FINAL Project Instructions

Date Submitted: January 7, 2016

Platform: NOAA Ship *Okeanos Explorer*

Project Number: EX-16-01

Project Title: Transit and Mission Patch Test

Project Dates: January 20, 2016 – February 7, 2016

Prepared by: Derek Sowers and Elizabeth Lobecker, NOAA
Expedition Co-Coordinators
Office of Ocean Exploration & Research

Approved by: MCDONOUGH.JOHN.J.III.1365836678 Digitally signed by MCDONOUGH.JOHN.J.III.1365836678 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OTHER, cn=MCDONOUGH.JOHN.J.III.1365836678 Date: 2016.01.08 08:42:24 -05'00' Dated: ___________________
John McDonough
Deputy Director
Office of Ocean Exploration & Research

Approved by: _________________________ Dated: ___________________
Captain Anne K. Lynch, NOAA
Commanding Officer
Marine Operations Center - Atlantic

I. Overview

A. Brief Summary and Project Period

The ocean is 95 percent unexplored, unknown, and unseen by human eyes. Resource managers cannot manage what they do not know. To understand, manage, and protect the ocean and its resources, NOAA believes it is critical to support a systematic program of ocean exploration, using the best of ocean technology to explore, discover, inform, educate, and motivate. Exploration of our largely unknown ocean supports key NOAA, national, and international goals related to a better understanding of the ocean that will benefit current and future generations. NOAA Ship *Okeanos Explorer* is helping us to better understand the unknown ocean by targeted exploratory mapping.

This document contains project instructions for EX-16-01, with operations expected to commence on January 20, 2016 in Alameda, CA and conclude on February 7, 2016 in Honolulu, HI. The primary goals of the cruise include: exploratory ocean mapping, shakedown, testing, and calibration of existing and newly-installed equipment, and positioning the ship for the 2016 exploration missions in the central and western Pacific Ocean. New equipment in need of shakedown testing includes a new Very Small Aperture Terminal (VSAT) antenna, a new Keyboard-Video-Monitor (KVM) system, new Doppler speed log, a new POS-MV inertial measurement and positioning system, four new EK 60 single beam sonars, two new ADCPs, new digital file storage systems, and a newly installed UnderwayCTD. Testing and fine tuning of the VSAT and KVM system are anticipated to occur throughout the cruise.

Multibeam and singlebeam mapping operations will be conducted 24 hours a day throughout the cruise. Sub-bottom profile mapping will be conducted 24 hours a day at the discretion of the CO. XBT and/or UnderwayCTD sound velocity casts in support of multibeam sonar mapping operations will be conducted at an interval defined by prevailing oceanographic conditions, but not to exceed 6 hours. All multibeam data will be fully processed according to standard onboard procedures and will be archived with the National Geophysical Data Center. Split-beam EK60 data will be archived at the National Oceanographic Data Center.

It will be necessary to swing the ship's compass during the first few hours of the cruise inside San Francisco Bay. A small boat transfer will be needed to return the compass adjuster back to shore. No additional small boat transfers back to San Francisco are planned as part of this cruise, but may become necessary if VSAT technician support is needed during the first 1-2 days.

A GPS Azimuth Measurement System (GAMS) calibration will be conducted prior to exiting San Francisco Bay. The GAMS calibration is needed following the ship's recent dry dock period and the installation of a new POSMV system. Details on conducting a GAMS calibration are provided in Appendix 6.

Initial ADCP data collection work will be conducted while transiting through, and leaving, San Francisco Bay until a depth of 1,000 meters is reached. This data will then be shared with the University of Hawaii (UH) team to determine initial settings for the applied transducer angles.

If sea state allows, a CTD cast and multibeam patch test calibration will be completed in the vicinity of Bodega Canyon within the Cordell Banks National Marine Sanctuary or the northern portion of the Greater Farallones National Marine Sanctuary (figure 3). If weather conditions are not conducive to a successful patch test in this area, the ship will begin the transit directly to the Molokai Fracture Zone and delay the patch test until later in the cruise. In this case, a suitable location during the transit to Honolulu or offshore of Hawaii at the location shown in figure 4 will be used for the patch test. The preference is to complete the multibeam patch test as early as feasible during the cruise, and definitely prior to picking up visiting technicians in Honolulu on February 2.

Bathymetric mapping of the Molokai Fracture Zones during the transit to Hawaii is planned, as allowed by equipment shakedown priorities and prevailing sea conditions. Mapping of the Murray Fracture Zone is a contingency option if weather conditions are considerably more favorable than those along the Molokai Fracture Zone. CTD casts may be requested at strategic locations along the fracture zone. The total transit between San Francisco and Honolulu is estimated to be approximately 2600 nm long, not including survey lines conducted for the multibeam patch test. Average transit speeds of 8.5-9.5 knots are required to collect good quality multibeam data during the survey. Faster speeds may be possible during the last transit day to Oahu, given the wealth of existing bathymetry data in that area. If the multibeam patch test was not able to be completed near California or along the Molokai Fracture Zone, it will be completed near Oahu in the area shown in figure 4 prior to making an approach to Honolulu. Interference testing of various sonar systems may be conducted during the transit from CA to HI.

Following completion of the transit to Oahu, EK60 and ADCP calibration and acceptance tests will be the focus of operations in the vicinity of the main Hawaiian Islands. Multiple small boat transfers in and out of Oahu may be needed in association with this work, but mission personnel will strive to make as few transfers as possible to maximize at-sea testing work.

A small boat transfer is needed on approximately February 2 in Honolulu to pick up a Kongsberg Engineer, a Teledyne Engineer, and an ADCP Technician from the University of Hawaii. Following this personnel transfer, the rest of the cruise will be dedicated to completing calibrations on five EK60 split-beam sonars and two new ADCP sonars. Four of the EK60 sonars are new units, and the calibrations are required as Sea Acceptance Tests. The two ADCPs (Teledyne RDI 300 kHz Workhorse Mariner and 38 kHz Ocean Surveyor) are also new equipment and require the completion of Sea Acceptance Tests and calibrations. Calibration work will occur in transits near Oahu and inside the operating area defined in figure 5. EK60 calibration work will be conducted during daylight hours only. ADCP calibration work will occur largely at night when EK60 calibrations are not feasible. A small boat transfer in Honolulu to drop off the three visiting technicians may be needed on February 5 or 6, but ideally they will stay on the ship until the end of the cruise.

B. Days at Sea (DAS)

Of the 19 DAS scheduled for this project, 12 DAS are funded by an OMAO allocation, and 7 DAS are funded by a Line Office Allocation. This project is estimated to exhibit a Medium Operational Tempo.

C. Operating Area (include optional map/figure showing op area)

The operating area encompasses a large region of the Pacific Ocean between San Francisco Bay and Oahu, Hawaii (Figure 1). The operating area box is large to enable the flexibility to map either the Murray or Molokai Fracture Zones during the transit, depending on available time, sea state considerations, and input from scientific partners.

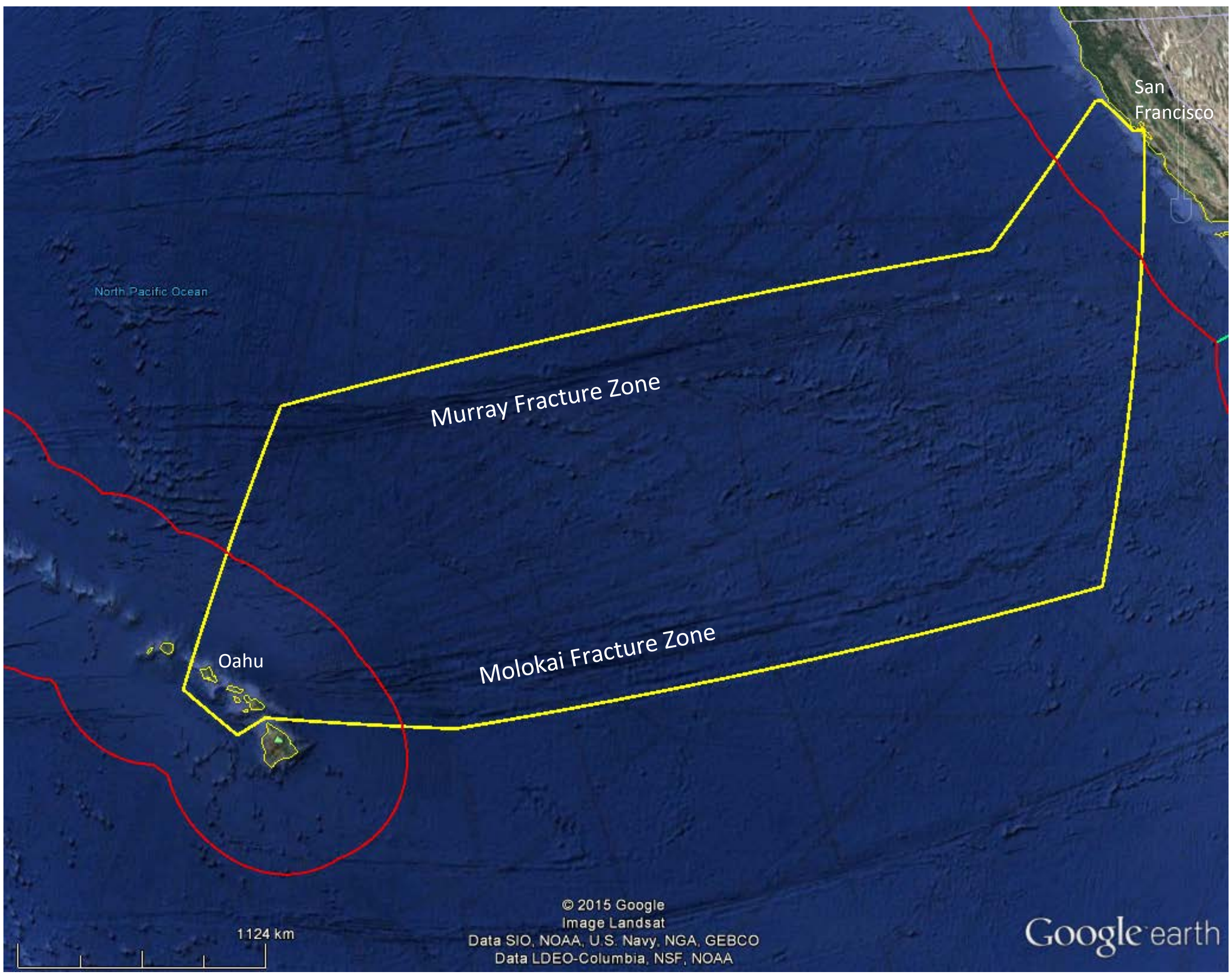

Figure 1: EX-16-01 operating area. The yellow box indicates the operating area for the project. The red lines show the approximate location of the US EEZ boundaries. Map made with Google Earth Pro.

Figure 2 shows the approximate location of the ship track line proposed during the transit from Alameda, CA to Honolulu, HI.

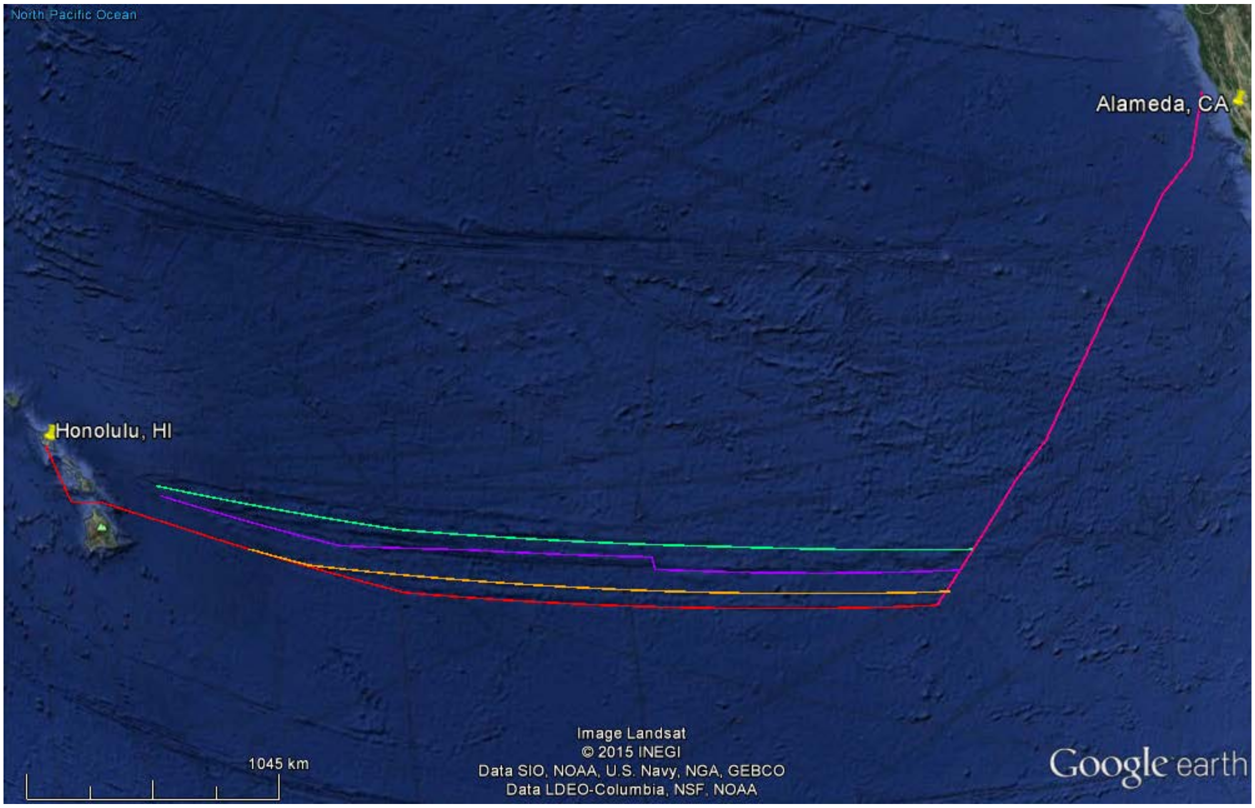

Figure 2: Approximate proposed ship track line(s) for transit from California to Hawaii on EX-16-01. Exact ship track to be determined. The pink line shows the transit to the start of mapping line options for surveying over the Molokai Fracture Zone, while mapping over several unexplored potential seamount features. The red and orange lines over the Molokai Fracture Zone have the least existing data. Transit path along the Molokai Fracture Zone to be determined in consultation with shoreside scientists. Map made with Google Earth Pro.

Table 1: Approximate transit waypoints (degrees decimal minutes) for transit from preferred patch test area to start of Molokai Fracture Zone mapping. If the preferred patch test area near CA is not feasible due to poor weather, the ship will skip waypoint 1 and proceed directly to waypoint 2 in the table.

Waypoint #	Latitude (North)	Longitude (West)	Description
1	38 12.167	123 42.692	Bodega Canyon patch test area
2	36 19.629	124 7.049	Transit to Molokai
3	35 16.283	125 12.650	Transit to Molokai
4	32 17.873	126 50.186	Transit to Molokai
5	29 42.81	127 59.81	Transit to Molokai
6	28 26.258	128 28.810	Transit to Molokai
7	27 16.635	129 16.214	Transit to Molokai
8	25 18.578	130 12.748	Junction with Molokai FZ lines

Figure 3 shows the preferred general area proposed for multibeam patch test work if weather conditions are favorable. Figure 4 shows an alternative location for the patch test near Hawaii if weather conditions prohibit the completion of the patch test on the West Coast. There may be other suitable patch test locations and sea state conditions encountered during the transit HI, in which case the test will be completed as early in the cruise as possible.

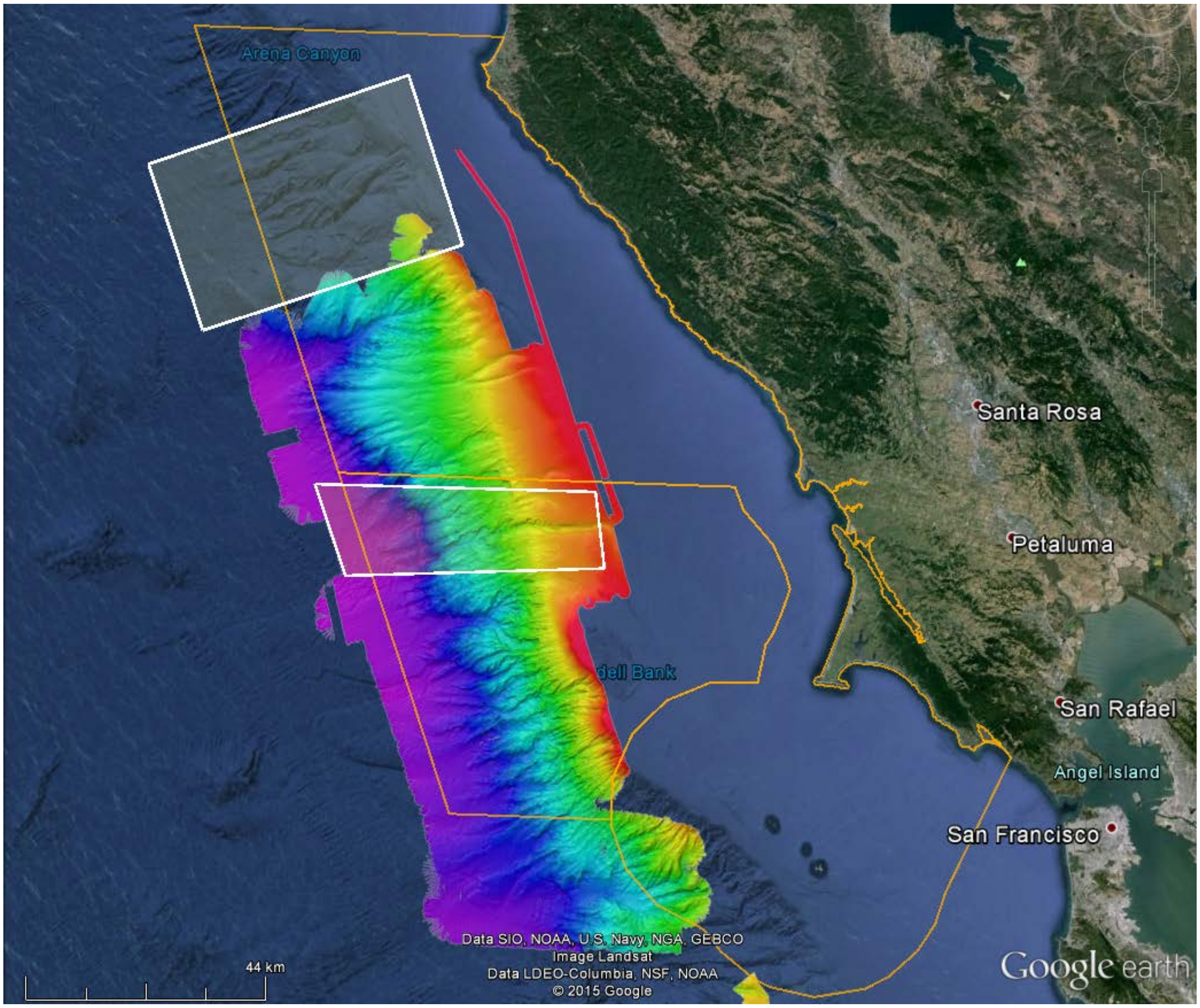

Figure 3: Proposed areas for West Coast multibeam patch test for EX-16-01 (white boxes) if sea state conditions are favorable. The patch test is planned for either Bodega Canyon or a poorly mapped section of canyons in the northern region of the Greater Farallones National Marine Sanctuary. Exact patch location and transit path to be determined. Orange lines indicate National Marine Sanctuary boundaries. Map made with Google Earth Pro. Color-coded bathymetry shown is previous EX data collected during EX-09-07.

