Cruise Plan for R/V *Kilo Moana* KM-2312A,B:
ALOHA Cabled Observatory Service
and
Deep Water Sentinels Deployment
19 August – 27 August 2022

Version 2.0

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1. Introduction

The ALOHA Cabled Observatory 100 km north of Oahu at Station ALOHA is the deepest (4728 m) power and internet node on the planet, returning oceanographic data from the seafloor in realtime to shore. The ACO has been operational with plug-and-play capability since 6 June 2011.

The provision of any long-term sustainable power on the seafloor is a continuing challenge. The Naval Research Laboratory (NRL) will deploy three prototype Deep Water Sentinel (DWS) fuel cells that take advantage of the difference in oxygen concentration in sediment (low) and in the water above (high) to generate a small amount of electrical power (~50 mW) mediated by microbes in the sediment.

On this cruise, we will perform engineering testing of the ROV, service the ACO infrastructure and instrumentation and deploy marine sediment fuel cells. Specific objectives are:

Dives 1 and 2
- Shallow ROV test dive, 430 m

Dives 3 and 4
- Deep ROV test dives, 2500 m and 4728 m

Dive 5
- Deploy and connect Basic Sensor Package 3 (BSP3; icListen hydrophone) to Observatory (OBS) port E4.
- Recover CAM1 (video camera, two lights, and hydrophone, in place since 2011.

Dive 6
- Test and use Port Test Tool (PTT) on all unused ports, on Secondary Node 1 (SN1, J3 and J4) and the OBS (E2 and E7).
- Recover ROV

Dive 7
- Recover CAM2
- Housekeeping (clean sea electrode, video survey of all bottom packages).

Dive 8
- Deploy the Deep Water Sentinel (DWS) Fuel Cell packages.
- Take sediment cores
- Search for lost CTD

Dive 9
- Survey and video ACO repeater R-60 and cable 50 km offshore of Makaha

Recovering CAM1 and CAM2 will allow a complete upgrade/repair (new camera, lights, and hydrophone), to then be deployed during the next cruise. BSP3 hydrophone will be deployed as far to the SSE of the HEM hydrophone as possible, on a line that is broadside to signals from the Kauai Beacon acoustic source (along 166 deg true, to the SSE of the JBOX/HEM. The PTT will test power, communications, and timing for each (unused) node port.

The fuel cells will be left in place until the next ROV visit, currently planned in December 2023.

The ROV *Lu'ukai* is the *sine qua non* for performing this work.

The ACO portion of the science party will consist of Bruce Howe, Chief Scientist; Grant Blackinton, Engineer; and 6 graduate students. Blue Eisen, ACO project engineer, is shared with the ROV team. The NRL team will consist of Jeff Book and Marius Pruessner.

This cruise is funded by (ACO portion) NSF award 1926188 ALOHA Cabled Observatory Operations and Maintenance, and award 2220319 Maintaining Deep Ocean Observations: The ALOHA Cabled Observatory. The NRL portion is funded by ONR.

The nominal schedule is as follows:

8/15 Tuesday - 18 Friday Mobilization.
8/19 0800 Saturday departure
8/20 0000 - 8/21 0300 *Lu'ukai* testing and maintenance and ACO transit.
8/21 0300 - 8/24 2359 ACO mission
8/25 0000 - 8/26 2359 NRL mission and CTD search
8/27 0000 - 1200 Transit to Honolulu
8/27 Demob

The detailed schedule has enough time to allow a 12 hour dive/survey of the ACO R60 cable repeater off Makaha during the transit back to Honolulu.

Table 1-1 gives coordinates of relevant points See Figure 1-1 for a map with cruise lines. The transit distance from the Sea Buoy to ACO (via Shallow Dive site) is 108 nm, and the returning distance (via R^) location is 120 nm, 10.3 hours and 11.4 hours, respectively, at 10.5 kt.

Location	Depth m	Latitude deg	N minutes	Longitude deg	W minutes
UHMC, Pier 35		21	18.933	157	52.628
Honolulu Sea Buoy		21	16	157	54
Shallow Test dive site	430	21	14.931	157	58.480
Barbers Point WP		21	16	158	09
ACO Repeater R-60	2629	21	29.51	158	37.81
Ka'ena Ridge WP		21	33	158	20
ACO Cable Termination Frame (CTF)	4728	22	44.324	158	00.372
Station ALOHA		22	45	158	00
Deep Water Sentinel (DWS)	4728	22	42.431	157	55.642
Lost CTD	4728	22	42.431	157	55.642

Table 1-1 Coordinates of waypoints and stations

In this Plan, we first describe some of the history of the ACO system and as it is now installed followed by a description of the new instrumentation to be installed. A section on the fuel cell is included. The ROV system is described, including the navigation system. The ship and deck configuration are described followed by a section on mobilization and responsibilities. The operations are described with a timeline (some readers may wish to skip some of the preceding material). An even more detailed step-by-step plan is given in Appendix B. Other appendices have system diagrams and connections, personnel/contacts, berthing, acronyms, and social media links.

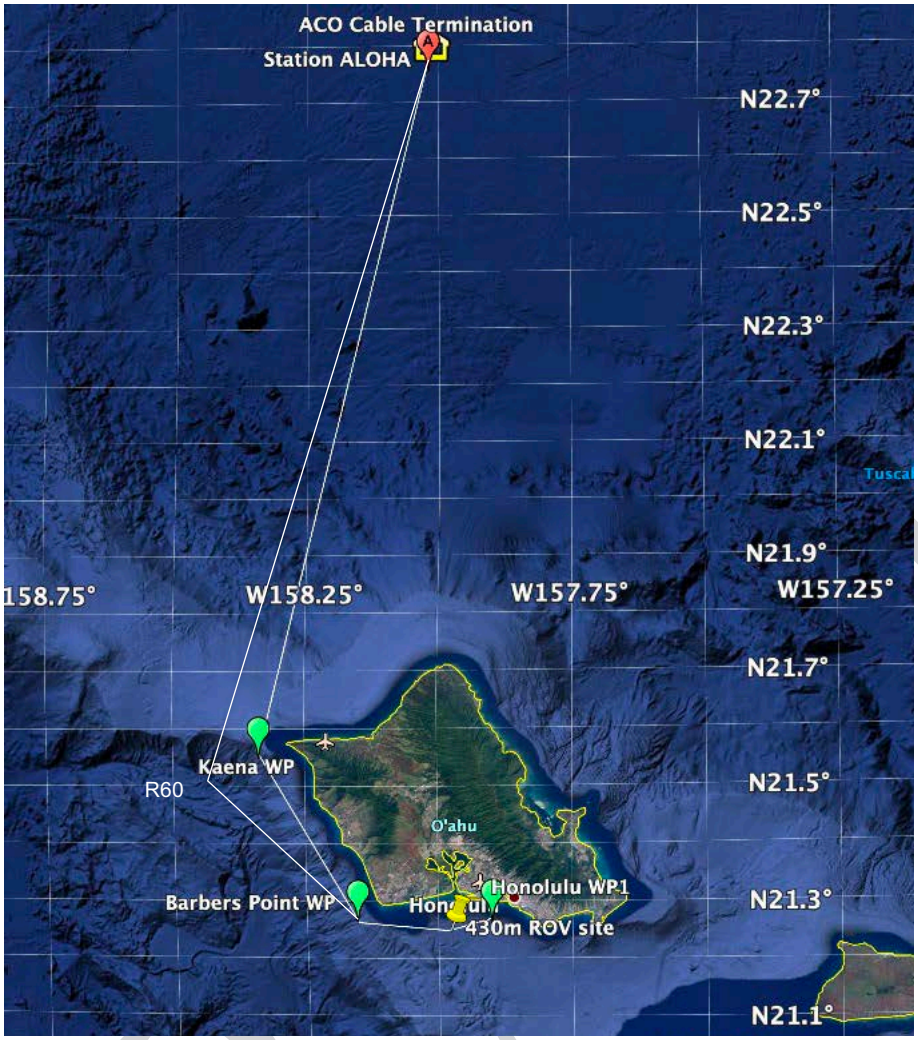

Figure 1-1 Map of area and nominal cruise lines.

2. ACO Description

Information on the previous service cruises (KM-21-07, KM-19-13, KM-18-09, KM-17-07, KM-15-16 and KM-14-26) and installation cruise (KM-11-16) can be found in the respective cruise plans and reports, and the Oceans11 paper. See the list of references and the ACO web site for this and other information including photographs and video, http://aco-ssds.soest.hawaii.edu/index.html. Because the ROV operations are so important for this cruise, this plan is written to emphasize those aspects. The copious background material is for the benefit of those new to the ACO and these operations.

The ACO is an example of a deep ocean observatory system that uses a retired submarine telecommunications cable. The ACO uses a highly reliable existing transoceanic cable system to provide power and communications bandwidth to a "node" on the seafloor. In the simplest terms, we provide power and communications ports for users to plug into on the seafloor for arbitrary instrumentation. Here we include core instrumentation for scientific measurements of water properties (pressure, temperature, salinity, velocity, optics), video and acoustics/ocean sound, and acoustic communications (presently absent). Most of these are Essential Ocean Variables (EOVs) of the Global Ocean Observing System.

The ACO node and instrumentation were deployed in May-June 2011 with CAM1, continuing a timeseries February 2007 – October 2008 using just a proof module with a pressure sensor and a

hydrophone. A subsequent service cruise in November 2014 removed a failed secondary node and added CAM2, LIGHT1, and basic sensor package BSP1. These subsequently failed, because of connectors known or suspected. In September 2015, BSP2 was plugged in, but the ROV failed, and time ran out before we could connect LIGHT4, and before we could recover BSP1, CAM2 and LIGHT1. The KM-17-07 cruise was a failure from the ACO service point of view, as the main ship's winch failed at the start and in the process of recovering the cable, the fibers were broken at 4500 m. During the KM-18-09 cruise, BSP3 with hydrophone and secondary node 1 SN1 were deployed. BSP2 was damaged during repair. BSP1 was recovered. During the 2019 cruise, BSP2 was repaired and redeployed, BSP3 (icListen hydrophone) was recovered, and LIGHT4 connected for CAM1. LIGHT4 failed in December 2020 as did the CT sensor on the OBS, leaving only one operating CTD on BSP4. In 2021, we deployed and connected a new Basic Sensor Package 5 (BSP5; CTDO2 -conductivity, temperature, depth/pressure, oxygen) to the Observatory (OBS); deployed and connected CAM2 (video camera, two lights, and hydrophone – a completely new version) to Secondary Node 1 (SN1); and deployed the memorial plaque for Fred Duennebier in view of CAM2. CAM2 failed in early 2023.

Photographs of the system at various stages are shown below to familiarize the cruise participants and a brief description of various components is given. System block diagrams with the last interconnections are shown in Appendix A, along with the planned configuration. Section 3 addresses new components and an overview of tasks.

Figure 2-1 shows an image taken by *Jason* of the seafloor equipment in November 2014; from left to right, CAM2, CAM1, LIGHT1, OBS, and JBOX (with HEM – hydrophone experiment module). The cable termination frame (CTF) is to the right (Figure 2-2). CAM1 is shown in Figure 2-3. A map showing all present-day and planned components is given in Figure 2-4.

The ELEVATOR is basically a package of deep-rated flotation with suitable mounting for beacons and recovery lines, dual acoustic releases, and then a weight below that can be acoustically released or by the ROV cutting the line to the drop weights.

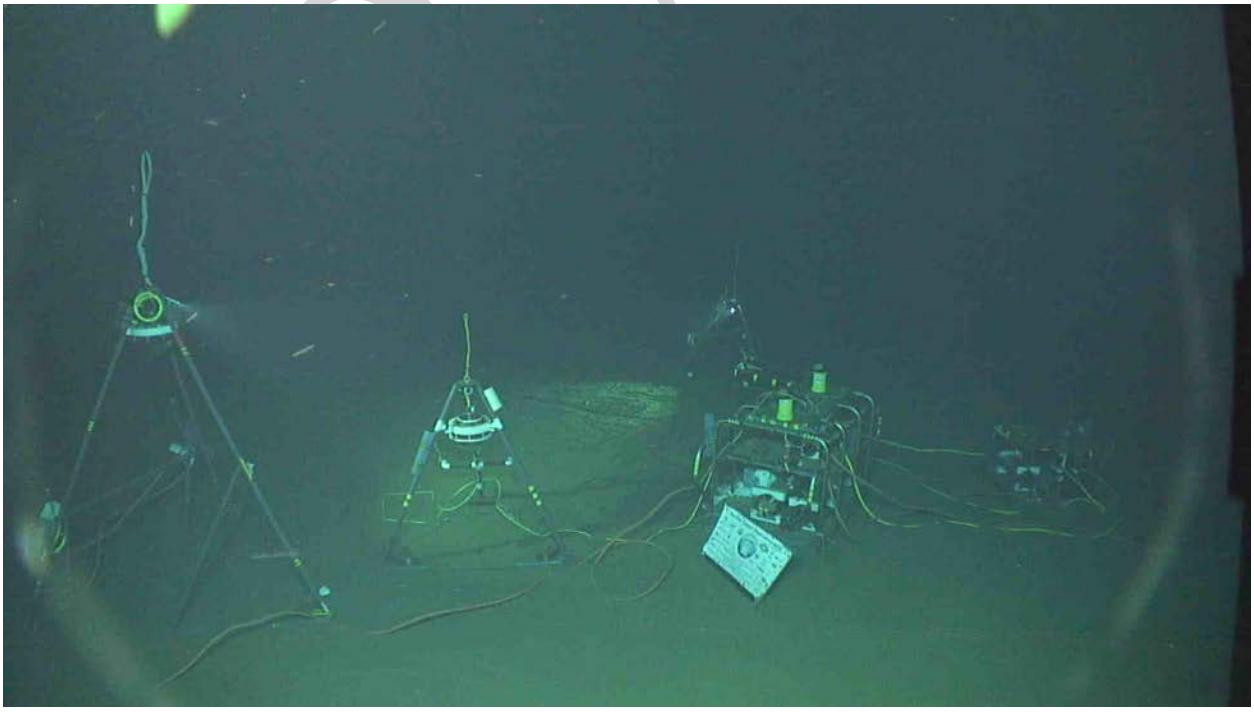

Figure 2-1 Image of system at the end of the November 2014 cruise.

