Cruise Plan
Coastal Pioneer 2 Deployment
R/V *Knorr* Cruise KN-217
9-11 April 2014

Control Number: 3204-00201
Version: 0-01
Author: A. Plueddemann
Date: 04/06/2014

Coastal and Global Scale Nodes
Ocean Observatories Initiative
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography

template number 3101-00045

Revision History

Version	Description	Originator	ECR No.	Release Date
0-01	Final Draft	A. Plueddemann	N/A	04/06/2014
1-00	Initial Release	A. Plueddemann	N/A	Xx/xx/2014

Table of Contents

List of Figures

1.0 Introduction

1.1. Overview

This cruise represents the second infrastructure deployment for the Pioneer Array of the National Science Foundation's Ocean Observatories Initiative (OOI; http://www.oceanobservatories.org). The Pioneer Array includes a network of moorings and autonomous robotic vehicles to monitor waters of the continental shelf and slope south of New England and, in particular, the shelfbreak front where nutrients and other properties are exchanged between the coast and the deep ocean. Data from the Pioneer Array will provide new insights into coastal ocean processes such as shelf/slope nutrient exchange, air-sea property exchange, carbon cycling, and ocean acidification that are important to the New England shelf and to continental shelf ecosystems around the world.

The Pioneer 2 deployment cruise (Pioneer-2) has nine primary objectives that include the recovery and deployment of Profiler Moorings, the deployment of gliders, and CTD casts with water sampling at the mooring sites. The Pioneer-2 cruise also has multiple ancillary objectives, including deployment of a Fuel Cell test mooring, recovery of a Surface Mooring, recovery of an anchor and line pack, multi-beam bathymetry surveys of the mooring sites, and CTD/ADCP surveys in the Pioneer moored array region.

1.2. Operating Area

The Pioneer operating area is the southern New England continental shelf and slope within a region bounded by approximately 39.0°-40.7° N and 69.9°-71.5° W (Fig. 1-1). Pioneer-2 operations will be focused on the Pioneer Moored Array centered near 40.15°N, 70.83°W (Fig. 1-2) and the glider lines (Fig. 1-3). Mooring site locations and water depths are provided in Appendix A.

2.0 Cruise Plan

2.1. Background

The Pioneer Array will be deployed in three phases, as described in the Pioneer Array Deployment Plan (CGSN 3101-00091: ECR 1303-01166). The deployment plan, and the instrument configurations on each platform, assume that Coastal Surface Moorings will be deployed for ~1 year and Coastal Profiler Moorings for ~6 months. The Pioneer Central Surface Mooring (CNSM) and the Upstream Inshore and Upstream Offshore Profiler Moorings (PMUI, PMUO) were deployed on the Pioneer-1 cruise. The Deployment Replan for Pioneer-2 calls for PMUI and PMUO to be turned, the remaining three Profiler Moorings to be deployed, and six gliders to be deployed. Direct communication from the OOI Project Management Office (T. Cowles email, 3/30/2014) requested that only 3 of the 6 gliders be deployed. Because CNSM was not fully functional, it was determined that the mooring, originally planned for recovery on the Pioneer-3 cruise (ECR 1302-01166), should be recovered on Pioneer-2 and returned for evaluation. Two other operations were included in the Pioneer-2 cruise. First, the cruise presented an opportunity to deploy the Fuel Cell test mooring (ECR 1303-01176). Second, it provided an opportunity to repeat the multibeam bathymetry surveys that were only partially successful on Pioneer-1 (see Pioneer-1 Cruise Report, 3204-00022).

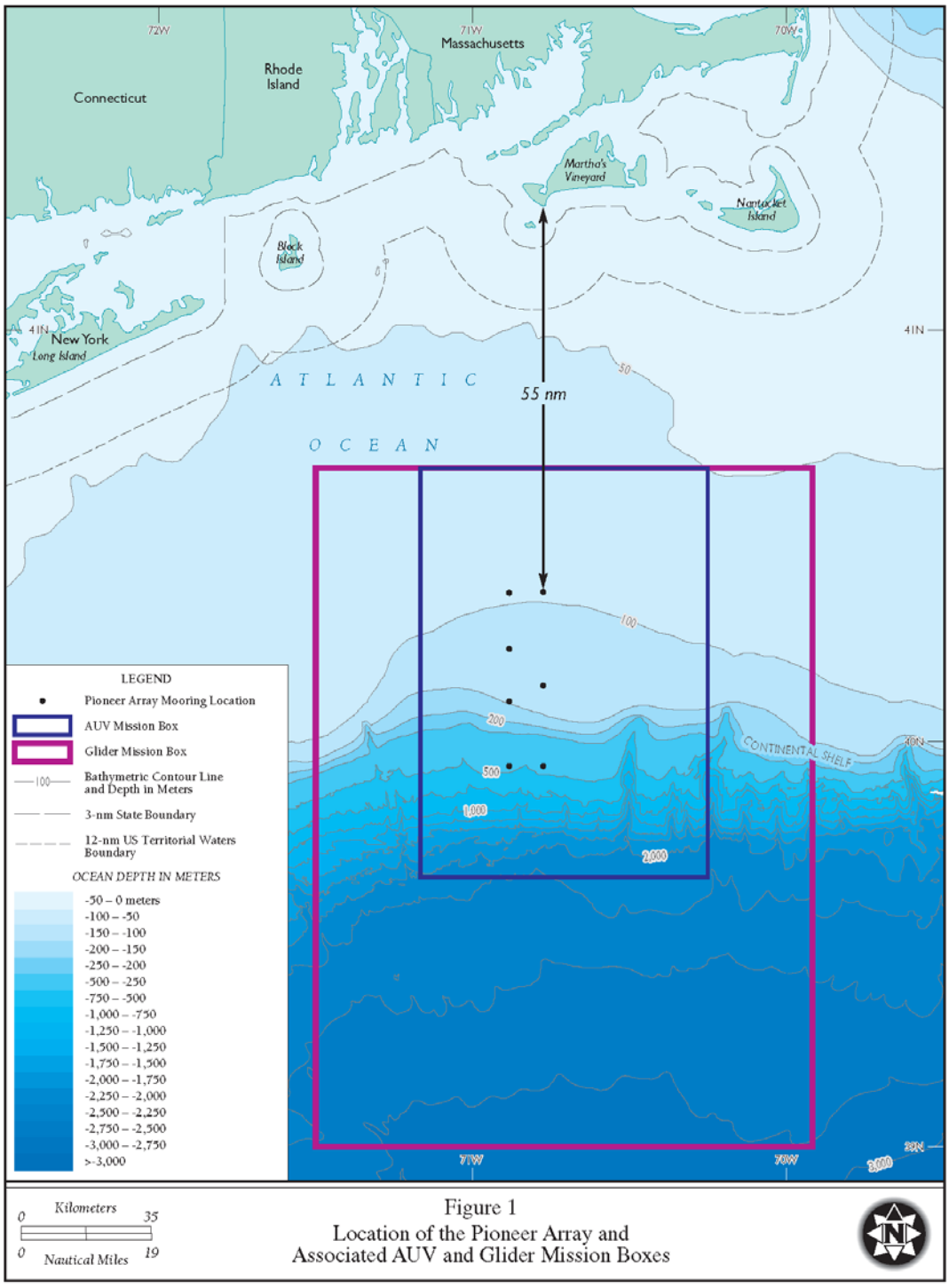

Figure 1-1 Map of the Pioneer Array region over the southern New England continental shelf and slope. The seven sites of the moored array, the AUV operating region and the glider operating region are shown along with bathymetric contours.

