UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NOAA Marine and Aviation Operations
Marine Operations Center
439 W. York Street
Norfolk, VA 23510-1114

MEMORANDUM FOR: Captain Joseph Pica, NOAA
Commanding Officer, NOAA Ship *Ronald H. Brown*

FROM: Captain Anita L. Lopez, NOAA
Commanding Officer, NOAA Marine Operations Center-Atlantic

SUBJECT: Project Instruction for RB-13-07
GOSHIP CLIVAR/CO2 Repeat Hydrography Cruise A16S_2014

Attached is the final Project Instruction for RB-13-07, GOSHIP CLIVAR/CO2 Repeat Hydrography Cruise A16S_2014, which is scheduled aboard NOAA Ship *Ronald H. Brown* during the period of 21 December, 2013 – 03 February, 2014. Of the 52 DAS scheduled for this project, 52 DAS are base funded by OMAO in support of OAR. This project is estimated to exhibit a Medium Operational Tempo. Acknowledge receipt of these instructions via e-mail to **OpsMgr.MOA@noaa.gov** at Marine Operations Center-Atlantic.

Attachment

cc:
MOA1

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami FL 33149

Project Instructions

Date Submitted:	December 20, 2013
Platform:	NOAA Ship *Ronald H. Brown*
Project Number:	RB-13-07
Project Title:	GOSHIP CLIVAR/CO2 Repeat Hydrography cruise A16S_2014
Project Dates:	December 20, 2013 to February 3, 2014

Prepared by: [signature] Dated: December 20, 2013
Rik Wanninkhof
A16S Chief Scientist
NOAA/OAR/AOML

Approved by: [signature] Dated: December 20, 2013
Joel Levy
Program Manager
Climate Observation Division of the Climate Program Office
NOAA/OAR

Approved by: [signature] CDR/NOAA Dated: 20 DEC 2013
FOR Robert M. Atlas
Director, AOML

Approved by: [signature], CDR/NOAA Dated: 20 DEC 2013
Captain Anita L. Lopez, NOAA
Commanding Officer
Marine Operations Center - Atlantic

I. Overview

A. Summary

This cruise will be a decadal reoccupation of repeat hydrography sections jointly funded by NOAA-COD/CPO and NSF-OCE as part of the GO-SHIP/CO2/hydrography/tracer program.
Academic institutions and NOAA research laboratories will participate. The program focuses on the need to monitor inventories of CO_2, heat and freshwater and their transports in the ocean. Earlier programs under CLIVAR, WOCE and JGOFS have provided a baseline observational field for these parameters. The new measurements will reveal much about the changing patterns on decadal scales. The program will serve as a backbone to assess changes in the ocean's biogeochemical cycle in response to natural and/or man-induced activity. Global warming-induced changes in the ocean's transport of heat and freshwater, which could affect the circulation by decreasing or shutting down the thermohaline overturning, can be followed through long-term measurements. The Repeat Hydrography Program provides a robust observational framework to monitor these long-term trends. The goal of the effort is to occupy a set of hydrographic transects with full water column measurements over the global ocean to study physical and hydrographic changes over time. These measurements are in support of:

* Model calibration and validation
* Carbon system studies
* Heat and freshwater storage and flux studies
* Deep and shallow water mass and ventilation studies
* Calibration of autonomous sensors
* Biogeochemistry and trace metal dynamics

This program will follow the invasion of anthropogenic CO_2 , CFCs and other tracers into intermediate and deep water on decadal timescales and determine the variability of the inorganic carbon system, and its relationship to biological and physical processes. More details on the program can be found at: http://ushydro.ucsd.edu/

In addition to the CTD/rosette casts, separate trace metal casts will be made at every other station along the section, nominally at 60 mile spacing. Because of contamination problems in sampling for iron and aluminum, these samples will have to be collected on separate casts, utilize a special trace-metal-clean winch and 1500 meter Kevlar coated cable provided by the trace metal investigators.
Near surface seawater (temperature, salinity, pCO_2, ADCP, IOP, Fluorometry) and atmospheric measurements (CO_2, CFCs, aerosols) will be made along the cruise track. Several ALACE-type profiling floats and surface drifters will be deployed along the section.

B. Service Level Agreements

Forty-five days on board NOAA Ship **Ronald H. Brown** are allocated to the **A16S** Project from Recife, Brazil to Punta Arenas, Chile, between December 17, 2013 and January 30, 2014. An additional 7 DAS are included for a transit from Punta Arenas to Valparaiso, Chile for the project. For this project, ***Ronald H. Browns***' budget was based on a **TRANSIT Fuel Tempo** and **MEDIUM Overtime** budget, as described on the attached Vessel Profile Page. The FY14 Voyage plan v1.2 has the days allocated as follows:

DEP: 11/11/13 Barbados	RB-13-06 PNE
ARR: 12/8/13 Recife, Brazil	
DEP: 12/17/13 Recife	RB-13-07 GOSHIP A16S
ARR: 1/30/14 Punta Arenas, Chile	
DEP: 2/5/14 Punta Arenas, Chile	RB-13-07-Transit (DART?)
ARR: 2/11/14 Valparaiso	

C. Operating Area (including map showing op area)

The RB-13-07 cruise will focus on completing a long meridional section through the middle of the North Atlantic, nominally along 20˚W from 60˚N to 5˚S. (see attached map). This section repeats the A16N section occupied during the World Ocean Circulation Experiment (WOCE) and CLIVAR periods , hence this cruise is designated A16N2013. This is a repeat of the NOAA lead cruise in 1993 and 2003, during which a full suite of inorganic carbon, hydrographic and CFC measurements were performed. Full water column CTD stations will be occupied at 30 nautical mile intervals and include a large variety of physical, chemical and biological parameters.

