# Cruise Plan
# Irminger Array 5 Deployment
# R/V Neil Armstrong Cruise AR30-03
# 5 June – 24 June 2018

**Control Number: 3202-00501**
**Version: 0-09**
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**Date: 2018-05-29**
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**Coastal and Global Scale Nodes**
**Ocean Observatories Initiative**
Woods Hole Oceanographic Institution

Template 3401-00003 Version 2-01

**Revision History**

| Version | Description | Originator | Release Date |
|---|---|---|---|
| 0-01 | Initial Draft | R. Travis | |
| 0-02 | Updates, edits | R. Travis | |
| 0-03 | Updates, edits | A. Macdonald | |
| 0-04 | Minor edits | E. Benway | |
| 0-05 | Insertions, minor edits | P. Brickley | |
| 0-06 | Corrected cruise #, ver# and date on cover page | R. Travis | |
| 0-07 | Updates for IRR | R. Travis, E. Benway, A. Macdonald | |
| 0-08 | Edits and formatting updates | S. White | |
| 0-09 | Final edits; ready for approval/release | A. Macdonald, R. Travis | |

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# 1.0 Introduction

## 1.1. Overview

This cruise is the fifth cruise to the Irminger Sea Global Array of the National Science Foundation's Ocean Observatories Initiative (OOI; http://www.oceanobservatories.org). The Irminger Sea Global Array includes four moorings (Figure 1-1) and a combination of Open Ocean and Global Profiling Gliders deployed off the southeast tip of Greenland, close to 39°W, 60°N (Figure 1-2). The location is one characterized by the strong air-sea interaction and wintertime water mass formation that supports the global thermohaline (a.k.a. meridional overturning circulation – MOC), where in recent years a freshening of the water column has been observed. The data from the array contributes to an improved understanding of the impact of both natural and climate variability in the region, as well as how they affect changes in ocean physics, chemistry, and biology and vice-versa.

The combination of the moored array and the gliders enables investigation into the role of processes at mesoscale and sub-mesoscale horizontal length scales through observations that sample the full water column, from the sea floor to the sea surface. The Surface Mooring provides unique time-history of observations of surface meteorology and air-sea fluxes.

This Irminger Sea Global Array deployment cruise (Irminger-5) has the following primary objectives: deployment of a new Surface Mooring (GI01SUMO), deployment of a new Hybrid Profiler Mooring (GI02HYPM), deployment of two new Flanking Moorings (GI03FLMA, GI03FLMB), deployment of new Irminger Sea mobile gliders (GI05MOAS) tasked to patrol around the moored array, recovery of the Surface Mooring, Profiler Mooring, and Flanking Moorings deployed in August 2017, and CTD casts with temperature, salinity and oxygen water sampling both for instrument validation and to further characterize the region of the mooring sites. Recovery of the 2017 Surface Mooring may involve dragging as the surface buoy has not been seen or heard from since it disappeared on October 12, 2017.

The plan is to deploy the fifth set of moorings before recovering the previously deployed fourth set of moorings so that a) data sets invaluable to the process of intercalibrating the moored instrumentation can be obtained and b) the decks can be cleared before the recoveries. To ensure that the deployment prior to recovery procedure can be executed, and as future mooring operations are expected to be conducted in close proximity to the moorings currently in the water, dual site locations for all the moorings were identified during the bathymetric survey conducted on the first OOI Irminger Sea cruise in September 2014.

There are three ancillary, NSF-funded programs sailing on Irminger 5. First, four Overturning in the Subpolar North Atlantic Program (OSNAP) moorings will be deployed and up to two sound sources (4 and 11) will be recovered. Four extra ship days are being supported by OSNAP. The OSNAP moorings, which will be deployed at the sites of recently recovered U.K. NOC (National Oceanography Centre) moorings, will monitor the velocity, temperature and salinity of the boundary current between ~37.8-41.1° W, 59.6-59.9° N. Direct CTD observations will also be made, and seawater will be collected to measure temperature, salinity both at, and if time permits, between the OSNAP moorings.

The second ancillary program is a NSF Project entitled "The Annual Cycle of the Biological Carbon Pump in the Subpolar North Atlantic", or the BCP Project. They will deploy one ancillary glider, and adapt one of the OOI gliders to include an oxygen sensor to measure the atmospheric oxygen content simultaneously with the ocean oxygen content. This project will make use of the

OOI and OSNAP temperature, salinity, oxygen water column observations, and will also measure dissolved gas, chlorophyll, particulate organic carbon, and carbonate chemistry from water samples, and the underway seawater intake, to better understand the biochemical cycles in the region.

The third ancillary project, will also make use of the underway sea water intake system as well as all available rosette casts to obtain samples to measure particulate organic carbon to investigate environmental lipidomics in upper ocean suspended and sinking particles. If time permits, an unspecified number of short (250 m) casts may be performed on the way from the mooring region on the steam back to Reykjavik for the lipid project. The latter two projects are truly ancillary in that their activities are subject to available time.

## 1.2. Operating Area

The planned cruise track is shown in Figure 1-3. The cruise is on R/V *Neil Armstrong* and identified as AR 30-03 The cruise track is advisory, meaning it's for displaying the distances involved for planning and timing of cruise operations. The actual courses and waypoints will be determined by the ship's officers. Navigation within the array will be directed by the Chief Scientist. The cruise originates in Reykjavik, Iceland and steams to the Irminger Sea array site, works there, and then returns to Reykjavik, Iceland. Mooring site locations and water depths are provided in Appendix A.