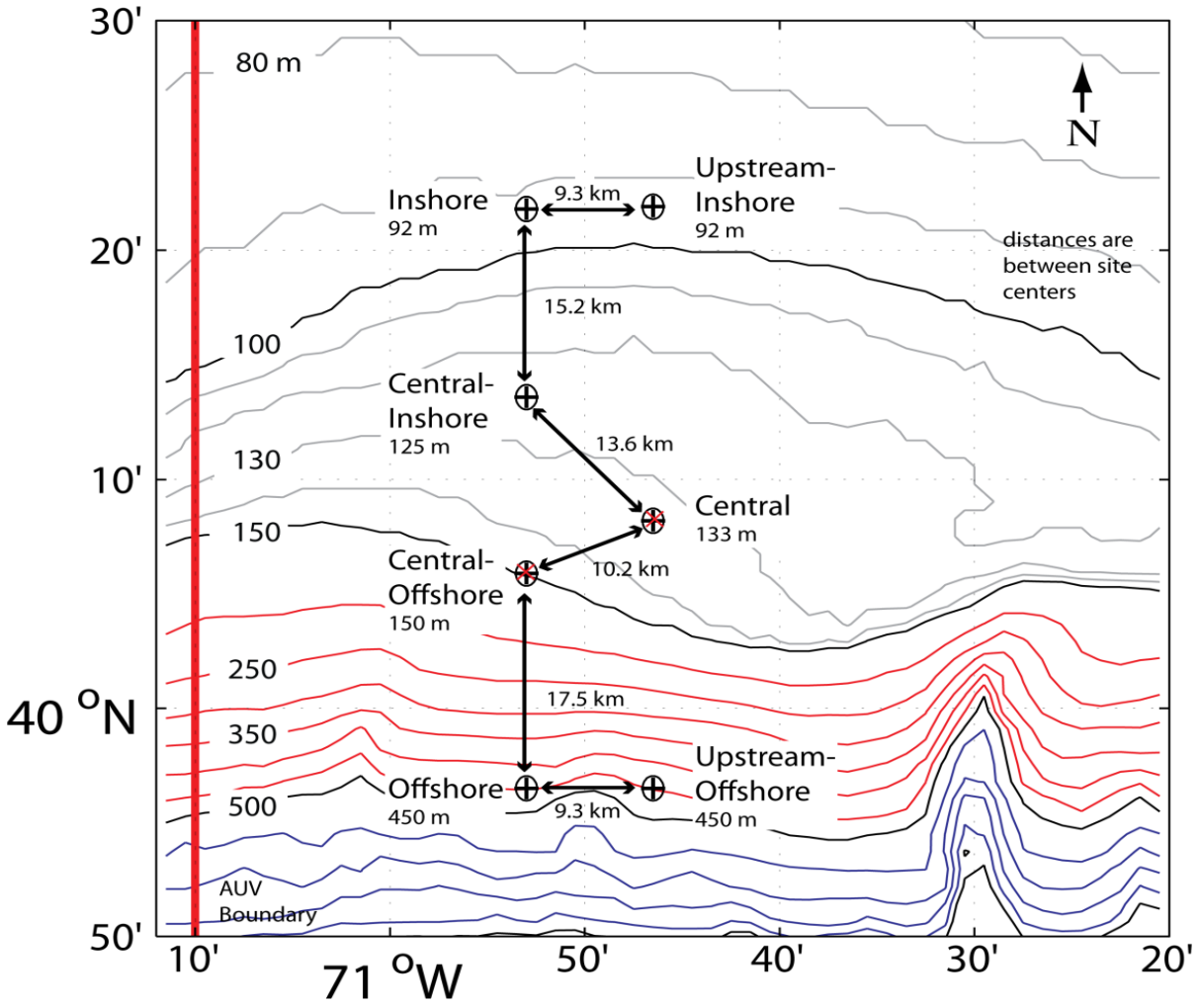

Figure 1-2 Pioneer Array mooring site locations and separations. Site centers are marked by black "+" and encircled by approximate 0.5 nm radius buffer zones. Distances between buffer zones are indicated. Red "x" denote locations of known "hangs" avoided by mobile-gear fishermen. Bathymetry is shown at 10 m (gray), 50 m (red) and 100 m (blue) intervals, respectively. Black contours are at 100 m, 150 m, 500 m and 1000 m.

2.2. Staging and De-Staging

Staging and loading will be done at the Woods Hole Oceanographic Institution (WHOI) dock during 9-10 April. The ship's crane should be suitable for loading all science gear. The project will make arrangements for a shore-side crane if needed. At the discretion of the R/V *Knorr*, partial loading and access to the ship may be possible before the 9th. As part of the staging operation, it will be necessary to mount several antennas and run cables from these antennas to the main lab. Antenna mount locations and cable runs will be determined by consultation with the ship. A list of major equipment to be loaded and a deck plan showing the location of major deck components are provided in Appendix A.

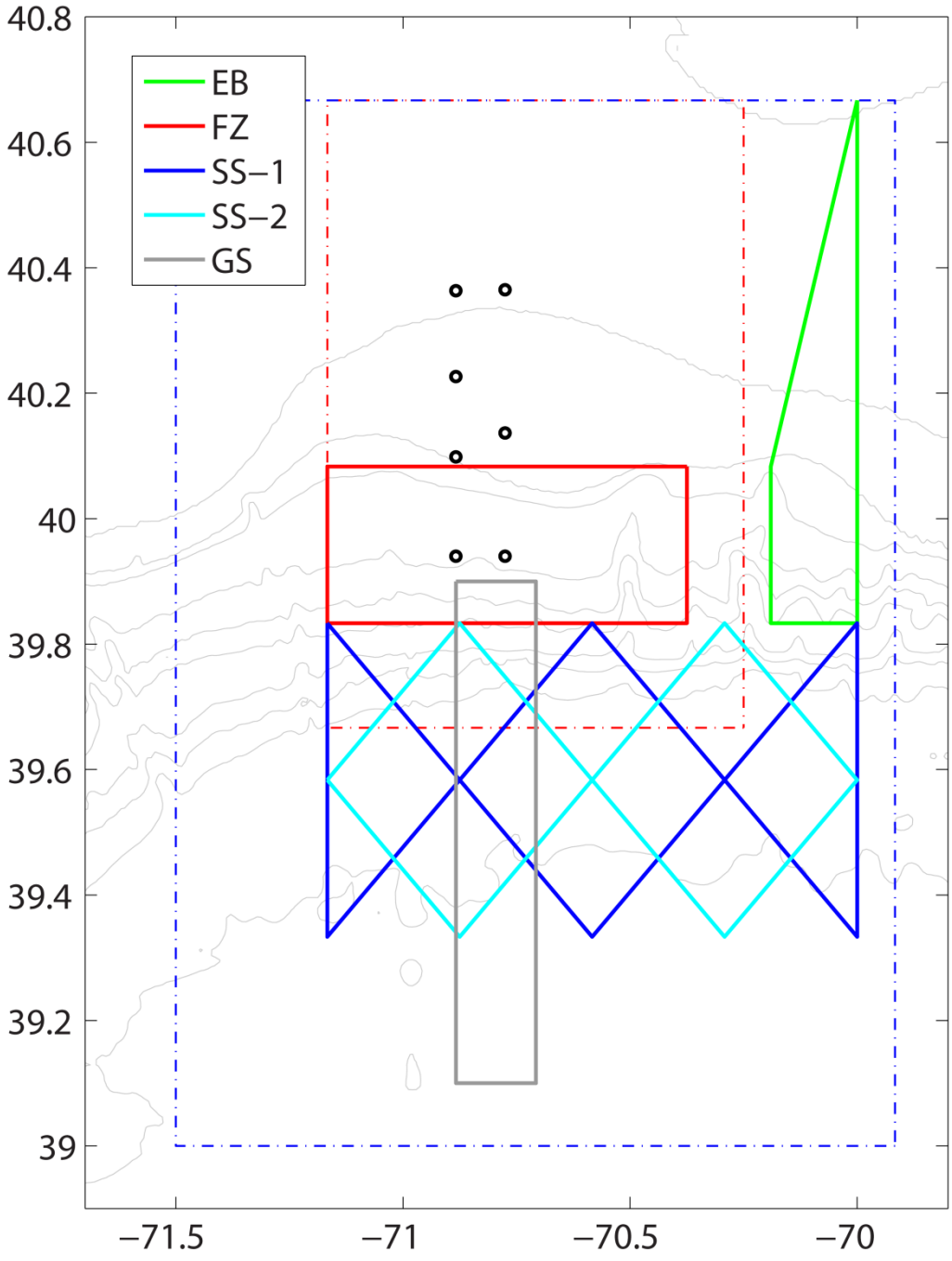

Figure 1-3 Pioneer Array glider lines. The Eastern Boundary (EB, green), Frontal Zone (FZ, red), Slope Sea (SS-1, blue; SS-2, cyan) and Gulf Stream (GS, gray) tracks are shown along with the Pioneer Array moorings (circles) and the glider and AUV operating areas (blue and red dashed lines, respectively).