The operating area is in the South Atlantic Ocean with a schematic of the cruise track shown in Figure 1.

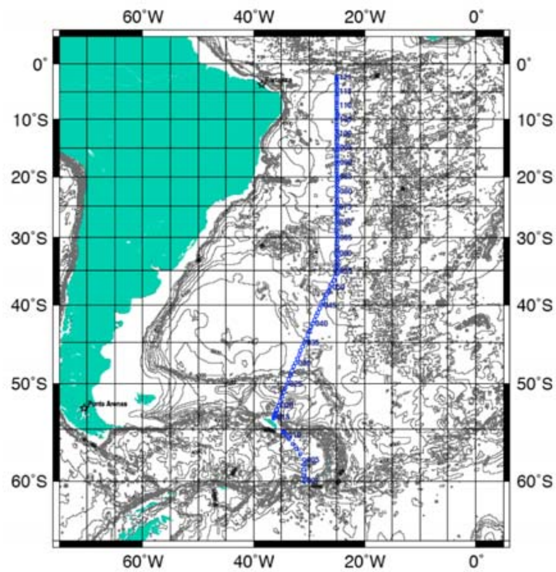

Figure 1: Cartoon of cruise track. The ship will depart Recife and end up in Barbados repeating the track of the A16S_2005 cruise in reverse order. A preliminary cruise schedule is listed in Appendix O, Table 1.

D. Summary of Objectives

(see Section A)

E. Participating Institutions

(for up to date list see http://www.aoml.noaa.gov/ocd/gcc/A16S_2014/)

Primary:

United States Department of Commerce
National Oceanic and Atmospheric Administration
Atlantic Oceanographic and Meteorological Laboratory (NOAA/AOML)
4301 Rickenbacker Causeway
Miami, FL 33149 USA
Telephone: 305 361 4380
Facsimile: 305 361 4392

Additional:

RSMAS	Rosenstiel School of Marine and Atmospheric Science/University of Miami
PMEL	Pacific Marine Environmental Laboratory
FSU	Florida State University
SIO	Scripps Institution of Oceanography/University of California at San Diego
U Hawaii	University of Hawaii at Manoa

UCSB	University of California, Santa Barbara
U Washington	University of Washington at Seattle
TAMU	Texas A&M University
WHOI	Woods Hole Oceanographic Institution
Princeton	Princeton University
LDEO	Lamont-Doherty Earth Observatory/Columbia University
OSU	Oregon State University

F. Personnel/Science Party: name, title, gender, affiliation, and nationality (for up to date list see: http://www.aoml.noaa.gov/ocd/gcc/A16N/participants.html)

Personnel List as of October 25, 2013

Personnel on RB 13-07 - 2013 A16S Cruise -

	Function	*Name*	*Institution*	*Sex*	*Nationality*
1	Chief Scientist	Wanninkhof, Rik	AOML	M	US
2	Co-Chief Scientist	Barbero, Leticia	AOML/CIMAS	F	Spain
3	Data Manager	Quintero, Alex	SIO	M	US
4	CTD	McTaggart, Kristene	PMEL	F	US
5	CTD watch-stander	Smith, Carlowen	FSU	M	US
6	CTD watch-stander	Bartz, John	RSMAS	M	US
7	CTD Watch-Stander	?	?	M/F	US
8	LADCP	?	?	M/F	?
9	LADCP/Salinity	Hooper, Jay	AOML/CIMAS	M	US
10	ET/LADCP/Salinity	?	?	?	?
11	O2	Langdon, Chris	RSMAS	M	US
12	O2	Stefanick, Andrew	AOML	M	US
13	Nutrients	Fischer, Charles	AOML	M	US
14	Nutrients	Wisegarver, Eric	PMEL	M	US
15	DIC	Castle, Robert	AOML	M	US
16	DIC	Peacock, Cynthia	PMEL	F	US
17	Alkalinity/pH	Woosley, Ryan	RSMAS	M	US
18	Alkalinity/pH	Rodriquez, Carmen	RSMAS	F	US

19	Alkalinity/pH	?	?	M/F	?
20	Alkalinity/pH	?	?	M/F	?
21	Trace Metal	Landing, William	FSU	M	US
22	Trace Metal	Shelley, Rachel	FSU	F	UK
23	Trace Metal	Measures, Chris	U Hawaii	M	US
24	Trace Metal	Hatta, Mariko	U Hawaii	F	Japan
25	CFCs/SF_6	Wisegarver, David	PMEL	M	US
26	CFCs/SF_6	Mears, Patrick	Texas A&M	M	US
27	Helium/Tritium	?	?	M/F	?
28	DOM/DI^{14}C/DOC	Klein, Liz	WHOI	F	US
29	Chipod	Lim, Byungo	OSU	M	Korea

G. Administrative

Chief Scientist: Dr. Rik Wanninkhof
Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami, FL 33149 USA
Telephone: 305-361-4379 Facsimile: 305-361-4392
Rik.wanninkhof@noaa.gov

Alternate Point of Contact: LCDR Stephen Meador
Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami, FL 33149 USA
Telephone: 305-361-4544 Facsimile: 305-361-4449
AOML.Associate.Director@noaa.gov

2. Diplomatic Clearances

This project involves Marine Scientific Research in waters under the jurisdiction of the United Kingdom (South Georgia)/South Sandwich), Argentina (Georgias del Sur) and Chile. Diplomatic clearance has been requested via the RATS system through Wendy Bradfield-Smith.