Figure 4. Alternative location for the patch test near Hawaii if weather conditions prohibit the completion of the patch test on the West Coast. This is the same patch test area used on EX-15-04 Leg 1 during the 2015 field season.

Bounding Box Coordinates for Proposed Multibeam Patch Test Areas

<u>Area 1: Bodega Canyon</u>

Latitude (degrees decimal minutes North)	Longitude (degrees decimal minutes West)
38 9.88	123 27.45
38 7.88	123 58.87
38 17.16	124 3.32
38 17.10	123 28.85

Area 2: Northern portion of Greater Farallones National Marine Sanctuary

Latitude (degrees decimal minutes North)	Longitude (degrees decimal minutes West)
38 40.07	123 46.02
38 31.03	124 17.48
38 46.71	124 25.09
38 56.06	123 53.45

Area 3: Oahu Patch Test Site

Latitude (degrees decimal minutes North)	Longitude (degrees decimal minutes West)
21 12.02	158 16.01
21 12.03	158 21.51
21 15.38	158 21.54
21 15.20	158 16.02

After completing the transit to Hawaii and the multibeam patch test, a small boat transfer will be needed near Pearl Harbor to pick up a Teledyne engineer, Kongsberg engineer, and an ADCP Technician from the University of Hawaii. The ship will then transit to a sheltered area to conduct approximately 5 days of testing and calibration work for all of the EK60 and ADCP sonars. The proposed sheltered area for this work is south of the islands of Molokai, Lanai and Maui, as shown in Figure 5. This working area should have reasonable currents and hopefully be sheltered from the dominant northern swell direction during the time of operations.

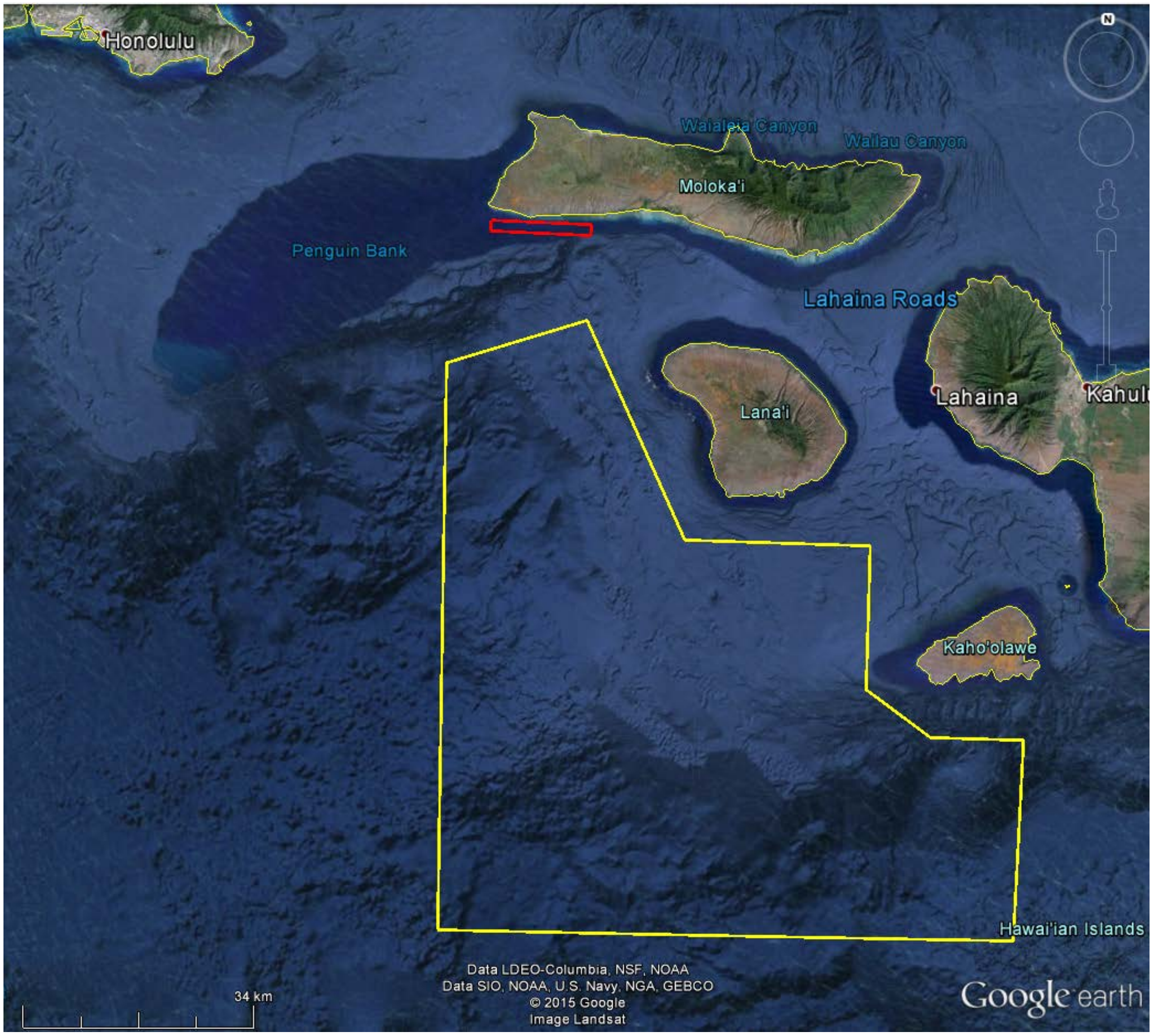

Figure 5. Proposed area for EK60 and ADCP calibration work (yellow box). This area is outside 3 NM from the nearest islands (i.e. not in state waters), and outside of National Marine Sanctuary boundaries. Exact locations for sonar testing work will be determined based on sea state, currents, and vessel traffic during operations. The smaller red box shows the area that meets the depth requirements for the ringing and XDCR alignment portion of the testing needed for the 300 kHz ADCP.

D. Summary of Objectives

JANUARY 20 – FEBRUARY 7, 2016 (Alameda, CA - Honolulu HI)

Testing and calibrating existing and new mission sonars, equipment, data management infrastructure, and telepresence capabilities to ensure readiness for the FY16 field season is the primary objective of this project. Table 1 provides a list of shakedown tasks shown with estimates of time needed for dedicated testing.

Table 2. Equipment shakedown tasks and associated time estimates

Equipment Shakedown Task (not in chronological order)	Estimate of ship time needed
1. Testing/calibration of two new ADCPs (38 kHz and 300 kHz)	4-5 nights (night testing concurrent with EK60 calibration work), 12 hours per night
2. POS-MV system (GAMS calibration)	1-2 hours
3. Multibeam sonar patch test	12 hours
4. Calibration of existing and new EK60 sonars (18, 38, 70, 120, and 200 kHz)	4-5 days (daylight hours - concurrent with ADCP testing)
5. Comparison cast(s) of new UnderwayCTD with ship CTD rosette package	6-12 hours
6. Test new Keyboard-Video-Monitor (KVM),MacProTC based VES01 and VES03system, and other Telepresence systems	Throughout project
7. Testing of new VSAT	Throughout project
8. Ship testing of new speed log	Throughout project
9. Testing and integration of new mission digital storage equipment on network	Throughout project
10. Testing of new or updated mission software (Caris 9, Fledermaus, Pydro, UnderwayCTD)	Throughout project
11. Testing of new POSMV GNSS aided inertial navigation system.	Throughout project
12. Test new Data Warehouse computers, deck to deck video recording system, and modified SAN	Throughout project
13. Testing of the ship's three XBT launchers	Underway
Total Estimated Dedicated Testing Days	6 days

Approximately 6 days of ship time are needed for dedicated testing as described in Table 1. The transit from San Francisco to Hawaii has been budgeted 13 days, including time to conduct the patch test (either near CA or HI depending on weather), GAMS calibration, and CTD/UnderwayCTD casts. This leaves approximately five days of dedicated sonar shakedown time needed in HI to focus on the EK60 and ADCP testing and calibration work.

The following are cruise objectives for EX-16-01:

1. Assess ship’s essential operational equipment and procedures.
   a. Annual review of small boat operational risk management and certification /practice for launch/recovery crews and coxswains.
   b. Swing the ship’s compass
   c. Test ship’s new speed log.

2. Conduct emergency drills. Drills may include some or all of the following as determined by CO:
   a. Fire/Damage Control
   b. Abandon Ship
   c. Man-Over-Board
   d. Steering Casualty
   e. Oil Spill/ Hazmat spill

3. Assess ship's equipment necessary to support operations.
   a. Brief testing of dynamic positioning system
   b. Test trigger jigger sync for EM 302, EK60, Sub-bottom sonars

4. Test and confirm functionality of new VSAT antenna.

5. Test and troubleshoot the new KVM system.

6. Complete a GAMS calibration for the new POS-MV.

7. Data management objectives:
   a) Test the new Data Warehouse computers
   b) Test the deck to deck video recording system
   c) Test modifications to SAN
   d) Ensure integration of ADCP data collection system into consolidation pathways (add to .24 network, develop synchronization routine to push to warehouse, setup standard naming convention and RSS error log reporting, etc.
   e) Maintain Okeanos Atlas with automated delivery of SCS data subsets
   f) Ensure realtime delivery of data products
   g) Ensure integration of new EK60 transducer datasets into shipboard collection and data synchronization to shore
   h) Ensure delivery of sonar data products in hourly rsync / troubleshoot what happened with EX1505 data consolidation problems
   i) Verify integration and implementation of new shipboard data warehouse and data management routines (OpenVDM)
   j) Verify delivery of automated warehouse products (shiptrack, dashboard, etc)
   k) Verify SCS is working properly

8. Test and calibrate two new ADCPs (38 and 300 kHz) and train Survey Department and Mapping Leads on running these new sonars. ADCP trials and calibration will be conducted with technical support from both a visiting Teledyne engineer and Toby

Martin from the University of Hawaii. ADCP testing is planned to take place mainly at night, concurrent with day time EK60 sonar calibrations. The primary testing area is proposed in Figure 5. Assistance from the ship's ET Department will be periodically needed to ensure integration of ADCPs with other ship sensors and the computer network.

9. Conduct sound velocity comparison cast(s) between CTD, XBT, and UnderwayCTD. Near surface values will be compared to values from the thermosalinograph (TSG) and Reson SVP-70 probe. CTD and XBT comparison casts will be obtained prior to collecting multibeam lines for the patch test. An UnderwayCTD cast may also be completed prior to the patch test if the system and trained personnel are ready at that time.

10. Conduct a patch test calibration for the EM 302 multibeam sonar.
    The patch test is needed after the recent dry dock and installation of the new POS-MV to ensure system offsets are calibrated for optimum data quality. Weather permitting, the patch test will be completed by running multibeam lines over continental slope canyons west of San Francisco Bay prior to the transit to Hawaii (operating area shown in Figure 3). If weather conditions are too rough at this location, the patch test will be done at the next earliest opportunity at a location with suitable seafloor characteristics. If no suitable location is found prior to arriving in HI, the alternative patch test site shown in Figure 4 will likely be used (weather permitting). A CTD cast using the ship's CTD rosette package will be required prior to running the patch test lines.

11. Collect 24-hr/day deep water multibeam (EM 302), split-beam (EK60), and sub-bottom sonar data (Knudsen 3260), as feasible while testing and calibrating new sonars.
    a. Conduct 24-hour mapping operations for the duration of the cruise
    b. Collect bathymetric, seafloor backscatter, and water column backscatter data.
    c. Map as much of the Molokai Fracture Zone as possible during the transit, with a priority on high quality multibeam bathymetry and sub-bottom sonar data.
    d. Sub-bottom sonar 24-hr data collection will be at discretion of CO.

12. Test the new UnderwayCTD equipment and associated software, and develop new Standard Operating Procedures (SOPs) for safely conducting profiles and appropriately processing the data. Support from ship ETs will be needed to install and test the Bluetooth data download antenna. Initial test profile casts will use the dummy probe.

13. Conduct XBT operations.
    a. Test the ship's 3 XBT hand-launchers.
    b. XBT casts will be collected at regular intervals of no more than 6 hours in support of multibeam sonar operations until the UnderwayCTD system is fully tested and operational.

14. Train personnel in data collection and processing procedures as needed (continuous throughout cruise).
    a) Train visiting mapping watchstanders on mapping operations

b) Provide succession training to new data management personnel
c) Mapping Leads to receive ADCP training from Toby Martin and Teledyne

15. Test new and upgraded mission software.
    a) Test Survey Department upgrades to Caris, Fledermaus, and Pydro.
    b) Install new UnderwayCTD software on the mission CTD computer and develop SOPs for importing and exporting water column profiles in appropriate file formats usable by the multibeam SIS computer.
    c) Updates to the multibeam SIS software are not currently planned, but may be done if strongly recommended by the visiting Kongsberg engineer.

16. Map a large section of the Molokai Fracture Zone during the transit to Hawaii. Mapping of this fracture zone as much as possible is a top exploration priority expressed by numerous science partners. Most of the mapping will likely be a single transit line of data. The Murray Fracture Zone is an alternative transit mapping focus area if local sea state along the Molokai Fracture Zone is too rough. The decision on which fracture zone to map will be based on time availability, detailed evaluation of other existing bathymetric datasets, guidance from scientific partners, and prevailing weather conditions during the project.

17. CTD operations
    a) A CTD cast at the start of the patch test survey is planned.
    b) Additional sensors typically mounted on the rosette should be functional and calibrated to support CTD operations, including: dissolved oxygen (DO), light scattering sensor (LSS), Oxidation-Reduction Potential (ORP), and altimeter.

18. Calibrate five EK 60 sonars (18, 38, 70, 120, 200 kHz).
    For the four new frequencies, this project will the first time these EK60s are field tested, and the calibration work is an essential component of the Sea Acceptance Test (SAT) required for new sonar installations. Calibration work is proposed to be conducted near Hawaii during the last 4-5 days of the project. Calibration can be conducted while drifting freely in an area with low vessel traffic, no navigational hazards, and lack of fishing gear. EK60 calibration work is planned to take place during daylight hours, concurrent with nighttime ADCP sonar calibrations. The area proposed for this calibration work is shown in Figure 5.

19. Telepresence (VSAT 5 mbps ship to shore; T1 shore to ship)
    a) Maintain single live stream video from ship to shore with a focus on the multibeam mapping display
    b) Install new MacProTC based VES01 and VES03
    c) Shakedown of general Telepresence and recording systems

20. Evaluate potential interference issues among all scientific sonars (EM302, EK60s, Sub-bottom, ADCPs). There is a high likelihood of interference issues occurring when simultaneously running the 38 kHz ADCP, 30 kHz EM302, and the 38 kHz EK60 sonar. Systematic testing will be conducted to determine if/when this interference occurs, the

severity of the interference, and best operating guidelines to avoid or mitigate interference among the sonars. Potential changes to syncing mechanisms among the sonars will require assistance from the ship's Chief ET. This work will be done opportunistically throughout the cruise.

21. The longstanding NASA marine aerosols network survey of opportunity will continue for the cruise.

22. If time allows, work with ET Department to set up a hot-swappable spare EM302 workstation. The workstation computer is onboard the ship, but has not been configured yet in such a way that it can be quickly put in service if the existing workstation fails.

23. Set up a procedure to automatically save the mapping electronic log to the public network, once/day (or twice). Continue to test the utility of the electronic log and make updates as necessary.