Destaging and offloading of scientific equipment will be initiated at WHOI upon termination of the cruse on 19 April and will continue on 21 April if necessary. The ship's crane should be suitable for offloading all science gear. The project will make arrangements for a shore-side crane if needed for offloading.

2.3. Cruise Operations and Objectives

The R/V *Knorr* will depart from Woods Hole and transit to the Pioneer Inshore site where operations will commence. In order to open up space on deck, the Fuel Cell mooring will be deployed first. This will be followed by a sequence of Profiler Mooring recoveries and deployments. CTDs with bottle samples will be done in conjunction with the mooring turns. Glider deployments will be interspersed with mooring operations at times and locations chosen for efficiency. Multibeam surveys will be conducted in late evening after mooring and glider operations are completed. A detailed timeline is provided in Appendix A.

The primary Objectives (O1-O9) are listed below. Nominal times for these activities are given in the cruise timeline (Appendix A). Site locations are listed in Appendix B.

O1. Recover the Upstream-Inshore Profiler Mooring (CP02PMUI-00001).

O2. Deploy the Upstream-Inshore Profiler Mooring (CP02PMUI-00002).

O3. Recover the Upstream-Offshore Profiler Mooring (CP02PMUO-00002).

O4. Deploy the Upstream-Offshore Profiler Mooring (CP02PMUO-00003).

O5. Deploy the Central Inshore Profiler Mooring (CP02PMCI-00001).

O6. Deploy the Central Offshore Profiler Mooring (CP02PMCI-00001).

O7. Deploy the Offshore Profiler Mooring (CP04OSPM-00001).

O8. Deploy three gliders (EB, FZ-1, SS-1).

O9. Conduct CTD casts with water sampling at the mooring sites.

There are also Ancillary objectives (A1-A7) that would be desirable to accomplish on the cruise. The Ancillary objectives are listed in rough priority order, and will be completed as time and conditions permit.

A1. Deploy the Fuel Cell (FC03ISSM) test mooring

A2. Recover the Pioneer Central Surface Mooring (CP01CNSM-00001).

A3. Recover the anchor and line pack from CP02PMUO-00001.

A4. Conduct multibeam bathymetry surveys at the mooring sites.

A5. Conduct a CTD survey (no bottle samples) in the vicinity of the moored array.

A6. Conduct shipboard ADCP surveys in the vicinity of the moored array.

A7. Recover a Sonardyne Fetch sensor deployed near the Pioneer CI site.

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 discretion to alter the order of operations as well as 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) or changes to the cruise plan anticipated to have significant financial impacts (e.g. additional ship days) will be communicated to the PM at the earliest opportunity. Incidents involving injury or damaged/lost equipment will follow established Program protocols (UNOLS policies, OOI Incident Reporting Process). Anomalies, suspected failures and confirmed failures will be handled according to the OOI Equipment Notification and Escalation Process.

2.3.1. Release Tests

At a convenient time prior to deployment of the moorings, the science party will to perform release tests. The release tests involve lowering multiple acoustic releases, to one or more depths between 500 m and the surface and held there 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 *Knorr*.

2.3.2. 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.

2.3.3. 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.

2.3.4. Anchor Surveys

Once the anchor has settled on the bottom, R/V *Knorr* will occupy three stations 0.3 to 0.5 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.

2.3.5. 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 analysis will be handled by the science party.

2.3.6. Sensor Performance Evaluation

Sensor evaluation operations will be conducted with at each mooring deployment site and glider deployment site. The primary means of evaluation will be CTD casts obtained in near proximity (e.g. 0.25 nm) to the mooring or glider. For validation of meteorological and sea surface variables the ship will establish and hold a position, with bow into the wind, approximately 0.10 nm downwind of a buoy. This station will be held, and adjusted if necessary, while the science party evaluates data received from the buoy. During this period, the ships 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.

2.3.7. 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. Sea surface temperature and salinity will be recorded continuously, using the ship's thermosalinograph.

2.3.8. Shipboard Multi-beam Bathymetry

Bathymetric surveys will be conducted at the seven Pioneer Array mooring sites (Appendix B). The ship's multibeam system will be used to perform bathymetric surveys covering an area of approximately 1.25 x 1.25 nm surrounding the site centers. Nominal waypoints for each survey will be provided to the bridge. Cruising speed, leg length, and leg spacing can be adjusted as needed to ensure adequate data overlap and good system performance. The results of the bathymetry survey will be displayed and interpreted immediately after the survey in order to confirm the suitability of the deployment site.

2.3.9. 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.

2.4. 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 Appendices

Appendix A – Cruise Timeline

Appendix B – Selected Waypoints and Maps

Appendix C – Equipment Inventory and Deck Plan

Appendix D – Science Party

Appendix E – Mooring Drawings

Appendix A – Cruise Timeline

08 – 10 Apr Mobilization, LOSOS and WHOI pier
11 – 19 Apr Cruise dates (9 DAS)
19 – 21 Apr Demob, WHOI pier and LOSOS (20th is Easter Sunday)

Timeline

11 Apr Depart WHOI
10:00 Depart Woods Hole, steam to Inshore site (~10 h)
Inshore site
Evening/Overnight, multibeam bathymetry survey, Inshore site

12 Apr Inshore site
07:00 – 08:00: Deck prep, ck weather, determine approach, steam line
08:00 – 09:00: Release tests, Fuel Cell mooring and PMCI
09:00 – 12:00: Deploy Fuel Cell mooring
12:00 – 13:00: Anchor survey, Fuel Cell mooring
13:00 – 14:00: Steam to Central Inshore site
Central-Inshore site
14:00 – 15:00: Deck prep, ck weather, determine approach, steam line
15:00 – 18:00: Deploy PMCI-001
18:00 – 19:00: CTD with samples and PMCI profile zero
19:00 – 20:00: Anchor survey, PMCI
20:00 – 22:00: Steam to Central-Offshore site
Central-Offshore site
Evening/Overnight: bathymetry survey, Central-Offshore site
Steam to Upstream-Inshore site

13 Apr Upstream Inshore site
07:00 – 08:00: Deck prep, ck weather, determine approach, steam line
08:00 – 09:00: Release tests, PMUI
09:00 – 12:00: Deploy PMUI-002
13:00 – 14:00: CTD with samples and PMUI profile zero
14:00 – 18:00: Recover PMUI-001
18:00 – 19:00: Anchor survey, PMUI
19:00 – 21:00: Steam to Offshore site
Offshore site
Evening/Overnight: bathymetry survey, Offshore site
Steam to Central-Offshore site

14 Apr Central-Offshore site
07:00 – 08:00: Deck prep, ck weather, determine approach, steam line
08:00 – 09:00: Release tests, PMCO
09:00 – 12:00: Deploy PMCO-001
12:00 – 14:00: Deploy glider FZ-1
14:00 – 15:00: CTD with samples, PMCO profile zero, glider dive zero
15:00 – 16:00: Anchor survey, PMCO
16:00 – 18:00: Release tests, OSPM, PMUO
18:00 – 19:00: Steam to Upstream-Offshore site

Upstream-Offshore site
Evening/Overnight: bathymetry survey, Upstream-Offshore site
Steam to Offshore site

15 Apr Offshore site
07:00 – 08:00: Deck prep, ck weather, determine approach, steam line
08:00 – 09:00: Release tests, OSPM
09:00 – 12:00: Deploy OSPM-001
12:00 – 13:00: CTD with samples and OSPM profile zero
13:00 – 14:00: Anchor survey, OSPM
14:00 – 15:00: Steam to SS-1 Waypoint 3
SS-1 Waypoint 3
15:00 – 19:00: Deploy glider SS-1
19:00 – 20:00: CTD with samples, glider dive zero
20:00 – 22:00: Steam to Central-Inshore site
Upstream-Offshore site
Evening/Overnight: bathymetry survey, Central-Inshore site
Steam to Upstream-Offshore site

