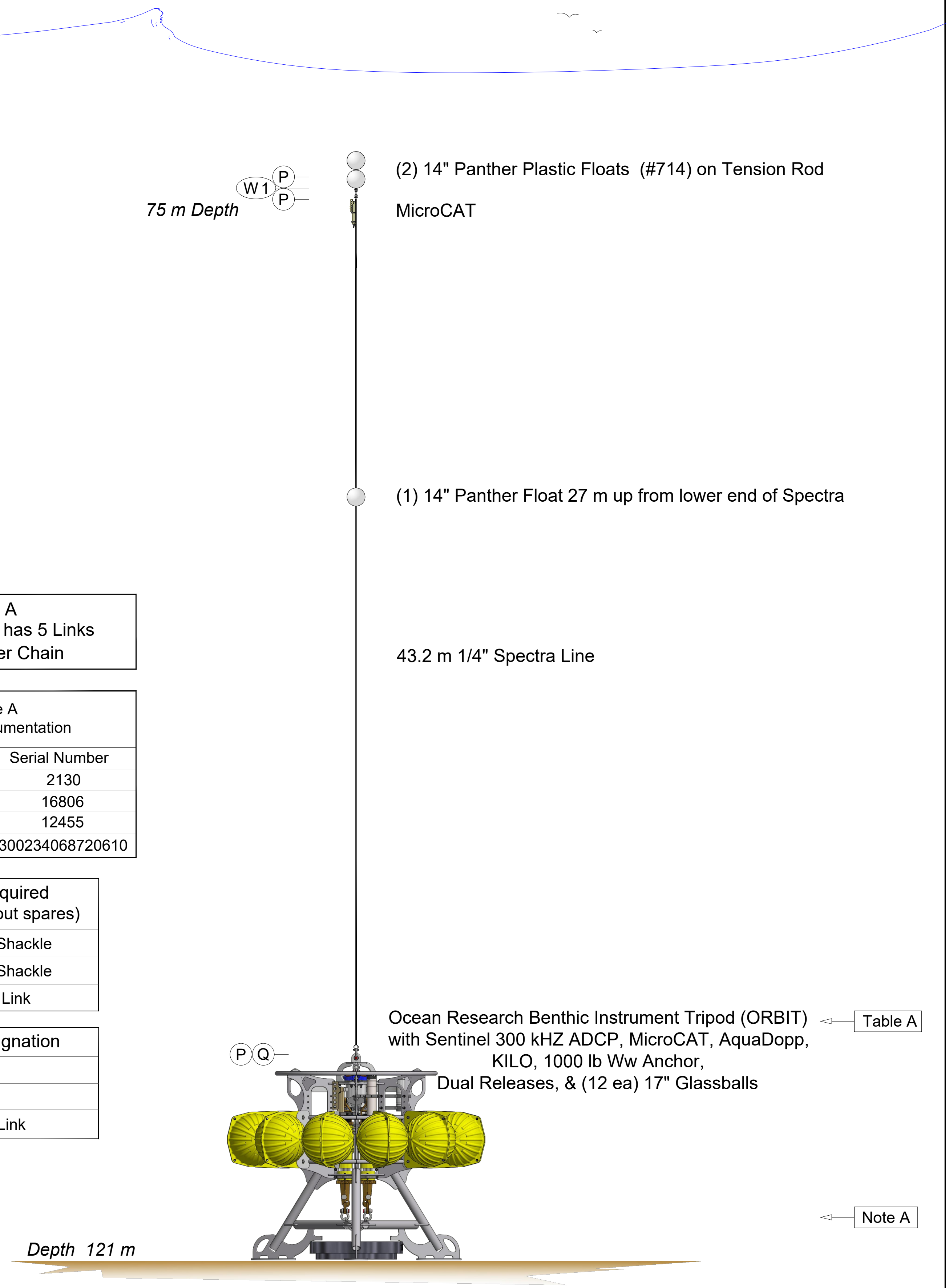
file: OSNAP Pickart 2020	date: 01/04/2022



Note A
Dualing Chain has 5 Links
1/2" Trawler Chain

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	2130
MicroCat	16806
Aqua Dopp	12455
XEOS Kilo	300234068720610

Hardware Required
(per mooring without spares)