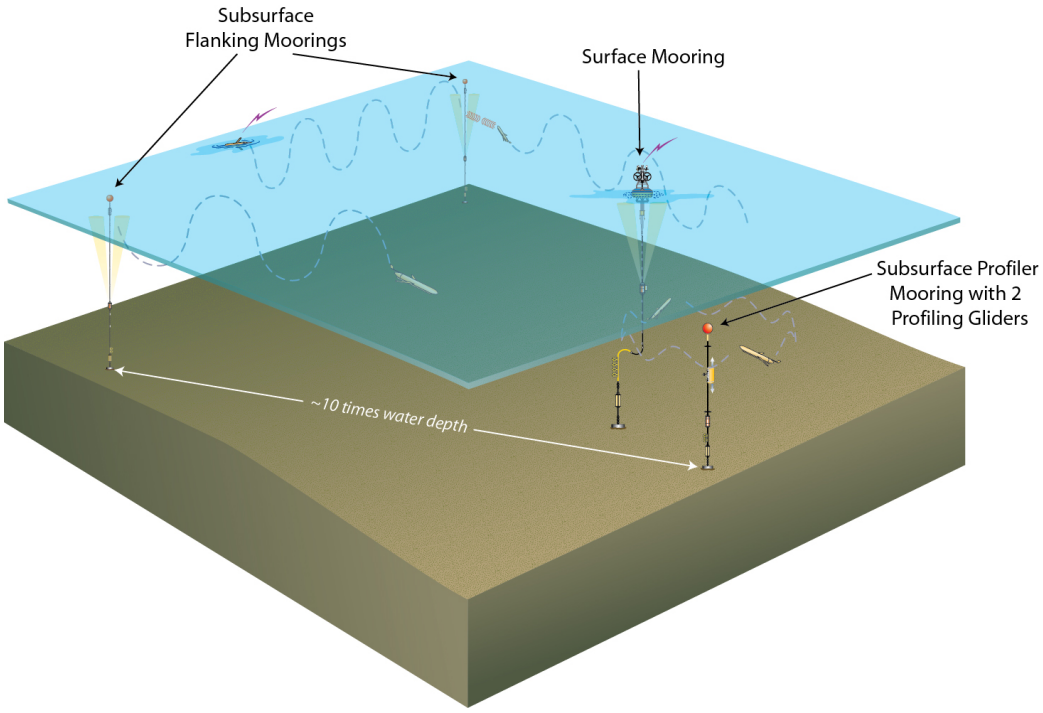


**Figure 1-1 Schematic drawing of the Irminger Sea Global Node.**

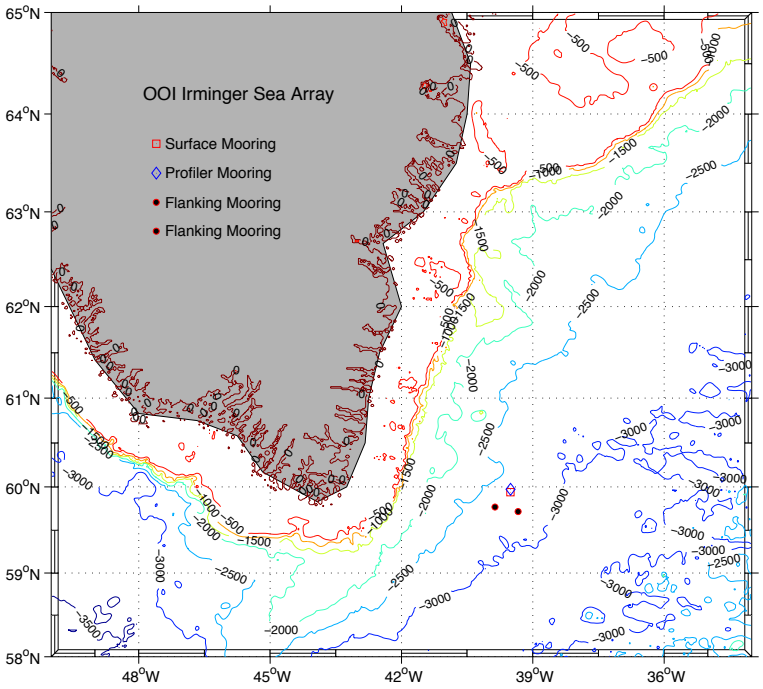


**Figure 1-2 The location of the OOI Irminger Sea array southeast of Greenland, in about 2,700 m of water. Bathymetry in all figures is Smith and Sandwell, in meters.**

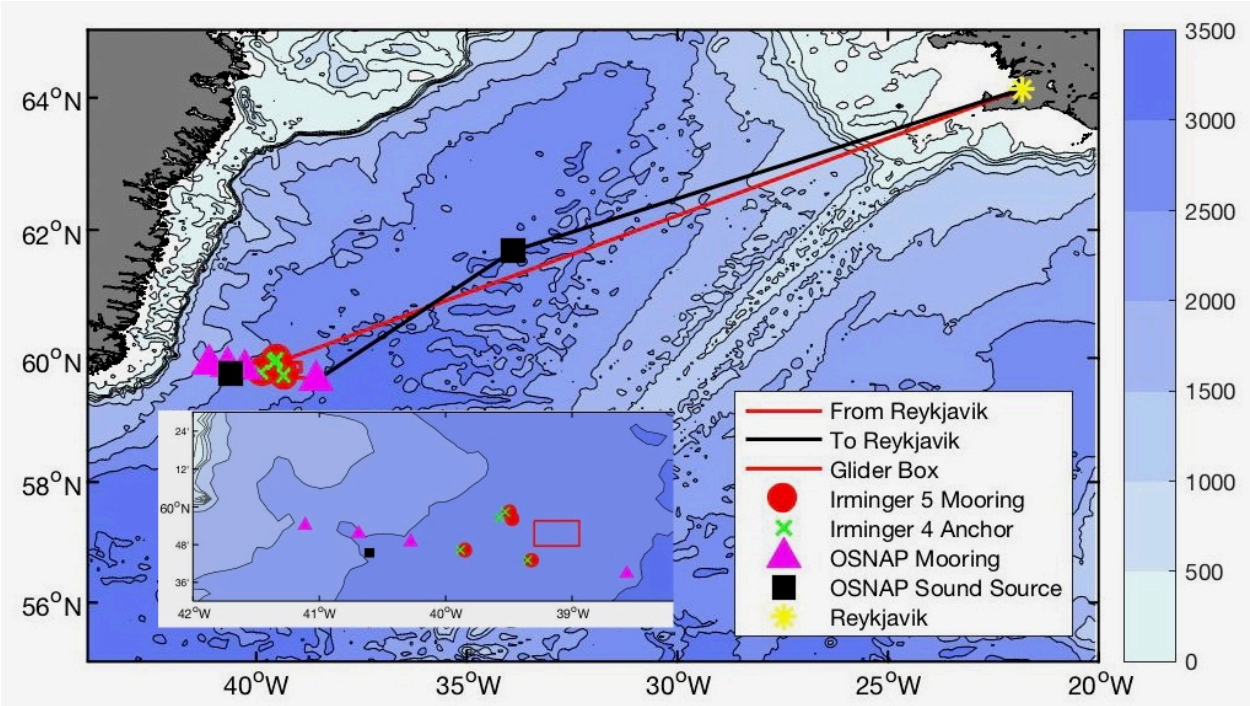


**Figure 1-3 Cruise Track for AR30-03, departing from and returning to Reykjavik, Iceland. Inset shows greater detail in the relative spacing of the mooring locations.**

## 2.0 Cruise Plan

### 2.1. Background

The Irminger Sea 5 Global Array will be deployed in June 2018 from R/V *Neil Armstrong* cruise AR 30-03, sailing from Reykjavik on 5 June 2018 and returning to Reykjavik on 24 June 2018. Organization, testing and instrument integration will be done in Woods Hole prior to the cruise to prepare equipment, however the building of the instrument platforms will be done in Reykjavik, Iceland between 22 May and 1 June 2018. R/V *Neil Armstrong* will be in Reykjavík 30 May and loading for the Irminger Sea Global Array deployment cruise will occur on 2–4 June.

For this cruise, four OOI moorings and four OSNAP moorings will be deployed, along with three Open Ocean Gliders to sample lateral scales of variability in and around the moored array.

This year, the gliders will be launched before any moorings are recovered or deployed to a) avoid the possibility of mooring operations interfering with the glider operations and b) to get them in the water early so as to assess their performance and provide an opportunity to recover and possibly repair those not performing to standard. Once launched, the gliders will be restricted to a holding area, away from the mooring operations area until mooring operations are finished (Figure 2-1).


**Figure 2-1 Location of Glider Box. Corner points are shown as white circles. Box corner coordinates are found in Appendix B.**

The Irminger Sea Array of the OOI has been coordinated with other ongoing ocean research efforts. In December 2013, Bob Weller hosted a workshop in Boston focused on coordination of observing efforts in the Irminger Sea region. The locations of the OOI Irminger Sea Global Node moorings were discussed and finalized and the plan to include additional deep single point velocity and CTD sensors to the two OOI Irminger flanking moorings was adopted. These sensors will be deployed once again on this fifth cruise. The siting of the OOI flanking moorings and the addition of these sensors enabled the OOI moorings to sample consistently with the instruments

on the OSNAP array, providing added-value to the OSNAP observing effort. Moorings from investigators at GEOMAR, Kiel, Germany and at the Royal Netherlands Institute for Sea Research (NIOZ) are or have been located near the OOI Irminger Sea moored array.

## 2.2. Overall Cruise Strategy

One to two days before arrival at the Irminger Array, a test CTD cast will be done in international waters between Iceland and the Irminger Array, where the water depth is greater than 1500 meters. The cast will serve asinitial tests of the CTD's proper operation and acoustic releases for operational testing down to 1500 meters. More than one test cast will be required to test all of the releases. The location and timing of these test casts will be weather dependent.

The plan for the cruise this year is to get the gliders safely launched and positioned in the "Glider Box", as described above. Following the launches, the vessel will conduct CTD casts and water sampling in the vicinity of the glider locations.

The vessel will proceed to investigate the state of GI01SUMO-00004 before proceeding with deployment of all four of the replacement OOI moorings. Given the experience of past cruises to this area and our increasing familiarity with the winds and currents to be expected, we are cautiously optimistic that we will accomplish the goal of having all 7 or 8 moorings in the water simultaneously. This will provide a crucial overlap period allowing the old and new mooring sensors to measure the same variables. With all moorings in place, testing and evaluation of the moored instrumentation, gliders, acoustic communications between the gliders and the moorings will be completed.