16 Apr Upstream-Offshore Site
07:00 – 08:00: Deck prep, ck weather, determine approach, steam line
08:00 – 09:00: Release tests, PMUO
09:00 – 10:00: Recover PMUO-001 anchor and line pack
10:00 – 13:00: Deploy PMUO-003
14:00 – 15:00: CTD with samples and PMUO profile zero
15:00 – 19:00: Recover PMUO-002
19:00 – 20:00: Anchor survey, PMUO
20:00 – 22:00: Steam to Upstream-Inshore site
Upstream-Inshore site
Evening/Overnight: bathymetry survey, Upstream-Inshore site
Steam to Central site

17 Apr Central site
06:00 – 07:00: Visual inspection of CNSM buoy
07:00 – 09:00: Small boat operation, buoy shut down
09:00 – 10:00: Deck prep, ck weather, determine approach, steam line
10:00 – 11:00: CTD with samples near CNSM
11:00 – 15:00: Recover CNSM-001
15:00 – 18:00: Document and disassemble CNSM
Central site
Evening/Overnight: bathymetry survey, Central site
Steam to EB Waypoint 4

18 Apr EB Waypoint 4
08:00 – 11:00: Deploy glider EB
11:00 – 12:00: CTD with samples, glider dive zero
12:00 – 18:00: Ancillary activities

19 Apr Arrive WHOI

Station List: Pioneer 2, R/V Knorr April 2014

See timeline for order of occupation; some sites are occupied more than once

Name	Code	Lat	Lon	water depth	comments
Upstream-Inshore	UI	40 21.9	70 46.5	91.5 m	profiler mooring recovery and deployment, CTD
Inshore	IS	40 21.8	70 53.0	91.5 m	surface mooring deployment
Central-Inshore	CI	40 13.6	70 53.0	125 m	profiler mooring deployment, CTD
Central	CN	40 08.2	70 46.5	133 m	surface mooring recovery, CTD
Central-Offshore	CO	40 05.9	70 53.0	150 m	profiler mooring deployment, CTD
Offshore	OS	39 56.4	70 53.0	450 m	profiler mooring deployment, CTD
Upstream-Offshore	UO	39 56.4	70 46.5	450 m	profiler mooring recovery and deployment, CTD
Glider EB	EB	40 05.0	70 11.4	~150 m	1 glider deployment, CTD
Glider FZ	FZ	40 05.0	70 53.0	~150 m	1 glider deployment, CTD
Glider SS-1	SS-1	39 50.0	70 35.0	~1000 m	1 glider deployment, CTD

Table B-1: Pioneer 2 station list

.

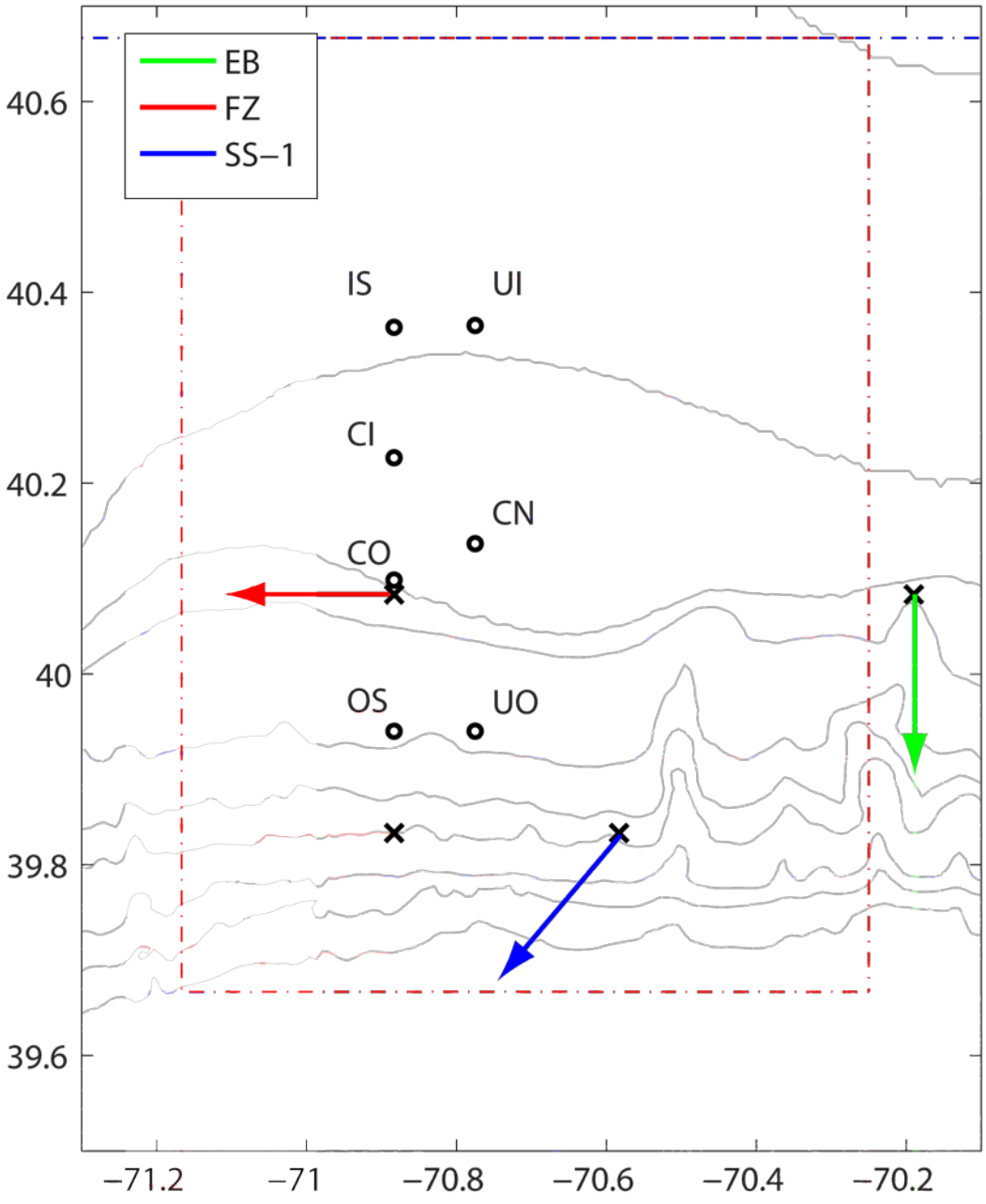

Figure B-2: Station map for Pioneer-2. The seven Pioneer Array mooring sites (circles) are shown along with three proposed glider deployment sites (crosses). Moorings will be recovered from UI, UO and CN sites and deployed at all sites except CN.

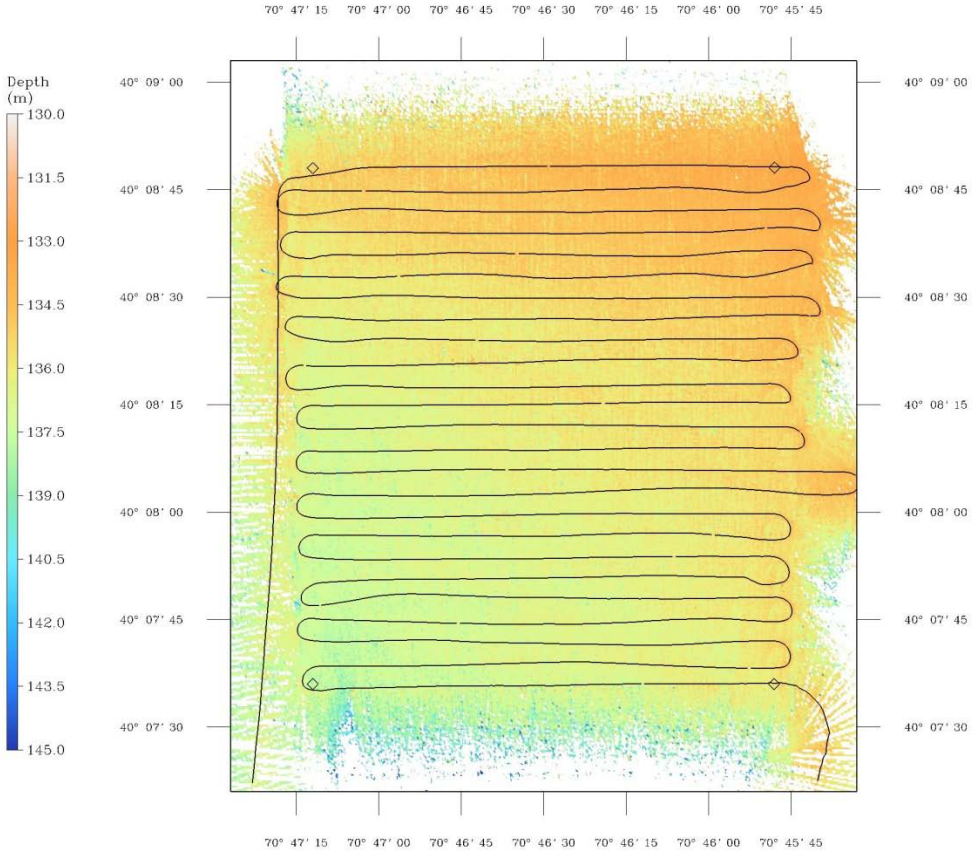

Figure B-3: Example of multibeam bathymetry survey conducted at the Pioneer Central site during At-Sea Test 2. The area surveyed is approximately 1.25 nm x 1.25 nm. The spacing between lines is about 0.05 nm. The total track distance is about 35 nm, which would take about 5 h to complete at 8 kt.