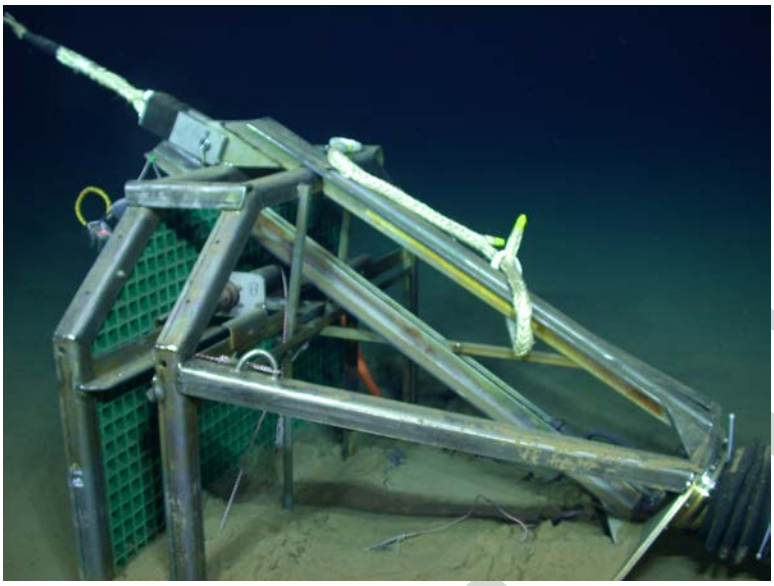

Figure 2-2 The cable termination frame, 2011

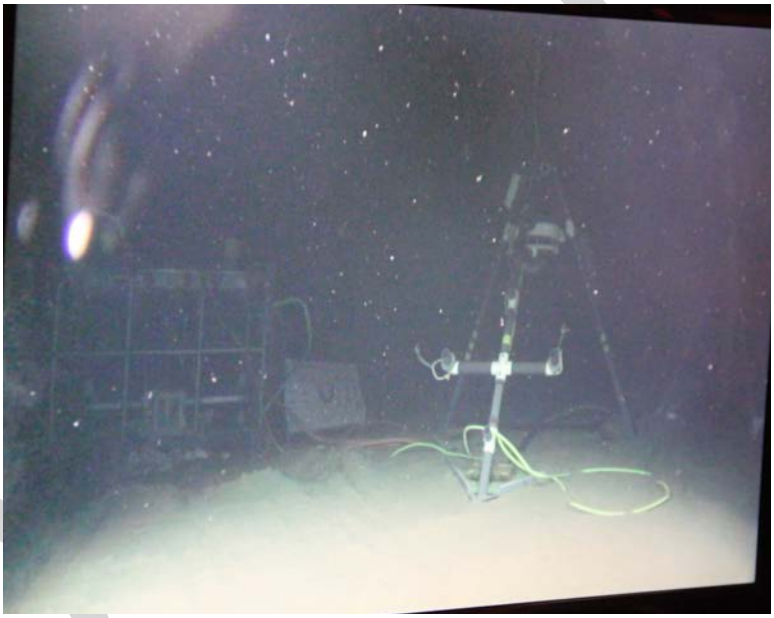

Figure 2-3 From Lu'ukai, OBS, sponsor poster, and CAM1

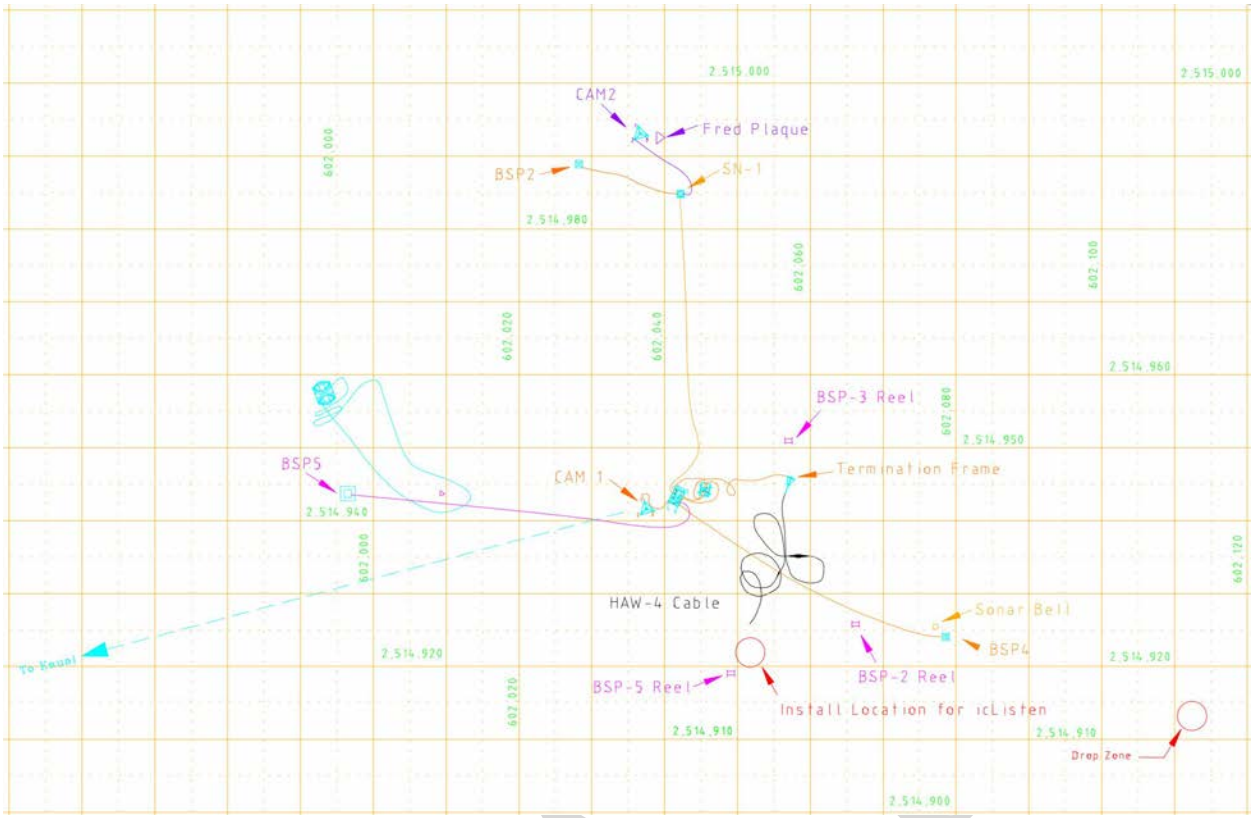

Figure 2-4 Present ACO seafloor configuration (June 2021 – August 2023).

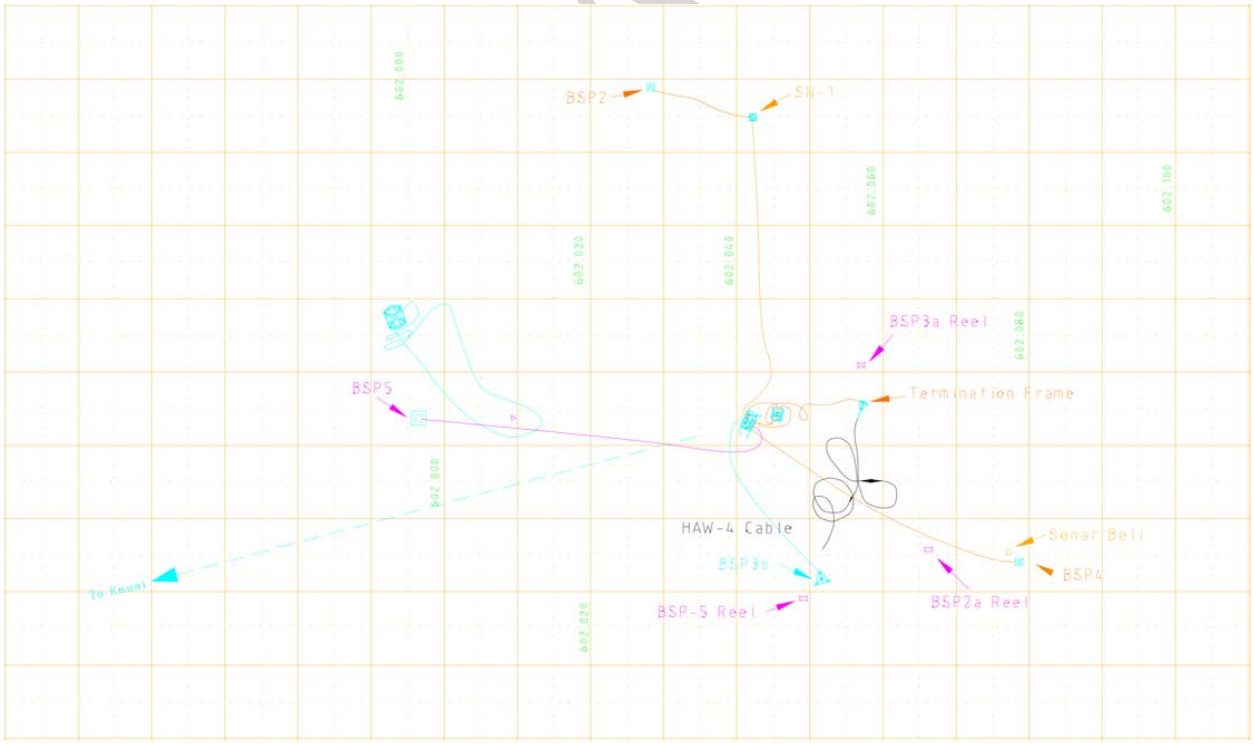

Figure 2-5 Desired post-cruise layout, after August 2023.

The ACO cable termination is connected to the junction box (JBOX) with an ODI hybrid optical fiber/electrical hose assembly. The JBOX provides the fiber-to-electrical 100 Mb/s Ethernet and generates a precise pulse-per-second referenced to GPS on shore using IEEE-1588v2-PTP

precise time protocol. On the JBOX frame is the hydrophone experiment module (HEM), now with one working hydrophone.

The observatory (OBS) is connected to the JBOX. The OBS converts the dc current on the cable to 48 V and 400 V, and distributes this, the 100 Mb/s Ethernet, and timing signals to eight user ports. On the observatory are two acoustic Doppler profilers (ADPs, one working), a temperature/conductivity instrument (CT, failed December 2020), and a light (failed), that are connected to one "micro science experiment module" (μSEM) that is in turn (hard) connected to one OBS port, E6. Note the orientation guides: yellow tape on corners (1-4; 1 is port bow, 2 is starboard bow, …), and port numbers; see also Appendix A for a schematic of this including instrument port assignments. Deck pictures show the CTD and light in stowed positions, as they are now since both have failed. Note the seawater return/ground plates on the bottom of the Observatory, port side (the white aragonite material needs to be periodically removed). Also note the pin-protecting dummy at the stern on the middle deck; there is also one in the E6 position on the port quarter.

Figure 2-6 OBS frame (on deck and seafloor).