## 2.3. Staging and De-Staging

### 2.3.1. WHOI Preparation and Staging

Initial phases of assembly, testing, and staging were done at the Woods Hole Oceanographic Institution (WHOI) prior to 24 April. All moorings were broken down and packed for shipping to Iceland on 30 April. There were three separate shipments to Reykjavik Iceland, on 30 April, 1 May and 7 May.

Final assembly and testing will be done in Reykjavik, Iceland. Arrangements have been secured to assemble the moorings in a warehouse space in the port of Reykjavik. Final assembly will take eleven days, from 22 May to 1 June.

Loading onto the R/V *Armstrong* will be done in Reykjavik, Iceland 2–4 June 2018. Arrangements have been made for forklifts and a crane as needed as well as for transport from staging locations to the ship's berth.

### 2.3.2. Reykjavik cruise wrap up and de-staging

De-staging and offloading of scientific equipment will occur in Reykjavik, Iceland. The two demob days are 25 June and 26 June.

Partial equipment breakdown will take place on the transit back into Reykjavik. Once in port, all equipment and instruments will be packed into shipping containers for a full return shipment to Woods Hole.

## 2.4. Cruise Objectives

In 2014 we carried out a bathymetric survey of the planned sites for the four Irminger Sea array

moorings, looking at both the sites for the first deployment and for the second deployment. These two sets of sites are used in alternate years. The survey provided anchor target sites for all moorings with alternates that allow establishment of the planned geometry of the array (Figure 1-2, Figure 2-2, and Figure 2-3). On servicing cruises, the new moorings are deployed before the old ones are recovered, so two sites had to be identified for each mooring.

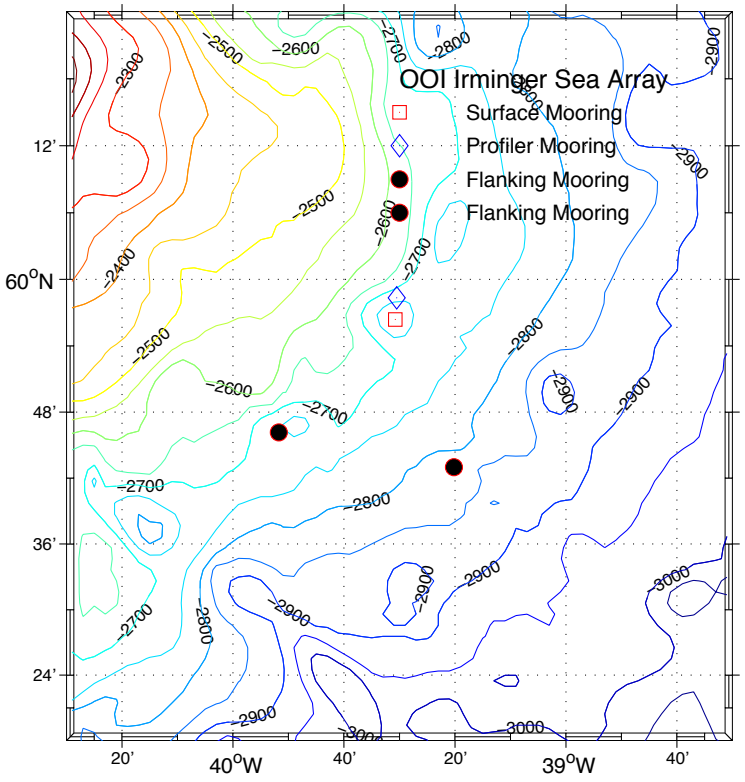


**Figure 2-2 The OOI Irminger Sea Array with mooring locations.**

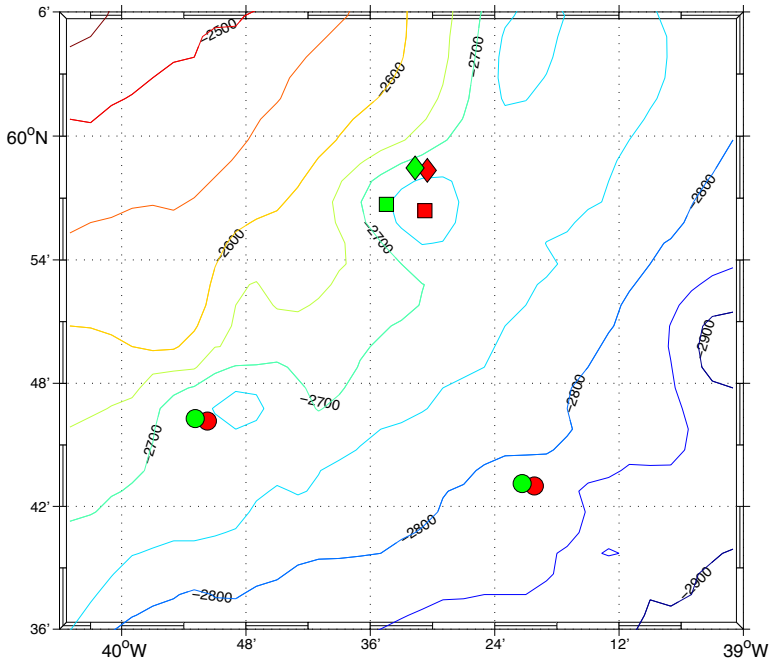


**Figure 2-3 OOI Irminger Sea Array.**

**Red symbols, defined as position "B" are the targeted initial, third and fifth deployment sites. Green, defined as position "A" are the targeted second, fourth and sixth deployment sites.**

The primary objectives of the fifth Irminger Sea cruise are listed below.

1) Deploy the Surface Mooring (GI01SUMO-00005)
2) Deploy the Hybrid Profiler Mooring (GI02HYPM-00005)
3) Deploy the Flanking Mooring A (GI03FLMA-00005)
4) Deploy the Flanking Mooring B (GI03FLMB-00005)
5) Recover the Flanking Mooring B (GI03FLMB-00004)
6) Recover the Flanking Mooring A (GI03FLMA-00004)
7) Recover the Hybrid Profiler Mooring (GI02HYPM-00004)
8) Investigate status and recover the Surface Mooring (GI01SUMO-00004)
9) Deploy 2 Open Ocean Gliders to sample the field around the OOI array
10) Conduct CTD casts with water sampling at the deployment/recovery sites
11) Carry out shipboard underway sampling in support of field calibration and validation of the platforms and sensors in the OOI Irminger Sea array.

Nominal dates for these activities are given in the cruise timeline provided in Appendix A. Site locations are listed in Appendix B. The mooring diagrams are shown in **Appendix E – Mooring Drawings**.

As discussed above, there are 3 ancillary projects. The Ancillary objectives are:

1) Deploy 1 Open Ocean Glider for the Biological Carbon Pump (BCP) Project

2) Deploy 4 OSNAP Moorings, 3 to the west and 1 to the east of the Irminger Array and carry out CTD casts at and between the OSNAP mooring sites. Recover 1 or 2 OSNAP sound sources.

3) Collect seawater for the Lipidomics (LIPIDS) study.

## 2.5. Cruise Plan

The R/V *Neil Armstrong* will depart from Reykjavik and transit to the Irminger Sea OOI Array region. A detailed timeline is provided in Appendix A – Cruise Timeline. Adjustments to the order of planned work will be made to accommodate poor weather conditions that make it difficult to accomplish particular tasks, and make the most of favorable conditions that present windows of opportunity for particular tasks to be accomplished. The most important cruise objective is to get the new OOI moorings launched and the old moorings recovered safely, so the weather will dictate when particular operations will occur.

For each new mooring, the following work is planned: 1) Assess currents, winds, and sea state and identify an initial point for the deployment of the top end of the mooring and a course to be followed after deployment; 2) Steam toward the anchor target site, paying out the mooring and attaching instruments; 3) Overshoot the anchor target by a fraction of the water depth to allow for fall back of the mooring and drop the anchor; 4) Allow the mooring to settle and then perform a 3-point acoustic survey to find the anchor coordinates; and 5) Carry out validation and verification of the moored instrumentation functions. For all moorings, prior to deployment, the acoustic releases will be lowered to 1,500 m, allowed to get cold (~30 minutes), and acoustic communication will verify their functionality prior to using them on the moorings. Set up for each deployment and staging of instrumentation will occur the day before deployment.