3. Licenses and Permits

None

II. Operations

Project	***Lead PI :***
CTD:	*Molly Baringer - AOML/Gregory Johnson - PMEL*
Salinity:	*Molly Baringer - AOML*
Total CO_2*(DIC),* pCO_2*:*	*Rik Wanninkhof - AOML/Richard Feely - PMEL*
Nutrients:	*Jia-Zhong Zhang - AOML/Calvin Mordy - PMEL*
Dissolved Oxygen:	*Chris Langdon - RSMAS/Molly Baringer - AOML*
Total Alkalinity/pH:	*Frank Millero - RSMAS*
CFCs/SF6:	*John Bullister - PMEL*
Helium/Tritium:	*Peter Schlosser - LDEO/William Jenkins - WHOI*
DOM:	*Dennis Hansell - RSMAS*
CDOM:	*Craig Carlson - UCSB*
Chipod:	*Jonathan Nash/OSU*

LADCP: *Eric Firing/U Hawaii*

Trace Metals: *William Landing - FSU/Chris Measures - U Hawaii*

DI14C/DOC: *Ann McNichol - WHOI/Robert Key - Princeton*

Bathymetry: *Ship personnel*

Underway Thermosalinograph: *Ship personnel*

A. Project Itinerary

The A16S_2014 expedition is scheduled for 2 legs (RB-13-07 (Main) , RB-13-07 (Transit), on RHB Estimated transit times and station locations are provided in Table 1 of Appendix O.

Leg RB-13-7 (Main): Recife to Punta Arenas;

After departing Recife, the vessel will steam to the start of the A16S_2014 section at 6 ˚S 25 ˚W and begin a series of full water column stations. On most casts the CTD/rosette will be lowered to within 10 meters of the bottom. The first station will be at a depth of ~5900m. The vessel will move southward, occupying stations at a nominal spacing of 30 nautical miles. Station spacing will be closer along boundary crossings and areas of steep bathymetry. Water samples will be collected with a 24 position, eleven-liter CTD/rosette system. Two backup rosette systems: a 24 position, 10-liter rosette; and RHB's CTD/rosette package [12 position, 10 liter] will also be available. Special trace metal casts will be occupied at every other station and will usually follow the completion of the CTD/rosette cast. The trace metal package will be deployed immediately after the CTD/rosette is on deck. Careful coordination will be required to minimize the time between the return of the CTD and deployment of the trace metal rosette. The number of trace metal casts will depend on the time required for each cast. If the trace metal casts require 1 hour to complete, then approximately 58 casts will be completed on the cruise.

We will end the leg at about 60 ˚S, 31 ˚W. If the cruise is ahead of schedule we will take select CTDs stations in the Scotia Sea en route to Punta Arenas.

Leg RB-13-07 (Transit) : Punta Arenas to Valparaiso

The vessel will depart Punta Arenas and steam toward Valparaiso following a seaward route rather than the inland passages. Underway measurements of sea surface temperature, salinity, pCO2, , and ADCP will be performed. There is a possibility that two DART moorings will be deployed during the transit and a dedicated plan will be provided by the cognizant parties

B. Staging and Destaging

Most equipment and laboratory vans for the cruise are already stored onboard. We request access to the ship four days before departure for moving vans and equipment set-up. Five 20-foot lab containers used for A16S are onboard: a 20-foot container for CO_2 analyses, a 20-foot container for CFC analyses, a 20-foot container for trace metal analyses, a 20-foot storage container from WHOI containing Helium/Tritium and $^{14}C/^{13}C$ of DIC sampling gear and a 20-foot storage container containing the CTD/rosette package. Several containers will be moved to proper position using a shoreside crane. Scientific personnel will be present for the purposes of repositioning and securing the craned equipment.

A list of equipment used on the cruise is shown in the FACILITIES section of the Project Instructions and in Appendix B.

We will require the assistance of the shipboard ET and Survey Technician for 8 hours four-days prior to sailing and 8 hours the day before sailing to help install computer systems, terminations for the CTD and other science equipment. The three laboratory vans should be connected to power as soon as practical once loaded on the ship and remained powered for the duration of the cruise.

Destaging: we anticipate shipping the CFC, CO_2, trace metal, the two storage vans and loose scientific gear from Valparaiso following the A16S transit leg. The scientific party will prepare all documentation and shipping arrangements. Arrangements will made with ship's personnel and subsequent cruise investigators if small numbers of frozen samples and possibly minor amounts of chemical need to remain on the ship till arrival in a USA port.