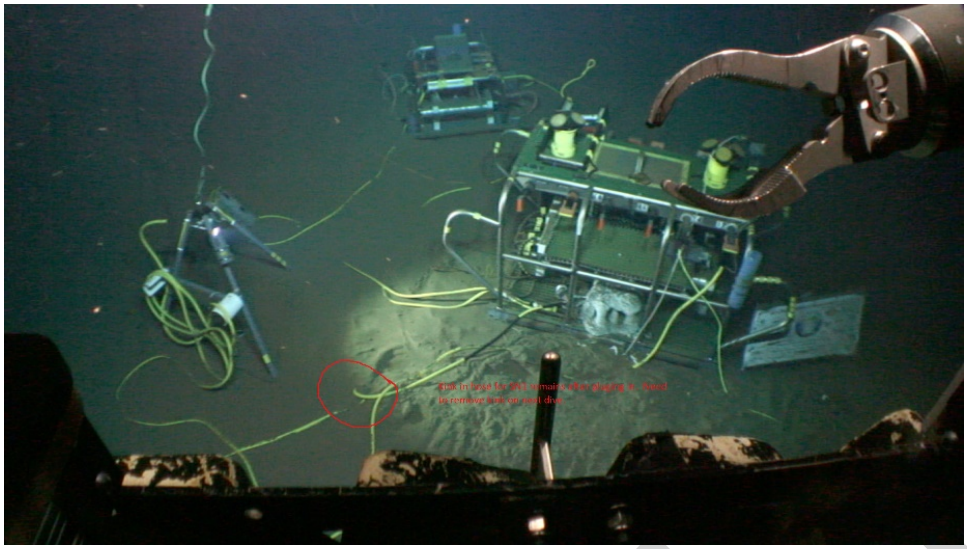

Figure 2-7 One view at end of June 2018.

The (failed) LIGHT1 is shown in Figure 2-8. The stand-alone LIGHT4 is a copy of LIGHT1. LIGHT4 is presently still connected to the OBS and was illuminating CAM1 until it failed in December 2020. Both failed lights were recovered in 2021.

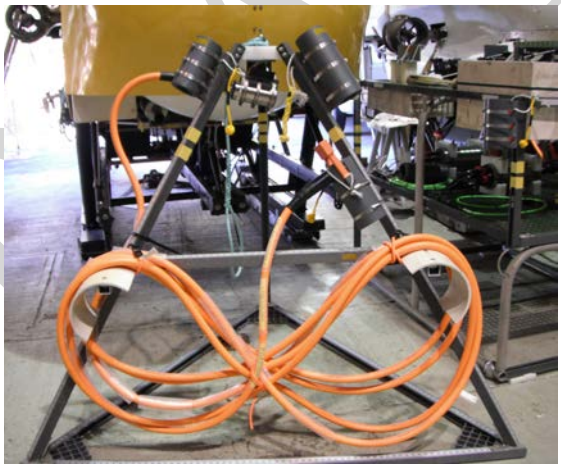

Figure 2-8 LIGHT1 – stand alone (with holsters)

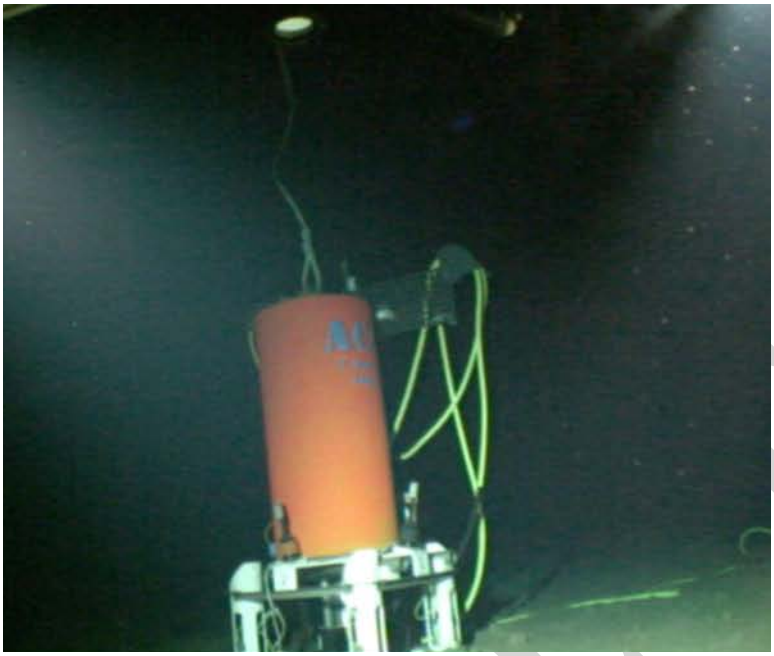

Figure 2-9 SN1 looking SE, prior to BSP2 being connected.

The input to SN1 comes from OBS E8 at 400 V on J5, along with ethernet, the 1 PPS and IRIG-B. This gets split between J1-J4. IEEE-1588v2 PTP is generated locally from the 1 PPS, and then distributed to J1-J4, with a 1 PPS; rather than IRIG-B being distributed, an ascii NMEA string with time of day is distributed.

The BSP2 (Figure 2-10) is made up of a Science Instrument Interface Module (SIIM, from APL-UW), several science instruments, and a frame with syntactic foam buoyancy and ballast weights and provision for carrying navigation beacons. The BSP2 is connected to the OBS via a 50 m pressure balanced oil-filled (PBOF) hose with a 12-pin flying connector, and a corresponding dry mate connector to the SIIM. This SIIM has been modified so it can plug into a 400 V port if necessary. The SIIM aggregates multiple instruments so that only one standard 12-pin connect or is required to connect to the Observatory (OBS) or similar. The SIIM brings together the following sensors: Seabird conductivity, temperature, depth (pressure) and oxygen pumped (CTDO2), SBE-52/43MP; Paroscientific nano-resolution pressure sensor; and WetLabs fluorometer/turbidity optical sensor (FLNTU). BSP2 is now deployed connected to SN1 and deployed west of SN1 50 m.

On BSP4 (Figure 2-11), the SIIM brings together the following sensors: Seabird conductivity, temperature, depth (pressure) and oxygen pumped (CTDO2), SBE- 37 SMP ODO; RBR bottom pressure recorder (BPR); WetLabs fluorometer/turbidity optical sensor, FLNTU; Woods Hole Oceanographic Institution (WHOI) acoustic micro-modem. Only the CTDO2 is working now. The corners of the BSP4 are numbered and marked with yellow tape (ADCP is at the bow): port bow, 1 tape; starboard bow 2 tapes; starboard stern 3 tapes; port stern 4 tapes. This is the same convention as with the OBS. BSP4 is now deployed about 40 m SE of the OBS.

A 200-mm diameter SonarBell is moored nearby 2 m off the bottom, attached to the parking position tripod, as a passive beacon (325 kHz) that will show on the sonar display (hard to see in Figure 2-11 as it is black).

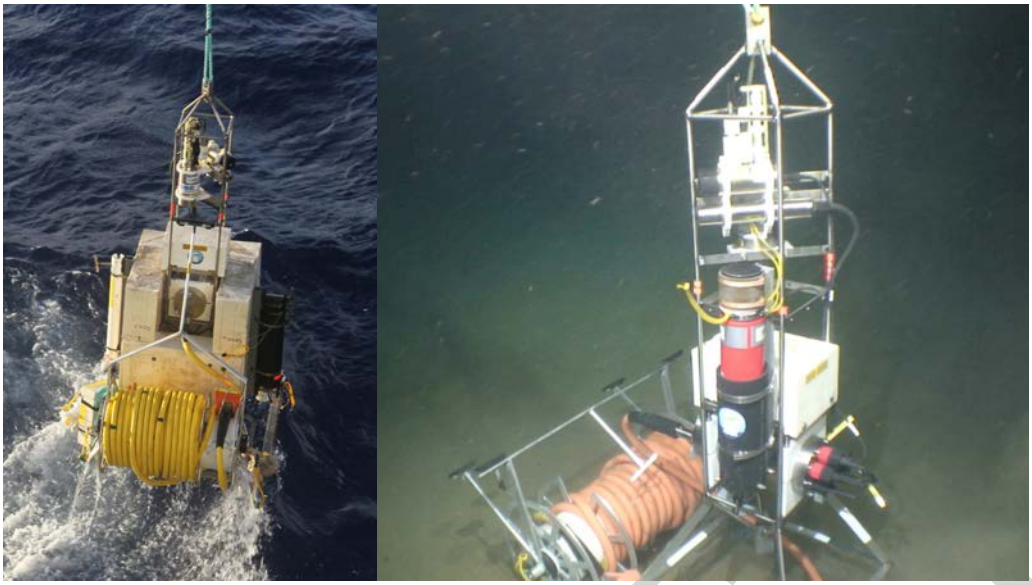

Figure 2-10 BSP2 with cable reel (2018, 2019 after repair).

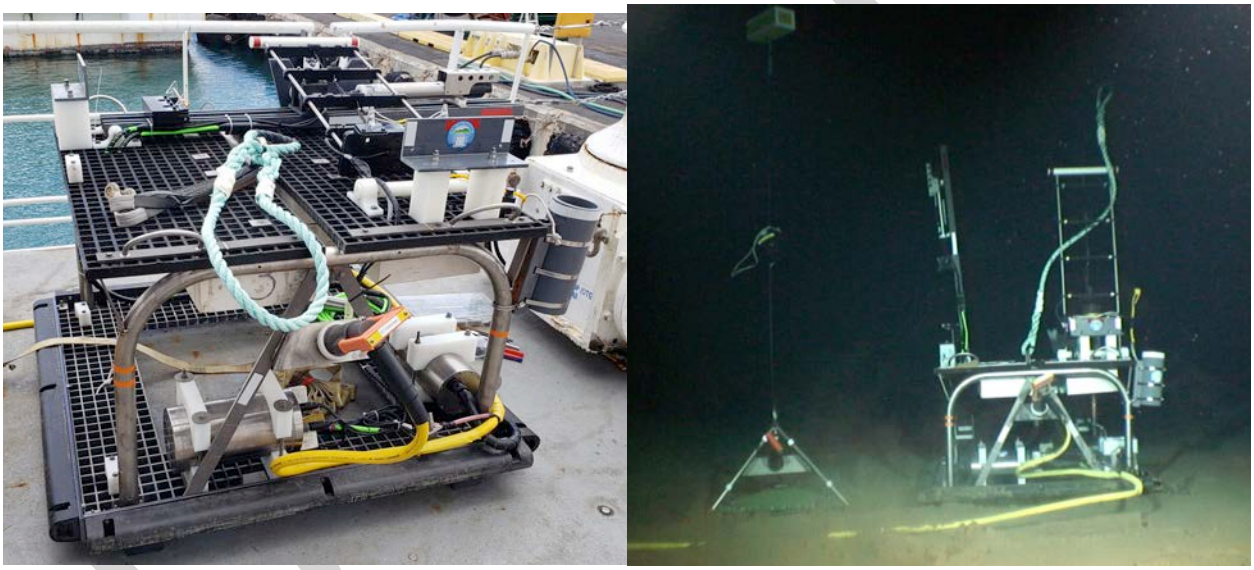

Figure 2-11 BSP4 at Makai pier for testing (left) and on the seafloor (right).

Figure 2-12 ELEVATOR

Figure 2-13 BSP5, on ELEV, port extension assembly, pre deployment 2021.

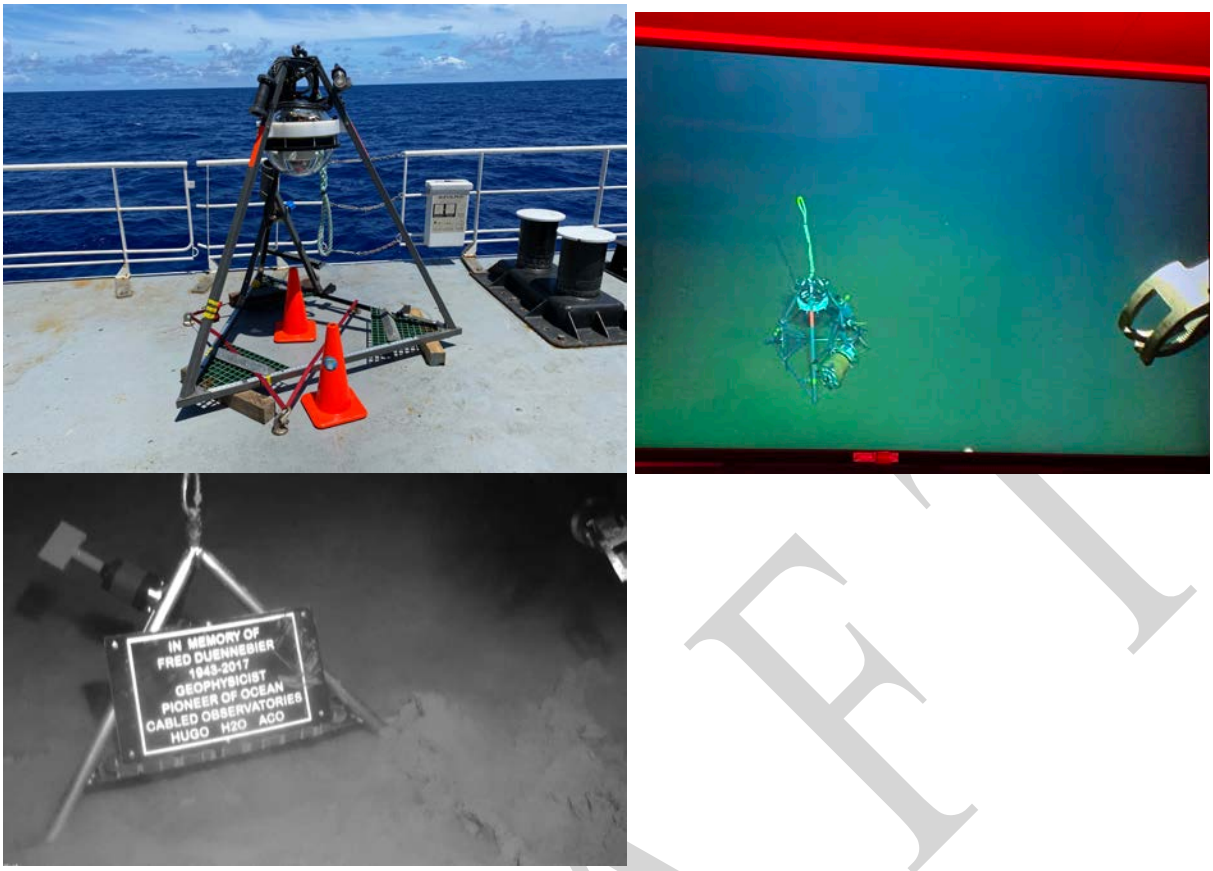

Figure 2-14 CAM2, and Fred's plaque 2021

3. New ACO Equipment and Overview

Some equipment (CAM1 and CAM2) will be recovered and new equipment installed (BSP3, icListen hydrophone) so that we end with a system layout as shown in Figure 3-1. A preview of tasks is useful here (more detail in Section 10 below). If all goes according to plan, for ACO, there are three ROV dives and 2 ELEV trips are required.