For each mooring deployed in 2017 and recovered on this cruise, the following work is planned: 1) Assess functionality by telemetry and acoustic communication where possible, 2) Recover and document recovered condition, 3) Download data, and 4) Preliminary cleaning.

CTD profiling and water sampling: CTD profiles are needed to verify glider ballasting and provide data to validate moored instrumentations. Water samples will be collected and processed for moored and glider-borne instrument validation. A CTD cast will be done after glider deployment, in association with pre-deployment instrument calibration, and for validation of moored and glider-borne instrumentation.

Gliders: There are no gliders presently on site to be recovered. Open Ocean Gliders will be deployed to be used in the patrol mode around the array and also to acquire and transmit data from the Flanking Moorings. Glider deployment will be followed by functionality testing and testing of the acoustic data communications and relay. The shore pilot team will perform the majority of final checkouts via Iridium and will also provide the final green light indicating gliders are ready to be deployed. The general time line for the glider deployments is below:

$T_0$: 0600 (or daylight): Gliders secured in carts on deck, clear sky view and green plug inserted (ON). Communication with shore-side pilots should be established through [on-board pilot TBD]. Shore team will have two pilots available.

| | |
|---|---|
| $T_0$+4 hours | Shore pilots complete pre-deployment checklist and signal ready for launch via satellite communication with deck ops lead. We should allow up to 4 hours to complete this task. The launches will be staggered and may take longer to complete. |
| $T_0$+4.5 hours | Once gliders are safely launched, the ship conducts a CTD in the general area, but positioned at least 1 km away from glider location. The ship is not required to stay near the gliders during the subsequent dive testing phase. |
| $T_0$+16 hours | Each glider requires up to 12 hours to complete basic functional dive checks to their full rated depth of 1000 m. Each glider must first complete a series of test dives. |

Following the successful installation of the new Irminger-5 platforms, and with a green light from the R/V *Armstrong*, the gliders will be sent to the nearest mooring to begin acoustic testing and to begin patrol duties.

The Chief Scientist (CS) will execute the cruise according to the direction of the Program Manager (PM) in order to accomplish, to the extent practicable, programmatic and scientific objectives as described above. The ship's Master and the CS have the discretion to alter the order of operations as well as to determine that some operations cannot be accomplished safely or effectively, based on conditions encountered at sea. The CS and PM have discussed tasks and responsibilities for the cruise, have reviewed likely at-sea failure modes and actions, have reviewed guiding principles for at-sea decision making, and have established communication pathways for both routine reporting (e.g. email) and emergency contact (e.g. satellite telephone).

The CS and PM will communicate frequently (typically daily by email) during the cruise to exchange status information and to assess the potential impact of at-sea decisions driven by weather or technical issues. Significant modifications to the cruise objectives (e.g. inability to deploy/recover a platform) will be communicated to the PM at the earliest opportunity. Changes to the cruise plan anticipated to have significant financial impacts (e.g. additional ship days) require approval from the PM prior to execution. Incidents involving injury or damaged/lost equipment will follow established Program protocols (report incident immediately to Program Manager and submit Redmine ticket to capture details). Anomalies, suspected failures, and confirmed failures will also be reported via submission of Redmine ticket to capture the details.

## 2.6. Specific Cruise Operations

### 2.6.1. Release Tests

At a convenient time prior to deployment of the moorings, the science party will perform release tests. The release tests involve lowering multiple acoustic releases, to one or more depths between 1,500 m and the surface and held in place while being interrogated acoustically. The science party will bring an acoustic transceiver than can be lowered over the rail with a cable run to the main lab and connected to a transceiver controller. Alternatively, the controller can be connected directly to a 12 kHz hull transducer on the R/V *Neil Armstrong*.

### 2.6.2. Mooring Operations

Mooring deployments and recoveries will be done in stages using the ship's crane and winches supplied by the science party. Science party personnel will be familiar with mooring deployment and recovery and will be capable of directing operations in cooperation with the

ship's crew. Additional science personnel will assist with mooring operations, met watches, and other observation and data collection activities.

### 2.6.3. Glider Operations

Glider deployments (and recoveries if necessary) will be done using the ship's crane and handling equipment supplied by the science party. Science party personnel will be familiar with glider deployment and recovery and will be capable of directing operations in cooperation with the ship's crew during all phases of glider operations. Gliders to be deployed include Serial Numbers 363, 453 and 469.

Once the gliders are launched, they will begin a series of dive tests to assess their function. The vessel will conduct CTD and water sampling in the vicinity of the glider locations. The appropriate standoff distance between gliders and the ship should be about 1500 m, or a distance determined by the vessel to be safe based on prevailing weather and local drift. Once the CTD sampling is completed, the vessel can depart to begin mooring operations.

Gliders will hold station within the Glider Box until the vessel provides clearance for gliders to enter the Irminger Array. Vessel entry into the glider box or glider excursions outside of the box will be communicated between the at-sea glider lead and the shore-pilot team. Maneuvers within the box will be coordinated between the vessel and the shore pilot team.

After the BCP Project glider is launched there will follow a coordinated CTD cast and glider dive. OOI and BCP Gliders will be brought to the surface together and commanded to profile to 1000 m. The vessel will occupy a station at least 1500 m away and complete a CTD cast to 1000 m. The ship shall position such that wind- or current-drift experienced by gliders will be away from the ship location. Gliders will dive towards waypoints distant from the vessel. Water samples will be collected as determined by the BCP project scientists.

### 2.6.4. Anchor Surveys

Once the anchor has settled on the bottom, R/V *Neil Armstrong* will occupy three stations 0.3 to 1.5 nm from the anchor drop point in a triangular pattern. At each station, the slant range to the acoustic release will be determined. Ranging from three stations will allow the release position, and thus the mooring anchor position, to be determined by triangulation.

### 2.6.5. CTD casts

CTD casts will be conducted using the ship's 9-11 CTD sensors, 24 bottle rosette frame, and deck box. Sensors requested in addition to C,T,D are dissolved oxygen, chlorophyll fluorometer, transmissometer, and PAR. CTD operations will be supervised by shipboard SSSG technicians – the science party will supply line handlers and a lab operator. Water sampling and any on board analysis will be handled by the science party. Water samples and filtered samples will be preserved for analyses on shore.

### 2.6.6. Sensor Performance Evaluation

Sensor evaluation operations will be conducted at each mooring deployment site and glider deployment site. The primary means of evaluation of the three subsurface moorings will be CTD casts obtained at a position halfway between the old mooring and the newly-deployed mooring (approximately ½ mile from each of the moorings), as well as within similar proximity to the gliders. This assures the capability of data validation of the old vs. new moorings with one CTD cast. For validation of meteorological and sea surface variables measured by the surface moorings, the ship will establish and hold a position, with the bow into the wind, approximately 0.25 nm downwind of a surface buoy. This station will be held, and adjusted if necessary, while the science party evaluates data received from the buoy. A CTD cast will

also be done during this time. During this period, the ship's underway data will be continuously recorded and the science party may make periodic observations with hand-held meteorological sensors. At a convenient time during the cruise, the ship may make a close approach to buoys to allow visual inspection, determination of the water line, and photographs.

### 2.6.7. Shipboard Underway Data

The ship's meteorological system will be used to continuously monitor weather conditions while underway and for evaluation of buoy meteorology during the intercomparison period. The ship's ADCP systems will be used to continuously measure the currents in the upper ocean while underway and while on station. Sea surface temperature and salinity will be recorded continuously, using the ship's thermosalinograph.

### 2.6.8. Small Boat Operations

The use of a work boat may be requested, at the discretion of the ship, for glider recovery or attending to unforeseen problems that would require physical access to a buoy tower. Expected duration of use is approximately 0.5 to 1.5 hr. Work boat operations would be within 0.5-1.0 nm of the ship.