C. Operations to be conducted

The preliminary personnel task assignments are indicated with each operation. The Chief Scientist and the Commanding Officer will determine final responsibilities.

- -- Full water column CTD/rosette casts (Ship's and scientific personnel)
- -- Sampling the rosette bottles for salinity, oxygen, nutrients, CFCs, helium, tritium, carbon dioxide, alkalinity, DIC, carbon isotopes, chlorophyll (Ship and scientific personnel)
- -- Release of ALACE floats (Ship and scientific personnel)
- -- Trace Metal Casts (Ship's and scientific personnel)
- -- Autonomous sampling from the underway sampling line

a. Full water column CTD/Rosette Casts (Ship's and scientific personnel)

It is of utmost importance to the success of the expedition that the ship be able to hold position at all times during the CTD casts, and that the CTD winch, meter wheel, hydraulic frame, conducting cable and backups function flawlessly during this expedition. Primary winch should have at least 6500 m of cable used during A16N and secondary winch must contain full lengths (10,000 m) of 0.322" CTD conducting cable in good condition. Skilled ship personnel and adequate spare parts must be available on all legs to assure that this equipment is maintained in good working order. The ship's personnel must be skilled in CTD wire re-terminations, and adequate supplies of materials for CTD wire re-terminations must be available. Since typical steaming time between stations is less than 3 hours, re-terminations of the conducting cable (when required) must be completed within 2-3 hours.

The CTD/rosette system will be deployed off the starboard side. During recovery, the CTD/rosette package will be lowered onto a cart and rail system that will be tugged into the staging bay. A 24-position rosette system with 11 liter bottles will be used for CTD/rosette casts. In addition to this primary system, a 24-position rosette with 10 liter water bottles will be available. The second package must be secured in a readily accessible area, and will be switched when required. The rail system supplied by PMEL will safely and quickly move the rosette into position for deployments and sampling during bad weather. A pinger and altimeter will be mounted on the rosette systems and used during casts to monitor distance from the bottom. We anticipate that during most casts the CTD/rosette will be lowered within about 10 meters of the bottom. The ship's PDR must be working properly for this purpose.

The winch, wire and meter wheel must be capable of routinely making 6000 meter casts with these rosette systems. AOML and PMEL are sending CTD watch leaders on Legs 1 & 2 to perform CTD data collection, processing and quality control. CTD watch leaders will assign science party members to monitor CTD casts. During the casts, if needed and available, ship's personnel will assist the CTD operators monitoring of the bathymetric recorder and pinger signal and to properly assess the distance of the rosette package off the bottom. The ship's electronics technician will share responsibility with the scientific party for maintaining good electrical and mechanical connections between the CTD/rosette system, the conducting cable and winch slip-rings, and to the deck unit for the CTD/rosette system.

The ship's personnel will be responsible for the deployment and recovery of the CTD/rosette and trace metal rosettes with assistance of scientific personnel during deployment and recovery. A number of members of the scientific party have experience with CTD deployments and will be available to assist with these operations. Members of the scientific party will be responsible for collecting the water samples from the rosette. Members of the scientific party will also be responsible to collect oxygen, nutrient and salinity samples and recording sample ID's. Particular care must be taken in the collection and analysis of water samples to assure that all properties are measured with the greatest accuracy possible. Many of the chemical measurements are sensitive to contamination from smoke, soot, oils, solvents, spray cleaners, lubricants, paints, hydraulic fluid, and other substances. The Chief Scientist must be notified prior to the use of these substances. Care must be taken to avoid contamination of the rosette system with these substances. Smoking is prohibited in the area around the rosettes during sampling and at all times in the laboratories and in and near the staging bay.

Discharges from holding tanks must be secured 20 minutes before arriving on station. The tanks may be pumped when the cast is at depth (>200 meters). Discharges must again be secured 20 minutes before the CTD/rosette returns to the surface layer. The bridge must inform the ship's engineers in advance when discharges are to be secured.

b. Sampling the rosette bottles (Ship's and scientific personnel)

The usual order for drawing seawater samples on deck will be: CFCs, SF_6, helium/tritium, oxygen, pH, pCO_2, DIC, pH, alkalinity, DOM, nutrients, salinity. Samples will be collected for salinity, oxygen and nutrient analysis from each sample bottle.

Scientific personnel will analyze salinity samples. Two salinity samples will be drawn from the deepest bottle at each station to monitor the precision of the sampling/analysis procedures. Salinity samples will be run using RHB's Guild line 8600B Autosal instrument that is calibrated in coordination with AOML, complete with computer interface and laptop computer. A backup salinometer must be provided by the ship. The salinometers must be checked for accuracy and precision during the import before the start of the expedition and the tests will determine which unit will be the primary one. Salinity samples will be analyzed in the salinity lab off the main oceanographic laboratory, and variations in laboratory temperature must not exceed 1°C during a 24 hour period. The salinity samples will also be stored in this temperature controlled area for at least 8 hours to allow them to come to ambient temperature. The Autosal will be standardized at least once each run with new vials of standard seawater. Standard seawater will be provided by the scientific personnel for use on this cruise, and one vial will be analyzed per day. To maintain the required accuracy, it is advisable to have one person run all salinity samples. We anticipate ~140-160 samples/day. An accuracy of 0.003 PSS-78 or better is required, and will be monitored by scientific personnel by comparison with CTD and historical data. To assure timely detection of any problems with the CTD system or Autosal, salinity analyses should be completed within 36 hours of sampling and submitted to the CTD operators. Any problems with the Autosal should be reported immediately to the Chief Scientist.