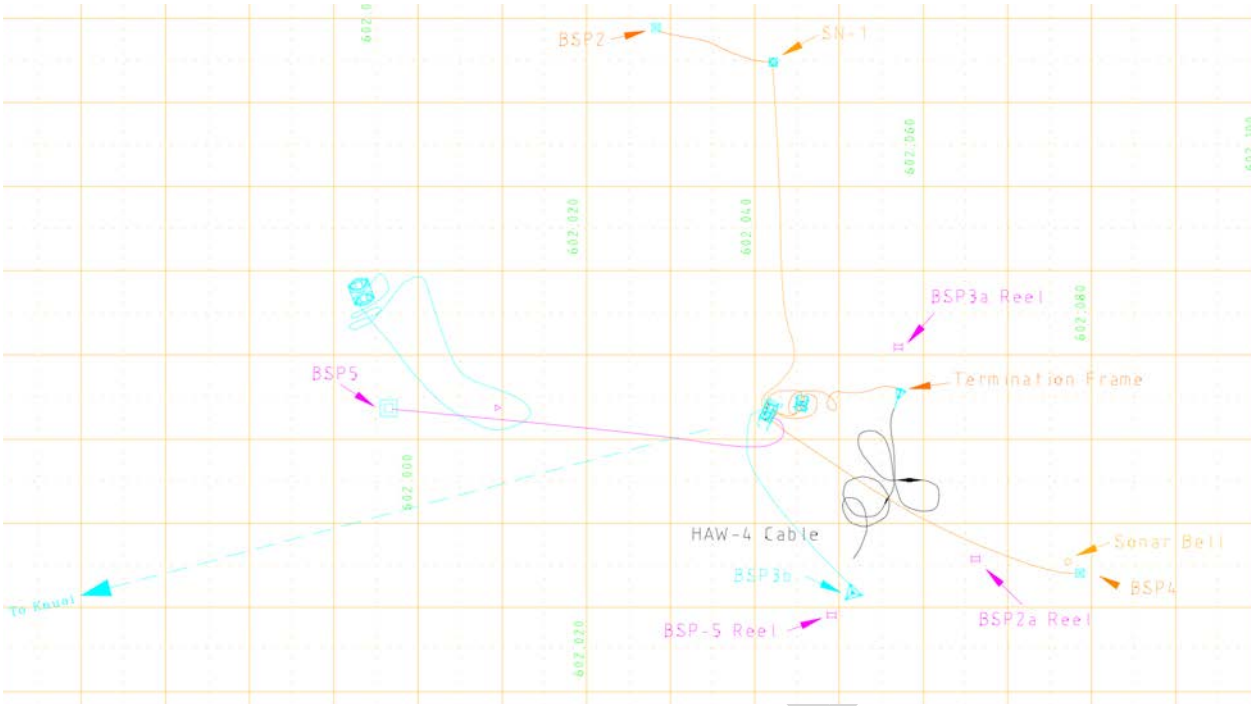

Figure 3-1 ACO Layout after 2023 elements.

BSP3 (Figure 3-2) will be the single new instrument package deployed. It has a single icListen hydrophone. It has been modified. In the PBOF hose, a small container with a (pressure tested) 48V to -12V dc-dc converter is in-line. After this is connected, CAM1 will be recovered using the ELEV.

On the second ACO dive, a newly developed Port Test Tool will be used to test the unused ports for power/voltage, communications and timing. Ports both on the OBS and the SN1 will be tested.

CAM2 will be recovered using the ELEV on the last ACO dive.

Figure 3-2 icListen in Lab

Figure 3-3 Port Test Tool in ROV basket

4. Deep Water Sentinel (DWS) Fuel Cell

The objective of this experiment is to demonstrate and test the potential for benthic microbial fuel cells to generate sufficient sustained electrical power when deployed at depths > 4000 m on the abyssal plain to run underwater electronics for long periods. The experiment will specifically gather data on the potential for power output of the fuel cell using an anode formed out of graphite gravel. Two replicates of that design will be deployed and compared to a fuel cell with a graphite plate as a control replicate. See Figure 4.1.

Figure 4-1 Deep Water Sentinel (DWS) fuel cell package.

We will be collaborating with the University of Hawaii (UH) to deploy and recover three test landers on the sea floor at depths > 4000 m using the ROV *Lu`ukai*. The approximate location of the deployment will be 22° 42.431'N 157° 55.642'W, 130 miles offshore of Oahu Hawaii, nearby the Aloha Cabled Observatory. This location is one of the closest full ocean depth sites to a UNOLS home port and is well characterized with regards to sediment type and other environmental properties from past UH work that has been conducted there. Use of an ROV is needed to position the landers and assure that they are deployed correctly with their anodes underneath the lander and shielded from the overlaying water by the lander body and rubber flukes attached to the body to prevent anode oxygen exposure. The landers will be left on the sea floor from their expected deployment in August 2023 until their expected recovery in December 2023.

5. ROV and TMS

ROV *Lu`ukai* is a two-body ROV system (Figure 5-1). A 0.681-inch electro-optic-mechanical (EOM) cable delivers electrical power and commands from the ship through the TMS and then to the ROV, both return data and live video imagery. The TMS serves as a dock for the ROV facilitating launch and recovery. When the ROV is swimming free of the TMS loosely tethered, the ROV is then decoupled from the movements (heave primarily) of the ship. While the tether is 100 m long, operationally, making effective use of this length requires further testing/practice. The TMS provides lighting and a bird's eye view of the ROV during seafloor operations. On this cruise, the ship's 0.681-inch electro-optical-mechanical cable is used as the main umbilical to TMS.

Figure 5-1 TMS and ROV.

6. Navigation

Lu'ukai will navigate in several ways. In addition to video, a scanning sonar will be used to detect targets/packages to a range of ~50 m. For large area coverage, the UH Sonardyne ultra-short-baseline (USBL) system will be used. The USBL transducer head will be installed on the retractable stem on the port side that can lower the sensor head 6-ft below the bottom of the hull. It will measure range and solid angle to beacons on the TMS and ROV, and our packages. The azimuthal orientation will be calibrated as the first step at Station ALOHA, using the beacons deployed on BSP5 and ELEV (a process called a Casius survey).

The ultra-short baseline transducer is a Sonardyne Marksman LUSBL Model 8023 with a 50° wide downward looking beam. The accuracy specification is 0.27 percent 1 Drms Slant Range, i.e., 63 per cent of fixes lie within 13.5-meter radius in 5,000 meters water depth. The transponder beacon is shown in Figure 5-3. The two beacons (Avtraks) on the TMS and ROV will be configured as responders (triggered with an electrical signal from the deck unit). WMT transponders will be used on the instrument packages. Absolute geographical position is provided by the ship's POS-MV system using Fugro GPS with decimeter accuracy.

The shipboard computer system and software has been recently updated, as has the firmware in the ship transceiver and all the transponders. A "Casius" survey will be conducted in deep water at the ACO site to calibrate the ship transceiver.

Figure 6-1 USBL Wideband Mini Transponder (WMT) – 7000 m

7. Deck Layout

When on deck, *Lu`ukai* will sit on the centerline under the A-frame. The tool van and the ROV control van will sit on the O1 level, port side. The motor-motor generator will be placed on the O1 level, starboard side. The Slack Tension Unit (STU, a passive heave compensation device) will be put in line between the traction winch and the A-frame, immediately adjacent to the bulkhead of the winch room. The STU weights 13,000 lb and the base plate 3,500 lb. The ELEV and BSP3 will be placed on the aft port quarter for deployment with the crane. CAM1 and CAM2 will take the place of BSP3 when they are recovered.

Interior space is allocated as follows: The PI and the ROV crew share Lab2. ROV supplies will be in the HydroLab. NRL will have the Chemistry Lab (forward, starboard). Hydraulic oil supplies will be in the WetLab. Personnel are free to use the rest of the lab space for personal computers, etc.

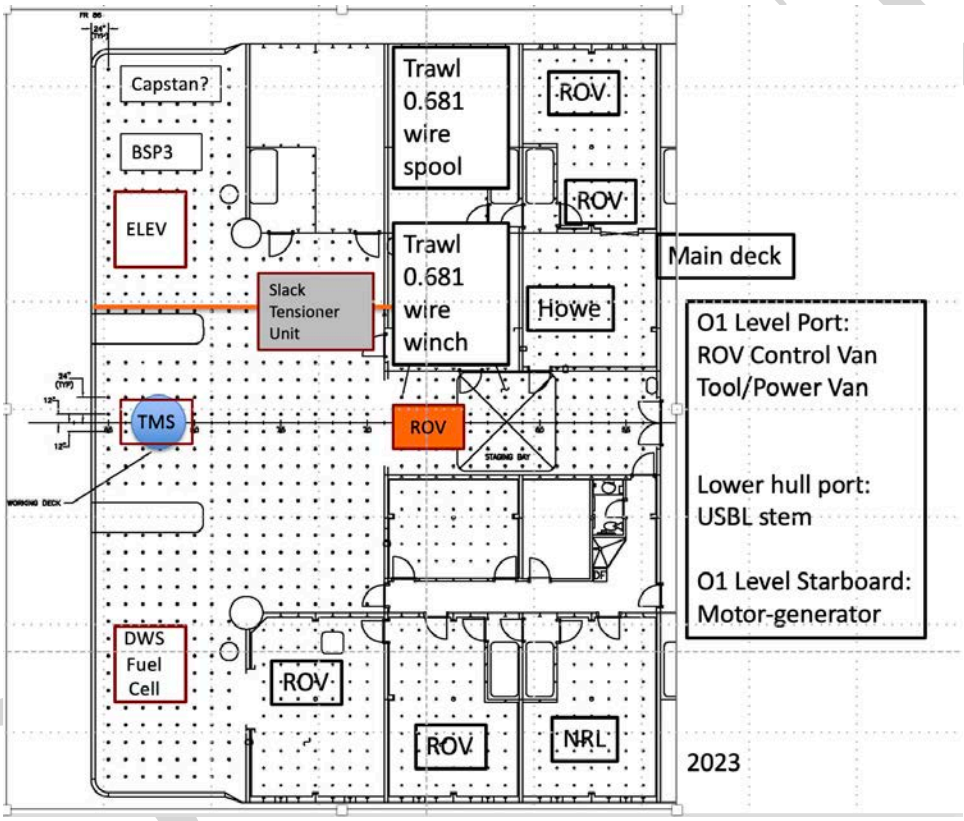

Figure 7-1 Main deck layout

8. Mobilization and Responsibilities

The ROV will be mobilized 15-18 August. The ACO gear will be loaded on the ship including: BSP3, Port Test Tool (PTT), ELEV, bench node for PTT, extra weights, and tools.

The ACO science team is responsible for all the ACO packages, testing and preparing these for deployment, and providing science direction to the ROV crew during operations.

Good communications with the shore party will be essential. The ship/OTG will provide a dedicated satellite Internet connection in the ROV van for real time email and chat with the ACO shore party. ACO will have a laptop in the control van for this purpose.

The ROV team will operate the ROV and oversee the deck during all operations that involve their equipment.