24. Finalize 2016 Readiness Report.

E. Participating Institutions

Kongsberg Underwater Technology, Inc., 19210 33rd Avenue West, Lynnwood, WA 98036-4707

National Oceanic and Atmospheric Administration (NOAA) - Office of Ocean Exploration and Research (OER) - 1315 East-West Hwy, Silver Spring, MD 20910 USA

NOAA Fisheries, Pacific Islands Regional Office, NOAA Inouye Regional Center (IRC), 1845 Wasp Blvd., Building 176, Honolulu, HI 96818

NOAA, National Centers for Environmental Information (NCEI),1021 Balch Blvd, Suite 1003
Stennis Space Center, MS. 39529

NOAA Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543-1026

NOAA, Office of Coast Survey, Hydrographic Surveys Division, Atlantic Hydrographic Branch (AHB), 439 W. York St., Bldg 2, Norfolk, VA 23510

Teledyne Instruments, 16830 Chestnut St, City of Industry, CA 91748

University Corporation for Atmospheric Research Joint Office for Science Support (JOSS), PO Box 3000 Boulder, CO 80307 USA

University of Hawai`i at Manoa, 1000 Pope Road, Marine Sciences Building, Honolulu, HI 96822 USA

University of New Hampshire (UNH) Center for Coastal and Ocean Mapping (CCOM), Jere

A. Chase Ocean Engineering Lab, 24 Colovos Road, Durham, NH 03824 USA

University of Rhode Island, Graduate School of Oceanography's Inner Space Center, 215 South Ferry Rd. Narragansett, RI 02882 USA

Woods Hole Oceanographic Institution, 86 Water St, Woods Hole, MA 02543

F. Personnel/Science Party: name, title, gender, affiliation, and nationality

List of Science Party personnel

Name (Last, First)	Title	Date Aboard	Date Depart	M/F	Affiliation	Nationality
Lobecker, Elizabeth "Meme"	Expedition Co-Coordinator, Mapping Lead	1/17/16	2/8/16	F	NOAA OER (ERT, Inc)	US Citizen
Sowers, Derek	Expedition Co-Coordinator, Mapping Lead	1/18/16	2/7/16	M	NOAA OER (ERT, Inc)	US Citizen
Freitas, Dan	Mapping Watch Leader	1/18/16	2/18/16	M	UCAR Contractor	US Citizen
Putts, Meagan	Mapping Watchstander	1/18/16	2/7/16	F	UCAR Explorer-in-Training	US Citizen
Bittinger, Amanda	Mapping Watch Leader	1/18/16	2/8/16	F	UCAR Contractor	US Citizen
O'Brien, Andy	Data Engineer	1/18/16	2/8/16	M	NOAA NCDDC (DGIT)	US Citizen
Reser, Brendan	Data Engineer	1/18/16	2/8/16	M	OER (Riverside Technologies)	US Citizen
Brian, Roland	Video Engineer	1/18/16	2/8/16	M	UCAR Contractor	US Citizen
Johnson, Jennifer	Mapping Watchstander, EK60 Technician	1/18/16	2/8/16	F	NOAA NMFS	US Citizen
Johna Winters	Mapping Watchstander	1/18/16	2/8/16	F	Oregon State University	US Citizen
Scott Idle	Teledyne Field Engineer	2/2/16	2/7/16	M	Teledyne	US Citizen
Juergens, Gregg	Kongsberg Field Engineer	2/2/16	2/7/16	M	Kongsberg	US Citizen
Martin, Toby	Oceanographic Data Specialist (ADCP)	2/2/16	2/7/16	M	University of Hawaii	US Citizen

A full mapping complement is necessary for this cruise. Required mission personnel include two Mapping Leads/Expedition Co-Coordinators, two Mapping Watch Leads, and two-three Mapping Watchstanders. The Mapping Leads are responsible for facilitating overall mapping operations, including participating in operational meetings, providing guidance for mapping/survey troubleshooting, and communicating status of mapping sensors to personnel on shore.

G. Administrative

1. Points of Contacts:

Ship Operations

Chief, Operations Division, Atlantic (MOA)
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Norfolk, VA 23510-1145
Telephone: (757) 441-6776
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Mission Operations

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2. Diplomatic Clearances

None Required. All operations in US and International waters.

3. Licenses and Permits

None Required. See Appendix for Categorical Exclusion documentation.

II. Operations

The Expedition Coordinator is responsible for ensuring the scientific staff are trained in planned operations and are knowledgeable of project objectives and priorities. The Commanding Officer is responsible for ensuring all operations conform to the ship's accepted practices and procedures.

A. Project Itinerary *(All times and dates are subject to prevailing conditions and the discretion of the commanding officer):*

Monday, January 18

- Most mission personnel arrive to ship throughout the day, mostly in the evening.
- Configure new ADCPs to run UHDAS software

Tuesday, January 19

- Remaining mission personnel arrive to ship, mission orientation and safety talk
- Pre-project meeting with Expedition Coordinators, CO, Ops
- Ensure all sonars are ready

Wednesday, January 20

- Depart Alameda, CA pier site early morning
- Swing ship's compass inside SF Bay, small boat transfer needed to get compass adjuster back to shore
- Complete GAMS calibration inside SF Bay
- Gather bottom tracking data on both ADCPS while in SF Bay and during transit to a depth of 1,000 meters
- Transit to patch test site within Cordell Banks or Greater Farallones National Marine Sanctuary and conduct multibeam patch test (if weather poor, begin transit to Molokai Fracture Zone instead)
- VSAT shakedown

Thursday, January 21

- Complete patch test and begin transit to Hawaii

Friday, January 22- Monday, February 1 (11 days)

- Transit to Oahu while mapping Molokai Fracture Zone
- Possible CTD casts and testing of UnderwayCTD as time/conditions allow

Tuesday, February 2

- Early morning small boat transfer near Honolulu of personnel needed for EK60 and ADCP calibration work (Kongsberg, Teledyne, and UH personnel)
- Transit to EK60 and ADCP calibration site and begin calibration work

Wednesday February 3– Saturday, February 6

- EK60 calibrations during the day
- ADCP testing at night

Sunday, February 7

- Finish EK 60 calibrations
- Arrive in port, complete mission, some mission personnel depart

Monday, February 8

- Remaining mission personnel depart ship (except for Dan Freitas who is staying on for EX-16-02)

Telepresence Events

There are currently no telepresence events scheduled.

In-Port Events

There are currently no in-port events scheduled.

B. Staging and Destaging:

The UnderwayCTD will need to be mounted and provided with power prior to the start of the project. ROVs *Deep Discover* and *Seirios* will need to be loaded onto the ship in Honolulu at the conclusion of EX-16-01. The Engineering Team will coordinate detailed logistics in concert with the ship.

Shipments

Send an email to *Okeanos Explorer's* Operations Officer at OPS.Explorer@noaa.gov indicating the size and number of items being shipped. All items should arrive no later than **COB January 15, 2015**.

Vessel shipping address:

Okeanos Explorer
C/O Bay Ship and Yacht
2900 Main Street
Alameda, CA 94501

C. Operations to be conducted:

Sonar Operations

If sea state allows, the Kongsberg EM302 sonar will be calibrated on the first day of the expedition by conducting a patch test in the general area noted in the white boxes of Figure 3. This area is within the continental slope canyons offshore of San Francisco and within National Marine Sanctuary boundaries in the area. A CTD cast is planned for the start of the patch test survey in order to obtain a high quality sound speed profile for the water column. XBT and/or UnderwayCTD sound velocity casts may be conducted right after the CTD cast for comparison purposes.

Multibeam and singlebeam mapping operations will be conducted 24 hours a day throughout the cruise. Sub-bottom profile mapping will be conducted 24 hours a day at the discretion of the CO. XBT and/or UnderwayCTD sound velocity casts in support of multibeam sonar mapping operations will be conducted at an interval defined by prevailing oceanographic conditions, but not to exceed 6 hours.

Bathymetric mapping of the Molokai Fracture Zone during the transit to Hawaii is planned, as allowed by equipment shakedown priorities and prevailing sea conditions. CTD casts may occur at strategic locations along the fracture zone.

Calibration of five EK 60 sonars will be done in the vicinity of Hawaii, and is currently planned for the area shown in Figure 5. A small boat transfer to pick up technicians in the Honolulu area should be expected prior to the start of calibration work. The general criteria pertaining to the selection of a suitable calibration site are as follows: water depth of at least 30 meters, minimal impact by fish (to avoid acoustic interference), mild currents and sea state, and minimal traffic hazards. The exact area for calibration work will be determined in consultation with science partners in Hawaii and consultation with the ship’s Operations and Navigation Officers and CO. Calibration operations require the deployment of ropes, weights, monofilament line, and metal spheres underneath the ship as controlled both by hand and on outrigger poles. The ship’s mobility is highly constrained during calibration work, and it is anticipated that the ship will need to be drifting freely during daytime calibration work. The SOP for EK60 calibration work is provided in Appendix 5.

ADCP testing and integration is estimated to require approximately 50-60 hours of cumulative dedicated ship time, and is an integral part of the overall acceptance testing of the new ADCP sonars. ADCP trials and calibration are planned for the area shown in Figure 5, same as the EK60 test area. Exact areas for at-sea testing and calibration to be determined using guidance from Teledyne and UH on testing criteria. Appendix 4 provides information about ADCP testing work recommended by Teledyne and UH.

CTD/UnderwayCTD Operations

CTD and UnderwayCTD casts may be requested during any day of the project. A CTD cast may be requested as part of ADCP testing, and is planned for the start of the patch test survey in order to obtain a high quality sound speed profile for the water column. Additional CTD/UnderwayCTD operations may be requested during the transit to Hawaii and for the EK60 calibrations.

D. Dive Plan

All dives are to be conducted in accordance with the requirements and regulations of the NOAA Diving Program (http://www.ndc.noaa.gov/dr.html) and require the approval of the ship's Commanding Officer.

Dives are not planned for this project.

E. Applicable Restrictions

Conditions which preclude normal operations: (1) XBTs, UnderwayCTD casts, and CTDs will not be conducted in very rough sea states or when there is significant risk of lightning. (2) If rough sea state is resulting in very poor data quality, sonar data may not be collected for that period of time. (3) EK 60 and multibeam sonar calibration work cannot be conducted in rough seas.

III. Equipment

A. Equipment and Capabilities provided by the ship (itemized)

- Kongsberg Simrad EM302 MultibeamEchosounder (MBES)
- Kongsberg Simrad EK60DeepwaterEchosounders and GPTs (18, 38, 70, 120, 200 kHz)
- Knudsen Chirp 3260 Sub-bottom profiler (SBP)
- Teledyne RDI Workhorse Mariner (300 kHz) ADCP
- Teledyne RDI Ocean Surveyor (38 kHz) ADCP
- Teledyne UnderwayCTD
- LHM Sippican XBT (Deep Blue probes)
- Seabird SBE 911Plus CTD
- Seabird SBE 32 Carousel and 24 2.5 L Niskin Bottles
- Light Scattering Sensor (LSS)
- Oxidation – Reduction Potential (ORP)
- Dissolved Oxygen (DO) sensor
- Altimeter Sensor and battery pack
- CNAV GPS
- POS/MV
- Seabird SBE-45 (Micro TSG)

- Kongsberg Dynamic Positioning-1 System
- NetApps mapping storage system
- CARIS HIPS Software
- IVS Fledermaus Software
- SIS Software
- Hypack Software
- Scientific Computing System (SCS)
- ECDIS
- Met/Wx Sensor Package
- Telepresence System
- VSAT High-Speed link (Comtech5Mbps ship to shore; 1.54 Mbps shore to ship)
- Cruise Information Management System (CIMS)

B. Equipment and Capabilities provided by the scientists (itemized)

- Microtops II Ozone Monitor -Sunphotometer and handheld GPS required for NASA Marine Aerosols Network supplementary project.

- EK60 calibration equipment and spheres

IV. Hazardous Materials

A. Policy and Compliance

No Hazardous Materials are being brought aboard the ship for this project.

V. Additional Projects

A. Supplementary ("Piggyback") Projects

During the cruise the marine aerosol layer observations will be collected for the NASA Maritime Aerosol Network (MAN). Observations will be made by mission personnel (mapping interns) with a sun photometer instrument provided by the NASA MAN program. Resulting data will be delivered to the NASA MAN primary investigator Alexander Smirnov by the expedition coordinator. All collected data will be archived and publically available at: http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html. Equipment is stewarded by OER physical scientists. See Appendix 3 for full Survey of Opportunity Form.

B. NOAA Fleet Ancillary Projects

No NOAA Fleet Ancillary Projects are planned.

VI. Disposition of Data and Reports

Disposition of data gathered aboard NOAA ships will conform to NAO 216-101 *Ocean Data Acquisitions* and NAO 212-15 *Management of Environmental Data and Information.* To guide the implementation of these NAOs, NOAA's Environmental Data Management Committee (EDMC) provides the *NOAA Data Documentation Procedural Directive* (data documentation) and *NOAA Data Management Planning Procedural Directive* (preparation of Data Management Plans). OMAO is developing procedures and allocating resources to manage OMAO data and Programs are encouraged to do the same for their Project data.

A. Data Classifications: *Under Development*

a. OMAO Data

The Commanding Officer is responsible for all data collected for missions until those data have been transferred to mission party designees. Data transfers will be documented on NOAA Form 61-29. Reporting and sending copies of project data to NESDIS (ROSCOP form) is the responsibility of OER.

b. Program Data

- At sea
  - Daily plans of the Day (POD)
  - Daily situation reports (SITREPS)
  - Daily summary bathymetry data files
- Post cruise
  - Refined SOPs for all pertinent operational activities
  - Assessments of all activities
- Science
  - Multibeam and XBT raw and processed data (see appendix 1 for the formal cruise data management plan)
  - EK 60 raw data
  - Knudsen 3260 sub-bottom profiler raw data
  - Mapping data report

B. Responsibilities: *Under Development*

VII. Meetings, Vessel Familiarization, and Project Evaluations

A. <u>Pre-Project Meeting</u>: The Expedition Coordinator and Commanding Officer will conduct a meeting of pertinent members of the scientific party and ship's crew to discuss required equipment, planned operations, concerns, and establish mitigation strategies for all concerns. This meeting shall be conducted before the beginning of the project with sufficient time to allow for preparation of the ship and project personnel. The ship's Operations Officer usually is delegated to assist the Expedition Coordinator in arranging this meeting.

B. Vessel Familiarization Meeting: The Commanding Officer is responsible for ensuring scientific personnel are familiarized with applicable sections of the standing orders and vessel protocols, e.g., meals, watches, etiquette, drills, etc. A vessel familiarization meeting shall be conducted in the first 24 hours of the project's start and is normally presented by the ship's Operations Officer.

C. Post-Project Meeting: The Commanding Officer is responsible for conducted a meeting no earlier than 24 hrs before or 7 days after the completion of a project to discuss the overall success and short comings of the project. Concerns regarding safety, efficiency, and suggestions for future improvements shall be discussed and mitigations for future projects will be documented for future use. This meeting shall be attended by the ship's officers, applicable crew, the Expedition Coordinator, and members of the scientific party and is normally arranged by the Operations Officer and Expedition Coordinator.

D. Project Evaluation Report:Within seven days of the completion of the project, a Customer Satisfaction Survey is to be completed by the Expedition Coordinator. The form is available at http://www.omao.noaa.gov/fleeteval.html and provides a "Submit" button at the end of the form. Submitted form data is deposited into a spreadsheet used by OMAO management to analyze the information. Though the complete form is not shared with the ships', specific concerns and praises are followed up on while not divulging the identity of the evaluator.

VIII. Miscellaneous

A. Meals and Berthing

The ship will provide meals for the scientists listed above. Meals will be served 3 times daily beginning one hour before scheduled departure, extending throughout the project, and ending two hours after the termination of the project. Since the watch schedule is split between day and night, the night watch may often miss daytime meals and will require adequate food and beverages (for example a variety of sandwich items, cheeses, fruit, milk, juices) during what are not typically meal hours. Special dietary requirements for scientific participants will be made available to the ship's command at least seven days prior to the project.

Berthing requirements, including number and gender of the scientific party, will be provided to the ship by the Expedition Coordinator. The Expedition Coordinator and Commanding Officer will work together on a detailed berthing plan to accommodate the gender mix of the scientific party taking into consideration the current make-up of the ship's complement. The Expedition Coordinator is responsible for ensuring the scientific berthing spaces are left in the condition in which they were received; for stripping bedding and linen return; and for the return of any room keys which were issued. The Expedition Coordinator is also responsible for the cleanliness of the laboratory spaces and the storage areas utilized by the scientific party, both during the project and at its conclusion prior to departing the ship.

All NOAA scientists will have proper travel orders when assigned to any NOAA ship. The Expedition Coordinator will ensure that all non NOAA or non-Federal scientists aboard also have proper orders. It is the responsibility of the Expedition Coordinator to ensure that the entire scientific party has a mechanism in place to provide lodging and food and to be reimbursed for these costs in the event that the ship becomes uninhabitable and/or the galley is closed during any part of the scheduled project.

All persons boarding NOAA vessels give implied consent to comply with all safety and security policies and regulations which are administered by the Commanding Officer. All spaces and equipment on the vessel are subject to inspection or search at any time. All personnel must comply with OMAO's Drug and Alcohol Policy dated May 17, 2000 which forbids the possession and/or use of illegal drugs and alcohol aboard NOAA Vessels.

B. Medical Forms and Emergency Contacts

The NOAA Health Services Questionnaire (NHSQ, NF 57-10-01 (3-14)) must be completed in advance by each participating scientist. The NHSQ can be obtained from the Expedition Coordinator or the NOAA website http://www.corporateservices.noaa.gov/noaaforms/eforms/nf57-10-01.pdf.

All NHSQs submitted after March 1, 2014, must be accompanied by NOAA Form (NF) 57-10-02- Tuberculosis Screening Document in compliance with OMAO Policy 1008 (Tuberculosis Protection Program).

The completed forms should be sent to the Regional Director of Health Services at the applicable Marine Operations Center. The NHSQ and Tuberculosis Screening Document should reach the Health Services Office no later than 4 weeks prior to the start of the project to allow time for the participant to obtain and submit additional information should health services require it, before clearance to sail can be granted. Please contact MOC Health Services with any questions regarding eligibility or completion of either form. Ensure to fully complete each form and indicate the ship or ships the participant will be sailing on. The participant will receive an email notice when medically cleared to sail if a legible email address is provided on the NHSQ.

The participant can mail, fax, or email the forms to the contact information below. Participants should take precautions to protect their Personally Identifiable Information (PII) and medical information and ensure all correspondence adheres to DOC guidance (http://ocio.os.doc.gov/ITPolicyandPrograms/IT_Privacy/PROD01_008240).