c. Oxygen and nutrient sampling and analysis (Scientific personnel)

Samples will be collected for oxygen and nutrient analysis from each sample bottle at all stations. Nutrients will be run on board ship by members of the scientific party. Refrigerator space will be required near the bio-analytical lab for nutrient sample storage prior to analysis. Nutrient measurements will be made using a AlpKem RFA system. Dissolved oxygen samples will be run in the bioanalytical lab by members of the scientific party.

d. CFC ('Freon'), SF_6 and helium samples (Scientific personnel)

Water samples will be drawn for CFC and SF_6 analyses at most stations. CFC/SF_6 samples must be drawn first, ahead of the helium and oxygen samples. The chief scientist should be notified prior to any service or maintenance of the air-conditioning system and of any discharge or leakage of CFCs or solvents on the ship.

e. Helium samples will be drawn at selected stations and will be stored. (Scientific Personnel)

Due to the risk of contamination, no luminous dial watches (that is, watches dials that glow in the dark and generally contain tritiated compounds) may be used on board the ship during this expedition. Bob Newton (LDEO) or his representative must be notified of any proposed use of helium gas on board ship during this expedition.

f. Dissolved inorganic carbon (DIC), Total Alkalinity (TALK), pH, pCO_2 (Scientific personnel)

The chemistry groups from AOML, and RSMAS will make the DIC, pH, pCO_2, and TALK measurements at the hydrocast stations. DIC and TALK samples will be collected from the 11-L Niskin bottles into 250 ml and 500 ml glass-stoppered bottles, respectively, containing 0.025 mL of a saturated solution of $HgCl_2$ to retard bacterial oxidation of organic matter prior to analysis. DIC samples will be measured by the coulometric titration method and will be done in a laboratory van. Discrete pCO_2 samples will be collected from the Niskins into 500 ml flasks for analyses at constant temperature by IR. TALK samples will be measured by the potentiometric methods. pH will be analyzed at constant temperature with a spectrophotometer.

g. Profiling ADCP (Scientific personnel)

The lowered ADCP (LADCP) will be used on the casts. The instrument is a broadband, self-contained, 150 kHz ADCP, which is to be mounted to the 24-position rosette system. The instrument is mounted in the inner part of the rosette. The instrument can be used to a depth of 6000 m. The instrument is turned on about 15 minutes prior to the launch of the CTD/rosette package using a removable cable connection to a deck box and PC computer. The deck box should be in a dry area within 10 m of the rosette. After the CTD station, about 30 minutes are required to transfer the data from the instrument and to turn it off. The LADCP may have to be removed from the rosette for repair and possible battery changes.

h. Chipod ADCP (Scientific personnel)

Small-scale turbulence measurements will be made from the rosette frame by a installing self-contained precise temperature probes and logging device. The instrument is turned on about 15 minutes prior to the launch of the CTD/rosette package using a removable cable connection to a deck box and PC computer. . After the CTD station, about 30 minutes are required to transfer the data from the instrument and to turn it off.

i. ALACE and Surface Float deployment (Ship and scientific personnel):

Six PMEL ALACE floats and several surface floats will be released during this expedition. The Chief Scientist will coordinate this program. These floats require about an hour of preparation prior to deployment. Preparations will be completed while the CTD is in the water. Floats will be deployed at stations immediately following recovery of the CTD and trace metal casts and before the ship gets underway. Deployment involves lowering the ~30 kg float by hand into the water from the stern of the ship. One or two persons from the ship and scientific party will be required for preparation and deployment. A deployment schedule will be provided prior to the cruise departure.

j. Navigation (Ship's personnel)

Navigation shall be based on the best available information including GPS, radar and visual. When GPS control is available, it is the preferred navigation method. It is important that accurate speed and course information be used in satellite position computation. At least one GPS P-code receiver and one Seapath 3DF GPS unit must be functional and integrated with the ship's SCS system for ADCP and LADCP measurements.

The station locations listed in Appendix O are nominal positions and some drift during CTD/rosette casts is acceptable to maintain wire angle. In most cases, starting station positions along the section should be within 1-2 nautical miles of the listed position. Navigation information will be recorded on the MOA form. In addition to satellite fixes and other events as they occur, MOA entries shall be made at least once every four hours, and at the time of each course and speed change when the ship is en route between stations (including slowdowns on arrival at the station and speedups on departure).

The numerical MOA entries will suffice for scientific purposes; a cruise plot is not required in the cruise data package. Since copies of the MOA forms will be made and used by various cruise participants, it is important that the entries be checked and made clearly and dark enough for reproduction.

k. Trace Metal sampling (Scientific personnel):

Salinity and nutrient samples will be drawn from each Go-FLO bottle of the trace metal casts.

Information is provided below by the PI’s of the project, Chris Measures and William Landing.

F. Underway Operations:

Underway measurements will be made along the entire cruise track, including the transit from Recife to Valparaiso. The ship’s seawater line including all branches of the lines to laboratories should be flushed with fresh water and cleaned with bleach prior to departure from Recife.