ACO/OTG will be responsible for deploying the free-falling ELEV, BSP3, and recovering the ELEV with CAM1 and CAM2.

ACO will supply pin-protecting dummies for ODI connectors, with ROV mating provision (i.e., T-Handle, in-basket jig). ACO will provide a cable/hose "guide" tool.

ACO will provide snap hooks/carabiners and line for ELEV use.

ROV will provide cutting tools, i.e., sharp knives and garden shears for line, bungies, tie wraps, in the "toolbox" in the basket. One cutting tool with protected blade inside a "c".

ROV will provide necessary USBL beacons.

ROV will provide bio-sample box.

ACO will provide cleaning/scraping/brushing tools for cleaning the precipitate crust on the seawater return (SWR) electrode on the OBS.

NRL will provide all necessary equipment and tools related to the Deep Water Sentinel.

The NRL science team is responsible for all the NRL DWS packages, testing and preparing these for deployment, and providing science direction to the ROV crew during operations.

The ship will operate much of the time in dynamic positioning. This entire system must be checked out before this cruise, and it must be fully operational with all backup and redundant systems tested and operational.

The ship and OTG will provide acoustic Doppler current profiler data/plots (using 38 kHz and 300 kHz instruments), two air tuggers, and pallet jack. ADCP data will be processed in near-real time to determine currents affecting free fall instruments.

9. Operations and timeline

See Table 10.1 for a summary of tasks and times, and Appendix D for a detailed version.

A test dive off Honolulu will be conducted first, at the "usual" test site.

At ACO, ELEV will be deployed first. Using the beacon on ELEV, a "Casius" procedure will be used to survey in the position, and the ship ultra-short baseline transducer attitude (especially the azimuth).

Then, BSP3 will be deployed. Followed by the ROV. When on the bottom, it will disconnect CAM1 and rig it on the ELEV for recovery at the end of the dive. BSP3 moved and plugged into OBS port E4 (where CAM1 was) and positioned along 163T relative to the JBOX/HEM, with the connecting oil-filled hose extended to maximum distance. The BSP3 position should be well noted from the ROV nav files. The ROV will be recovered, after which the ELEV+CAM1 will be acoustically released, and then recovered. The ship's boat may be used for this recovery op.

The next dive will be to use the Port Test Tool to check unused ports on the ACO Observatory (OBS) and Secondary Node 1 (SN1).

On the third ACO dive, the ELEV will be deployed first, and then the ROV to meet at the bottom. The ELEV will be moved to CAM2 and rigged for recovery. The electrode on the OBS will be further cleaned, and video of all bottom instrumentation taken. The ROV will be recovered, after which the ELEV+CAM2 will be acoustically released, and then recovered. The ship's boat may be used for this recovery op.

The next dive will be to deploy the DWS. Each of the three units will be deployed in rapid succession and nearby each other (20 m). They will have small parachutes to assure they remain upright. The ROV will be deployed and follow them to the bottom. For each one, vertical orientation will be checked, and the parachute secured. The ROV will push sediment with the basket over the rubber boot/skirt, to assure no water flow between under the package and the outside water. Relative positions will be noted. One or several sediment cores will be taken. Finally, a search for the lost CTD location will be conducted.

The last dive, time permitting, will be just west of Makaha to survey and collect video of R60, the shoreward repeater on the ACO cable. A standard mow the lawn search pattern will be used running lines perpendicular to the cable route that runs E-W.

KM-2314_Timeline_202308117.xlsx 8/17/23 9:25 PM

		HST (UTC-10)		
	Task	Start	Elapsed	End
1	Transit to test site - Test Dives 1 and 2, LK-001, LK-002	08/19 08:00	7:00	08/19 15:00
2	Transit to Station ALOHA	08/19 15:00	10:10	08/20 01:10
3	ROV Test Dive 3 (LK-003)	08/20 01:10	8:55	08/20 10:05
4	Turn around the ROV	08/20 10:05	5:15	08/20 15:20
5	ROV Test Dive 4 (LK-004)	08/20 15:20	10:05	08/21 01:25
6	Turn around the ROV	08/21 01:25	1:35	08/21 03:00
7	ACO Casius survey	08/21 03:00	7:20	08/21 10:20
8	Deploy ACO BSP3 and ROV, ACO Dive 1, LK-005	08/21 10:20	10:40	08/21 21:00
9	Disconnect CAM1 and move away	08/21 21:00	1:15	08/21 22:15
10	Move and connect BSP3	08/21 22:15	3:10	08/22 01:25
11	Rig CAM1 to ELEV for recovery	08/22 01:25	1:45	08/22 03:10
12	Recover ELEV+CAM1 and ROV	08/22 03:10	5:50	08/22 09:00
13	Service ROV; ACO Dive 2, LK-006, Port Test Tool	08/22 09:00	11:00	08/22 20:00
14	Port Test Tool (PTT): SN1 J3 and J4, and OBS E2 and E7	08/22 20:00	4:30	08/23 00:30
15	Recover ROV	08/23 00:30	3:00	08/23 03:30
16	Prep ROV and Deploy ELEV	08/23 03:30	7:20	08/23 10:50
17	Deploy ROV to recover CAM2	08/23 10:50	4:35	08/23 15:25
18	Move ELEV to CAM2	08/23 15:25	1:30	08/23 16:55
19	Disconnect CAM2 and rig to ELEV	08/23 16:55	1:40	08/23 18:35
20	Clean Electrode	08/23 18:35	3:35	08/23 22:10
21	Recover ELEV+CAM2 and ROV	08/23 22:10	5:50	08/24 04:00
22	NRL Work - Prep ROV	08/24 04:00	6:00	08/24 10:00
23	NRL - Deploy DWS	08/24 10:00	1:35	08/24 11:35
24	Deploy ROV, DWS Dive 1, LK-008	08/24 11:35	4:25	08/24 16:00
25	Adjust DWS units	08/24 16:00	11:00	08/25 03:00
26	Conduct CTD search survey	08/25 03:00	14:00	08/25 17:00
27	Recover ROV	08/25 17:00	3:00	08/25 20:00
28	Contingency	08/25 20:00	15:20	08/26 11:20
29	Transit from ACO to Honolulu with ACO R60 survey	08/26 11:20	24:40	08/27 12:00
			196:00	

Table 9-1 Summary cruise tasks and times (local HST time)

References

2011 cruise plan
http://aco-ssds.soest.hawaii.edu/ACO/docs/20110515_KM1116_Cruise_Plan_Howe_lo-res.pdf
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2021 Cruise Report
https://aco-ssds.soest.hawaii.edu/ACO/docs/Cruise_Summary_KM-21-07_ACO_Howe_20210602.pdf

Oceans 11 paper
Howe, B. M., R. Lukas, F. Duennebier, and D. Karl, ALOHA cabled observatory installation, *OCEANS 2011*, 19-22 Sept. 2011, URL:
http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6107301&isnumber=6106891
or
http://aco-ssds.soest.hawaii.edu/Howe_et_al_ACO_Oceans11.pdf

Additional photographs and other system documentation can be found on the project web site http://aco-ssds.soest.hawaii.edu/index.html. Also see the ROV *Jason* Virtual Control Van videos from the KM-11-16 June 2011 cruise and the KM-14-26 November 2014 cruise, http://4dgeo.whoi.edu/jason/.

Appendix A – ACO Diagrams

The following diagrams show the OBS port assignments, current and planned.

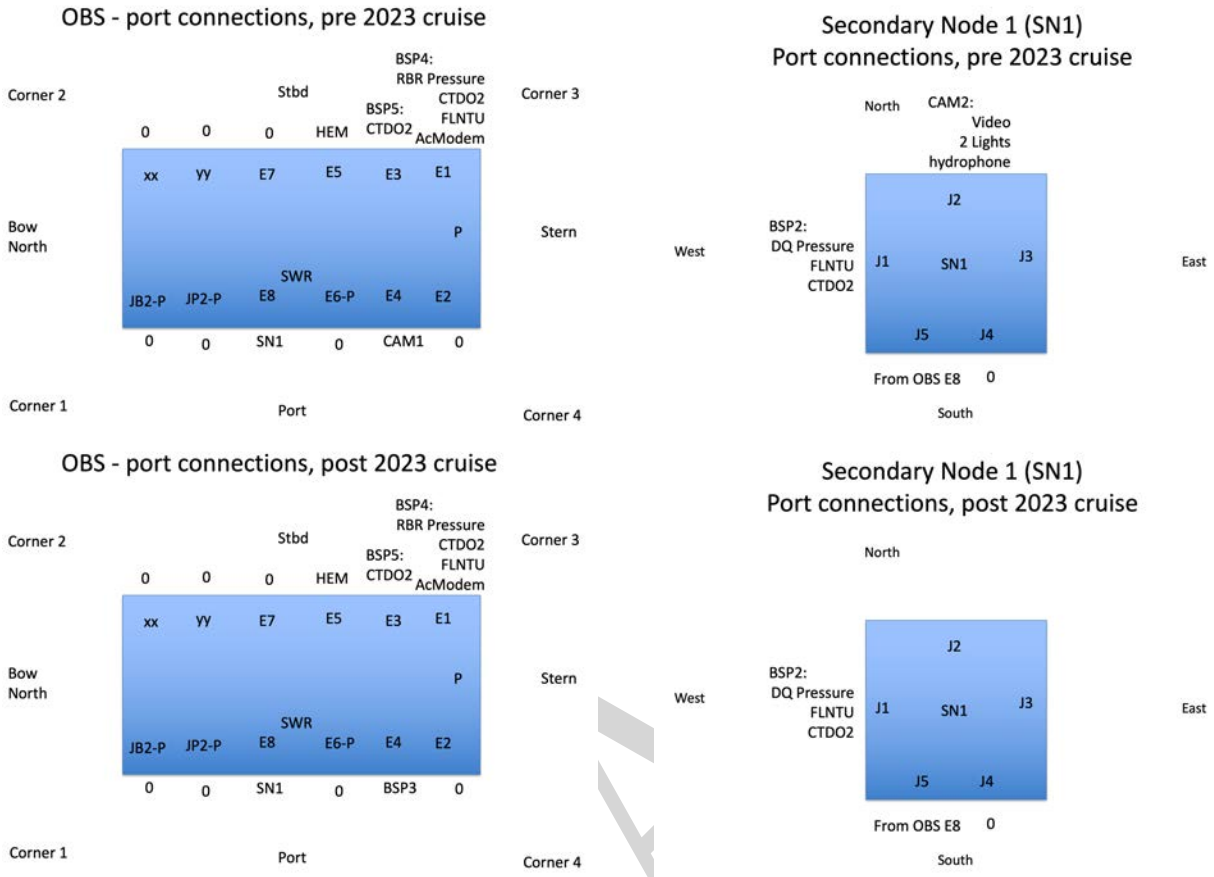

Figure A-0-1 ACO Observatory port connections – present and new (P = parking)

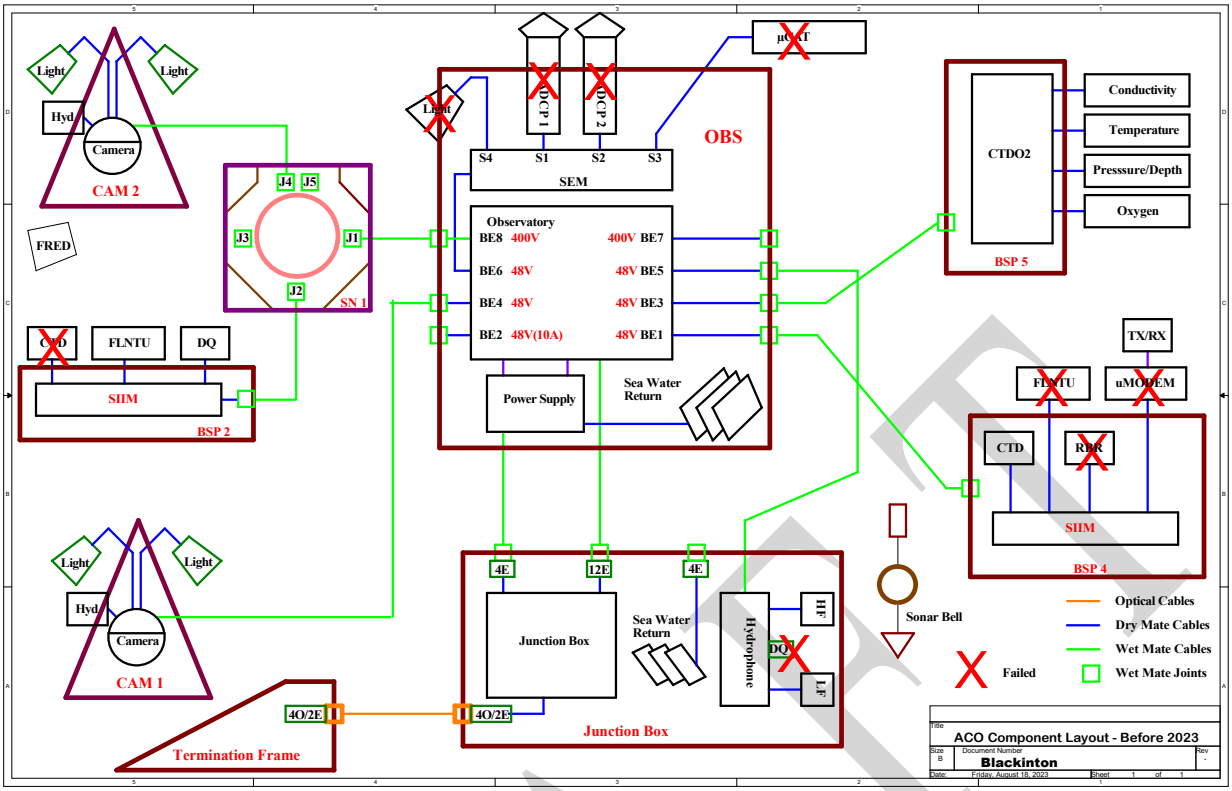

Figure A-0-2 ACO connections – pre-August 2023 (CAM1 and 2 are failed); x = failed