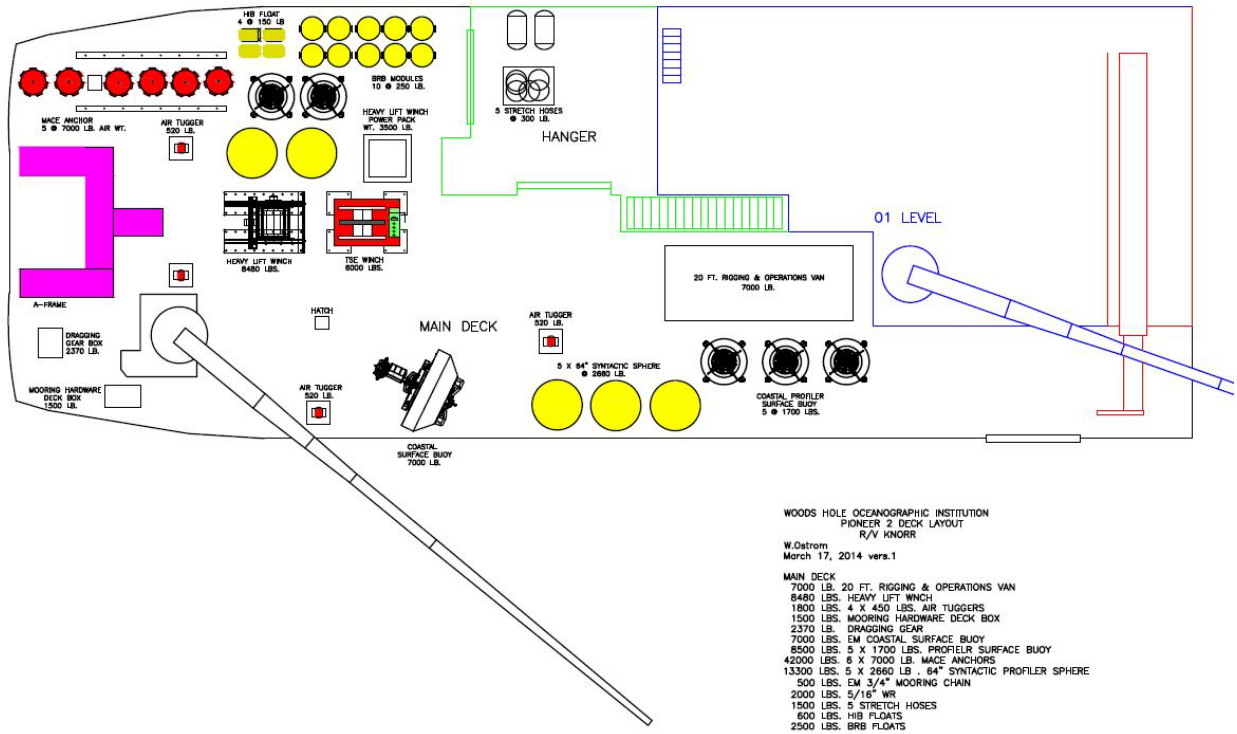

Figure C-1: Nominal deck layout for the major components associated with Pioneer-2 operations. Proposed location of major deck elements are shown. Estimates weights of major deck components are also documented in a table. The approximate deck load is 99,000 lb and the lab gear is estimated to be an additional 5,000 lb.

Table C-1: Estimated Deckload

Need updated version for Pioneer-2

	Ocean Observatories Inititve (OOI)		
	Pioneer 1 Deployment Cruise		
	Projected Deckload		
Piece No.	Description of Items	Unit Dimensions L" x W" X H"	Weight in Lbs.
	Support Equipment		
1	20 Foot Rigging and Operations Container	240 x 96 x 96	12000
2	TSE Mooring Winch	108 x 98 x 72	7000
3	Heavy Lift Anchor Winch	48 x 48 x 30	8400
4	HLW Power Pack	72 x 48 x 50	3000
5	Air Tugger Winch on Stand	28 x 28 x 57	520
6	Air Tugger Winch on Stand	28 x 28 x 57	520
7	Air Tugger Winch on Stand	28 x 28 x 57	520
8	Air Tugger Winch on Stand	28 x 28 x 57	520
9	Galvanized Bell Mouth	52 x 53 x 10	820
10	Galvanized Anchor Track (1 set)	151 x 8 x 9	500
11	Hydraulic Tensioning Cart	67 x 48 x 51	690
12	Fairlead Plate	28 x 28 x 7	170
	Central Surface Mooring - CP01CNSM		
14	Surface Buoy	102 x 102 x 156	10000
15	Electrical Mechanical Potted Chain	12 x 12 x 220	500
16	Near Surface Instrument Frame (NSIF)	48 x 24 x 24	300
17	Wooden Reel with EOM Cable	36 x 36 x 30	400
18	Plastic Bin Box with (2) EOM Stretch Hoses	56 x 45 x 45	900
19	Hose Interface Buoyancy (HIB)	24 x 30 x 30"	300
20	Hose Interface Buoyancy (HIB)	24 x 30 x 30"	300
22	Benthic Anchor Recovery Frame (BARF) with Mooring Anchor	60 x 60 x 40	10,700
	Surface Mooring with Profiler - CP02PMUI		
21	Pressure Hardened Surface Buoy on stand	96 x 48 x 48	800
22	64" Syntatctic Sphere on Stand	48 x 48 x 60	2580
23	Plastic Bin Box with (4) EM Stretch Hoses	56 x 45 x 45	600
24	Wooden Reel with 5/16" Mooring Cable	32 x 32 x 30	380
25	Backup Recovery Module (BRB)	56 x 44 x 44	490
26	Backup Recovery Module (BRB)	57 x 44 x 44	490
27	Cast Iron Mooring Anchor	33 x 32 x 40	7000
	Surface Mooring with Profiler - CP02PMUO		
28	Pressure Hardened Surface Buoy on stand	96 x 48 x 48	800
29	64" Syntatctic Sphere on Stand	48 x 48 x 60	2580
30	Plastic Bin Box with (4) EM Stretch Hoses	56 x 45 x 45	600
31	Wooden Reel with 5/16" Mooring Cable	32 x 32 x 30	380
32	Backup Recovery Module (BRB)	56 x 44 x 44	490
33	Backup Recovery Module (BRB)	57 x 44 x 44	490
34	Cast Iron Mooring Anchor	33 x 32 x 40	7000
		Total Weight (Lbs.)	**82740**
		Total Weight (Tons)	**41.37**
	Estimated Weight		

Appendix D - Science Party

There will be 12 participants in the science party, all affiliated with the Woods Hole Oceanographic Institution (WHOI). The Chief Scientist is Dr. Albert J. Plueddemann (WHOI). WHOI Shipboard Scientific Services Group (SSSG) participants will be Laura Stolp and Dave Sims. An alphabetical list is given in the table below.