-Automated underway measurement of sea surface temperature and salinity. (Ship's personnel)
-Automated Underway sea surface measurements of carbon dioxide, chlorophyll, and atmospheric measurements of CFCs, (Scientific personnel).
- Underway air measurements of carbon dioxide (Scientific and ship's personnel)
- ADCP (Scientific and ship's personnel)
- Routine weather observations (Ship's personnel).
- Center-beam Sea Beam data logging (Ship's personnel).

Sea surface temperature and salinity (Ship's personnel):

Sea surface temperature and salinity will be recorded continuously with a system accurate to within 0.02°C and 0.1 PSS-78. A copy of the calibration data will be provided to the Chief Scientist. The thermosalinograph should be calibrated no more than 8 months before the start of the cruise.

Underway sea surface measurements and sampling (Ship’s and scientific personnel):

Continuous water sampling will be made from the ship's bow scientific seawater supply intake system. It is of utmost importance that the line is cleaned with bleach and flushed prior to departure from Recife and during the cruise if contamination/biofouling is suspected. Ship's personnel will maintain this pump and provide adequate spare parts. This system must be capable of delivering 60 liters/minute of seawater at deck level. Seawater will be drawn off this line to sea/air equilibrators. Care must be taken to prevent contamination from smoke, solvent fumes, cleaning solutions, etc. Continuous underway measurements of pCO_2 will be made from one of the headspace equilibrators utilizing a LICOR NDIR Analyzer. Continuous measurements of chlorophyll will also be made.

Underway air measurements (Scientific personnel):

Aerosol and rainfall samples will be taken on the CLIVAR A16S_2014 cruise. Installation of equipment will be done in consultation with officers/crew of RHB.

On the 2003 A16N cruise on RHB, an aluminum fold-down mast (20-ft tall, about 1.5-ft diameter) deployed on the forward starboard corner of the 03 deck was used. This mast interfered somewhat with the view forward from the bridge, although it turned out not to be a problem for steering and navigation. It requires stringing guy wires (in 3 directions) from the mast, and those guy wires can get in the way of people moving around on that deck.

To avoid these issues, different equipment will be deployed on the forward safety rail of the 05 deck (above the bridge). The equipment includes one aerosol sampler and one automated rain collector. Mounting brackets will secure them to the safety rails. The aerosol sampler makes noise, and sounds like a high-pitched vacuum cleaner and it should be deployed as high as possible on the ship where the noise won't bother anyone.

To avoid stack exhaust, the aerosol sampling is "sector controlled" using its own anemometer/wind vane sensor that mounts on a 10-ft pole (also attached to the forward safety rail). Since the ship is usually oriented into the wind while on station, the sector control is set to 60 degrees on either side of the bow. When the wind falls outside that sector, the control electronics turn the power off immediately. The anemometer sensor wires run down into a ship's lab (or other room on an upper deck) to the control electronics box, and power cords run through AC relays in the control box and back up to the samplers to turn them on/off depending on what the wind is doing. The electronics and relay boxes take up about 4-5 square feet of table-top space, or can be wall-mounted using the uni-strut channels on the wall. This could go in the Radio/Chart room or anywhere around the aft control station.

ADCP underway operations (Ship's and scientific personnel):

Data from the ADCP system will be logged continuously while underway.

Weather observations (Ship's personnel):

Observations must be done at each station, and at regular intervals while underway.

Seabeam and PDR (Ship's personnel):

While underway, in place of annotation of the bathymetric (PDR) chart record, Sea Beam (center beam) will be operated to obtain a continuous record of time, position and bottom depth. During CTD stations, the PDR will be required for bottom detection.

III. Equipment

Equipment and Capabilities provided by the ship (itemized)

The following communications devices are currently on board RHB and are expected to be in working order. The chief scientist should be apprised at earliest possibility of malfunction of equipment.

1. High Frequency SSB (SEA 330): SEA Inc. 300-watt high frequency transceiver. The transceiver covers a frequency range from 1.6 to 29.9 MHz
2. Furuno Global Maritime Distress and Safety System (GMDSS)
3. Satellite communication system (INMARSAT -A, -B, -M)
4. Five fixed VHF radios with eight channels pre-programmed with a selection of marine band and NOAA frequencies.
5. Cell phones

The electronic instrumentation used for navigation includes:

6. Furuno Navigator GP-150 GPS
7. Applanix POSMV GPS
8. Furuno GP-90 GPS
9. Meridian Commercial Gyro Compass SG Brown
10. Two Furuno FAR 2xx7 Series Marine RADAR(S-band (10 cm) 30 kW radar and an X-band (3 cm) 25 kW radar)
11. Konsberg K-POS Dynamic Positioning System
12. Raytheon model DSN-450 Doppler Speed/distance log
13. NAVTEX receiving and printing the international automated medium frequency (518 KHz) weather warnings
14. Weather maps: Medium frequency/high frequency

Scientific Equipment requested from the Ship:

1. Echo Sounder (Ocean Data Equipment Corporation (ODEC) Bathy 2000 or the Knudsen system) used in12 kHz mode (to track CTD package to within 10 meters of the bottom) to be used while on CTD station. This will be resolved with CST and ETs prior to cruise
2. Continuous EM122 multibeam swath bathymetric sonar system sampling while underway between stations.
3. Barometer
4. WOCE IMET sensors
5. Hydrographic Winch system and readouts (using 10 km of 0.322 conducting cable for CTD operations).
6. One backup hydrographic winch system for CTD operations with 8 km of 0.375 conducting cable.
7. Hull mounted acoustic Doppler current profiler (RD Instruments (RDI), 75 kHz Ocean Surveyor acoustic Doppler current profiler) with gyro input.
8. MAHRS gyro system for acquisition of heading data used by acoustic Doppler current profiler.
9. Seapath GPS system for acquisition of heading data for testing the new MAHRS system.