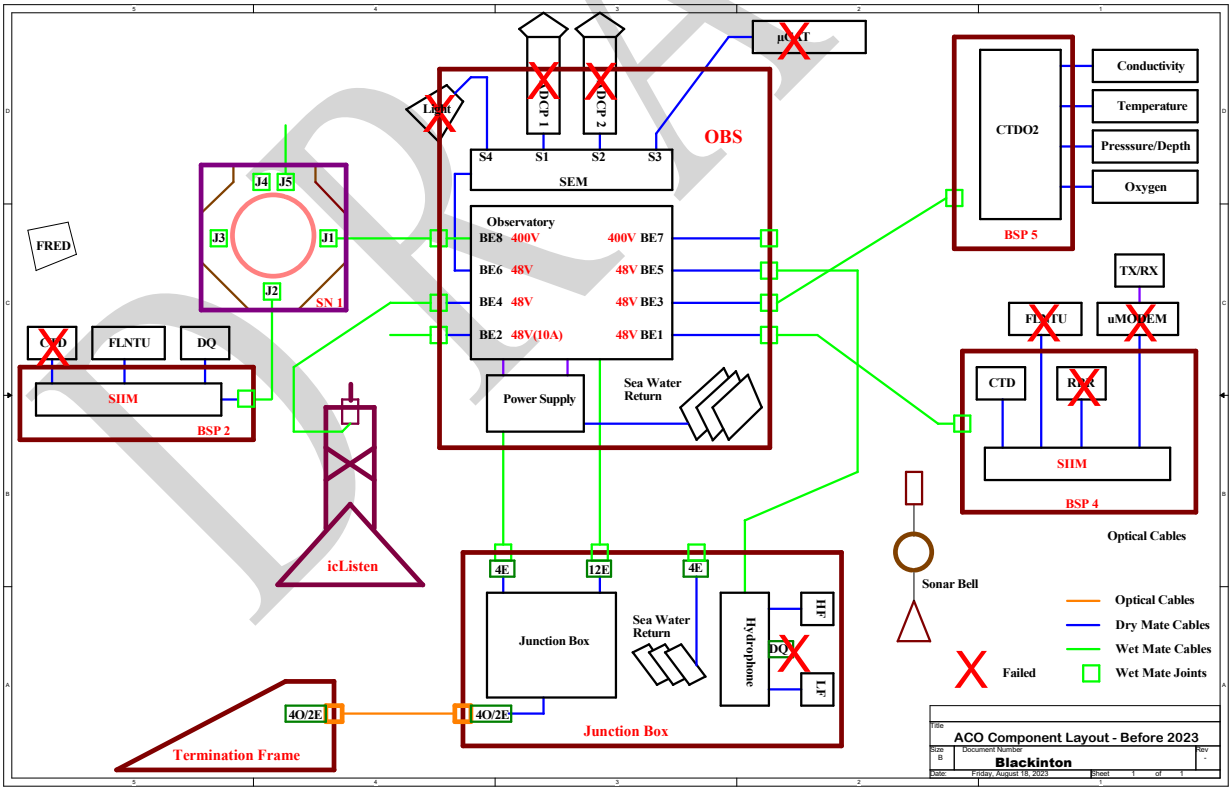

Figure A-0-3 Planned ACO connections – post August 2023; x = failed

Appendix B – ACO Operations

The following table gives the detailed ACO tasks associated with deploying and recovering the instrumentation. Time is local HST.

Table B-1 ACO tasks for deployment

ACO + DWS Cruise, 19 - 27 August 2023 **KM-2312A,B**

Bruce Howe, Jeff Book

		HST (UTC-10)		
	Task	**Start**	**Elapsed**	**End**
1	Transit to test site - Test Dives 1 and 2, LK-001, LK-002	08/19 08:00	7:00	08/19 15:00
2	Transit to Station ALOHA	08/19 15:00	10:10	08/20 01:10
3	ROV Test Dive 3 (LK-003)	08/20 01:10	8:55	08/20 10:05
4	Turn around the ROV	08/20 10:05	5:15	08/20 15:20
5	ROV Test Dive 4 (LK-004)	08/20 15:20	10:05	08/21 01:25
6	Turn around the ROV	08/21 01:25	1:35	08/21 03:00
7	ACO Casius survey	08/21 03:00	7:20	08/21 10:20
8	Deploy ACO BSP3 and ROV, ACO Dive 1, LK-005	08/21 10:20	10:40	08/21 21:00
9	Disconnect CAM1 and move away	08/21 21:00	1:15	08/21 22:15
10	Move and connect BSP3	08/21 22:15	3:10	08/22 01:25
11	Rig CAM1 to ELEV for recovery	08/22 01:25	1:45	08/22 03:10
12	Recover ELEV+CAM1 and ROV	08/22 03:10	5:50	08/22 09:00
13	Service ROV; ACO Dive 2, LK-006, Port Test Tool	08/22 09:00	11:00	08/22 20:00
14	Port Test Tool (PTT): SN1 J3 and J4, and OBS E2 and E7	08/22 20:00	4:30	08/23 00:30
15	Recover ROV	08/23 00:30	3:00	08/23 03:30
16	Prep ROV and Deploy ELEV	08/23 03:30	7:20	08/23 10:50
17	Deploy ROV to recover CAM2	08/23 10:50	4:35	08/23 15:25
18	Move ELEV to CAM2	08/23 15:25	1:30	08/23 16:55
19	Disconnect CAM2 and rig to ELEV	08/23 16:55	1:40	08/23 18:35
20	Clean Electrode	08/23 18:35	3:35	08/23 22:10
21	Recover ELEV+CAM2 and ROV	08/23 22:10	5:50	08/24 04:00
22	NRL Work - Prep ROV	08/24 04:00	6:00	08/24 10:00
23	NRL - Deploy DWS	08/24 10:00	1:35	08/24 11:35
24	Deploy ROV, DWS Dive 1, LK-008	08/24 11:35	4:25	08/24 16:00
25	Adjust DWS units	08/24 16:00	11:00	08/25 03:00
26	Conduct CTD search survey	08/25 03:00	14:00	08/25 17:00
27	Recover ROV	08/25 17:00	3:00	08/25 20:00
28	Contingency	08/25 20:00	15:20	08/26 11:20
29	Transit from ACO to Honolulu with ACO R60 survey	08/26 11:20	24:40	08/27 12:00
			196:00	

				HST (UTC-10) 08/19 08:00	196:00	08/27 12:00
			Task	**Start**	**Elapsed**	**End**
1	**Transit to test site - Test Dives 1 and 2, LK-001, LK-002**			08/19 08:00		
1		1	Transit from Honolulu Pier 35 to Shallow site	08/19 08:00	1:30	08/19 09:30
1		2	Prep for dive	08/19 09:30	0:25	08/19 09:55
1	LK 001	1	**Start Test Dive 1, LK-001, water depth 423 m, undock and on bottom**	08/19 09:55	0:45	08/19 10:40
1	LK 001	2	Finished checkout on bottom, ascend, on deck	08/19 10:40	1:30	08/19 12:10
1		3	Purge hydraulics etc.	08/19 12:10	1:00	08/19 13:10
1	LK 002	4	**Start Test Dive 2, LK-002, water depth 423 m, undock and on bottom**	08/19 13:10	0:45	08/19 13:55
1	LK 002	5	Finished checkout on bottom, ascend, on deck	08/19 13:55	1:00	08/19 14:55
1		6	Proceed to Station ALOHA	08/19 14:55	0:05	08/19 15:00
2	**Transit to Station ALOHA**					
2		1	Transit to Station ALOHA	08/19 15:00	10:00	08/20 01:00
2		2	Establish DP position (A-frame of ship) over Cable Termination (CT)	08/20 01:00	0:10	08/20 01:10
3	**ROV Test Dive 3 (LK-003)**					
3	LK 003	1	**Deploy ROV Test Dive 3, LK-003**	08/20 01:10	0:10	08/20 01:20
3	LK 003	2	In water, lines clear	08/20 01:20	0:40	08/20 02:00
3	LK 003	3	continue	08/20 02:00	0:00	08/20 02:00
3	LK 003	4	Stop at 400 m	08/20 02:00	0:40	08/20 02:40
3	LK 003	5	Passing 1000 m	08/20 02:40	0:40	08/20 03:20
3	LK 003	6	Passing 2000 m	08/20 03:20	1:20	08/20 04:40
3	LK 003	7	At 2500 m	08/20 04:40	0:40	08/20 05:20
3	LK 003	8	Undock	08/20 05:20	0:15	08/20 05:35
3	LK 003	9	Check ROV trim and perform all testing	08/20 05:35	1:00	08/20 06:35
3	LK 012	10	continue	08/20 06:35	0:30	08/20 07:05
3	LK 013	11	recover ROV, on deck, end Test Dive 3, LK-003	08/20 07:05	3:00	08/20 10:05
4	**Turn around the ROV**					

4		1	Refurb ROV (add ACO tools to basket to check trim)	08/20 10:05	5:15	08/20 15:20
4		2	continue	08/20 15:20	0:00	08/20 15:20
5	**ROV Test Dive 4 (LK-004)**					
5	LK 004	1	**Deploy ROV Test Dive 4, LK-004**	08/20 15:20	0:05	08/20 15:25
5	LK 004	2	In water, lines clear	08/20 15:25	0:40	08/20 16:05
5	LK 004	3	continue	08/20 16:05	0:00	08/20 16:05
5	LK 004	4	Stop at 400 m	08/20 16:05	0:40	08/20 16:45
5	LK 004	5	Passing 1000 m	08/20 16:45	0:40	08/20 17:25
5	LK 004	6	Passing 2000 m	08/20 17:25	1:00	08/20 18:25
5	LK 004	7	Passing 3000 m	08/20 18:25	1:00	08/20 19:25
5	LK 004	8	Passing 4000 m	08/20 19:25	1:00	08/20 20:25
5	LK 004	9	At 4700 m	08/20 20:25	0:50	08/20 21:15
5	LK 004	10	Undock	08/20 21:15	0:10	08/20 21:25
5	LK 004	11	Check ROV trim and perform all testing	08/20 21:25	1:00	08/20 22:25
5	LK 004	12	continue	08/20 22:25	0:00	08/20 22:25
5	LK 004	13	recover ROV, on deck, end Test Dive 4, LK-004	08/20 22:25	3:00	08/21 01:25
6	**Turn around the ROV**					
6		1	Refurb ROV	08/21 01:25	1:35	08/21 03:00
6		2	continue	08/21 03:00	0:00	08/21 03:00
7	**ACO Casius survey**					
7		1	Continue (can start when ROV on deck)	08/21 03:00	0:00	08/21 03:00
7		2	Deploy ELEV 70 m E, 40 m S of CT. ELEV with USBL beacon, flasher, radio, dual acoustic releases. Log USBL data (surface/bottom) for drop/current analysis	08/21 03:00	0:20	08/21 03:20
7		3	ELEV fall to bottom	08/21 03:20	1:30	08/21 04:50
7		4	XBT cast	08/21 04:50	0:00	08/21 04:50
7		5	Casius survey	08/21 04:50	5:30	08/21 10:20
7		6	continue	08/21 10:20	0:00	08/21 10:20
7		7	End at 70 m E, 40 m S of CT	08/21 10:20	0:00	08/21 10:20
8	**Deploy ACO BSP3 and ROV, ACO Dive 1, LK-005**					
8		1	Continue	08/21 10:20	0:00	08/21 10:20
8		2	continue	08/21 10:20	0:15	08/21 10:35