(1)	3/8" Anchor Shackle
(3)	1/2" Anchor Shackle
(1)	250 lb Weak Link

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W 1	250 lb Weak Link

Pickart OSNAP Mooring LS-A
As Deployed 2020

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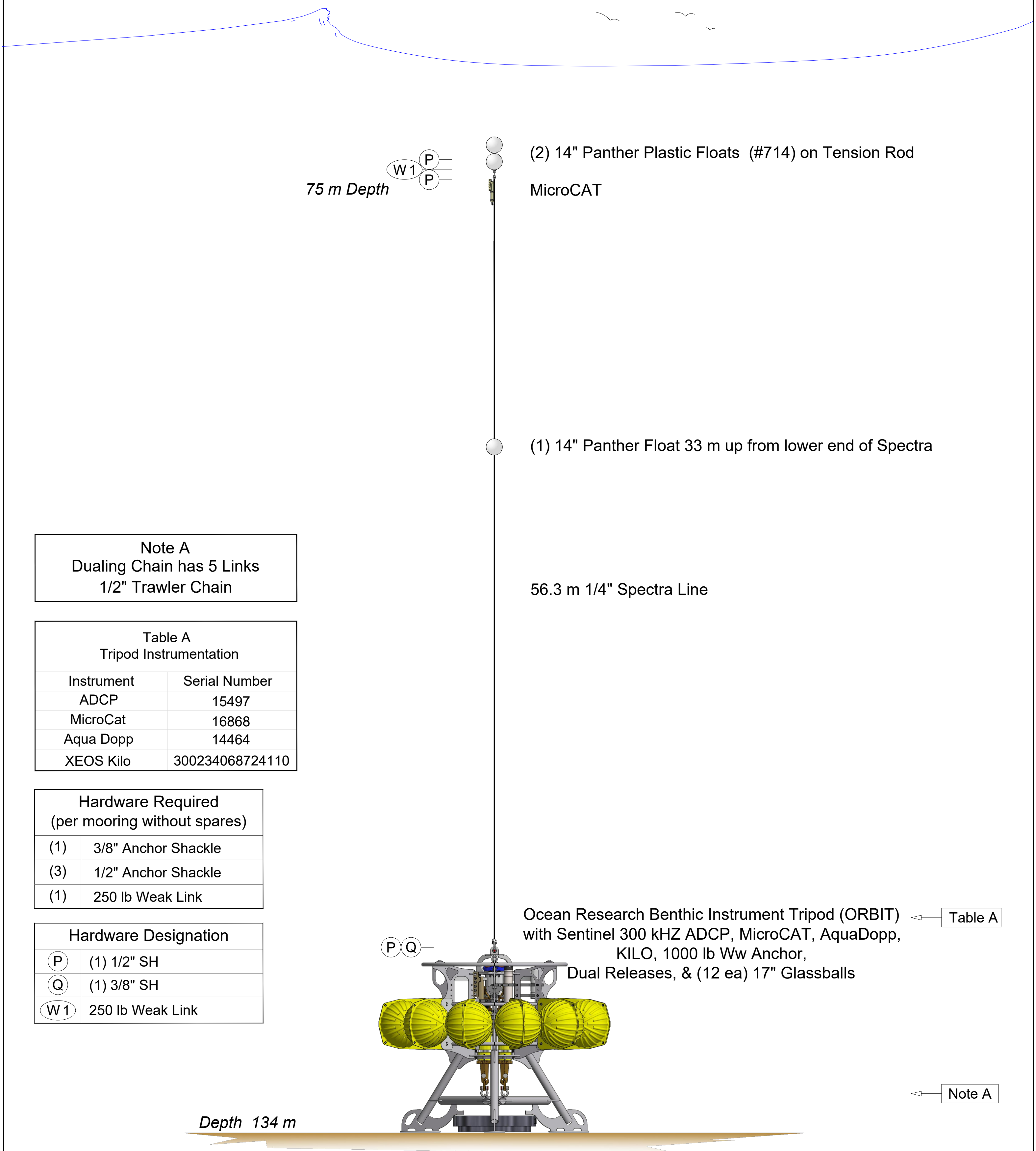
file: OSNAP Pickart 2020 | date: 01/04/2022



Note A
Dualing Chain has 5 Links
1/2" Trawler Chain

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	15497
MicroCat	16868
Aqua Dopp	14464
XEOS Kilo	300234068724110

Hardware Required
(per mooring without spares)