The only secure email process approved by NOAA is Accellion Secure File Transferwhich requires the sender to setup an account. Accellion's Web Users Guideis a valuable aid in using this service, however to reduce cost the DOC contract doesn't provide for automatically issuing full functioning accounts. To receive access to a "Send Tab", after your Accellion account has been established send an email from the associated email account toaccellionAlerts@doc.gov requesting access to the "Send Tab" function. They will notify you via email usually within 1 business day of your approval. The 'Send Tab" function will be accessible for 30 days.

Contact information:

Regional Director of Health Services
Marine Operations Center – Atlantic
439 W. York Street
Norfolk, VA 23510
Telephone 757-441-6320
Fax 757-441-3760
EmailMOA.Health.Services@noaa.gov

Prior to departure, the Expedition Coordinator must provide a listing of emergency contacts to the Operations Officer for all members of the scientific party, with the following information: name, address, relationship to member, and telephone number using the Google Form at

https://docs.google.com/a/noaa.gov/forms/d/1pcoSgPluUVxaY64CM1hJ75l1iIYirTk48G-lv37Am_k/viewform

C. Shipboard Safety

Hard hats are required when working with suspended loads. Work vests are required when working near open railings and during small boat launch and recovery operations. Hard hats and work vests will be provided by the ship when required.

Wearing open-toed footwear or shoes that do not completely enclose the foot (such as sandals or clogs) outside of private berthing areas is not permitted. At the discretion of the ship CO, safety shoes (i.e. steel or composite toe protection) may be required to participate in any work dealing with suspended loads, including CTD deployment and recovery. The ship does not provide safety-toed shoes/boots. The ship's Operations

Officer should be consulted by the Expedition Coordinator to ensure members of the scientific party report aboard with the proper attire.

D. Communications

A progress report on operations prepared by the Expedition Coordinator may be relayed to the program office. Sometimes it is necessary for the Expedition Coordinatorto communicate with another vessel, aircraft, or shore facility. Through various means of communications, the ship can usually accommodate the Expedition Coordinator. Special radio voice communications requirements should be listed in the project instructions. The ship's primary means of communication with the Marine Operations Center is via email and the Very Small Aperture Terminal (VSAT) link. Standard VSAT bandwidth at 128kbs is shared by all vessels staff and the science team at no charge. Increased bandwidth in 30 day increments is available on the VSAT systems at increased cost to the scientific party. If increased bandwidth is being considered, program accounting is required and it must be arranged through the ship's Commanding Officer at least 30 days in advance.

Specific information on how to contact NOAA Ship *Okeanos Explorer* and all other fleet vessels can be found athttp://www.moc.noaa.gov/MOC/phone.html#EXhttp://www.moc.noaa.gov/MOC/phone.html - EX

Important Telephone and Facsimile Numbers and E-mail Addresses

Ocean Exploration and Research (OER):
Phone: (301) 734-1010
Fax: (301) 713-4252

University of New Hampshire, Center for Coastal and Ocean Mapping
Phone: (603) 862-3438
Fax: (603) 862-0839

NOAA Ship *Okeanos Explorer* - Telephone methods listed in order of increasing expense:

Okeanos Explorer Cellular: (401) 713-4114
*Okeanos Explorer*Iridium:(808) 659-9179
OER Mission Iridium (dry lab): (808) 851-3827

EX INMARSAT B
Line 1: 011-870-764-852-328
Line 2: 011-870-764-852-329

Voice Over IP (VoIP) Phone:
301-713-7772 (expect a delay once picked up by directory)

E-Mail: Ops.Explorer@noaa.gov - (mention the person's name in SUBJECT field)

expeditioncoordinator.explorer@noaa.gov - For dissemination of all hands emails by Expedition Coordinator while on board. See ET for password.

E. IT Security

Any computer that will be hooked into the ship's network must comply with the *OMAO Fleet IT Security Policy*1.1 (November 4, 2005) prior to establishing a direct connection to the NOAA WAN. Requirements include, but are not limited to:

(1) Installation of the latest virus definition (.DAT) file on all systems and performance of a virus scan on each system.
(2) Installation of the latest critical operating system security patches.
(3) No external public Internet Service Provider (ISP) connections.

Completion of the above requirements prior to boarding the ship is required.

Non-NOAA personnel using the ship's computers or connecting their own computers to the ship's network must complete NOAA's IT Security Awareness Course within 3 days of embarking.

F. Foreign National Guests Access to OMAO Facilities and Platforms

All foreign national access to the vessel shall be in accordance with NAO 207-12 and RADM De Bow's March 16, 2006 memo (http://deemedexports.noaa.gov). National Marine Fisheries Service personnel will use the Foreign National Registration System (FNRS) to submit requests for access to NOAA facilities and ships. The Departmental Sponsor/NOAA (DSN) is responsible for obtaining clearances and export licenses and for providing escorts required by the NAO. DSNs should consult with their designated Line Office Deemed Export point of contact to assist with the process.

Full compliance with NAO 207-12 is required.

Responsibilities of the Expedition Coordinator:

1. Provide the Commanding Officer with the email generated by the Servicing Security Office granting approval for the foreign national guest's visit. (For NMFS-sponsored guests, this email will be transmitted by FNRS.)This email will identify the guest's DSN and will serve as evidence that the requirements of NAO 207-12 have been complied with.
2. Escorts – The Expedition Coordinator is responsible to provide escorts to comply with NAO 207-12 Section 5.10, or as required by the vessel's DOC/OSY Regional Security Officer.

3. Ensure all non-foreign national members of the scientific party receive the briefing on Espionage Indicators (NAO 207-12 Appendix A) at least annually or as required by the Servicing Security Office.
4. Export Control - Ensure that approved controls are in place for any technologies that are subject to Export Administration Regulations (EAR).

The Commanding Officer and the Expedition Coordinator will work together to implement any access controls necessary to ensure no unlicensed export occurs of any controlled technology onboard regardless of ownership.

Responsibilities of the Commanding Officer:

1. Ensure only those foreign nationals with DOC/OSY clearance are granted access.
2. Deny access to OMAO platforms and facilities by foreign nationals from countries controlled for anti-terrorism (AT) reasons and individuals from Cuba or Iran without written approval from the Director of the Office of Marine and Aviation Operations and compliance with export and sanction regulations.
3. Ensure foreign national access is permitted only if unlicensed deemed export is not likely to occur.
4. Ensure receipt from the Expedition Coordinator or the DSN of the FNRS or Servicing Security Office email granting approval for the foreign national guest's visit.
5. Ensure Foreign Port Officials, e.g., Pilots, immigration officials, receive escorted access in accordance with maritime custom to facilitate the vessel's visit to foreign ports.
6. Export Control - 8 weeks in advance of the project, provide the Expedition Coordinator with a current inventory of OMAO controlled technology onboard the vessel and a copy of the vessel Technology Access Control Plan (TACP). Also notify the Expedition Coordinator of any OMAO-sponsored foreign nationals that will be onboard while program equipment is aboard so that the Expedition Coordinator can take steps to prevent unlicensed export of Program controlled technology. The Commanding Officer and the Expedition Coordinator will work together to implement any access controls necessary to ensure no unlicensed export occurs of any controlled technology onboard regardless of ownership.
7. Ensure all OMAO personnel onboard receive the briefing on Espionage Indicators (NAO 207-12 Appendix A) at least annually or as required by the Servicing Security Office.

Responsibilities of the Foreign National Sponsor:

1. Export Control - The foreign national's sponsor is responsible for obtaining any required export licenses and complying with any conditions of those licenses prior to the foreign national being provided access to the controlled technology onboard regardless of the technology's ownership.

2. The DSN of the foreign national shall assign an on-board Program individual, who will be responsible for the foreign national while on board. The identified individual must be a U.S. citizen and a NOAA or DOC employee. According to DOC/OSY, this requirement cannot be altered.
3. Ensure completion and submission of Appendix C (Certification of Conditions and Responsibilities for a Foreign National

VIII. Appendices

Appendix 1. Data Management Plan

Data Management Plan
Okeanos Explorer (EX1601): Transit and Mission Patch Test

OER Data Management Objectives
Maintain Okeanos Atlas with automated delivery of SCS data; ensure delivery of operational data products in near real-time; ensure integration of the new EK60 transducer datasets into shipboard systems and in data sync to shore; ensure delivery of sonar data products in hourly rsync; verify integration and implementation of new shipboard data warehouse and data management routines; verify delivery of automated warehouse products; ensure integration of ADCP data collection system into data pathways

1. General Description of Data to be Managed

1.1 Name and Purpose of the Data Collection Project

Okeanos Explorer (EX1601): Transit and Mission Patch Test

1.2 Summary description of the data to be collected.

Normal underway operations and mapping patch testing. Bathymetric mapping of either the Murray or Molokai Fracture Zones during the transit to Hawaii is planned, as allowed by equipment shakedown priorities and prevailing sea conditions. CTD casts may be requested at strategic locations along the fracture zone. New equipment in need of shakedown testing includes a new Very Small Aperture Terminal (VSAT) antenna, a new Keyboard-Video-Monitor (KVM) system, new Doppler speed log, four new EK 60 single beam sonars, two new ADCPs, new digital file storage systems, and a newly installed Underway CTD.

1.3 Keywords or phrases that could be used to enable users to find the data.

expedition, exploration, explorer, marine education, noaa, ocean, ocean discovery, ocean education, ocean exploration, ocean exploration and research, ocean literacy, ocean research, OER, science, scientific mission, scientific research, sea, stewardship, systematic exploration, technology, transformational research, undersea, underwater, Davisville, mapping survey, multibeam, multibeam backscatter, multibeam sonar, multi-beam sonar, noaa fleet, okeanos, okeanos explorer, R337, Rhode Island, scientific computing system, SCS, single beam sonar, singlebeam sonar, single-beam sonar, sub-bottom profile, water column backscatter, Molokai Fracture Zone, Murray Fracture Zone

1.4 If this mission is part of a series of missions, what is the series name?

Okeanos Mapping Cruises

1.5 Planned or actual temporal coverage of the data.

Dates: 1/20/2016 to 2/7/2016

1.6 Planned or actual geographic coverage of the data.

Latitude Boundaries:	22.5	to	38
Longitude Boundaries:	-160	to	-122.5

1.7 What data types will you be creating or capturing and submitting for archive?

Cruise Plan, Cruise Summary, Data Management Plan, Highlight Images, Quick Look Report, Bottom Backscatter, CTD (processed), CTD (raw), EK60 Singlebeam Data, GSF, Mapping Summary, Multibeam (image), Multibeam (processed), Multibeam (product), Multibeam (raw), SCS Output (compressed), SCS Output (native), Sub-Bottom Profile data, Temperature data, Water Column Backscatter, XBT (raw)

1.8 What platforms will be employed during this mission?

NOAA Ship Okeanos Explorer

2. Point of Contact for this Data Producing Project

Overall POC:	Derek Sowers, Physical Scientist, NOAA Office of Ocean Exploration and Research, Derek.Sowers@noaa.gov
Title:	Mapping Lead
Affiliation/Dept:	CCOM/JHC, University of New Hampshire, OER
E-Mail:	derek.sowers@noaa.gov
Phone:	603-862-0369

3. Point of Contact for Managing the Data

Data POC Name:	Susan Gottfried
Title:	OER Data Manager
E-Mail:	susan.gottfried@noaa.gov

4. Resources

4.1 Have resources for management of these data been identified? True

4.2 Approximate percentage of the budget devoted to data management. (specify % or "unknown")

unknown

5. Data Lineage and Quality

5.1 What is the processing workflow from collection to public release?

SCS data shall be delivered in its native format as well as an archive-ready, documented, and compressed NetCDF-4 format to NCEI-MD; multibeam data and metadata will be compressed and delivered in a bagit format to NCEI-CO.

5.2 What quality control procedures will be employed?

Quality control procedures for the data from the Kongsberg EM302 is handled at UNH CCOM/JHC. Raw (level-0) bathymetry files are cleaned/edited into new data files (level-1) and converted to a variety of products (level-2). Data from sensors monitored through the SCS are archived in their native format and are not quality controlled. Data from CTD casts and XBT firings are archived in their native format and are not quality controlled. CTDs are processed into profiles for display only on the Okeanos Atlas.

6. Data Documentation

6.1 Does the metadata comply with the Data Documentation Directive? True

6.1.1 If metadata are non-existent or non-compliant, please explain:

not applicable

6.2 Where will the metadata be hosted?

Organization: An ISO format collection-level metadata record will be generated during pre-cruise planning and published in an OER catalog and Web Accessible Folder (WAF) hosted at NCDDC for public discovery and access. The record will be harvested by data.gov.

URL: data.noaa.gov

Meta Std: ISO 19115-2 Geographic Information with Extensions for Imagery and Gridded Data will be the metadata standard employed; a NetCDF-4 standard for oceanographic data will be employed for the SCS data; the Library of Congress standard, MAchine Readable Catalog (MARC), will be employed for NOAA Central Library records.

6.3 Process for producing and maintaining metadata:

Metadata will be generated via xml editors or metadata generation tools.

7. Data Access

7.1 Do the data comply with the Data Access Directive? True

7.1.1 If the data will not be available to the public, or with limitations, provide a valid reason.

Not Applicable

7.1.2 If there are limitations, describe how data are protected from unauthorized access.

Account access to mission systems are maintained and controlled by the Program. Data access prior to public accessibility is documented through the use of Data Request forms and standard operating procedures.

7.2 Name and URL of organization or facility providing data access.

Org: OER Digital Atlas - one-stop access point to all data and information

URL: explore.noaa.gov/digitalatlas

7.3 Approximate delay between data collection and dissemination. By what authority?

Hold Time: data are immediately publicly accessible as soon as possible after cruise end - usually 30-60 days.

Authority: not applicable

7.4 Prepare a Data Access Statement

No data access constraints, unless data are protected under the National Historic Preservation Act of 1966.

8. Data Preservation and Protection

8.1 Actual or planned long-term data archive location:

Data from this mission will be preserved and stewarded through the NOAA National Centers for Environmental Information. Refer to the Okeanos Explorer FY16 Data Management Plan at NOAA's EDMC DMP Repository (EX_FY16_DMP_Final.pdf) for detailed descriptions of the processes, procedures, and partners involved in this collaborative effort.

8.2 If no archive planned, why?

not applicable

8.3 If any delay between data collection and submission to an archive facility, please explain.

usually 30-60 days

8.4 How will data be protected from accidental or malicious modification or deletion?

Data management standard operating procedures minimizing accidental or malicious modification or deletion are in place aboard the Okeanos Explorer and will be enforced.

8.5 Prepare a Data Use Statement

Data use shall be credited to NOAA Office of Ocean Exploration and Research.

Appendix 2. Categorical Exclusion

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OCEANIC AND ATMOSPHERIC RESEARCH
Office of Ocean Exploration and Research
Silver Spring, MD 20910

December 21, 2015

MEMORANDUM FOR: The Record

FROM: John J. McDonough, Deputy Director
Office of Ocean Exploration & Research (OER)

MCDONOUGH.JOHN.J.III.1365836678

SUBJECT: NEPA Categorical Exclusion for NOAA Ship *Okeanos Explorer* Cruise EX-16-01

NAO 216-6, Environmental Review Procedures, requires all proposed projects to be reviewed with respect to environmental consequences on the human environment. This memorandum addresses NOAA Ship *Okeanos Explorer's* scientific sensors possible effect on the human environment.

Description of the Project
This project is part of the NOAA Office of Ocean Exploration and Research's "Science Program" and entails ocean mapping activities and water column profiling using CTD, XBT, and Underway CTD casts designed to increase knowledge of the marine environment. This Categorical Exclusion addresses NOAA Ship *Okeanos Explorer* cruise EX-16-01 "Transit and Mission Patch Test" led by Derek Sowers and Elizabeth Lobecker, Expedition Coordinators for NOAA OER.

This cruise will be conducted from January 20, 2016 to February 7, 2016 starting in San Francisco, CA and ending in Honolulu, HI. Shakedown, testing, and calibration of existing and newly-installed mission scientific equipment is the principal purpose of this project, while secondary objectives focus on collecting information of scientific value along one of the major marine fracture zones in the eastern Pacific. A standard multibeam sonar patch test calibration is planned for an area off of the California continental slope at the start of the cruise. Sonar mapping of the Molokai Fracture Zone will be the focus of operations during the thirteen day transit from San Francisco to Honolulu. Once in Hawaii, calibration of EK60 fisheries sonars and Acoustic Doppler Current Profilers (ADCPs) in federal waters south of the islands of Lanai and Maui in the Hawaiian Islands region will be the focus of work for approximately six days. The Kongsberg EM 302 multibeam sonar (30 kHz), Kongsberg EK 60 singlebeam sonars (18, 38, 70, 120, 200 kHz), and Knudsen 3260 Sub-Bottom Profiler sonar (3.5 kHz) will be operated during the project. Additionally, expendable bathythermographs (XBTs), underway CTD casts, and CTD rosette casts will be conducted in conjunction with multibeam data collection. Mapping and sonar testing/calibration operations will be conducted nearly continuously throughout the cruise.

Mapping
The acquisition of high-resolution seafloor mapping data is an essential precursor to making significant biological, geological, archaeological and oceanographic discoveries. The *Okeanos*

Explorer cruise will collect seafloor mapping data to supplement previous multibeam mapping in the region. NOAA Ship *Okeanos Explorer* has three scientific sonars that are configured to operate simultaneously without interference: a 30 kHz multibeam echosounder (Kongsberg EM 302), an 18 kHz singlebeam echosounder (Kongsberg EK60), and a 3.5 kHz sub-bottom profiler (Knudsen Chirp 3260). Sonar operations with all three systems running simultaneously are planned to occur continuously throughout the day and night during the transit to Hawaii. Once in Hawaii, the EK60s and ADCP sonars will be run one at a time in order to calibrate each sonar. Expendable bathythermographs (XBTs) will be deployed at regular intervals in association with multibeam data collection. All of these systems are routinely used by this exploration vessel (except for the ADCPs, which were just installed on the ship in December 2015).