8		3	Deploy BSP3 70 m E, 40 m S of CT. With USBL beacon, flasher, radio. Log USBL data (surface/bottom) for drop/current analysis	08/21 10:35	0:30	08/21 11:05
8	**LK 005**	**4**	**Deploy ROV ACO Dive 1, LK-005**	08/21 11:05	0:05	08/21 11:10
8	LK 005	5	ROV descending, go to BSP3	08/21 11:10	4:30	08/21 15:40
8	LK 005	6	continue	08/21 15:40	0:00	08/21 15:40
8	LK 005	7	Stop at 400 m	08/21 15:40	0:40	08/21 16:20
8	LK 005	8	Passing 1000 m	08/21 16:20	0:40	08/21 17:00
8	LK 005	9	Passing 2000 m	08/21 17:00	0:50	08/21 17:50
8	LK 005	10	Passing 3000 m	08/21 17:50	0:50	08/21 18:40
8	LK 005	11	Passing 4000 m	08/21 18:40	0:35	08/21 19:15
8	LK 005	12	At 4700 m	08/21 19:15	0:05	08/21 19:20
8	LK 005	13	Undock	08/21 19:20	0:10	08/21 19:30
8	LK 005	14	Check ROV trim and perform all testing	08/21 19:30	0:15	08/21 19:45
8	LK 005	15	Go to BSP3	08/21 19:45	0:10	08/21 19:55
8	LK 005	16	continue	08/21 19:55	0:00	08/21 19:55
8	LK 005	17	Put BSP3 loop on horn	08/21 19:55	0:10	08/21 20:05
8	LK 005	18	Dock ROV	08/21 20:05	0:05	08/21 20:10
8	LK 005	19	Move BSP3 to desired position ~15 m S and 5 m E of JBOX/HEM (on line 165T from HEM)	08/21 20:10	0:40	08/21 20:50
8	LK 005	20	Orient BSP3 so hose reel in optimal direction to OBS E4	08/21 20:50	0:10	08/21 21:00
9	**Disconnect CAM1 and move away**					
9	LK 005	1	Move to Port E4 on OBS (SW corner, #4, port/stern with light boom/stowed)	08/21 21:00	0:10	08/21 21:10
9	LK 005	2	continue	08/21 21:10	0:00	08/21 21:10
9	LK 005	3	Confirm with shore no power	08/21 21:10	0:05	08/21 21:15
9	LK 005	4	Unplug ODI flying lead from E4, put on horn	08/21 21:15	0:10	08/21 21:25
9	LK 005	5	continue	08/21 21:25	0:00	08/21 21:25
9	LK 005	6	Take flying lead to CAM1	08/21 21:25	0:10	08/21 21:35
9	LK 005	7	Attach pin protecting dummy. Then put flying lead into holster on CAM1, secure with bungie	08/21 21:35	0:20	08/21 21:55

9	LK 005	8	Pick up CAM1 and move out of way (suggest to SW)	08/21 21:55	0:20	08/21 22:15
10	**Move and connect BSP3**					
10	LK 005	1	Go to BSP3	08/21 22:15	0:10	08/21 22:25
10	LK 005	2	Put reel on ROV basket. Outer ODI flying lead connector already attached to BSP3, mechanically and electrically.	08/21 22:25	0:20	08/21 22:45
10	LK 005	3	Lift off and start unreeling cable as moving toward OBS (likely do a 180)	08/21 22:45	0:05	08/21 22:50
10	LK 005	4	continue	08/21 22:50	0:05	08/21 22:55
10	LK 005	5	Unspool reel until inner ODI connecror comes off just to W of OBS and Port E4	08/21 22:55	0:05	08/21 23:00
10	LK 005	6	Connector with pin protecting dummy free.	08/21 23:00	0:05	08/21 23:05
10	LK 005	7	Hose Yale thimble on basket horn. Connector held by Orion.	08/21 23:05	0:05	08/21 23:10
10	LK 005	8	continue	08/21 23:10	0:00	08/21 23:10
10	LK 005	9	Lift up to OBS port E4 to check length of hose, enough slack	08/21 23:10	0:05	08/21 23:15
10	LK 005	10	Thimble back on horn.	08/21 23:15	0:05	08/21 23:20
10	LK 005	11	continue	08/21 23:20	0:00	08/21 23:20
10	LK 005	12	Removing pin-protecting dummy from ODI flying lead (using tool in basket)	08/21 23:20	0:10	08/21 23:30
10	LK 005	13	Confirm E4 power off	08/21 23:30	0:05	08/21 23:35
10	LK 005	14	Connect flying lead to OBS Port E4	08/21 23:35	0:20	08/21 23:55
10	LK 005	15	Continue	08/21 23:55	0:00	08/21 23:55
10	LK 005	16	Connector in E4 and latched. Shore notified.	08/21 23:55	0:05	08/22 00:00
10	LK 005	17	sit on bottom	08/22 00:00	0:10	08/22 00:10
10	LK 005	18	Shore reports xx mA current into BSP3	08/22 00:10	0:05	08/22 00:15
10	LK 005	19	Moving back to BSP3, dress hose with hose hook tool	08/22 00:15	0:05	08/22 00:20
10	LK 005	20	Verify data from BSP3	08/22 00:20	0:10	08/22 00:30
10	LK 005	21	Move BSP3 if necessary	08/22 00:30	0:15	08/22 00:45
10	LK 005	22	Remove parking position tripod from BSP3 and set by BSP3	08/22 00:45	0:20	08/22 01:05

10	LK 005	23	Dress cable and parking position tripod near BSP3	08/22 01:05	0:10	08/22 01:15
10	LK 005	24	Final dress of Port Extension Assembly and BSP3	08/22 01:15	0:10	08/22 01:25
11	**Rig CAM1 to ELEV for recovery**					
11	LK 005	1	Move to CAM1	08/22 01:25	0:15	08/22 01:40
11	LK 005	2	Pickup and move to ELEV	08/22 01:40	0:40	08/22 02:20
11	LK 005	3	Set down the package	08/22 02:20	0:05	08/22 02:25
11	LK 005	4	Fly line to ELEV eye	08/22 02:25	0:15	08/22 02:40
11	LK 005	4	Connect CAM1 line to ELEV eye, set down	08/22 02:40	0:15	08/22 02:55
11	LK 005	5	release recovery lines on ELEV	08/22 02:55	0:15	08/22 03:10
12	**Recover ELEV+CAM1 and ROV**					
12	LK 005	1	continue	08/22 03:10	0:00	08/22 03:10
12	LK 005	2	recover ROV, on deck, end ACO Dive 1, LK-005	08/22 03:10	3:00	08/22 06:10
12		3	Release ELEV with acoustic release	08/22 06:10	0:20	08/22 06:30
12		4	ELEV ascends	08/22 06:30	1:30	08/22 08:00
12		5	continue	08/22 08:00	0:00	08/22 08:00
12		6	Recover ELEV+CAM1 - small boat	08/22 08:00	1:00	08/22 09:00
12		7	Prep ELEV for next use	08/22 09:00	0:00	08/22 09:00
12		8	continue	08/22 09:00	0:00	08/22 09:00
13	**Service ROV; ACO Dive 2, LK-006, Port Test Tool**					
13		1	continue	08/22 09:00	0:00	08/22 09:00
13		2	Refurb ROV, rig basket for Port Test Tool (PTT)	08/22 09:00	6:00	08/22 15:00
13	LK 006	3	**Deploy ROV, ACO Dive 2, LK-006, hold at 50 m**	08/22 15:00	0:15	08/22 15:15
13	LK 006	4	continue	08/22 15:15	0:00	08/22 15:15
13	LK 006	5	ROV starts down, head for SN1	08/22 15:15	0:00	08/22 15:15
13	LK 006	6	ROV Stop at 400 m	08/22 15:15	0:40	08/22 15:55
13	LK 006	7	Passing 1000 m	08/22 15:55	0:40	08/22 16:35
13	LK 006	8	continue	08/22 16:35	0:50	08/22 17:25
13	LK 006	9	Passing 2000 m	08/22 17:25	0:50	08/22 18:15
13	LK 006	10	Passing 3000 m	08/22 18:15	0:50	08/22 19:05
13	LK 006	11	Passing 4000 m	08/22 19:05	0:35	08/22 19:40
13	LK 006	12	At 4700 m moving to SN1	08/22 19:40	0:10	08/22 19:50

13	LK 006	13	Undock and rotate ROV to scan sonar	08/22 19:50	0:00	08/22 19:50
13	LK 006	14	Check ROV trim	08/22 19:50	0:00	08/22 19:50
13	LK 006	15	continue	08/22 19:50	0:10	08/22 20:00
14	**Port Test Tool (PTT): SN1 J3 and J4, and OBS E2 and E7**					
14	LK 006	1	Move to SN1, J3	08/22 20:00	0:05	08/22 20:05
14	LK 006	2	Remove dust cover if there	08/22 20:05	0:10	08/22 20:15
14	LK 006	3	Confirm J3 off	08/22 20:15	0:05	08/22 20:20
14	LK 006	4	Plug in PTT to J3	08/22 20:20	0:10	08/22 20:30
14	LK 006	5	Test J3	08/22 20:30	0:30	08/22 21:00
14	LK 006	6	Unplug PTT from Port J3	08/22 21:00	0:05	08/22 21:05
14	LK 006	7	Put on dust cover	08/22 21:05	0:05	08/22 21:10
14	LK 006	8	Move to J4 on OBS (S side)	08/22 21:10	0:10	08/22 21:20
14	LK 006	9	Remove dust cover if there	08/22 21:20	0:05	08/22 21:25
14	LK 006	10	Confirm J4 off	08/22 21:25	0:05	08/22 21:30
14	LK 006	11	Plug in PTT to J4	08/22 21:30	0:05	08/22 21:35
14	LK 006	12	Test J4	08/22 21:35	0:20	08/22 21:55
14	LK 006	13	Unplug PTT from Port J4	08/22 21:55	0:05	08/22 22:00
14	LK 006	14	Put on dust cover	08/22 22:00	0:05	08/22 22:05
14	LK 006	15	Move to E2 on OBS (SW corner, #4)	08/22 22:05	0:30	08/22 22:35
14	LK 006	16	Remove dust cover if there	08/22 22:35	0:05	08/22 22:40
14	LK 006	17	Confirm E2 off	08/22 22:40	0:05	08/22 22:45
14	LK 006	18	Plug in PTT to E2	08/22 22:45	0:15	08/22 23:00
14	LK 006	19	Test E2	08/22 23:00	0:15	08/22 23:15
14	LK 006	20	Unplug PTT from Port E2	08/22 23:15	0:05	08/22 23:20
14	LK 006	21	Put dust cover on E2	08/22 23:20	0:05	08/22 23:25
14	LK 006	22	Move to E7 on OBS (NE corner, #2))	08/22 23:25	0:15	08/22 23:40
14	LK 006	23	Remove dust cover if there	08/22 23:40	0:05	08/22 23:45
14	LK 006	24	Confirm E7 off	08/22 23:45	0:05	08/22 23:50
14	LK 006	25	Plug in PTT to E2	08/22 23:50	0:15	08/23 00:05

14	LK 006	26	Test E7	08/23 00:05	0:15	08/23 00:20
14	LK 006	27	Unplug PTT from Port E7	08/23 00:20	0:05	08/23 00:25
14	LK 006	28	Put on dust cover	08/23 00:25	0:05	08/23 00:30
14	LK 006	29	continue	08/23 00:30	0:00	08/23 00:30
15	**Recover ROV**					
15	LK 006	1	Recover ROV. End of ACO Dive 2, LK-006	08/23 00:30	3:00	08/23 03:30
15		2	continue	08/23 03:30	0:00	08/23 03:30
16	**Prep ROV and Deploy ELEV**					
16		1	Refurb ROV, rig basket CAM2 recovery, electrode cleaning, etc	08/23 03:30	7:00	08/23 10:30
16		2	Deploy ELEV 70 m E, 40 m S of CT. ELEV with USBL beacon, flasher, radio, dual acoustic releases. Log USBL data (surface/bottom) for drop/current analysis	08/23 10:30	0:20	08/23 10:50
17	**Deploy ROV ACO Dive 3, LK-007, recover CAM2**					
17		1	continue	08/23 10:50	0:00	08/23 10:50
17		2	continue	08/23 10:50	0:00	08/23 10:50
17	LK 007	3	**Deploy ROV, ACO Dive 3, LK-007, hold at 50 m**	08/23 10:50	0:15	08/23 11:05
17	LK 007	4	continue	08/23 11:05	0:00	08/23 11:05
17	LK 007	5	ROV starts down, head for ELEV	08/23 11:05	0:00	08/23 11:05
17	LK 007	6	ROV Stop at 400 m	08/23 11:05	0:40	08/23 11:45
17	LK 007	7	continue	08/23 11:45	3:10	08/23 14:55
17	LK 007	8	At 4700 m moving to ELEV	08/23 14:55	0:10	08/23 15:05
17	LK 007	9	Undock and rotate ROV to scan sonar	08/23 15:05	0:10	08/23 15:15
17	LK 007	10	Check ROV trim	08/23 15:15	0:10	08/23 15:25
17	LK 007	11	continue	08/23 15:25	0:00	08/23 15:25
18	**Move ELEV to CAM2**					
18	LK 007	1	Move to ELEV	08/23 15:25	0:10	08/23 15:35
18	LK 007	2	Put ELEV eye on horn	08/23 15:35	0:10	08/23 15:45
18	LK 007	3	Dock ROV	08/23 15:45	0:05	08/23 15:50
18	LK 007	4	Move to CAM2	08/23 15:50	1:00	08/23 16:50
18	LK 007	5	Set down ELEV	08/23 16:50	0:05	08/23 16:55