## 2.7. Potential Restrictions

Small boat activities may be restricted by weather. In the case of a recovery operation, the ship will maneuver to the item to be retrieved and grappling lines and/or pick up poles will be used. Mooring activities may be restricted by severe weather or equipment failure. Severe weather would result in postponement until conditions eased. Failure of a given piece of Project equipment (e.g. winch, air tugger) can typically be compensated by use of an alternative approach. Failure of ship's equipment (e.g. electrical or hydraulic system) would result in postponement of operations until the failure was addressed. Deployment and recovery activities may be restricted by the presence of multiple fixed objects (e.g. fishing gear) in the deployment area or along the deployment/recovery track. If possible, operations will be delayed until conditions are more favorable (e.g. change in prevailing wind direction allowing deployment approach along a different, unobstructed course).

## 3.0 Appendixes

Appendix A – Cruise Timeline

Appendix B – Selected Waypoints and Maps

Appendix C – Deck Plan

Appendix D – Science Party

Appendix E – Mooring Drawings

## Appendix A – Cruise Timeline

*Cruise Plan*

Note: – The cruise transits have been planned at 10 knots.
– This tentative schedule could vary due to weather and logistics
– Some overnight work will consist of having the ship drift over the HYPM mooring to compare the EK-80 with the ZPLSG instrument on the mooring.

| | | |
|---|---|---|
| Day -13 to -4 | May 22-Jun 1 | In Reykjavik, mooring build and integration |
| Day -3 to -1 | Jun 2-4 | In Reykjavik, loading OOI & OSNAP gear on board *R/V Neil Armstrong* |
| Day 1 | Jun 5 | Depart Reykjavik @ 0830 |
| Day 2 – 3 | Jun 6-7 | Transit towards Irminger Array position |
| Day 3 | Jun 7 | Test CTD station in at least 1500 meters water depth, first release tests |
| Day 3-4 | Jun 7-8 | Arrive at "Glider Box", deploy gliders; occupy glider CTD station, Cross-comparison CTD cast with BCP glider |
| Day 5 | Jun 9 | Investigate status of GI01SUMO-00004 mooring, visually, acoustically and with multibeam (possibly EK-80 as well). |
| Day 6 | Jun 10 | Deploy GI01SUMO-00005, validate/verify/CTD halfway between old and new moorings, anchor survey |
| Day 7 | Jun 11 | Deploy GI02HYPM-00005 mooring, validate/verify/CTD halfway between old and new moorings, anchor survey/ Night ops- try to find mooring with EK-80. Also, drift over the HYPM mooring to compare the EK-80 with the ZPLSG instrument on the mooring. |
| Day 8 | Jun 12 | Deploy GI03FLMB-00005 mooring, validate/verify/CTD halfway between old and new moorings, anchor survey/Night ops-try to find mooring with EK-80 |
| Day 9 | Jun 13 | Deploy GI03FLMA-00005 mooring, validate/verify/CTD halfway between old and new moorings, anchor survey/ Night ops-try to find mooring with EK-80 |
| Day 10 | Jun 14 | Assess functionality of acoustic releases on the four old moorings. Overnight transit to westernmost OSNAP mooring site (M1). |
| Day 11 | Jun 15 | Deploy OSNAP Mooring M1 in 2086 m, validate/verify/CTD at M1 and between M1 and M2. |
| Day 12 | Jun 16 | Deploy OSNAP Mooring M2 in 2434 m, validate/verify/CTD at M2 and between M2 and M3, Recover OSNAP Sound Source 4. |

| | | |
|---|---|---|
| Day 13 | Jun 17 | Deploy OSNAP Mooring M3 in 2564 m, validate/verify/CTD at M3. Transit to FLMA. Overnight data downloads from the old profiler mooring. |
| Day 14 | Jun 18 | GI03FLMA-00004 mooring recovery. Overnight data download from GI03FLMB-00004 |
| Day 15 | Jun 19 | GI03FLMB-00004 mooring recovery. Overnight data downloads from HYPM02-00004. |
| Day 16 | Jun 20 | HYPM02-00004 mooring recovery. Overnight data downloads of GI01SUMO-00004, if possible. |
| Day 17 | Jun 21 | GI01SUMO-00004 mooring recovery, if possible. Heave to ¼ mile downwind of new surface mooring for ship/buoy data comparisons. Overnight transit to OSNAP M4. |
| Day 18 | Jun 22 | Deploy OSNAP mooring M4 in 2989 m, validate/verify/CTD at M4. |
| Day 19-20 | Jun 23-24 | Transit to Reykjavik. If time permits, recovery of OSNAP Sound Source 11 and possible 250 m CTD casts for LIPIDS. |

## Appendix B – Selected Waypoints, Locations, and Transit Distances

From the deployment cruise in 2017 at Locations A:

OOI Irminger Mooring Locations – Anchor Positions from Acoustic Survey August 2017.

| Mooring | Deployment Date/Time (UTC) | Latitude | Longitude | Depth (m) |
|---|---|---|---|---|
| GI01SUMO (Surface Mooring) | 8/05/2017 18:17 | 59° 56.6938' N (59.9449° N) | 39° 34.5034' W (39.5751° W) | 2659 |
| GI02HYPM (Profiler Mooring) | 8/06/2017 13:45 | 59° 58.3977' N (59.9733° N) | 39° 31.7738' W (39.5296° W) | 2659 |
| GI03FLMA (Flanking Mooring A) | 8/08/2017 15:13 | 59° 46.303' N (59.7717° N) | 39° 52.964' W (39.8827° W) | 2689 |
| GI03FLMB (Flanking Mooring B) | 8/07/2017 15:29 | 59° 43.0687' N (59.7178°N) | 39° 21.1511' W (39.3525° W) | 2817 |

Note: 1488 m $s^{-1}$ used for mean sound speed.

Port of origin: Reykjavik, Iceland (64.1283° N, 21.8278° W)
(64° 7.698' N, 21° 49.668' W)

Center OOI Irminger Array: (59.82°N, 39.58°W) (59° 49.2' N, 39° 34.8' W)

General Target Positions for OOI Irminger Moorings

Irminger Surface Mooring Deployment Target B: (59.9344° N, 39.4685° W)
(59° 56.064'N, 39° 28.110'W)

Irminger Profiler Mooring Deployment Target B: (59.9704° N, 39.4888° W)
(59° 58.224'N, 39° 29.328'W)

Irminger Flanking Mooring A Deployment Target B: (59.7674° N, 39.8426° W)
(59° 46.044'N, 39° 50.556'W)

Irminger Flanking Mooring B Deployment Target B: (59.7147° N, 39.3168° W)
(59° 42.882'N, 39° 19.008W)

Nominal waypoints used to calculate distance to and from Irminger Array (Note: these are not directive, simply convenient positions to calculate rough distances)

1. Reykjavik: 64° 7.698’ N, 21° 49.668’ W
2. Irminger Array center: 59° 49.2’ N, 39° 34.8’ W
3. OSNAP Mooring M1: 59° 54.180’ N, 41° 6.708’ W
4. OSNAP Mooring M4: 59° 38.796’ N, 38° 33.942’ W
5. Sound Source 11: 61° 40.740’ N, 33° 14.400’ W

Transit distances:

| | | |
|---|---|---|
| Reykjavik to Array | 560 nm | 560 nm |
| Array to M1 | 50 nm | 610 nm |
| M1 to M4 | 80 nm | 690 nm |
| M4 to Reykjavik | 545 nm | 1235 nm |
| or | | |
| M4 to Sound Source 11 | 140 nm | 830 nm |
| Sound Source 11 to Reykjavik | 420 nm | 1250 nm |

Distances in and around array:

Array perimeter: 60 nm

Array sides: Surface to Flanking A – 14.0 nm
Surface to Flanking B – 14.0 nm
Flanking A to Flanking B – 16.3 nm

Glider Box (Roughly square box 8-10 nmi on a side)

| | |
|---|---|
| Upper left corner | 59 55.60’ N, 39 18.0’ W |
| Lower right corner | 59 47.50’ N, 38 56.50’ W |