Equipment and Capabilities provided by the scientists (itemized)

In addition to the suite of oceanographic and meteorological instruments on board RHB, the science party will bring the following instruments and materials on board (in addition see Appendix B for full specifications):

Five container vans will be aboard RHB for this cruise. Three of these containers will act as laboratory vans, and must be accessible at all times throughout the expedition. Compressed gas (non-flammable) cylinders will be used in ship's laboratories and laboratory vans.

CTD equipment

(a) Two 24 position rosette sampling with 12 (or 10) liter water sampling bottles and spare parts.
(b) Complete CTD recording and processing system including 2 Sea-Bird CTDs, 2 deck units, connectors, spare parts and consumables.
(c) Chemical analysis instrumentation including gas chromatographs, equilibrators, oxygen titration system, autoanalyzer, coulometer, alkalinity titrator, and spectrophotometers.
(d) Chemical reagents, compressed gases (approximately 30 cylinders). A listing of chemicals is given in Appendix A and spreadsheet and will be updated prior to departure for Leg 1.
(e) Two Benthos pingers with spare batteries, and altimeter.
(f) Winch, Kevlar cable, meter wheel for trace metal casts
rosette, CTD and data acquisition system for trace metal casts
(g) Strain gage
(h) Milli-Q system, and replacement parts

Equipment weight and location:

Extensive instrumentation to measure a variety of biogeochemical parameters in ocean water and atmosphere will be deployed during the cruise as detailed in Appendix B.

IV. Hazardous Materials

A. Policy and Compliance

The Chief Scientist is responsible for complying with FEC 07 Hazardous Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or the OMAO procedure that supersedes it). By Federal regulations and NOAA Marine and Aviation Operations policy, the ship may not sail without a complete inventory of all hazardous materials by name and the anticipated quantity brought aboard, MSDS and appropriate neutralizing agents, buffers, or absorbents in amounts adequate to address spills of a size equal to the amount of chemical brought aboard, and a chemical hygiene plan. Documentation regarding those requirements will be provided by the Chief of Operations, Marine Operations Center, upon request.

Per FEC 07, the scientific party will include with their project instructions and provide to the CO of the respective ship 60 to 90 days before departure:

- A list of hazardous materials by name and anticipated quantity (See Appendix A)
- A list of neutralizing agents, buffers, and/or absorbents required for these hazardous materials, if they are spilled
- A chemical hygiene plan.

Upon embarkation and prior to loading hazardous materials aboard the vessel, the scientific party will provide to the CO or their designee:

- An inventory list showing actual amount of hazardous material brought aboard
- A link to the MSDS for each material (see spreadsheet *A16_2013_Hazmat.xlsx)*
- Confirmation that neutralizing agents and spill equipment were brought aboard

Upon departure from the ship, scientific parties will provide the CO or their designee an inventory of hazardous material indicating all materials have been used or removed from the vessel. The CO's

designee will maintain a log to track scientific party hazardous materials. MSDS will be made available to the ship's complement on request, in compliance with Hazard Communication Laws.
The scientific party will manage and respond to spills of scientific hazardous materials. Overboard discharge of scientific chemicals is not permitted during projects aboard NOAA ships.

Radioactive Isotopes

Only sealed source radioisotopes will be used on the A16S (RB-13-07) cruise. They are solid Nickel-63, present in the Electron Capture detectors used in four gas chromatographs for CFC and SF6 analyses situated in the CFC laboratory van. The detectors contain low-activity (≈ 10 mCi) sealed sources used routinely in the laboratory and on research vessels. The Nickel-63 foils are in a sealed detector and operated according the manufacturer's specification. These items are under NOAA-PMEL licensing and will undergo standard wipe-testing before shipment to RHB. They present no hazards to personnel and no contamination risk to scientific programs. These extremely low level sealed sources are classified as 'excepted materials'- no external labeling is required for commercial transport and use.

The Chief Scientist will comply with OMAO 0701-10 Radioactive Material aboard NOAA Ships.

At least three months in advance of a domestic project and eight months in advance of a foreign project start date the chief scientist shall submit required documentation to MOC-CO, including:

1. NOAA Form 57-07-02, Request to Use Radioactive Material aboard a NOAA Ship
2. Draft Project Instructions
3. Nuclear Regulatory Commission (NRC) Materials License (NRC Form 374) or a state license for each state the ship will operate in with RAM on board the ship.
4. Report of Proposed Activities in Non-Agreement States, Areas of Exclusive Federal Jurisdiction, or Offshore Waters (NRC Form 241), if only state license(s) are submitted).
5. MSDS
6. Experiment or usage protocols, including spill cleanup procedures.