Bridge Officers and Watch Standers will be on watch during all hours and will look for marine mammals and other observable species potentially sensitive to the sound of the sonars. If cetaceans are sighted, knowledgeable personnel will follow established best management practices to minimize disturbance. If cetacean species are present within 400 m of the ship, the vessel will stop until the animals depart the area.

Multibeam

Multibeam sonar data will produce high-resolution bathymetry and acoustic backscatter maps. These maps will provide critical baseline information over a very poorly mapped major fracture zone in the Pacific Ocean, the Molokai Fracture Zone. Mapping of this fracture zone is a top exploration priority expressed by numerous science partners. Most of the mapping will likely be a single transit line of data, yet will still provide much greater resolution maps of the seafloor than currently exist in this region. The data collected will help scientists better understand the marine geology of the fracture zone, allowing for improved targeting of future exploration and research.

Expendable bathythermographs (XBT):

XBTs are deployed to obtain sound velocity profiles. The profiles are required to calibrate the multibeam system and ensure accurate bathymetric mapping. During the transit to HI, mapping operations will be conducted continuously, and will require the collection of water column sound velocity profiles every 4-6 hours. If the Underway CTD is not yet ready for collecting these profiles, the data will be gathered using XBTs. The very fine wire connecting the XBT probe to the ship is extremely easy to break by hand once the probe reaches maximum depth. The minimal tensile strength of the wire should represent a minimal entanglement risk for marine animals. The expended materials are unlikely to result either in any significant environmental impacts to the sea floor or in a significant degradation of marine water quality. Over a period of years, these materials would degrade, corrode, and become incorporated into the sediments.

Underway CTD

The Underway CTD is used to gather conductivity/temperature/depth (CTD) measurements or sound velocity measurements while the ship is moving. The ship currently obtains sound velocity profiles using expendable probes (XBTs). OER is installing the Underway CTD in order to minimize the use of XBTs while still gathering essential sound velocity profile data needed in order to accurately collect high quality multibeam sonar data. The Underway CTD was installed on the ship in December 2015 and will be tested on this cruise. When working correctly, Underway CTD casts will be used instead of XBTs to obtain water column profile data.

Split Beam Sonars:
Kongsberg EK 60 split-beam sonars are used to collect information about the water column, such as at gas plume or seep sites, and to obtain information about biomass. The EK60 split-beam sonar is used as a quantitative scientific echosounder to identify water column acoustic reflectors - typically biological scattering layers, fish, or gas bubbles - providing additional information about water column characteristics and anomalies. Fishery scientists have developed methods to analyze EK60 data to support fish stock assessment (e.g. Atlantic herring, pollock, capelin) and to predict hot spots of large fish in coral reefs. Split-beam sonars are also being used to help develop "acoustic signatures" of different marine species, which will greatly enhance existing efforts to assess abundance, distribution, and behavior using remote sensing methods. Additionally, split beam sonars are being used to estimate gaseous seep flux rates and improve assessments of their contribution to ocean and atmospheric chemistry. The *Okeanos Explorer* has five operational EK60 transducers at the following frequencies: 18 kHz, 38 kHz, 70 kHz, 120 kHz, and 200 kHz. One or more of these sonars will be operated during the majority of the cruise.

Sub Bottom Profiler:
The primary purpose of the Knudsen Chirp 3260 (3.5 kHz) sonar is to provide echogram images of surficial geological sediment layers underneath the seafloor to a maximum depth of about 80 meters below the seafloor. The Sub Bottom Profiler is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar is fundamental in helping geologists interpret the shallow geology of the seafloor. Collecting this data over the Molokai Fracture Zone will provide improved insights into the geology of the region.

CTD Operations
The CTD instrument package does not emit an acoustic signal and is used to obtain conductivity, temperature, depth and other oceanographic data (dissolved oxygen, light scattering, and oxygen reduction potential). At least one, and potentially several, CTD casts are planned for this cruise. The CTD would not touch the seafloor and would have limited time and presence in the marine environment.

Effects of the Project
The methods used to map the ocean during this cruise are used routinely by NOAA and UNOLS research vessels and are non-destructive in nature. As expected for ocean research with limited duration or presence in the marine environment, this project will not have the potential for significant impacts. Knowledgeable experts who are aware of the sensitivities of the marine environment will conduct the at-sea portions of this project. The potential gains or beneficial effects of the project seem to outweigh any potential adverse effects.

This expedition will provide data and information on poorly understood deep water features contained within both the U.S. Exclusive Economic Zone (EEZ) and in international waters. This work will provide essential information for further research, exploration, conservation and management of marine habitats. The testing and calibration of sonar systems during the cruise are essential for ensuring these systems provide the best possible quality data for the rest of the

Okeanos Explorer's 2016 missions. Providing the United States with scientifically credible and quality-controlled oceanographic data is a key benefit that will result from the cruise.

A portion of the cruise will occur within a geographic area with somewhat unique characteristics, since we will be mapping a tectonic plate fracture zone of key scientific interest. However, fracture zones are broadly distributed throughout the world's oceans and cumulatively cover immense areas. Furthermore, no physical modification of the fracture zone will take place. EK60 and ADCP sonar calibration work planned near Hawaii is specifically planned for an area outside any marine managed areas, Sanctuaries, known sensitive habitats, and state waters. These scientific sonars are routinely used by NOAA and have no documented impacts on habitats or species of concern.

As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this is a research project of limited size or magnitude and will not result in individually or cumulatively significant impacts on the quality of the human environment. Specifically, this research cruise would have only short-term effects with the principle goals of natural resource inventories and environmental monitoring over a wide geographic area. Furthermore, this action would not be subject to any of the exceptions for categorical exclusion provided at NAO 216-6 section 5.05c. As such, this project is categorically excluded from the need to prepare a NEPA environmental assessment.

Appendix 3. Survey of Opportunity

NASA Maritime Aerosols Network Survey of Opportunity
Survey or Project Name

Maritime Aerosol Network

Points of Contact (POC): Dr. Alexander Smirnov

Activities Description(s) *(Include goals, objectives and tasks)*

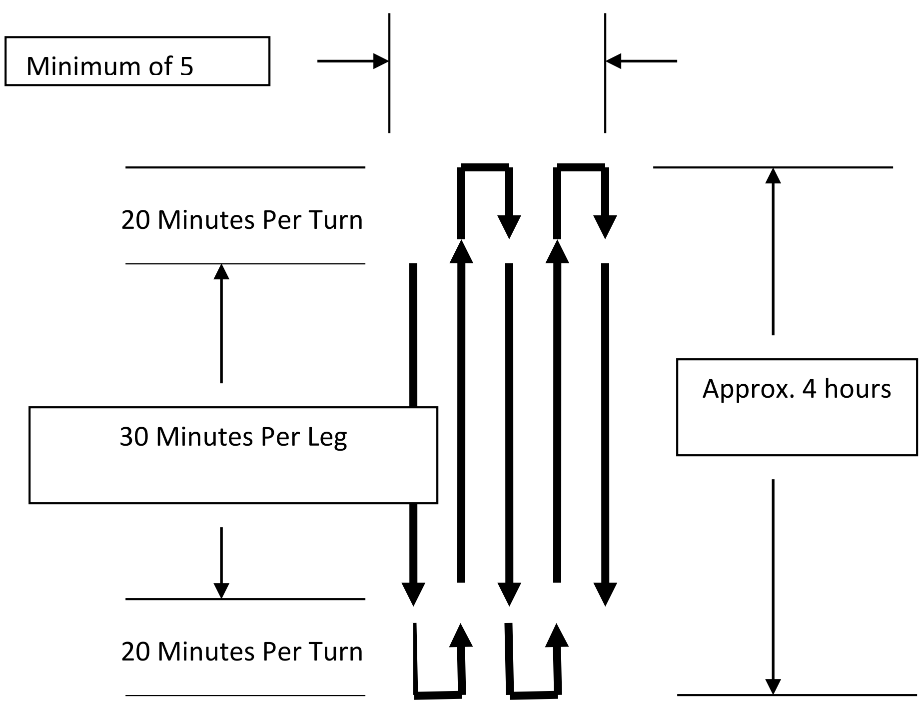
The Maritime Aerosol Network (MAN) component of AERONET provides ship-borne aerosol optical depth measurements from the Microtops II sun photometers. These data provide an alternative to observations from islands as well as establish validation points for satellite and aerosol transport models. Since 2004, these instruments have been deployed periodically on ships of opportunity and research vessels to monitor aerosol properties over the World Oceans.

Appendix 4. ADCP Testing Plans

Teledyne SAT Rough Schedule
(Assuming no trouble, and approximate depths and times)

1) Travel to 2000m
2) 5-6hr, Interference, Both ADCPs
3) 3-4hr, Profile Range, Both ADCPs at drift, 3, 6, 9, 12, & fast as she goes for 15 min at each speed
4) 2hr, Bottom Track OS38, from 1800m to 2000m traveling at 8 knots
5) 0.5-1hr, Bottom Track Test 0S38
6) Ringing OS38, to 300-700m (travel time from 2000m to 600m at 12 knots = 1.5hr)
7) 2-2.5hr, Ringing OS38
8) Transducer alignment, to 300-600m (travel time = 0)
9) 4-5hr, Transducer alignment OS38 with a test speed of between 5-10 knots depending on test 3 results. Course is reciprocal runs with 100 to 200 m separation between reciprocal tracks. See appended diagram.
10) 0.5-1hr, Bottom Track Test WHVM300
11) Ringing WHVM300, to 30m (travel time = 0)
12) 2-2.5hr, Ringing WHVM300
13) 4-5hr, XDCR Alignment, WHVM300, at 30 m (course: see diagram below). Note: Worst case with rough seas specified. This can be reduced depending on sea state.

Total time: 19.5-24.5hr (not including interference testing)



Variable speed range test notes:

OS38, 3 knots, 10 min, stop
WHVM, 3 knots, 10 min, stop
WHVM, 6 knots, 10 min, stop
OS28, 6 knots, 10 min, stop
OS38, 9 knots, 10 min, stop
WHVM, 9 knots, 10 min, stop
WHVM, 12 knots, 10 min, stop
OS38, 12 knots, 10 min, stop

UHDAS ADCP preparation and Testing

The Teledyne RDI Sea Acceptance Tests (SATs):

New ADCP installations should be tested and accepted by the manufacturer, Teledyne RDI. These tests will likely acquire data using the VmDAS software.
If your installation undergoes Teledyne RDI Sea Acceptance Tests:

- Upload the VmDAS data from the Teledyne RDI SATs to the UHDAS team.
- Based on the VmDas data, the UHDAS team will make a second guess at transducer angles.
- Based on the VmDAS data, the UHDAS team will comment on alignment, ringing, and penetration.
- The alignment of the transducers relative to the vessel heading input is recommended to be in the neighborhood of positive (starboard) 45 degrees for beam 3. Teledyne RDI should confirm orientation and estimate the mounting alignment angle of each transducer relative to the heading inputs from the vessel as part of their initial Sea Acceptance Tests (SATs).

Dockside UHDAS procedures:

- Confirm serial feeds to the UHDAS server:
    - Each ADCP transducer has a separate serial feed;
    - Gyrocompass (as many as possible) -- These should be raw feeds: They should not be combined nor run through some other device or application like SCS.
    - GPSs (2-3 if possible)
    - If serial cable runs are longer than 10-ish feet we strongly recommend using RS422 and converting to RS232 at the server, especially for the ADCP feeds. This allows faster error-free data transfer and can allow faster ping rates.
    - All serial feeds should be raw and direct from the device.
        - Serial broadcasters / repeaters / expanders that pass along the raw signal are okay.

        - Combiners, collectors, averagers, repackagers, best guessers and SCS are **NOT** okay.
    - UHDAS **really** wants an accurate heading device (POS/MV, SeaPath, MAHRS, Ashtech, …).
    - NMEA devices configured to output appropriate (to UHDAS) sentences:

Device	**NMEA sentences**
Ashtech ADU2	($GPGGA and $PASHR,AT2) or ($GPPAT)
Ashtech ADU5	$GPGGA and ($GPPAT or $PASHR,ATT or $PASHR,AT2)
Ashtech ADU800	$GPGGA and $PASHR,ATT
GPS, CNav	$GPGGA and $GNGGA and $INGGA (AR) or $GPGGA
GPS, CNAV-3050 (FK)	$GPGGA and $GLGGA and $GNGGA and $INGGA
GPS, generic	$GPGGA
GPS Compass, Coda Octopus F185	$GPGGA and $PASHR
GPS Compass, Furuno	$GPHDT (on SP)
Gyro (KOK, NH)	$AGHDT (AG = Autopilot General)
Gyro, Furuno SC-50	$HEHDT
Gyro, generic	$HEHDT
Gyro, Northrup Grumman MK39	$INHDT
Gyro, Meridian	$HEHDT
Gyro, Sperry	$HEHDT
iXBlue Hydrins (RR)	$PHGGA and $HEHDT
iXBlue Phins (KN)	$HEHDT and $PIXSE,POSITI
iXBlue Phins III (AR, RR)	$HEHDT

Teledyne TSS MAHRS	$HEHDT
Applanix POS MV	($INGGA or $GPGGA on EX) and $PASHR
Kongsberg Seapath	$INGGA and $INHDT and $PSXN,20 and $PSXN,23 ($GPGGA on NP) (GPGGA and GPHDT on SKQ)
Kongsberg Seapath 320 (FK)	$INGGA and $PSXN,20 and $PSXN,23
Speedlog (HLY, KM)	$VDVBW

For informational purposes:

NMEA talker ID	**Description**
AG	Autopilot - General
GL	GLONASS, according to IEIC 61162-1
GN	Mixed GPS and GLONASS data, according to IEIC 61162-1
GP	Global Positioning System (GPS)
HE	Heading - North Seeking Gyro
IN	Integrated Navigation
VD	Velocity Sensor, Doppler, other/general
Source	<http://www.catb.org/gpsd/NMEA.html>

- Confirm network connection for UHDAS server:
    - UHDAS server can "see" the outside world (often tested by browsing to Google).
    - UHDAS server can send e-mails to UHDAS shore-side monitoring (`daily.py --use_defaults`).
    - UHDAS server can be accessed from shore via the NOAA network.
    - On-board users on the science network can browse the UHDAS plots and data.
    - On-board users on the science network can remotely access data files on the UHDAS server via SMB, CIFS, NFS.

UHDAS Sea Tests:

UHDAS requires heading from both reliable and accurate heading devices. Ship's gyrocompasses are well established reliable heading devices, but not very accurate (especially in high latitudes). Accurate heading device such as POS/MV, Mahrs, Ashtech are not as reliable as gyrocompasses. UHDAS adjusts the gyrocompass heading value based on the accurate heading device, and fills missing or wild headings from the accurate device with adjusted gyrocompass values.

- **Bottom Tracking:**

  Bottom tracking is a **very** useful component for aligning the transducers. However it is only useful so long as the instrument can "see" the bottom (is in shallow water). Therefore it is recommended to energize the system with bottom tracking enabled on all transducers, before leaving the dock. Disable bottom tracking once the water depth exceeds a 1000 meters, and enable narrowband mode (NB) on appropriate transducers. Please inform the UHDAS team <uhdas@hawaii.edu> as soon as possible after bottom tracking has been disabled.

- **Transducer angle:**

  Upon being informed that bottom tracking has been disabled, the UHDAS team would like to remotely connect to the UHDAS server to evaluate the bottom track data and apply that information to make refinements to applied transducer angles. It is important to get a reasonably good estimate of the transducer angle in place soon after the ship leaves port (a few hours).

  The UHDAS team will coordinate with the on-board technicians regarding any configuration changes that might result from the bottom track evaluations. Although the UHDAS team should have remote access, changing the UHDAS cruisename (required when changing configurations) is best done from the local GUI on the UHDAS server. The procedure only takes a few moments:

- stop logging
- end cruise
- kill UHDAS GUI
- start UHDAS GUI (killing and restarting is only required for calibration changes)
- start new cruise (leg 02)?
- start logging

- **Reciprocal runs:**

  Make multiple passes between two waypoints in opposite directions. Choose two waypoints that are 30 minutes apart at 6-9 knots, steam back and forth between the waypoints. Turns should be beyond the waypoints, outside the runs.

- energize both transducers, bottom tracking disabled,
- the Ocean Surveyors should have both narrowband (NB) and broadband (BB) enabled,
- blanking should be set to zero (0)
- more is better, optimal is 6-8 cycles.

- **Speed / range test (1.5 hrs)**

- straight line course
- energize all transducers, bottom tracking disabled,
- the Ocean Surveyor should have both narrowband (NB) and broadband (BB) enabled,
- make note of:
- relative wind direction (running upwind, downwind, crosswind?)
- sea-state (also note direction)
- run for 15 minutes at each speed:
    - drift (1-2 knots)
    - 3 knots
    - 6 knots
    - 9 knots
    - 12 knots
    - full speed, if different from above

- **Water-track calibration, zigzag**

Occasionally turn 60-90 degrees and hold the course 30-60 minutes, at least 6 turns would be optimal.

- **Interference of OTHER instruments ON ADCP**

Interference evaluation is time and labor intensive, it is best done with more than one person (someone to stop/start logging, someone to energize and secure all the other acoustic instruments being evaluated).

Each evaluation suite contrasts the ADCP signal alone versus the signal of one other acoustic device (energized at one frequency, if possible).

- Choose a ship speed that produces maximal ADCP range (see speed / range tests).
- Repeat all the evaluation suite for each ADCP.
- Run each configuration for 12-15 minutes.
- Perform multiple iterations of the configuration, alternating between the ADCP only, and the ADCP plus the one acoustic device being evaluated, see the UHDAS Interference Worksheet.