## Appendix C – Equipment Inventory and Deck Plan

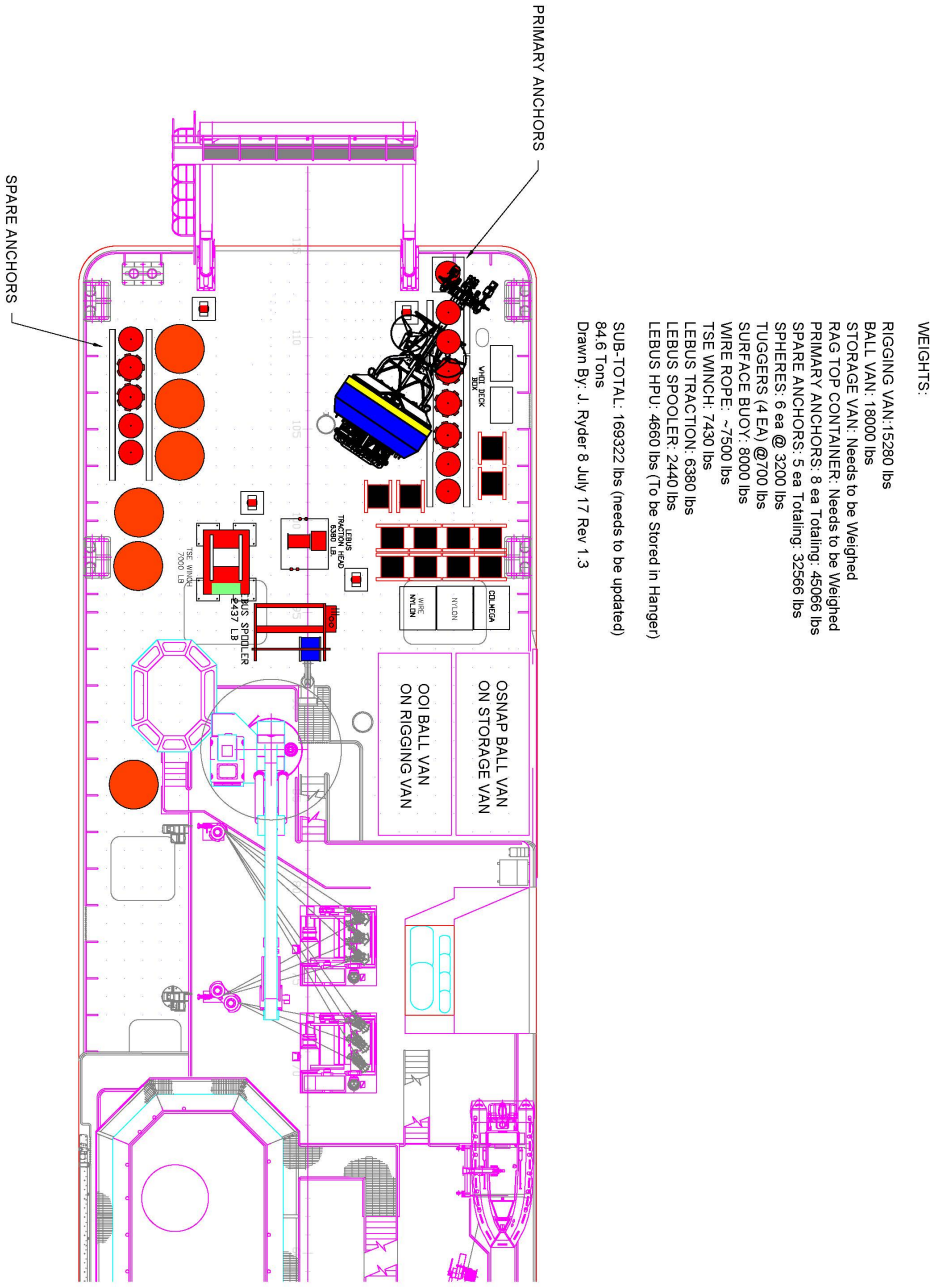


**Figure 3-1 Deck layout for the major components associated with Irminger-5 operations. Proposed locations of major deck elements are shown. Estimates weights of major deck components are also documented in a table.**

## Appendix D – Science Party

There will be 18 participants in the science party, 1 WHOI Shipboard Scientific Services (SSSG) technician and 1 MATE intern (SSSG Intern).

Scientific Party

| | Name | Gender | Nationality | Affiliation |
|---|---|---|---|---|
| 1. | Alison Macdonald | F | UK | WHOI/Chief Sci |
| 2. | John Kemp | M | USA | WHOI |
| 3. | Meghan Donohue | F | USA | WHOI |
| 4. | Jim Dunn | M | USA | WHOI |
| 5. | Stephanie Petillo | F | USA | WHOI |
| 6. | James Kuo | M | USA | WHOI |
| 7. | Dan Bogorff | M | USA | WHOI |
| 8. | Allen Smith | M | USA | WHOI |
| 9. | Sheri White | F | USA | WHOI |
| 10. | Dave Wellwood | M | USA | WHOI |
| 11. | Collin Dobson | M | USA | WHOI |
| 12. | Amy Bower | F | USA | WHOI |
| 13. | Heather Furey | F | USA | WHOI |
| 14. | Andrew Davies | M | USA | WHOI |
| 15. | Hillary Palevsky | F | USA | WHOI |
| 16. | Emma Jackson | F | USA | Wellesley |
| 17. | Lucy Wanzer | F | USA | Wellesley |
| 18. | Henry Holm | M | USA | WHOI |
| 19. | Christopher Seaton | M | USA | WHOI/SSSG |
| 20. | Julian Race-Moore | M | USA | Volstad (MATE) |

Roles and responsibilities:

Chief Scientist, bathymetry: A. Macdonald

Overall logistics and deck operations lead: J. Kemp

Safety (MSDS) and Shipping Document Coordination: J. Kemp

WHOI Surface Mooring: S. Petillo

WHOI Subsurface Moorings: J. Kuo, D. Bogorff

WHOI Instrumentation: A. Smith

Gliders: C. Dobson

CTD/Water Sampling: D. Wellwood

Mooring team (winch, deck): J. Kemp, M. Donahue, J. Dunn

Cruise Documentation: S. White, A. Macdonald

# Appendix E – Mooring Drawings

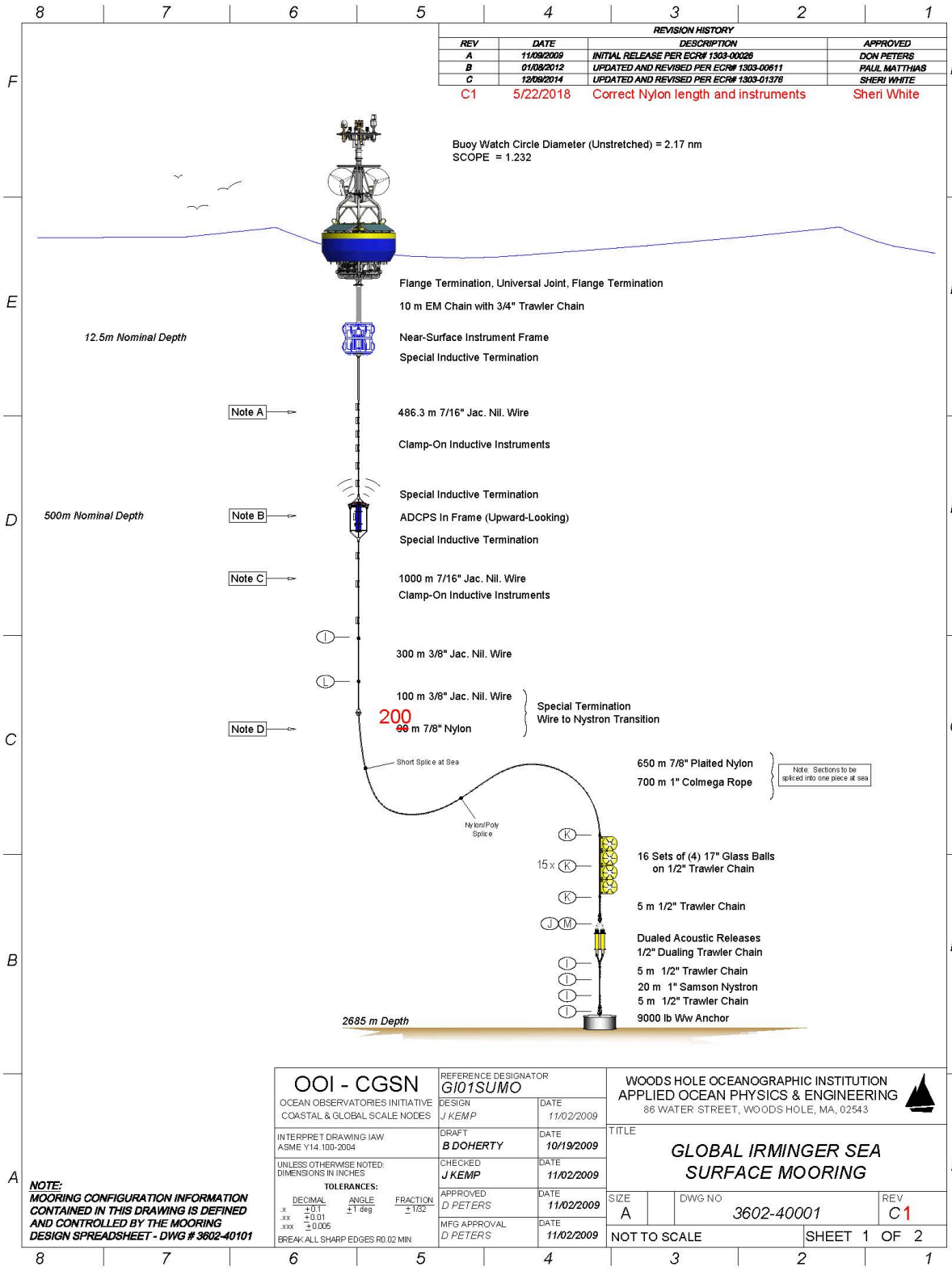


**Figure 3-2 Irminger Sea Surface Mooring (GI01SUMO)**

| Note A: Measure cable back from upper swage of 7/16" Wire and Label for mounting Instrumentation | | |
|---|---|---|
| Measure At: | Label | Instrument |
| 8 m | 20 m | PHSEN-E + CTDMO-Q |
| 28 m | 40 m | CTDBP-P + DOSTA+ FLORD + PCO2W-C |
| 48 m | 60 m | CTDMO-Q |
| 88 m | 100 m | PHSEN-E + CTDMO-Q |
| 118 m | 130 m | CTDBP-P + DOSTA+ FLORD + PCO2W-C |
| 168 m | 180 m | CTDMO-Q |
| 238 m | 250 m | CTDMO-Q |
| 338 m | 350 m | CTDMO-Q |
| 80 m | | CTDBP-P + DOSTA+ FLORD + PCO2W- |

Note B:
500 m CTDMO-Q mounted directly ~~below~~ above ADCP Frame

| Note C: Measure cable back from upper swage of 7/16" Wire and Label for mounting Instrumentation | | |
|---|---|---|
| Measure At: | Label | Instrument |
| 249.9 m | 750 m | CTDMO-R |
| 499.9 m | 1000 m | CTDMO-R |
| 999.9 m | 1500 m | CTDMO-R |

Note D:
Special overbraid on upper ~~99~~ 200 meters of 7/8" Nylon

| MOORING HARDWARE DESIGNATION | |
|---|---|
| (I) | (1) 5/8" Chain Shackle, (1) 7/8" End Link, (1) 7/8" Anchor Shackle |
| (J) | (1) 5/8" Chain Shackle, (1) 7/8" End Link, (1) 3/4" Anchor Shackle |
| (K) | (2) 5/8" Chain Shackle, (1) 7/8" End Link |
| (L) | (2) 3/4" Chain Shackle, (1) 7/8" End Link |
| (M) | (1) 1-1/4" Master Link |

| MOORING HARDWARE REQUIRED | |
|---|---|
| 39 | 5/8 " Anchor Shackles: shot peened & coated |
| 3 | 3/4 " Anchor Shackles: shot peened & coated |
| 6 | 7/8 " Anchor Shackles: shot peened & coated |
| 24 | 7/8" End Links |
| 1 | 1-1/4" Master Link |
| Qty Ea | Description |

***NOTE:***
***MOORING CONFIGURATION INFORMATION CONTAINED IN THIS DRAWING IS DEFINED AND CONTROLLED BY THE MOORING DESIGN SPREADSHEET - DWG # 3602-40101***