(1)	3/8" Anchor Shackle
(3)	1/2" Anchor Shackle
(1)	250 lb Weak Link

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W 1	250 lb Weak Link

Pickart OSNAP Mooring LS-B
As Deployed 2020

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designed by John Kemp, drawn by Jim Ryder
file: OSNAP Pickart 2020 | date: 01/04/2022

Note A
Dualing Chain has 5 Links
1/2" Trawler Chain

Table A
Tripod Instrumentation

Instrument	Serial Number
ADCP	2225
MicroCat	7584
Aqua Dopp	14460
XEOS Kilo	300234060374100

Hardware Required
(per mooring without spares)

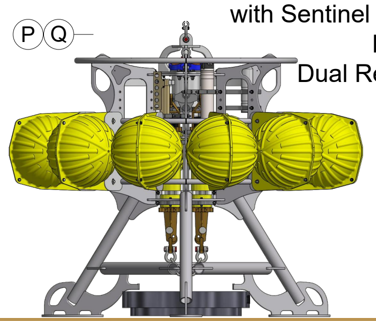
(1)	3/8" Anchor Shackle
(3)	1/2" Anchor Shackle

Hardware Designation

P	(1) 1/2" SH
Q	(1) 3/8" SH
W 1	250 lb Weak Link

Ocean Research Benthic Instrument Tripod (ORBIT)
with Sentinel 300 kHZ ADCP, MicroCAT, AquaDopp,
KILO, 1000 lb Ww Anchor,
Dual Releases, & (12 ea) 17" Glassballs

Table A



Note A

Depth 129 m

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Pickart OSNAP Mooring LS-I(nshore)
As Deployed 2020

Woods Hole Oceanographic Institution
designed by John Kemp, drawn by Jim Ryder

file: OSNAP Pickart 2020 date: 01/04/2022

Short name: DSOW3 / KPO 1227

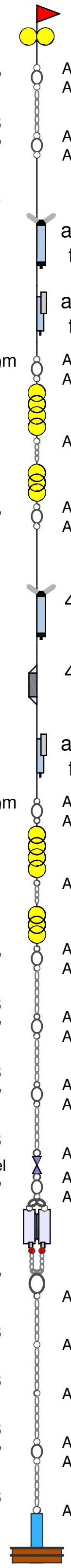
Deployment: MSM 94 - Aug. 2020

GEOMAR

Source: 03-Sep-2020 21:34:28, .../Dropbox/cruises/msm94/design/kpo_1227_dsow3_final.cfg
Author: 03-Sep-2020 22:28:30, begler@po-see02(GLNXA64)

depth (incl. stretch)	component	S/N description	rope # & Length	Distance from Upper / Lower rope end	in/out of water comment

59N00.43, 47W33.87   !!! Check ALL shackles for cotter pins !!!   *2020-08-26*



13:11 UTC

2551 m **BE2 Top** **XMA Argos ID 5506**

Lat: 58N59.283
Long: 47W33.118

OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"
chain **0.6m** chain-13
OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"
#1 **20m** 1/4" ins

2573 m **AquadoppDW-IM** **#P26209-7 T,P,U,V,W** — above term. — *13:12*

2573 m **MCP-SM** **#6854, P 500m above lower** — above term. — *13:12*

#1 bottom
OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"

2574 m **7 17" Floats (5m)** — AS 2t 1/2"

OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"
#2 **500m** 3/16" ins

Shorten wire by 25m on future deployments
Mount upper MC on Top-float bar

3078 m **AquadoppDW-IM** **#P26209-11 T,P,U,V,W** — 498.5 / 1.5 — *13:31*

3078 m **RBR-O2** **#204329** — 499.0 / 1.0 — **Dal.Ca** — *13:31*

3079 m **MCP-SM** **#10704, P 25m above bottom** — above term. — *13:31*

#2 bottom
OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"

3081 m **7 17" Floats (5m)** — AS 2t 1/2"

OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"
chain **0.6m** chain-13
OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"
chain **2.7m** chain-13
OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"
chain **0.6m** chain-13

!!! Am Ring abstoppen !!!
#1645: Mode B

Swivel — AS 3t 5/8" / AS 3t 5/8"
OL 2t 5/8" — AS 2t 1/2"

#1645: Enable 0A8A (20sec release window open)

3090 m **Dual AR Oceano** **AR861 #1645** / **AR861 #1643**

#1645: Release 0A55 — *13:34*

chain **0.3m** 13mm dropchain

#1643: Mode B

OL 4t 7/8" — AS 2t 1/2"
chain **2.7m** chain-13

#1643: Enable 0A88 (20sec release window open)

AS 2t 1/2"
chain **2.7m** chain-13

#1643: Release 0A55 !!! Same Release Codes !!!