- Each test suite should result in 5 segments, 3 with only the ADCP and 2 with both ADCP and the acoustic device being evaluated.
- Log all start and stop times on the worksheet.
- Environmental conditions should remain relatively constant throughout the test, if possible block out enough time to run the entire (or large chunks thereof) test suite in one go.
- It is important for the segment lengths to be similar, and to minimize the gaps between segments. Each test suite should take about 80min (12-15min per segment)

The test procedure for each acoustic device to be evaluated is:

- Start cruise, log cruisename.

  The cruisename should be similar to:

  ex1601_test01_wh300_ek60_38

  which would mean: the Okeanos Explorer ("ex"), during cruise 1601, the first set of tests, the workhorse 300 versus the EK60 running at 38 kHz.
- Energize the ADCP being tested.
- Start recording, log time of "start recording" as start time
- Run test for 12-15 minutes.
- Stop recording, log time of "stop recording" as stop time.
- Energize device being evaluated
- Start recording, log time of "start recording" as start time
- Run test for 12-15 minutes.
- Stop recording, log time of "stop recording" as stop time.

- Repeat with:
  - ADCP only,
  - ADCP + device,
  - and finish with ADCP only

- End cruise

- Choose another device or frequency and start over

Example acoustic devices that should be tested for interfering with ADCPs are:

- Multibeam
- EK60, test each frequency available
- sub-bottom profiler, if Chirp run test at two different depths

Last modified: 04 Jan 2016 by Jules Hummon and Toby Martin

Appendix 5. EK60 Calibration Procedures

***S**tandard*

***O**perating*

EK60 Calibration

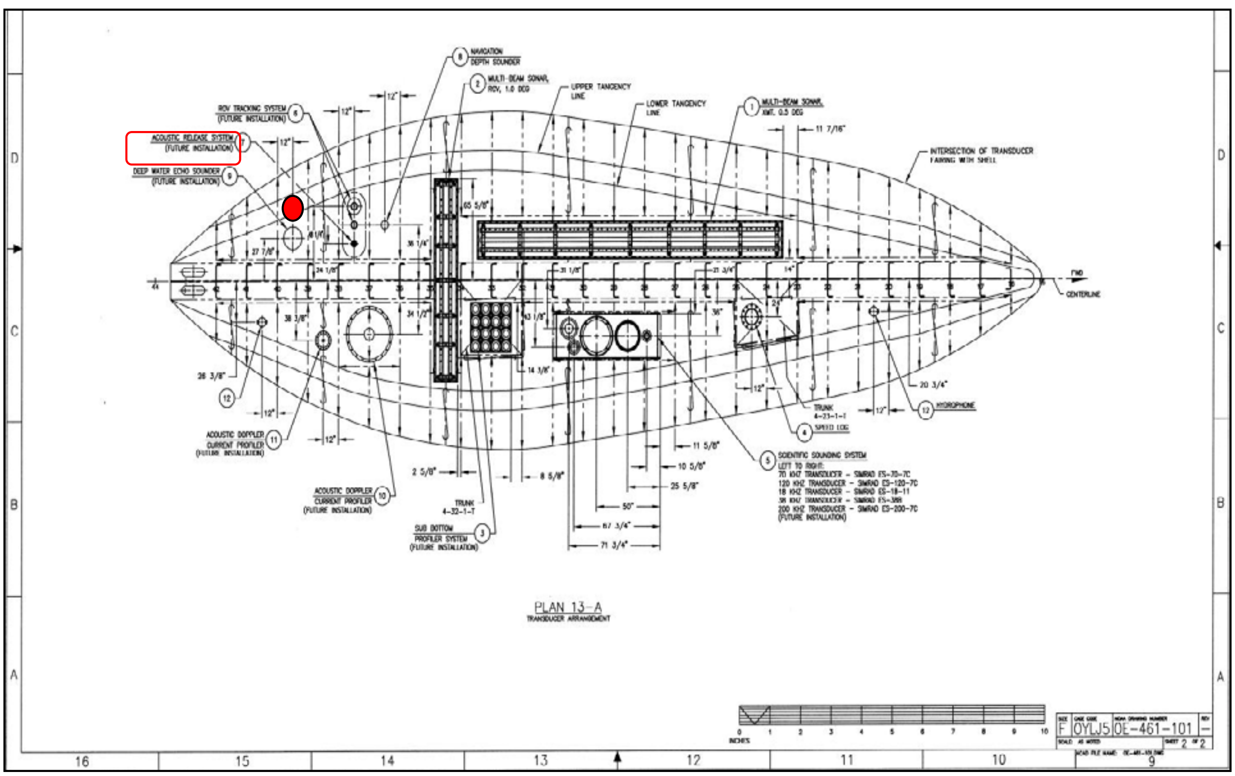
PROCESS OWNER
NOAA Ship *Okeanos Explorer*

REVISION HISTORY			
REV	Description of Change	Author	Effective Date
0	Initial release	Malik and Peters	August 2011
1	Revised to reflect updated pictures using calibration equipment provided by UNH CCOM as part of EK80 testing. Simplified text.	Sowers	March 2015
2	Revised	Chris Taylor	March 2015

REFERENCE DOCUMENTS	
Document Number	Document Title
	Simrad EK 60 Scientific Echo Sounder Reference Manual Release 2.2.0, January 2008

Simrad EK60 calibration procedures are outlined in Simrad EK60 Scientific Echo Sounder Reference Manual Release 2.2.0, January 2008. The following procedures have been adapted for the *Okeanos Explorer*. EK60 calibration is required to maintain the accuracy of the data for scientific applications and is generally recommended when the ship moves to an operating area with substantially different water mass properties (*e.g.* temperature, salinity, depth, or moving from N. Atlantic to the Gulf of Mexico or Tropical Pacific).

EK60 18kHz Transducer, installed May 2011. Arrows point towards the bow of the ship .The transducer is on the port side of the ship.



EX Transducer Arrangement in hull blister. Not all of the labeled equipment is currently installed. Indicated is the location of the EK60 transducer. It is on the port side of the vessel.

1.0. Purpose/Overview

This plan describes an in situ beam pattern measurement procedure for the Simrad ES-18-11, 18 kHz split-beam scientific transducer using the Simrad EK60 general purpose transceiver (GPT, 18 kHz) aboard the *Okeanos Explorer.* During calibration a reference target with known target strength (TS) is lowered into the sound beam, and the measured target strength is compared with the known target strength. If it is necessary to adjust the echo sounder, this is performed automatically by the calibration software. If you have an EK60 system with several transceivers, you must calibrate each frequency separately. All the different combinations of pulse duration and transmitter power for each frequency that will be used during normal operation of the echo sounder must be calibrated.

A CTD profile should be conducted prior to calibration to obtain temperature and salinity depth profiles. If it is relatively shallow and a mixed watercolumn is expected, the readout from the surface TSG can be used. Measurements on the main response axis (MRA) are of primary importance to provide a general offset for TS in the center of the beam pattern. If no other data are collected elsewhere in the echosounder FOV, this MRA offset may be used in conjunction with beam pattern models to estimate TS corrections across the beam pattern. If conditions and time constraints allow, and only after MRA data have been collected, it is also useful to collect data with the sphere in positions across the beam pattern to provide beam pattern corrections directly.

Preparation of the materials on deck and selection of favorable sea conditions can save several hours of ship time. It is ideal to minimize current relative to the ship, because relative currents of 1 kt or more will severely complicate sphere deployment and control. More importantly, stress and failure of the lines, rods, and reels increase the chances of losing the sphere and may present hazards to personnel on deck.

2.0. Location

A water depth of at least 30m is required to conduct this calibration. It is recommended to conduct calibration at a deep pier facility (with depth > 30 m). If no deep pier facility is available the calibration can be conducted at anchor or drifting in a location where there is minimal impact by fish (to avoid acoustic interference) and current/sea conditions (to avoid excessive movement which makes the mechanics of the calibration difficult). The calibration can also be conducted while the ship is drifting in an area with light winds, calm seas, mild currents, and minimal traffic hazards. A final location will be chosen based on the impeding weather conditions and discussions with the ship's command.

3.0. Equipment

The following equipment is required to conduct the calibration and resides on the EX:

- 150 feet of line and a weight (large shackle) secured in a loop in the center of the line.
  - *The line is bright yellow as of Feb. 2015 (white line shown in picture has been replaced)*
- EK 60 transducer and ER60 software
  - *These are installed on the ship.*
- 4 people minimum: 1 for each of 3 outriggers and at least 1 in the lab to conduct the calibration.
  - *Lead Scientist/Mapping Lead/Expedition Coordinator, Survey Technicians, Mapping personnel.*

- 4 handheld VHF radios
    - *Located in the Dry Lab and/or available from upon request from ETs.*

- 3 Canon Easi-Troll ST Manual Downrigger reels with 100+ meters of high strength braided line (100lb or 200lb test green or yellow "Spectra", "PowerPro" or similar braided fishingline is excellent)

- 3 stainless outrigger holders
- 3 eight-foot long fiberglass outrigger poles with eye-bolt at end
- Hardware to secure downriggers to the side of the ship
- 3 (three) 6" angle aluminum with reel base screwed in – one per downrigger
- 6 (six) metal C-clamps – 2 per downrigger
- 9 (nine) hose clamps – 3 per outrigger
- Calibration sphere (Copper, 63.0 mm diameter) and liquid soap+

- 3-way swivel for connecting bow, port, and starboard lines without entanglements
- 20-25 m length of monofilament line (30 lb test) with snap swivel for sinker weight. Make loop knot at end to attach to three downrigger snap swivels. Make loop knot in mono line 10 meters down to attach sphere.
- Gloves for protecting hands during deployment of the monofilament line, sphere, and weight
- Boat hook for maneuvering lines for setup and retrieving sphere/weight.

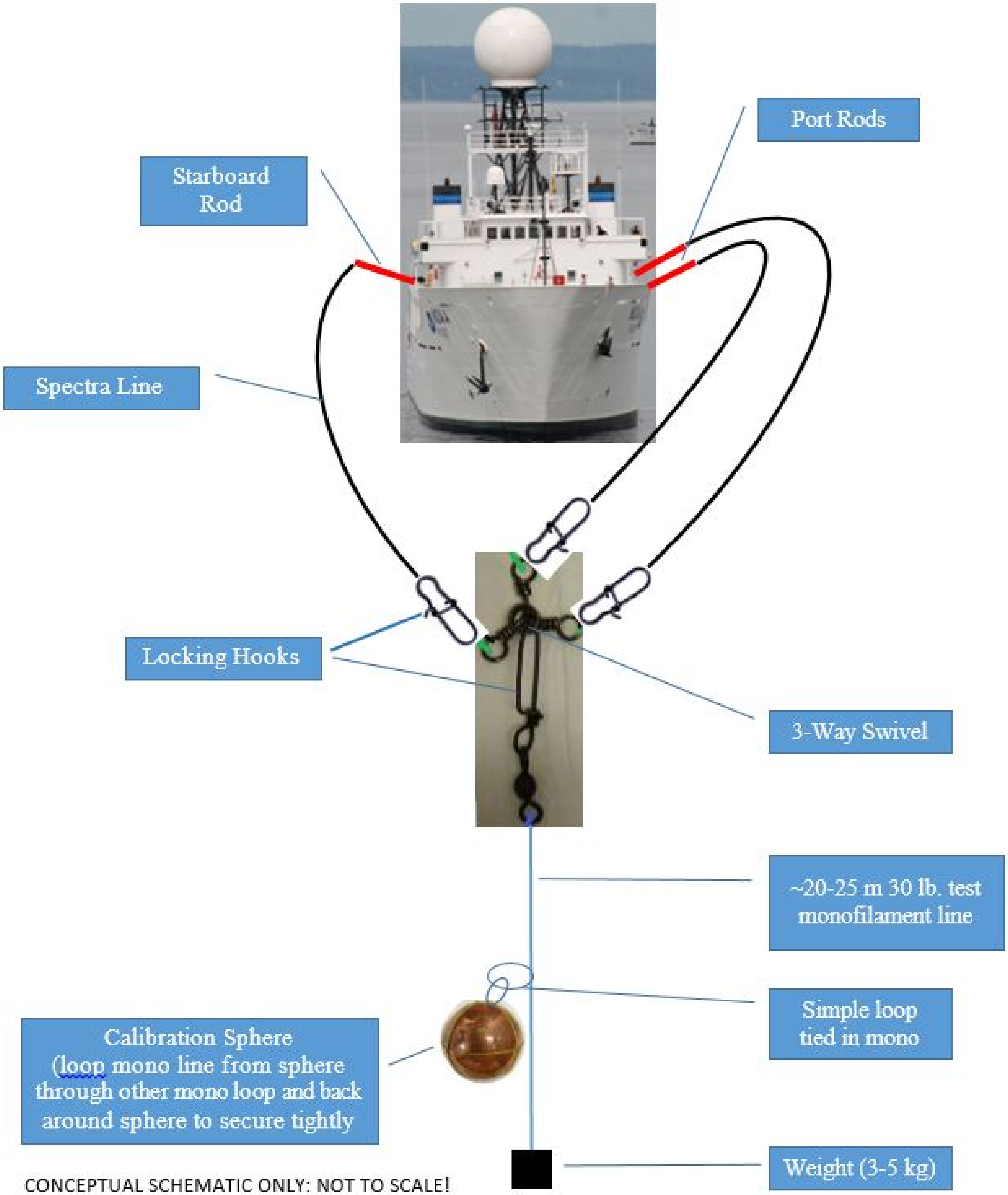
3.0. Pre Calibration

Significant preparations have to be made to set up the gear for EK 60 calibrations. Three lines on reels with outrigger rods are used for positioning the sphere within the beam of the transducer. Control over the sphere position within the beam requires approximately equiangular and equidistant spacing of rods and reels with respect to the transducer.Having the rods, reels, lines, sinker, sphere, and personnel prepared and in place before the calibration will save many hours of ship time.

3.1. Equipment Setup:

1. Set up the downrigger reels and outriggers with two on the port side (fwd and aft) and one on the starboard side of the ship in line with location of hull installed EK 60 transducer.

The following is a conceptual diagram illustrating the arrangement of the lines, sphere, and weight.



CONCEPTUAL SCHEMATIC ONLY: NOT TO SCALE!

Port Forward:

This station is set up on the port side 0-1 deck, as shown below. The pole is mounted on the stanchion furthest forward, and the Canon reel is mounted on the bulwarks vertical flaring just aft of this.


Secure the angled aluminum plate to the metal bulwarks flaring on the ship using C-clamps as shown in the photo below.

Attach the Canon downrigger into its mounting plate that is screwed into the aluminum plate. Orient the downrigger reel handle to face the walkway so it is easy to operate. Secure the metal pole holder to the stanchion using rubber padding and screwing tightly three hose clamps to minimize rotation of the holder.

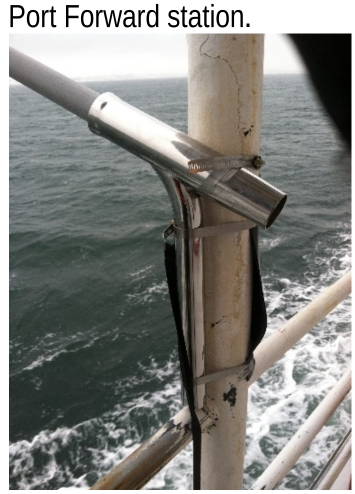
Before putting the fiberglass pole in the holder, run the end of the monofilament line through the eyelet at the end of the fiberglass downrigger pole. Make sure to run the line through the eyelet in such a way that it will freely move when being reeled in or let out. While having one person holding the end of the monofilament line and letting line out from the reel, have another person place the pole into the holder. Clip the end of the monofilament line into the orange zip tie at the end of the Canon reel. Keep the line taught to avoid any tangles.

Port Aft:

This station is mounted just forward of the chains on the port 01-deck forward of the breezeway.

Secure the angled aluminum plate to the metal post on the ship using C-clamps as shown in the photo below. Secure the metal pole holder to the first ship stanchion forward of the chains using rubber padding and screwing tightly three hose clamps to minimize rotation of the holder.

Put the monofilament line through the fiberglass pole and secure to the orange zip tie as described for the Port Forward station.



<u>Starboard:</u>
This station is set up between the 4th and 5th stanchions (counting forward to aft).




Once the mounting equipment is in place, the line can be run through the eyes of the poles, and the poles can be placed in the holders until it is time to connect the rest of the gear.

2. Take the yellow paracord line and shackle weight to the front deck, tie one end of the paracord to a railing, and carefully unreel the paracord line around the front of the ship's bow. Maneuver the paracord around the ship's anchors to get the line below them without entanglement. Keep the loop in the middle of the paracord at the front of the bow (you can tie it the front with a lot of slack on either side.) Once the line has been place around the bow and tied to railings on both the starboard and port side, attach the shackle weight to the loop and drop the line clear of the ship to sink the paracord underneath the vessel. Carefully move on end of the paracord line to the starboard downrigger and attach to the downrigger's spectra line. Move the other end of the paracord to the forward port downrigger and do the same. This line will then be used to join the port and stbd filament line on the downriggers.

    a. Note: If anchoring, set up the line with the weight prior to anchoring or it will not be possible to get the line past the anchor chain on the bow.

3. Dip the sphere in liquid dish detergent to ensure there are no bubbles or fouling on the target.

4. Confirm that the vessel is secure in a suitable location (bow/stern anchored in still water that is free of biological scatterers, or drifting). If anchoring is not possible, calibration can be conducted while adrift.

3.2. CTD Cast:
A CTD cast is required to obtain a sound velocity measurement for the depth of the sphere. The CTD only needs to be lowered to about 50 meters. Once the cast is completed, print out a sound velocity profile for the top 50 meters of the water column. Once the sphere is lowered, and a depth is determined, use the profile to select the appropriate sound velocity. You will also need the sound speed or temperature in order to select the correct sphere target strength during the calibration. The CTD cast will be conducted by the Ship's crew—OOD, SST and deck department.