Participating Scientists

Name	Gender	Nationality	Affiliation
1. Caporelli, Elizabeth	F	USA	WHOI
2. Batchelder, Sidney	M	USA	WHOI
3. Dunn, James	M	USA	WHOI
4. Kemp, John	M	USA	WHOI
5. Lemmond, Peter	M	USA	WHOI
6. Lund, John	M	USA	WHOI
7. Murphy, Steven	M	USA	WHOI
8. Plueddemann, Al	M	USA	WHOI/Chief Sci
9. Ryder, Jim	M	USA	WHOI
10. Sims, Dave	M	USA	WHOI/SSSG
11. Stolp, Laura	F	USA	WHOI/SSSG
12. Wellwood, Dave	M	USA	WHOI

Roles and responsibilities will be delegated among individuals and groups per the following major categories. These assignments are representative, and not intended to be limiting – all participants will assist with multiple aspects of the cruise effort as warranted.

- Overall cruise coordination and execution
  - Al Plueddemann, John Kemp
- Cruise documentation, deployment records, platform and instrument metadata
  - Liz Caporelli, John Lund (profilers), Sidney Batchelder (gliders)
- Logistics, deck operations, mooring hardware, mooring operations
  - John Kemp, Jim Ryder, Steve Murphy, Jim Dunn
- Mooring control, power and telemetry systems
  - John Lund (profilers), Bob Petitt and Protonex (Fuel Cell)
- Instrument configuration, preparation and pre-deployment checks
  - John Lund (profilers), Sidney Batchelder (gliders)
- Platform configuration and mission plan
  - John Lund (profilers), Sidney Batchelder (gliders)
- Hydrographic sampling, including physical sample preparation
  - Dave Wellwood, Liz Caporelli, Sidney Batchelder
- Shipboard Scientific Services (CTD, ADCP, multibeam)
  - Laura Stolp, Dave Sims, Peter Lemmond (multibeam)

Appendix E - Mooring Drawings

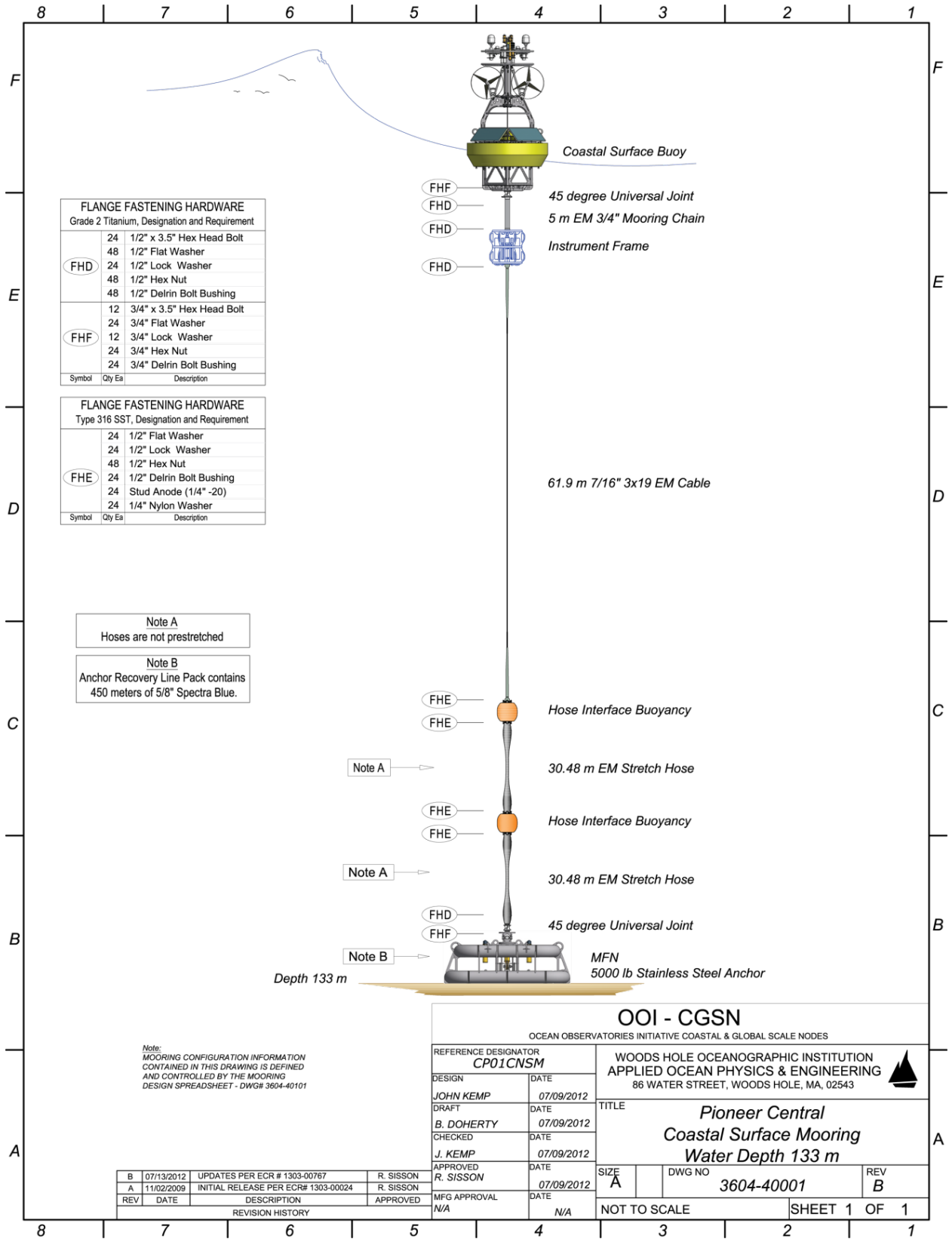

Figure E-1. Pioneer Central Surface Mooring (CNSM).

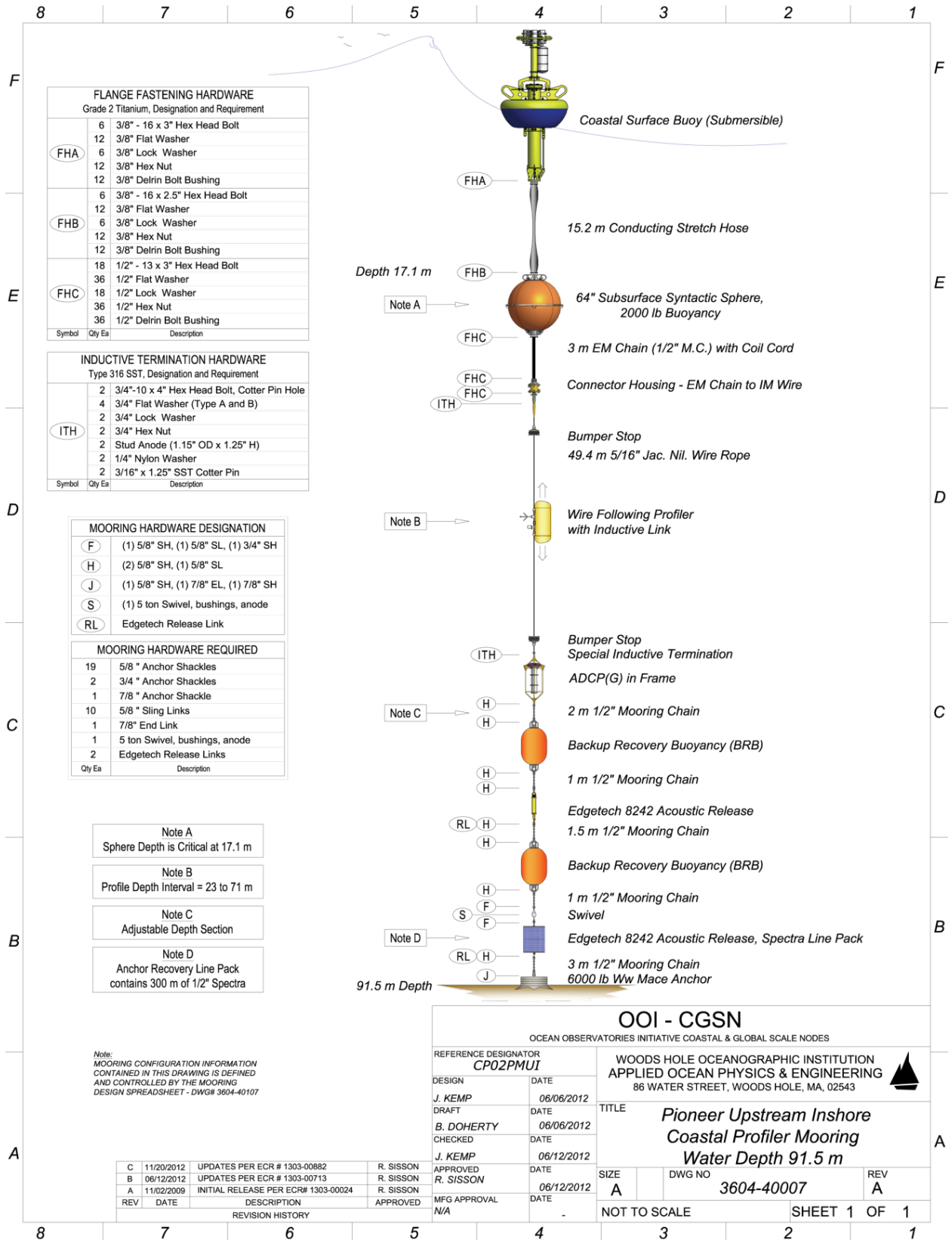

Figure E-2. Pioneer Upstream Inshore Profiler Mooring (PMUI).