AS 2t 1/2"
chain **2.7m** chain-13

13:38 *ready to slip*

OL 2t 5/8" — AS 2t 1/2" / AS 2t 1/2"
chain **2.7m** chain-13

3104 m **Anchor (2)** **(3000m)** — AS 3t 5/8" — *13:58*
600 kg dry
524 kg wet

314 kg dry safe
274 kg wet safe

Drop at Lat: 59N00.541 Long: 47W33.940

Target at Lat: 59N00.430 Long: 47W33.870

Submerged at Lat: 59N00.631 Long: 47W34.003 14:01

Short name: DSOW4 / KPO 1228

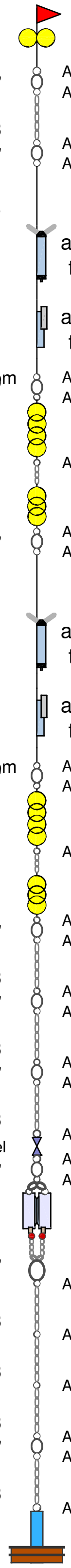
Deployment: MSM 94 - Aug. 2020

GEOMAR

Source: 03-Sep-2020 22:12:29, .../Dropbox/cruises/msm94/design/kpo_1228_dsow4_final.cfg
Author: 03-Sep-2020 22:29:05, begler@po-see02(GLNXA64)

depth (incl. stretch)	component	S/N description	rope # & Length	Distance from Upper / Lower rope end	in/out of water comment

59N12.93, 47W04.99 !!! Check ALL shackles for cotter pins !!! *2020-08-25*



21:22 UTC

2382 m **BE2 Top** **XEOS-XMA Argos ID 2268**

Lat: 59N13.927
Long: 47W04.673

OL 2t 5/8" — AS 3t 5/8", AS 2t 1/2"
chain **0.6m** chain-13
OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"
#1 **20m** 1/4" ins

2404 m **AquadoppDW** **#P26209-26 T,P,U,V,W** — above term. *21:23*

2404 m **MCP-IM** **#10634, P7000 525m above bottom** — above term. *21:23*

#1 bottom
OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"

2405 m **7 17" Floats (5m)** *21:23*

AS 2t 1/2"

OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"
#2 **500m** 3/16" ins

Shorten wire by 25m on future deployments
Mount upper MC on Top-float bar

2910 m **AquadoppDW** **#P26209-32 T,P,U,V,W** — above term. *21:43*

2910 m **MCP-IM** **#3752, P3500 25m above bottom** — above term. *21:43*

#2 bottom
OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"

2912 m **7 17" Floats (5m)** *21:43*

AS 2t 1/2"

OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"
chain **0.6m** chain-13
OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"
chain **2.7m** chain-13
OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"
chain **0.6m** chain-13

!!! Am Ring abstoppen !!!

#271: Mode B

Swivel — AS 3t 5/8"
OL 2t 5/8" — AS 3t 5/8", AS 2t 1/2"

#271: Enable 1405 (20sec release window open)

2921 m **Dual AR Oceano** **AR861 #271** chain **0.3m** **AR861 #1548** 13mm dropchain

#271: Release 1455 *21:45*

#1548: Mode B

OL 4t 7/8" — AS 2t 1/2"

#1548: Enable 0A04 (20sec release window open)

chain **2.7m** chain-13 — AS 2t 1/2"

#1548: Release 0A55

chain **2.7m** chain-13 — AS 2t 1/2"
chain **2.7m** chain-13

21:48 *ready to slip*

OL 2t 5/8" — AS 2t 1/2", AS 2t 1/2"
chain **2.7m** chain-13 — AS 3t 5/8"

2935 m **Anchor (2)** **(2600m)** *22:09*
600 kg dry
524 kg wet

314 kg dry safe
274 kg wet safe

Drop	**at Lat: 59N12.863**	**Long: 47W05.001**	**2945m**
Target	**at Lat: 59N12.930**	**Long: 47W04.990**	
Submerged	**at Lat: 59N12.784**	**Long: 47W05.026**	**22:12**