3.3. Time Estimates:

It could take a few hours to precisely place the sphere under the EK 60. Up to 12 hours on-site may be required to conduct the full calibration.

NOTE: Make sure everyone working outside is cognizant of the weather conditions—to take breaks and wear sunblock in extreme heat or to bring suitable layers for cold weather—this process may take several hours. Also make sure to rotate personnel through the positions so that everyone can have enough breaks.

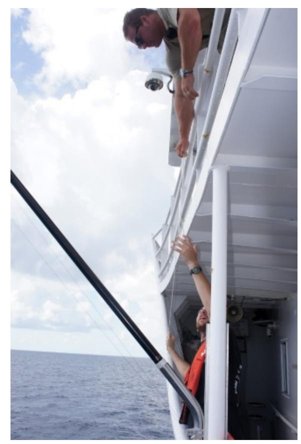
3.4. Risks:

Gear entanglement: The ship's motion during the calibration procedure should be minimal to avoid any gear entanglement. If gear entanglement is suspected, the calibration procedure will be halted and ship's divers will inspect the ship hull for any entanglement.

4.0. Calibration

Once the line with the weight has been draped below the ship's hull, and the vessel is secure either at anchor or adrift, the following methodology is the recommended approach for giving us the best control of the gear under the ship's hull.

4.1. Deployment

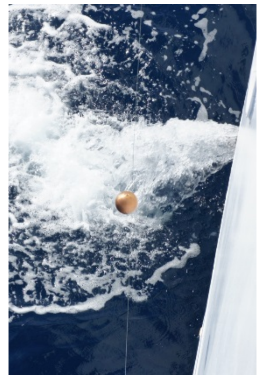


1) With the spectra line fully reeled in to end of the outrigger pole, reset all the reel counters to zero. Attach one end of the line to a pole/reel on the stbd side of the vessel.

2) Pay out the monofilament on the stbd side reel, and pull in the paracord on the port side until the monofilament is reached. Detach the line, and attach the two remaining reels (e.g., fwd and aft port reels).

3) Attach a >12m length of monofilament, the calibration sphere, and a weight (weight needs to be at least one pulse length below the calibration sphere, and the sphere needs to be at least one pulse length below the swivel) to the point where the monofilament from all three reels are attached.

4) Soap the calibration sphere using ordinary dish detergent to avoid bubble development on the surface of the sphere.

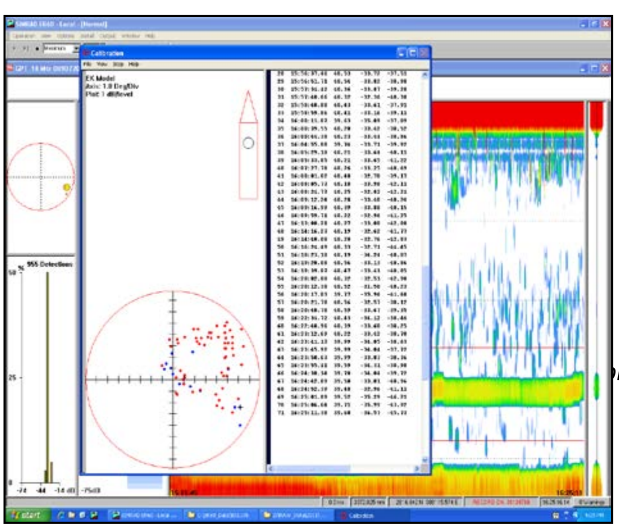


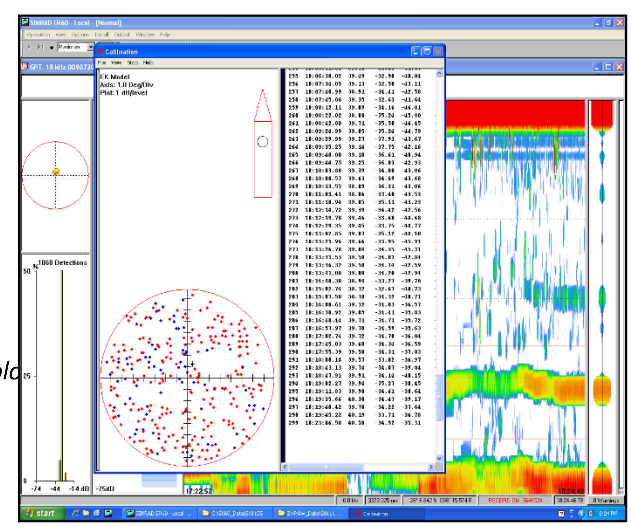
5) Lower the weight and calibration sphere over the port side with the port side reels holding tension. Instruct the port side reel personnel to pay out line slowly as the starboard side takes up line. Keep some tension on the starboard side to avoid too much slack in the line that could entangle ship's hull or instruments. Instruct reel operators to payout/takeup line until the sphere can be seen in the sonar's field of view. The following reel out numbers should get the sphere positioned close to the center of the sonar's field of view. These numbers on the reel will have the sphere at about 18-20m below the transducer: The numbers assume the reel counters were zeroed with the snap swivel at the end of the downrigger (rather than at the end of the outrigger pole).

STBD: 76 ft
Port Aft: 96 ft
Port FWD: 75 ft

6) Adjust the lines in order to conduct the calibration. This will require someone in the control room and on each reel, all with radios, to communicate the direction each reel needs to be operated to position the sphere.

7) The sphere needs to be moved into all four quadrants of the sonar beam. It is suggested to keep a written log of these changes in order to keep track of the motion of the sphere. Once the entire circle has been filled with points, the calibration is complete. (Consult section 5.0 for details of operating the calibration software. Make sure the RAW data is being recorded. The calibration can be re-examined in playback mode if necessary.





4.2. Recovery

1) After the calibration is finished, pay out the lines on port side and reel in on stbd until the stbd line is vertical and the connection point reaches the surface.

2) Next, grab the stbd line with a boat hook to bring it closer to the ship. Haul in the sphere and weight by hand until the gear is on deck. Use gloves for protection.

3) Disconnect the sphere and the weights.

4) Disconnect the port lines and attach a small weight to each line and tell each person standing by the reels to haul in.

5) Inform the bridge when all equipment is out of the water and stowed.

4.0. Troubleshooting

- If the ship is drifting, and you cannot get the sphere into a particular quadrant simply by shifting the lines on the downriggers, consider turning the ship around. A shift in current direction may help get the sphere into the sector you need.

5.0. ER60 18 calibration software

Once the sphere has been lowered below the transducer, use the following procedure to run the calibration routine on the EK 60 software. The settings used for calibration on 08/29/2011 are provided as guidelines.

The theoretical target strength of the calibration sphere can be calculated using the following link http://swfscdata.nmfs.noaa.gov/AST/SphereTS/. Enter the sphere material (e.g., Cu), size (e.g., 64mm), temperature and salinity at target depth, frequency and pulse length for calibration.

Setting up the calibration window

1. Click **Operation →Ping control**.
2. In the **Ping Control** dialogue, set **Ping rate** to *Interval* and *1 second*. This can also be done from the toolbar.
3. Click **Operation →Normal**.
4. In the **Normal Operation** dialogue:
Select transceiver, and switch to *Active* mode.

Set the *Transmit Power* to the level you wish to calibrate [2000 W]

Choose the *Pulse Duration* you wish to calibrate [0.512ms, 1.024ms, 2.048ms, or 4.096 ms]

5. In the **Output -> File** set the Current Output Directory to a folder ../<Cruise>/Calibration/<pulselength>/.On the **Raw Data** tab, specify a filename prefix to reference the cruise/ship and pulselength used. Set **Range** to 50m and Max. file size to 50Mb. **Start recording the raw data!**

6. Right-click in an echogram, select **Range** on the short-cut menu, and set the range for one of the echogram views to cover the range you wish to see around the sphere. This range should include the depth range where you expect to find the reference target, weight below the target (and seafloor if visible).

7. Check that you see the reference target in the *Single Echo* view.

8. Right-click in the *Single Echo* view corresponding to the echogram to open the **Single Target Detection** dialogue box.

9. In the **Single Target Detection** dialogue, click the **Calibration** button to start the calibration program, and to create a new *Calibration* window. The calibration program allows you to record new calibration data, or read previously recorded calibration data.

10. In the *Calibration* window, click **File →New** to open the **Record** dialogue and to start a new calibration.

111. Enter the following data in the **Record** dialogue box:

a.Transducer's serial number [2097]

b. Correct theoretical target strength (TS) for the reference target [e.g., -34.60 dB, dependent on sphere and sound speed at the calibration depth, see http://swfscdata.nmfs.noaa.gov/AST/SphereTS/ for a TS calculator]

*c. Allowed deviation from the TS for the reference target [5 dB]

**d. Upper and lower depth limits for the target window (that include only the sphere and exclude the weight and seafloor).

e. Any comments you may wish to add to the calibration file

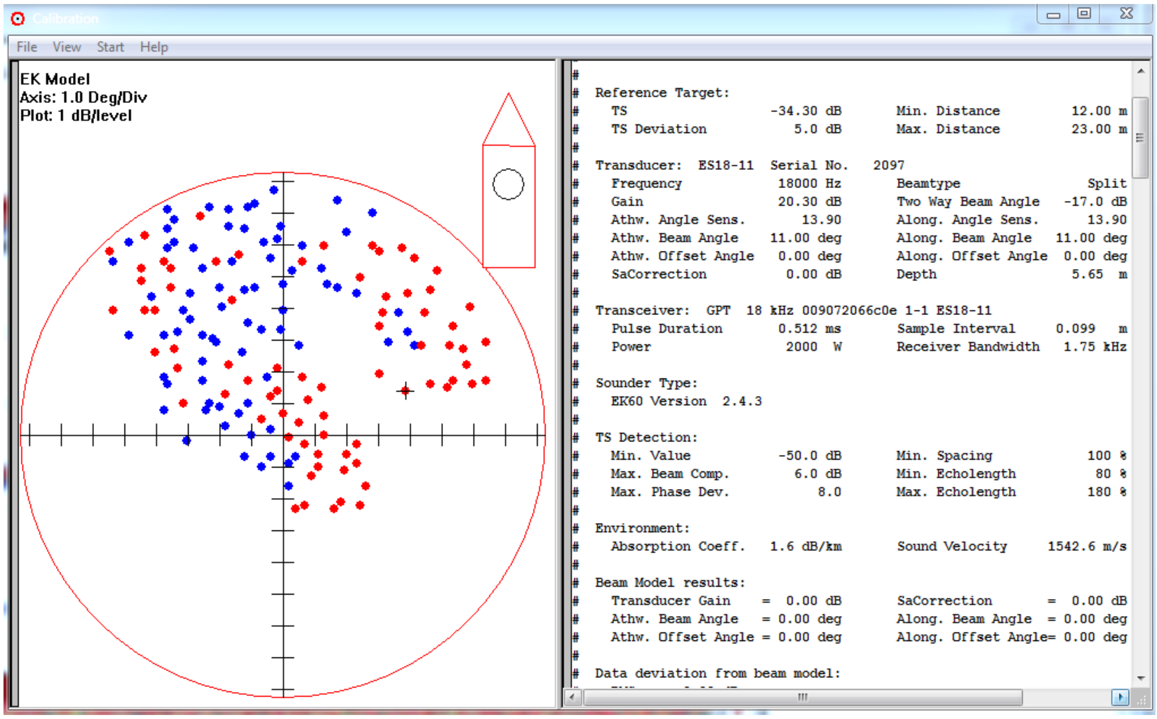
*This is a window giving the limits for the system's acceptance of single target echoes coming from fish. The closer to the correct reference target TS the limits have been set, the more of the unwanted fish echoes will be rejected. On the other hand, if the echo from the reference target is too close to one of the limits, the deviation has to be increased before starting collecting data. This is because it will always be a certain variation in TS values when the reference target is being moved to cover the complete beam.

**A narrow window will have same effect as above, reducing the possibility of detecting unwanted echoes from fish. But change in the range of the sphere may take it outside the depth. It is best to keep the sphere within 1-2 m range/depth during entire calibration.

12. Click OK when you have finished entering data. The calibration program will now begin.

Running the calibration routine

Different views can be set up during the calibration. You will see two views in the *Calibration* window; a *Plot* view and an *Information* view.



Plot view (left) shows position of the reference target in the transducer beam, crosshairs over dot show current or last target location. Information view (right) shows calibration and EK60 system parameters. Scrolling down in right panel shows target strength and position as target position is recorded.

A vertical bar is shown on the left side of each view. A blue colour indicates that the view is active, while gray colour indicates a passive view. If you wish to print a view, or perform other operations connected to it, you must make sure that the desired view is active.

In the *Plot* view you will see recorded data plotted as blue and red circles. Blue circles indicate TS values below the current beam model, while red circles indicate values above the current beam model. In the upper part of the *Information* view you will see various information associated with recording of the calibration data. Lines containing this information all begin with a #. Below this information, recorded values for each new TS detection are updated continuously during data recording.

1. Move the reference target slowly around to record a sufficient number of data points (>100) evenly distributed inside the beam. Make sure that a reasonable number of hits are made close to the centre of the beam. This is important in order to ensure a correct estimate for the Sa correction parameter.

2. While moving the target you should keep the reference target within the depth limits you entered in the **Record** dialogue (<2m change in range over calibration).

3. While moving the target and recording of data points stops, the measured TS value may be outside the limits entered in the **Record** dialogue.
4. Stop and restart recording as required by using the **Stop/Start** command found in the **Main** menu. It is recommended to stop collecting data if unwanted fish echoes are entering into the depth window, and restart again when disappeared.

5. When you have finished data recording, click **File →Save As**to open the **Save As** dialogue.

6. Choose the directory where you want the calibration file to be saved, and enter a file name for your calibration file.

7. Click **Save As** to finish.

Name the Results file according to the Date, Frequency and Pulse Length.

The calibration program will now use two different models to fit recorded data, a polynomial model and a beam model. The *Plot* view will plot the model along with the recorded data points. Blue circles indicate values below the model; red circles indicate values above the model. The green circles close to the centre axis indicate the points that have been used when estimating the Sa Correction value.

Examine the Information view. Under the "Data Deviation from Beam Model", the RMS value should be <0.4 A higher RMS may be caused by encroaching fish targets or other noise that has contributed to the reference target strength. If there were fish targets during portions of the Calibration, the RAW file can be Replayed (Main Menu – Operation – Replay) and follow the same Calibration program procedures above. Use Stop/Start in the Calibration program main menu to not record targets when fish are present.

Updating transducer parameters

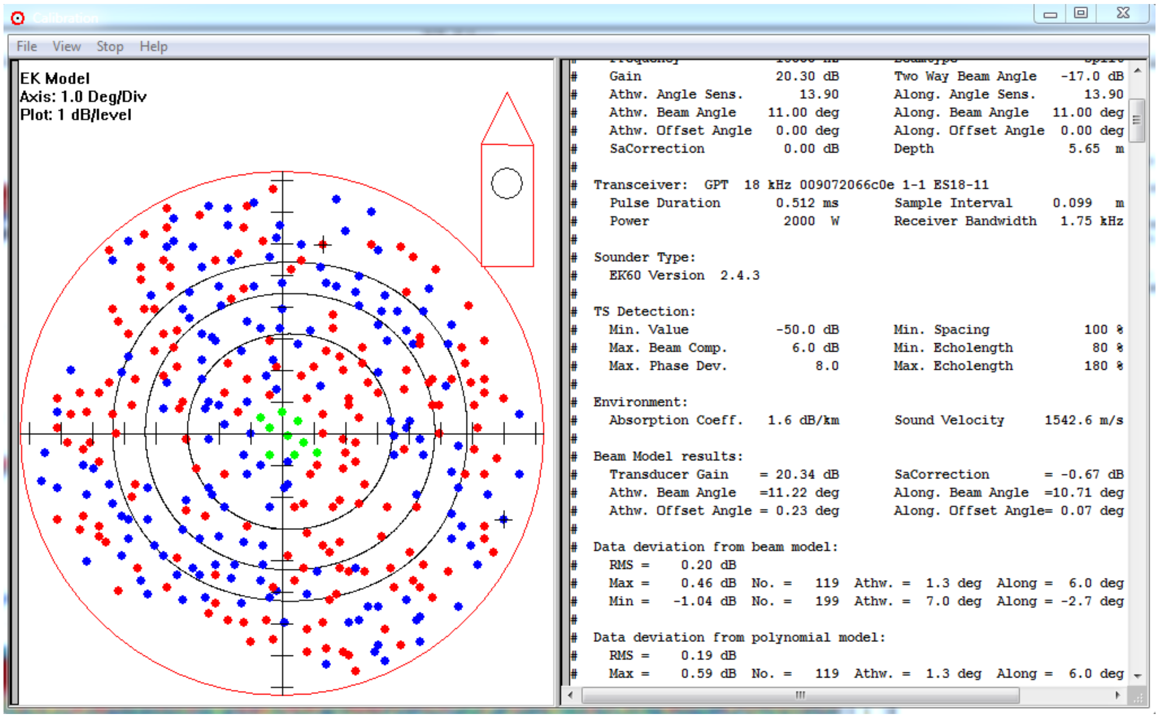
When you are satisfied with the calibration results you can use the results to update your transducer parameters in the echo sounder.

In the ER60 installation directory, find the TrList.ini file. This file contains factory default parameters for all SimradTranceiver and Transducers. Copy this file and paste is the same directory as "TrList-Default.ini".

1. In the *Calibration* window, click **File →Update Beam Data** to perform this task.

This step updates the Gain, SaCorrection, and Beam Angle parameters in the TrList.ini file for the selected transducer and pulse length for the calibration.

NOTE:



Calibration program view after saving calibration data. Green targets indicate those used to calculate Gain and Sa Correction. Blue targets are below expected target strength and red are above expected target strength using the updated Beam Model.