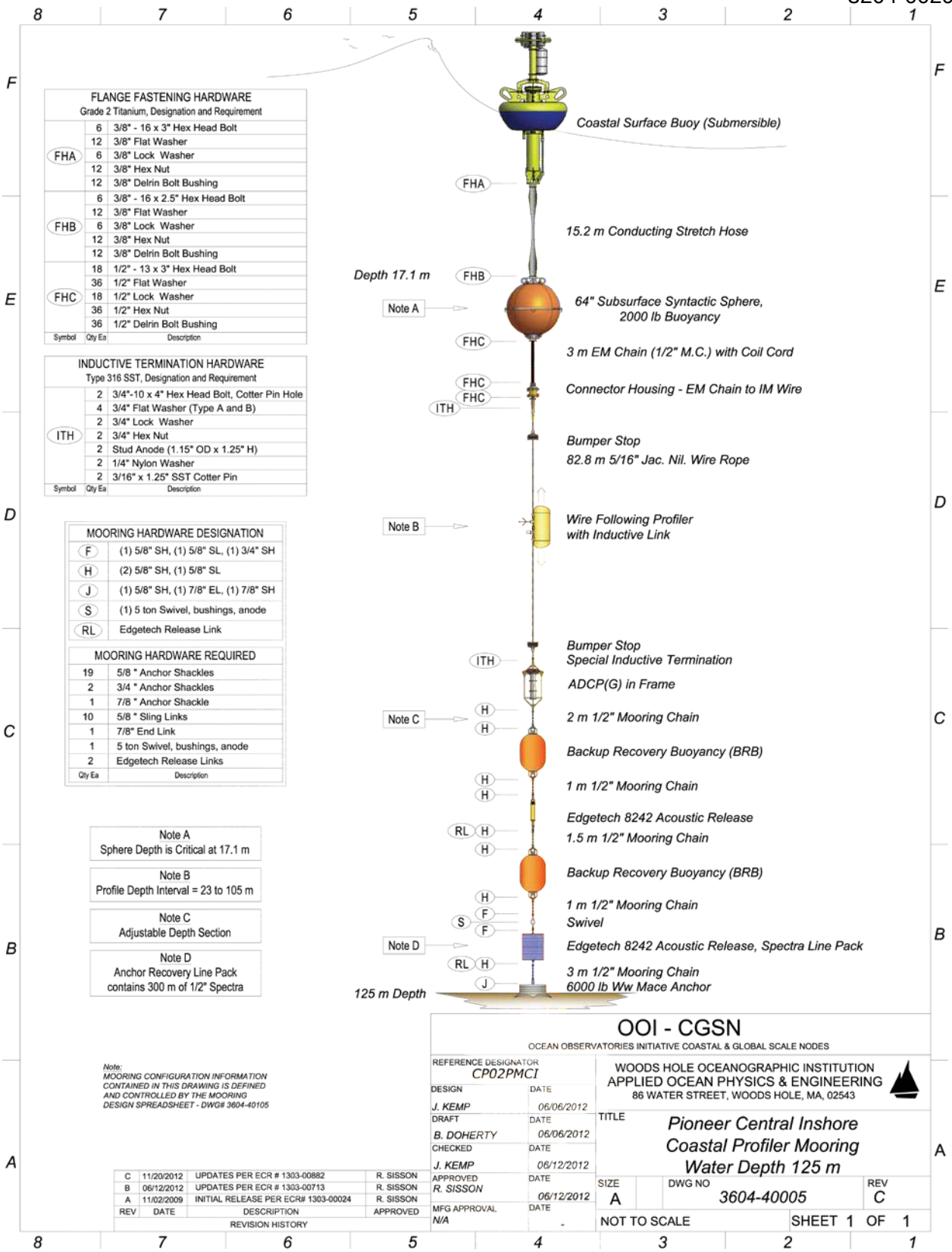

Figure E-3. Pioneer Central Inshore Profiler Mooring (PMCI).

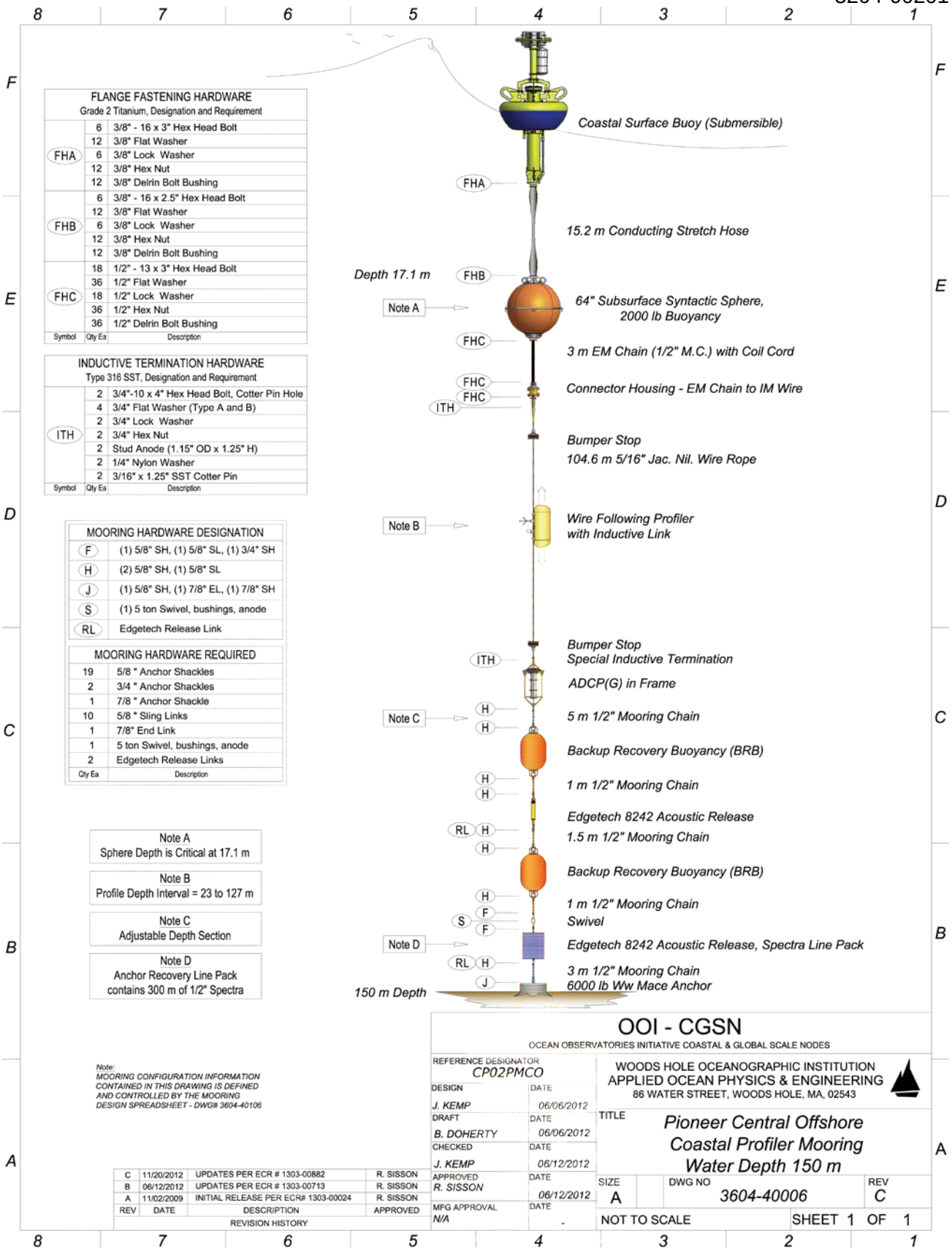

Figure E-4. Pioneer Central Offshore Profiler Mooring (PMCO).