| SIZE | DWG NO | REV |
|---|---|---|
| A | 3602-40001 | C1 |
| NOT TO SCALE | SHEET 2 OF 2 | |

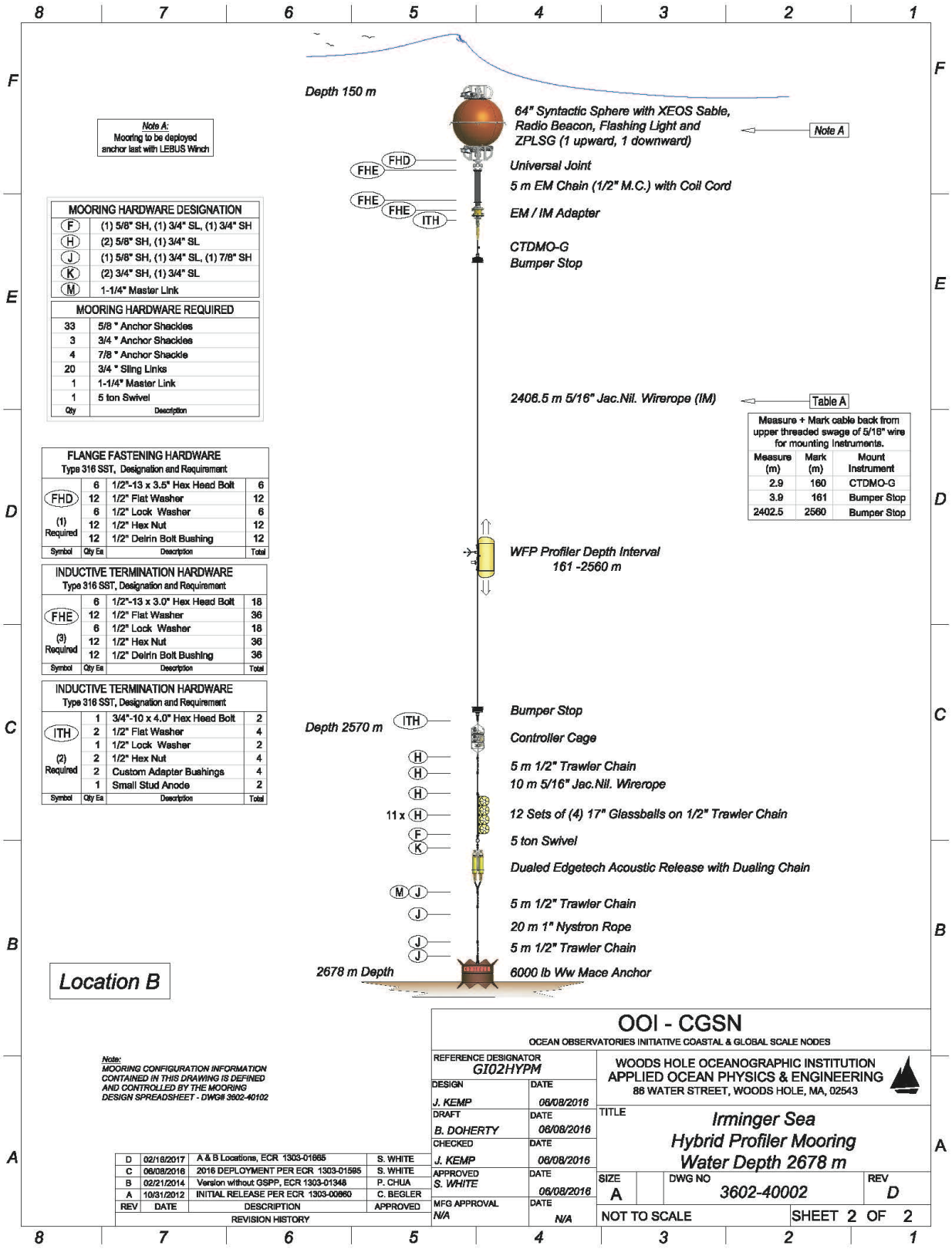


**Figure 3-3 Irminger Sea Profiler Mooring (GI02HYPM) – Target Water Depth 2678 m**

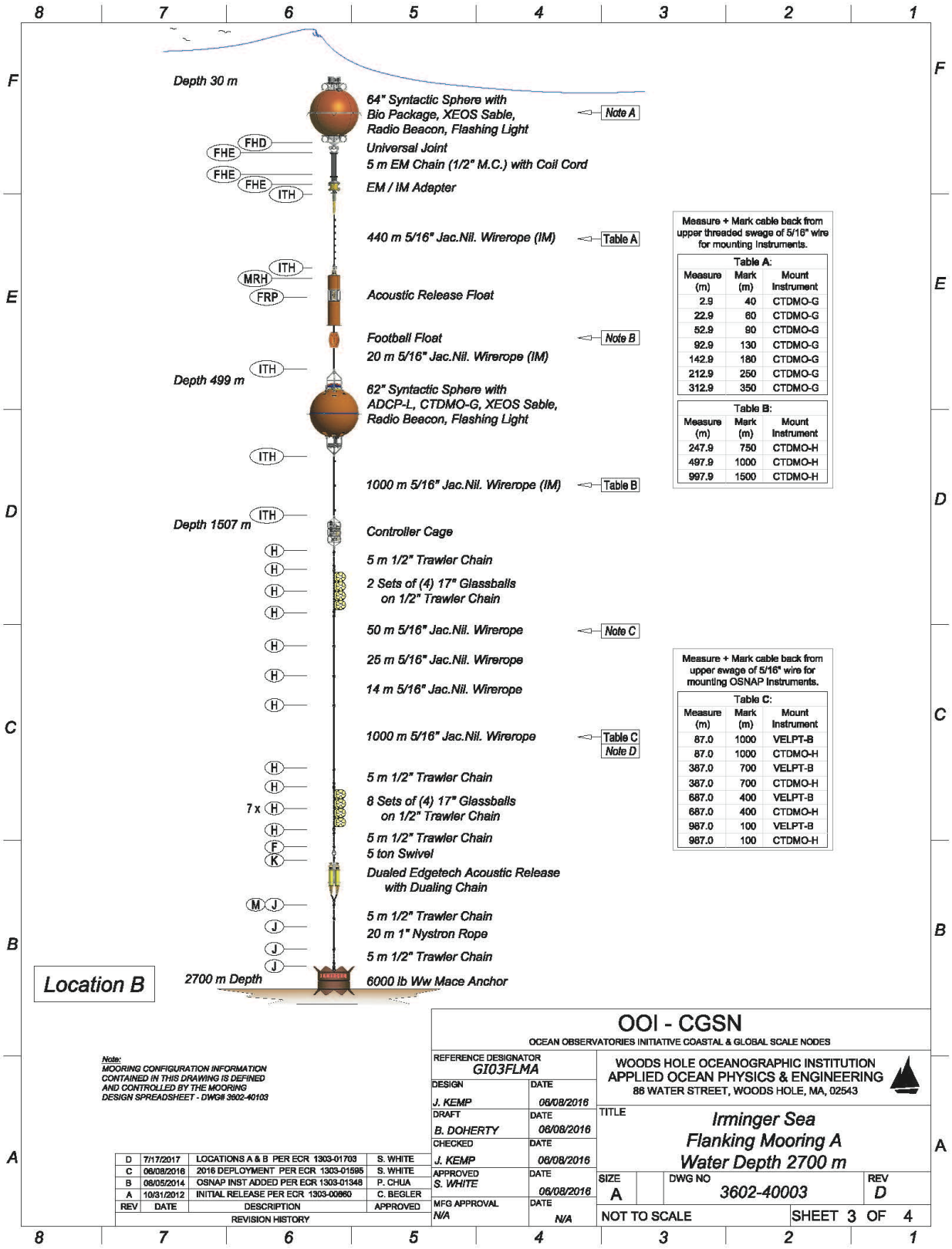


**Figure 3-4 Irminger Sea Flanking Mooring A (GI03FLMA) – Target Water Depth 2700 m**

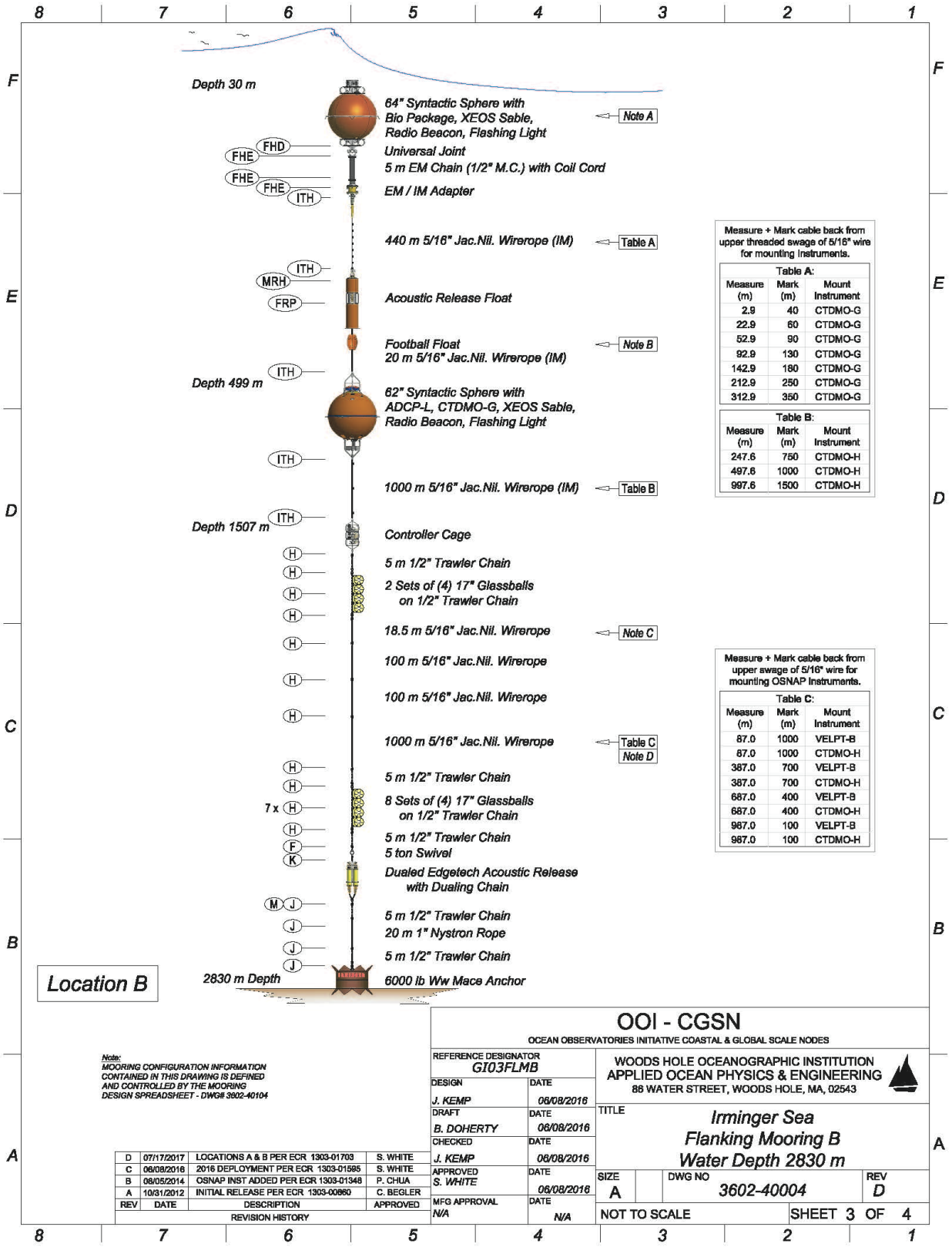


**Figure 3-5 Irminger Sea Flanking Mooring B (GI03FLMB) – Target Water Depth 2830 m**