19	**Disconnect CAM2 and rig to ELEV**					
19	LK 007	1	Move to CAM2	08/23 16:55	0:15	08/23 17:10
19	LK 007	2	continue	08/23 17:10	0:00	08/23 17:10
19	LK 007	3	Confirm with shore no power	08/23 17:10	0:05	08/23 17:15
19	LK 007	4	Unplug ODI flying lead from CAM2, put on horn	08/23 17:15	0:10	08/23 17:25
19	LK 007	5	Put environmental cover on CAM2	08/23 17:25	0:10	08/23 17:35
19	LK 007	6	Take flying lead to parking position	08/23 17:35	0:05	08/23 17:40
19	LK 007	6	Connect flying lead to parking position pin protecting dummy.	08/23 17:40	0:15	08/23 17:55
19	LK 007	7	Connect eye on CAM2 with Eye on ELEV	08/23 17:55	0:20	08/23 18:15
19	LK 007	8	Release recovery lines on ELEV	08/23 18:15	0:20	08/23 18:35
20	**Clean Electrode**					
20	LK 007	1	Move to portside of OBS (west side)	08/23 18:35	0:10	08/23 18:45
20	LK 007	2	Set ROV on bottom by OBS (? Or hold on to frame with Mantis)	08/23 18:45	0:10	08/23 18:55
20	LK 007	3	Chip away at white aragonite deposit on electrode	08/23 18:55	1:30	08/23 20:25
20	LK 007	4	Other housekeepong video survey, dress hoses	08/23 20:25	1:45	08/23 22:10
20	LK 007	5	continue	08/23 22:10	0:00	08/23 22:10
21	**Recover ELEV+CAM2 and ROV**					
21	LK 007	1	continue	08/23 22:10	0:00	08/23 22:10
21	LK 007	2	continue	08/23 22:10	0:00	08/23 22:10
21	LK 007	3	recover ROV, on deck, end ACO Dive 3, LK-007	08/23 22:10	3:00	08/24 01:10
21		4	Release ELEV with acoustic release	08/24 01:10	0:20	08/24 01:30
21		5	ELEV ascends	08/24 01:30	1:30	08/24 03:00
21		6	continue	08/24 03:00	0:00	08/24 03:00
21		7	Recover ELEV+CAM2- small boat	08/24 03:00	1:00	08/24 04:00
22	**NRL Work - Prep ROV**					
22		1	Prep ROV	08/24 04:00	6:00	08/24 10:00
22		2	Transit to DWS site	08/24 10:00	0:00	08/24 10:00
23	**NRL - Deploy DWS**					
23		1	continue	08/24 10:00	1:00	08/24 11:00
23		2	Deploy 3 DWS units, about 20 m apart as quickly as possible	08/24 11:00	0:35	08/24 11:35
24	**Deploy ROV, DWS Dive 1, LK-008**					

24		1	continue	08/24 11:35	0:00	08/24 11:35
24		2	continue	08/24 11:35	0:00	08/24 11:35
24	LK 008	3	**Deploy ROV, DWS Dive 1, LK-008, hold at 50 m**	08/24 11:35	0:15	08/24 11:50
24	LK 008	4	continue	08/24 11:50	0:00	08/24 11:50
24	LK 008	5	ROV starts down, head for DWS	08/24 11:50	0:00	08/24 11:50
24	LK 008	6	ROV Stop at 400 m	08/24 11:50	0:40	08/24 12:30
24	LK 008	7	continue	08/24 12:30	3:10	08/24 15:40
24	LK 008	8	At 4700 m moving to DWS	08/24 15:40	0:10	08/24 15:50
24	LK 008	9	Undock and rotate ROV to scan sonar	08/24 15:50	0:00	08/24 15:50
24	LK 008	10	Check ROV trim	08/24 15:50	0:00	08/24 15:50
24	LK 008	11	continue	08/24 15:50	0:10	08/24 16:00
25	**Adjust DWS units**					
25	LK 008	1	Adjust unit 1	08/24 16:00	3:00	08/24 19:00
25	LK 008	2	Adjust unit 2	08/24 19:00	3:00	08/24 22:00
25	LK 008	3	Adjust unit 3	08/24 22:00	3:00	08/25 01:00
25	LK 008	4	Take sediment cores	08/25 01:00	1:00	08/25 02:00
25	LK 008	5	Final dress	08/25 02:00	1:00	08/25 03:00
26	**Conduct CTD search survey**					
26	LK 008	1	Conduct survey	08/25 03:00	12:00	08/25 15:00
26	LK 008	2	If possible, attach lift line with eye	08/25 15:00	2:00	08/25 17:00
26	LK 008	3	continue	08/25 17:00	0:00	08/25 17:00
27	**Recover ROV**					
27	LK 008	1	continue	08/25 17:00	0:00	08/25 17:00
27	LK 008	2	continue	08/25 17:00	0:00	08/25 17:00
27	LK 008	3	recover ROV, on deck, end DWS Dive 1, LK-008	08/25 17:00	3:00	08/25 20:00
27		4	continue	08/25 20:00	0:00	08/25 20:00
28	**Contingency**					
28		1	Contingency	08/25 20:00	15:20	08/26 11:20
28		2	Contingency	08/26 11:20	0:00	08/26 11:20
28		3	Contingency	08/26 11:20	0:00	08/26 11:20
29	**Transit from ACO to Honolulu with ACO R60 survey**					
29		1	Transit to R60	08/26 11:20	8:00	08/26 19:20

29	LK 009	2	Dive LK 009 - Survey at ACO R60 repeater - find cable, 1-inch diameter "fish bite protection" (2500 m up/down 8 hr + survey 4 hr)	08/26 19:20	12:00	08/27 07:20
29	LK 009	3	complete dive	08/26 19:20	0:00	08/26 19:20
29		4	Transit to Honolulu buoy and Pier	08/27 07:20	4:40	08/27 12:00
29		5	Arrive	08/27 12:00	0:00	08/27 12:00
				08/19 08:00	**196:00**	**08/27 12:00**
				08/19 08:00	**196:00**	**08/27 12:00**

Dives	**Start**	**Duration (h:min)**	**End**
LK 001	**08/19 09:55**	2:15	**08/19 12:10**
LK 002	**08/19 13:10**	1:45	**08/19 14:55**
LK 003	**08/20 01:10**	5:25	**08/20 06:35**
LK 004	**08/20 15:20**	10:05	**08/21 01:25**
LK 005	**08/21 11:05**	19:05	**08/22 06:10**
LK 006	**08/22 15:00**	12:30	**08/23 03:30**
LK 008	**08/24 11:35**	32:25	**08/25 20:00**
LK 009	**08/26 19:20**	12:00	**08/27 07:20**
		86:05	

Appendix C – Cruise Participants and Contacts List

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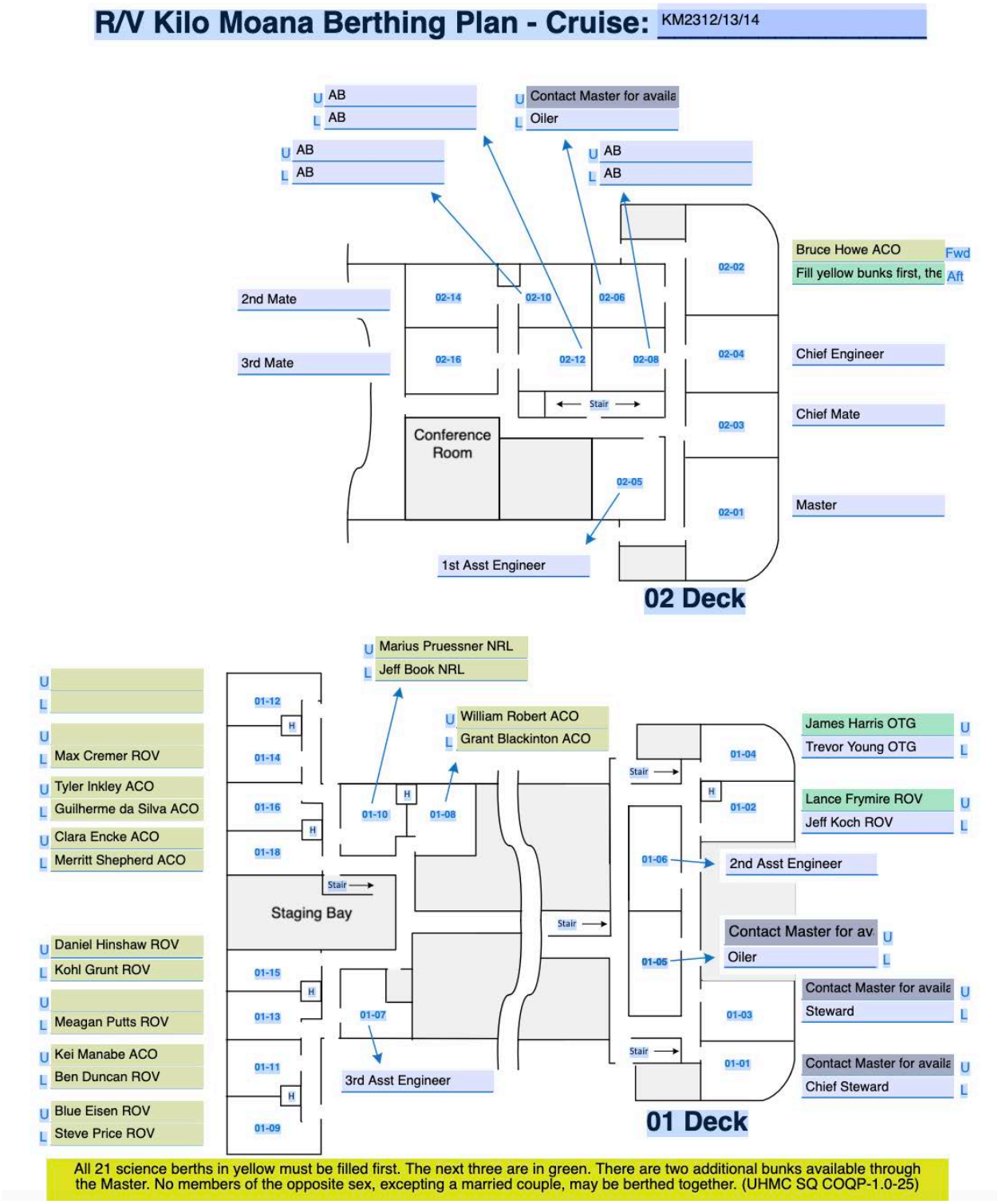
Appendix D – Berthing Plan



Appendix E – Acronyms and abbreviations

12E	Electrical connector with 12 electrical circuits
2E	ODI NRH Connector with 2 electrical circuits and 4 optical circuits
4E	Electrical connector with 4 electrical circuits
ACO	ALOHA Cabled Observatory
ACP	Acoustic current profiler
ADCP	Acoustic Doppler current profiler
AMM	Aloha Mars Mooring Secondary Node
BSP	Basic Sensor Package
CAM	Camera Tripod
CTF	Cable Termination Frame
$CTDO_2$	Conductivity, temperature, depth, oxygen sensor package
DMAS	Data Management and Archiving System
DP	Dynamic positioning
DWS	Deep Water Sentinel Fuel Cell
EC	Environmental Cover – protective cap for unconnected ODI bulkheads
EM	Electrical-Mechanical
EO	Electrical-Optical
EOM	Electrical-Optical-Mechanical
HEM	Hydrophone Experiment module, resides on JBOX
HOT	Hawaii Ocean Timeseries
µSEM	micro Science Experiment Module
JBOX	Frame with junction box and HEM with cables and connectors
MARS	Monterey Accelerated Research System
MBARI	Monterey Bay Aquarium Research Institute
NRH	Nautilus Rolling Hybrid – optical and electrical ODI connector
NRL	Naval Research Laboratory
NTP	Network Time Protocol
OBS	Observatory package
ODI	Ocean Design, Inc. wet mateable connector
PBOF	Pressure balanced, oil filled
PMACS	Power Management and Control System
PPS	Pulse Per Second (GPS-derived precise timing signal)
PTP	Precise Time Protocol
PTT	Port Test Tool
ROV	Remotely Operated Vehicle
SIIM	Science Instrument Interface Module
SMF	Single mode fiber
SN	Secondary Node
TF	Termination Frame (also CTF)