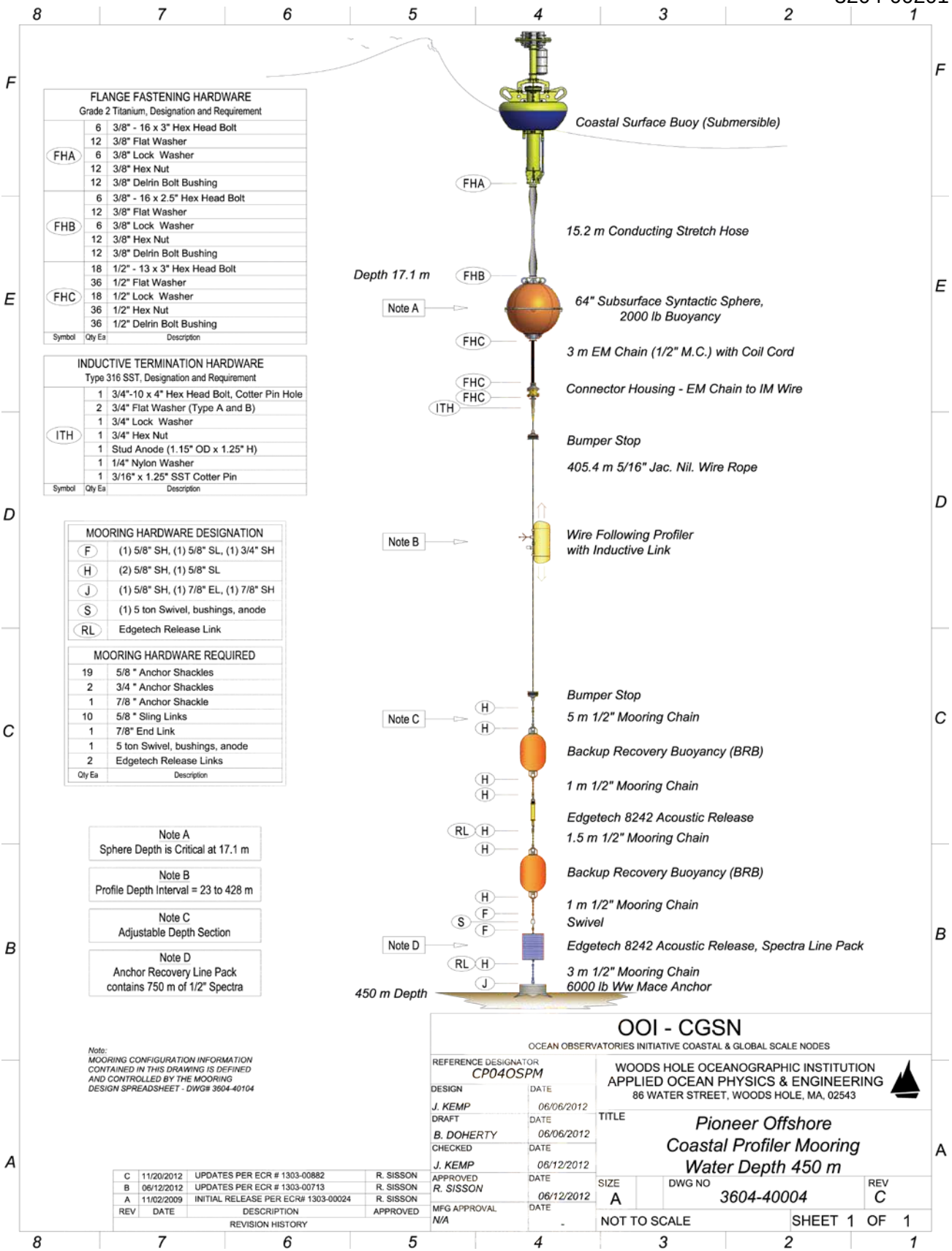

Figure E-5. Pioneer Offshore Profiler Mooring (OSPM).

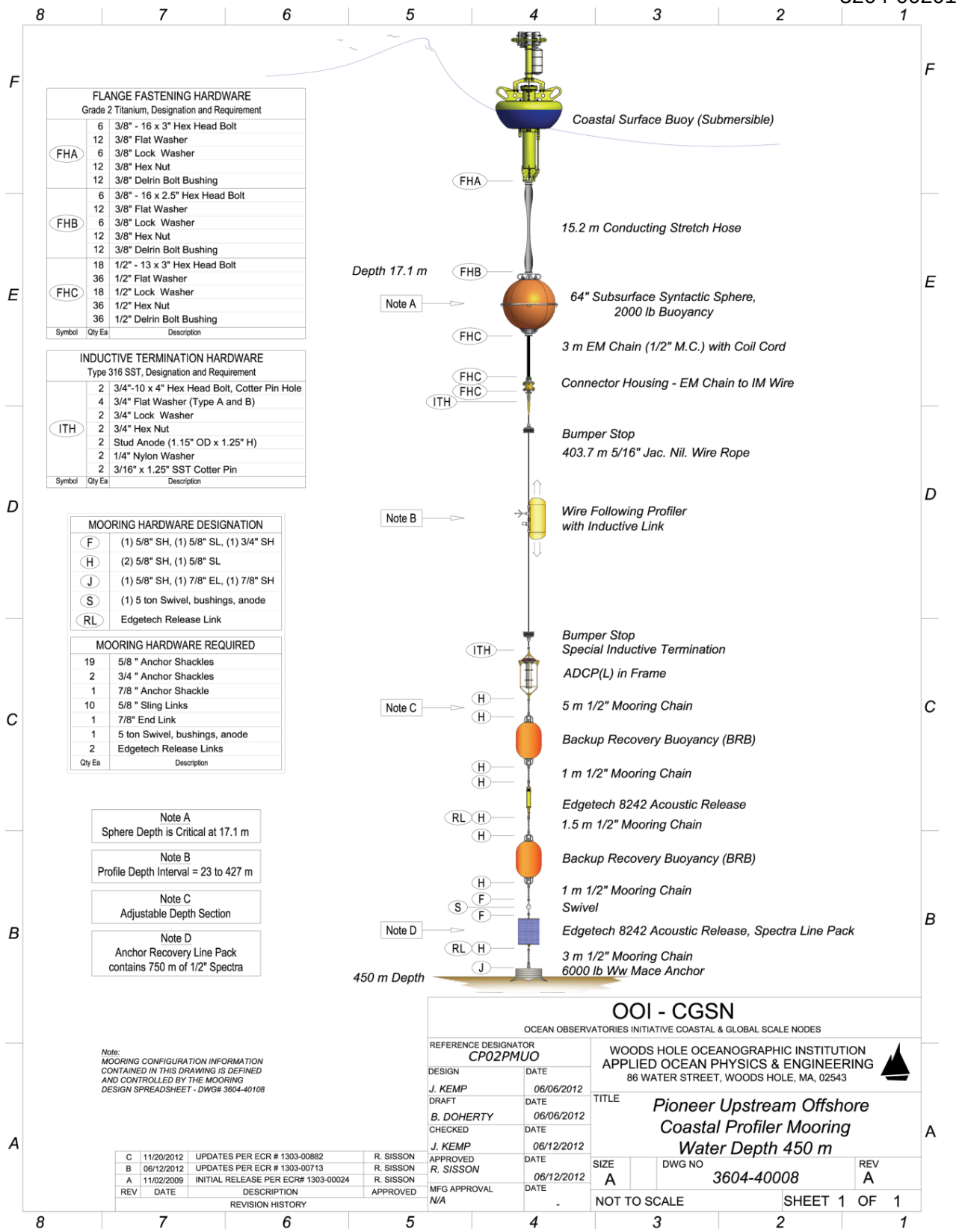

Figure E-6. Pioneer Upstream Offshore Profiler Mooring (PMUO).