Repeat Calibration steps for other pulse lengths and frequencies. Copy and rename the TrList.ini with TrList_<date><frequency><pulse length(s)>.ini

Note:
This is a serious operation, which will affect the transducer installation parameters and will thus affect all future results to be obtained using the current transducer and pulse duration.Thus, to prevent accidentally use of this operation, you are asked to confirm this operation. The changes take effect automatically the next time you start Normal operations on the echo sounder. ***If the RMS in the calibration beam model results is >0.4, do not update beam data.***

Example Data: August 29, 2011 calibration results

```
#  Calibration  Version   2.1.0.12
#
#  Date:  8/29/2011
#
#  Comments:
#
#
#  Reference Target:
#    TS                  -34.60 dB       Min. Distance         36.00 m
#    TS Deviation           5.0 dB       Max. Distance         47.00 m
#
#  Transducer:  ES18-11  Serial No.   2097
#    Frequency            18000 Hz       Beamtype                 Split
#    Gain                 23.00 dB       Two Way Beam Angle   -17.2 dB
#    Athw. Angle Sens.       13.90       Along. Angle Sens.      13.90
#    Athw. Beam Angle    10.60 deg       Along. Beam Angle   10.40 deg
#    Athw. Offset Angle   0.00 deg       Along. Offset Angle  0.00deg
#    SaCorrection          0.00 dB       Depth                 4.57  m
#
#  Transceiver:  GPT  18 kHz 009072066c0e 1-1 ES18-11
#    Pulse Duration       4.096 ms       Sample Interval     0.771   m
#    Power                 2000  W       Receiver Bandwidth   0.72 kHz
#
#  Sounder Type:
#    EK60 Version  2.2.1
#
#  TS Detection:
#    Min. Value           -38.0 dB       Min. Spacing            100 %
#    Max. Beam Comp.        6.0 dB       Min. Echolength          80 %
#    Max. Phase Dev.          10.0       Max. Echolength         470 %
#
#  Environment:
#    Absorption Coeff.   1.5 dB/km       Sound Velocity     1505.0 m/s
#
#  Beam Model results:
#    Transducer Gain    = 23.09 dB       SaCorrection       = -0.43 dB
#    Athw. Beam Angle   =10.93 deg       Along. Beam Angle  =10.61 deg
#    Athw. Offset Angle = 0.17 deg       Along. Offset Angle= 0.03 deg
#
#  Data deviation from beam model:
#    RMS =    0.42 dB
#    Max =    1.21 dB  No. =   228  Athw. = -5.2 deg  Along = -2.8 deg
#    Min =   -1.87 dB  No. =   263  Athw. = -1.2 deg  Along =  5.0 deg
#
#  Data deviation from polynomial model:
#    RMS =    0.39 dB
#    Max =    1.16 dB  No. =   228  Athw. = -5.2 deg  Along = -2.8 deg
#    Min =   -1.66 dB  No. =   263  Athw. = -1.2 deg  Along =  5.0 deg
#
#  Data:
#  No.    Time    Distance  TS-c    TS-u      Athw.    Along     sA
#                  [m]      [dB]    [dB]      [deg]    [deg]  [m2/nm2]
#
1  15:39:55.89  40.42   -34.54  -34.81     1.11     0.20       482
```

```
2  15:40:00.64  40.41   -34.56  -34.74     0.91     0.00       484
3  15:42:04.39  40.37   -34.43  -34.74     1.11     0.40       516
   ///////
   ///////
295  18:19:11.83  39.90   -34.61  -38.64    -3.24     2.93       207
296  18:19:35.66  40.30   -34.47  -39.17    -3.54     3.14       154
297  18:19:40.42  39.78   -34.22  -37.64    -2.73     2.93       257
298  18:19:45.22  40.19   -33.71  -36.78    -2.63     2.73       308
299  18:23:06.58  40.50   -34.92  -35.31     0.51     1.21       444
```

Appendix 6. GAMS Calibration Procedures from Applanix

GAMS Calibration procedures from the Applanix POS MV-V5 Operating Instructions Manual for both an auto-start calibration and a manual calibration are included.

POS MV V5 Installation and Operation Guide

System Configuration

Antenna Installation Calibration

A successful antenna installation calibration depends upon the GNSS Azimuth Measurement Subsystem (GAMS) being able to use data from five or more satellites with a Positional Dilution of Precision (PDOP) equal to or less than three. Perform the antenna installation calibration at a time when there is good satellite geometry.

Note: Applanix recommends that the user make use of the GNSS mission planning software to identify an optimal time of day during which the PDOP is at a minimum in order to achieve a good GAMS calibration.

Perform the following steps with the vessel under way in an area where unrestricted manoeuvring is possible. You have the option of allowing POS MV to start the calibration automatically (this is called a calibration auto-start) or to start the calibration manually.

1. Ensure that MV-POSView is **Connected** as indicated in the status bar, refer to
2. Figure 35 on page 5-3.
3. Select **View, GAMS Solution** from the menu bar to open POS MV **GAMS Solution** window shown in Figure 28.

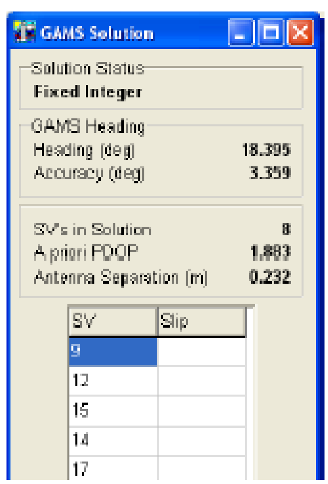


Figure 28: GAMS Solution Status

4. Transition the system to standby mode by selecting the **Standby** icon from the MV-POSView tool bar.
5. Select **Settings, Installation, GAMS Parameter Setup** from the menu bar to open the **GAMS Parameter Setup** window shown in Figure 29.

6. In the **GAMS Parameter Setup** window, enter a value in the **Heading Calibration Threshold** field that represents the best achievable with the vessel, ideally 0.5° or less. Select the **OK** button.

   When the indicated **Heading Accuracy** (**Attitude** pane on the controller main window) falls below the setting in the **Heading Calibration Threshold** field and the **GAMS** status (main window **Status** pane) reads ***Ready Offline***, POS MV will start the antenna installation calibration routine. Choose an easy value for POS MV to achieve as you perform a series of calibration manoeuvres with the vessel:

   - Set a lower value (approximately 0.2°) if you can manoeuvre the vessel aggressively.
   - Conversely, set a higher value (approximately 1°) if the most aggressive manoeuvres you can perform are 180° turns followed by a straight run.

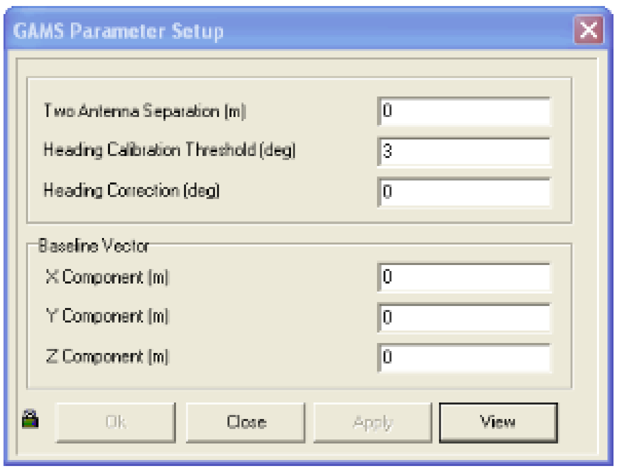


Figure 29: POSView GAMS Parameters Setup

7. Perform the following in the **GAMS Parameter Setup** window:

   a) In most cases, this value is entered as '0'. Only if you are able to measure the antenna separation to 1 mm accuracy should you enter a value here.

   Refer to the Installation Checklist on page 2-32 for instructions on how to measure the antenna separation distance.

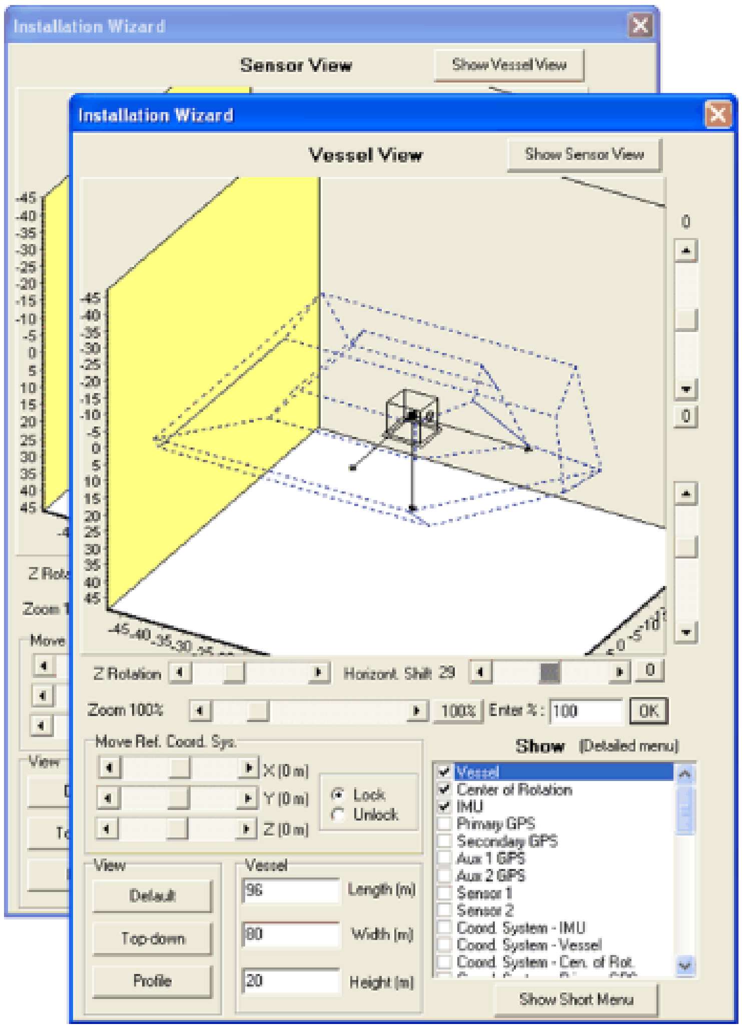


Figure 30: POSView GAMS Installation Wizard

b) In each of the component fields in the **Baseline Vector** pane, enter '0'. Select the **Apply** and **OK** buttons.

8. Manually transition POS MV to the navigate mode. This also commands GAMS to begin execution of its on-the-fly (OTF) ambiguity resolution algorithm.

9. Next, perform either the auto-start calibration (steps 10 and 11)or the manual calibration procedure (steps 12 and 13).

Auto-Start Calibration Procedure

10. Select **Settings, GAMS Calibration Control, Start** from the MV-POSView menu bar (Figure 31, page 4-22). The **Status** pane for **GAMS** indicates ***CAL Requested*** (Figure 31, page 4-22).

    The **Start** command prepares the system for an automatic start to the calibration process, but does not actually start it. Instead, the calibration process will start automatically when the POS MV RMS heading error falls below the value that you set for the **Heading Calibration Threshold** field in step 6 above.

11. If possible, when GAMS has resolved the carrier phase ambiguities (**GAMS** on the main window **Status** pane reads ***Ready Offline***), perform a series of full turns, 'S-turns' or 'Figure-8' manoeuvres, each lasting approximately one minute.

    During these manoeuvres, monitor the POS MV **Heading Accuracy** field on the MV-POSView main window **Attitude** pane (Figure 31, page 4-22). When the value displayed falls below the setting for the **Heading Calibration Threshold** field (Figure 29), finish the turns and manoeuvres and hold the vessel steady on a course and at a fixed speed.

    The **Status** pane for **GAMS** now indicates ***CAL in Progress*** and this condition lasts for approximately 60 seconds. When POS MV has completed the calibration, the displayed **GAMS** status becomes ***CAL Completed***. This condition lasts for approximately five seconds and then changes to ***Online***.

    See Options starting with step 14.

Manual Calibration Procedure

Note: Before proceeding ensure the **GAMS Parameters Setup** window displays the values that you entered in step 6 above.

12. When GAMS has resolved the carrier phase ambiguities, the **Status** pane for **GAMS** indicates ***Ready Offline*** (Figure 31, page 4-22). You can start the calibration manually at any time.

    If possible, perform a series of full turns, 'S-turns' or 'Figure-8' manoeuvres, each lasting approximately one minute. During these manoeuvres, monitor the POS MV **Heading Accuracy** on the MV-POSView main window **Attitude** pane (Figure 31, page 4-22). Ideally, the heading accuracy displayed should be as small as possible.

    Wait until the heading error becomes as small as possible before starting the calibration. Simple manoeuvres of the vessel, such as a change of course, will cause the heading accuracy to improve.

13. To start the manual calibration, select **Settings, GAMS Calibration Control, Force** from the MV-POSView menu bar (Figure 31, page 4-22). This commands an immediate start of the calibration process.

    The **Status** pane for **GAMS** indicates ***CAL in Progress*** and this condition lasts for approximately 60 seconds. When POS MV has completed the calibration, the displayed **GAMS** status becomes ***CAL Completed***. This condition lasts for approximately five seconds and then changes to ***Online***.

    See Options starting with step 14.

OPTIONS

14. Suspend calibration while in progress: Select **Settings, GAMS Calibration Control, Suspend**. The displayed **GAMS** status then becomes ***CAL Suspended***.

    The system suspends the partially completed calibration process until you resume it. To resume the calibration process select **Settings, GAMS Calibration Control, Start**.

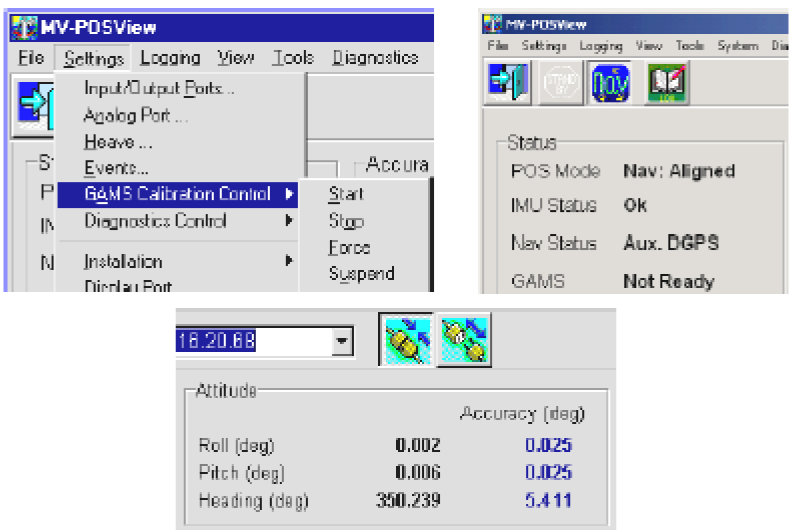


Figure 31: POSView Settings Menu, Status and Attitude Panes

15. Stop calibration while in progress: Select **Settings, GAMS Calibration Control, Stop**. The displayed **GAMS** status then becomes ***Ready Offline***. The system cancels the partially completed calibration process.

16. Save calibration data: Select **Settings, Save Settings**. Wait until the MV-POSView Controller program displays the **Settings Saved** message panel. Select the **OK** button to close the message panel.

17. Monitor system operation: Indications of a successful calibration appear in the main window of the MV-POSView Controller program:
    - The **Status** pane for **GAMS** indicates *Online*.
    - The **Altitude** pane **Heading Accuracy** field drops slowly to less than 0.15° and eventually settles to a value of 0.03° in a low multipath environment. The actual value that it settles to depends on the current setting for the multipath environment.

    If the calibration was successful and no GNSS dropouts occurred, POS MV should settle into a steady-state operation using the GAMS heading aiding, as indicated by the *Online* status.

    If the calibration was not successful, GAMS will reject the carrier phase ambiguities repeatedly and will eventually reject the installation parameters. If this occurs, repeat the calibration process.
18. Record data: If the installation parameters appear to be correct, select **Settings, Installation, GAMS Parameter Setup** from the menu bar (Figure 29, page 4-19) and write down the displayed parameters. Keep the written record in a safe place for future reference.

Refer to the Operation with GAMS topic on page 1-8 for a description of how GAMS uses the GAMS installation parameters to aid the On-the-Fly (OTF) ambiguity search.

Installation Parameter Correction

The surveyed antenna baseline vector may include the following errors:

- The length of the vector may not be correct if there were large multipath errors during the calibration process. This may affect the reliability of the GAMS ambiguity resolution during future POS MV Initialization sequences.
- There may be an azimuth error similar in size to the displayed heading accuracy that existed during the calibration process. This results in a constant offset in the displayed heading during normal operation of the POS MV with GAMS heading aiding.

Correct these errors by:

1. If the displayed antenna separation differs by more than 5 mm (~¼ in) from the value that you measured after you installed the antennas, clear the installation parameters and then re-enter the measured separation distance in the **GAMS Parameter Setup** window, see Figure 29 on page 4-19. Select the **OK** button to install the new antenna separation distance.

    Begin a new calibration procedure, see Antenna Installation Calibration on page 4-18.

    The 5 mm (~¼ in) allowance accounts for differences that may exist between the antenna phase centres and their geometric centres.

2. If you can identify a heading offset then enter this value in the **Heading Correction** field of the **GAMS Parameter Setup** window, see Figure 29 on page 4-19. Select the **OK** button to install the new correction value.

   POS MV will then compute new components of the surveyed antenna baseline vector having a corrected azimuth.

3. Select **Settings, Save Settings** from the MV-POSView menu bar to save the new values to the PCS Non-Volatile Memory (NVM).

Note: The **Heading Correction** field in the **GAMS Parameter Setup** window allows you to correct an inaccurately surveyed baseline vector. You can use this method to obtain a more accurate vector.

Note: You should *not* use this facility to implement the installation angles of the IMU body frame with respect to the echo-sonar frame. Refer to the Installation Parameters and the Configuration Data descriptions on pages 2-24 and 4-7 respectively, for instructions on how to measure and enter these installation parameters.