Scientific parties will follow responsibilities as outlined in the procedure, including requirements for storage and use, routine wipe tests, signage, and material disposal as outline in OMAO 0701-10.
All radioisotope work will be conducted by NRC or State licensed investigators only, and copies of these licenses shall be provided per OMAO 0701-10 at least three months prior to the start date of domestic projects and eight months in advance of foreign project start dates.

C. Chemical Inventory (itemized)

Appendix A provides the inventory according to scientific analysis

V. Additional Projects

A. Supplementary ("Piggyback") Projects

Underway Measurements in support of Global Carbon Cycle Research

The underway sensors on RHB will be used in support of the objectives of the Global Carbon Cycle Research to quantify the uptake of carbon by the world's ocean and to understand the bio-geochemical mechanisms responsible for variations of partial pressure of CO_2 in surface water (pCO_2). This work is a collaborative effort between the CO_2 groups at AOML.

Principal investigators:

Dr. Rik Wanninkhof, AOML 305-361-4379 rik.wanninkhof@noaa.gov
Contact person: Mr. Robert Castle, AOML 305-361-4418 robert.castle@noaa.gov

The semi-automated instruments are installed on a permanent basis in the hydro lab of RHB. All work is performed on a not-to-interfere basis and does not introduce any added ship logistic requirements other than the continuous operation of the bow water pump and thermosalinograph. The chief scientist assumes responsibility of the hazardous materials aboard RHB for this project. A list of the HAZMAT associated with this project is provided in Appendix A.

A. *NOAA Fleet Ancillary Projects*

Any additional work will be subordinate to the primary project and will be accomplished only with the concurrence of the Commanding Officer and the Chief Scientist(s).

The following projects will be conducted by ship's personnel in accordance with the general instructions contained in the MOC Directives, and conducted on a not-to-interfere basis with the primary project:

a. SEAS Data Collection and Transmission
b. Marine Mammal Reporting
c. Bathymetric Track line
d. Weather Forecast Monitoring
e. Sea Turtle Observations
f. Automated Sounding Aerological Program

VI. Disposition of Data and Reports

A. Data Responsibilities

The Chief Scientist will be responsible for the disposition, feedback on data quality, and archiving of data and specimens collected on board the ship for the primary project. As representative of the program manager (Director, AOML), the Chief Scientist will also be responsible for the dissemination of copies of these data to participants in the cruise, to any other requesters, and to NESDIS in accordance with NDM 16-11 (ROSCOP within 3 months of cruise completion). The ship may assist in copying data and reports insofar as facilities allow.

The Chief Scientist will receive all original data gathered by the ship for the primary project, and this data transfer will be documented on NOAA Form 61-29 "Letter Transmitting Data". The Chief Scientist in turn will furnish the ship with a complete inventory listing all data gathered by the scientific party detailing types and quantities of data.

Individuals in charge of piggyback projects conducted during the cruise have the same responsibilities for their project's data as the Chief Scientist has for primary project data. All requests for data should be made through the Chief Scientist.

B. Pre and Post Project Meeting

Prior to departure, the Chief Scientist will conduct a meeting of the scientific party to train them in sample collection and inform them of project objectives. Some vessel protocols, e.g., meals, watches, etiquette, etc. will be presented by the ship's Operations Officer.

Post-Project Meeting: Upon completion of the project, a meeting will be held and attended by the ship's officers, the Chief Scientist and select members of the scientific party to review the project. Concerns regarding safety, efficiency, and suggestions for improvements for future projects should be discussed. Minutes of the post-project meeting will be distributed to all participants by email, and to the Commanding Officer and Chief of Operations, Marine Operations Center.

C. *Ship Operation Evaluation Report*

Within seven days of the completion of the project, a Ship Operation Evaluation form is to be completed by the Chief Scientist. The preferred method of transmittal of this form is via email to omao.customer.satisfaction@noaa.gov. If email is not an option, a hard copy may be forwarded to:

Director, NOAA Marine and Aviation Operations
NOAA Office of Marine and Aviation Operations
8403 Colesville Road, Suite 500
Silver Spring, MD 20910

VII. 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 cruise.

Berthing requirements, including number and gender of the scientific party, will be provided to the ship by the Chief Scientist. The Chief Scientist and Commanding Officer will work together on a berthing plan to accommodate the gender mix of the scientific party taking into consideration the current make-up of the ship's complement. The Chief Scientist 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 Chief Scientist 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 federal NOAA scientists will have proper travel orders when assigned to any NOAA ship. The Chief Scientist will ensure that all non-NOAA or non-Federal scientists aboard also have proper documentation. It is the responsibility of the Chief Scientist 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 7, 1999 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, Revised: 02 JAN 2012) must be completed in advance by each participating scientist. The NHSQ can be obtained from the cruise website: http://www.aoml.noaa.gov/ocd/gcc/A16N/ or the NOAA website http://www.corporateservices.noaa.gov/~noaaforms/eforms/nf57-10-01.pdf. The completed form should be sent to the Regional Director of Health Services at Marine Operations Center. The participant can mail, fax, or scan the form into an email using the contact information below. The NHSQ should reach the Health Services Office no later than 4 weeks prior to the project to allow time for the participant to obtain and submit additional information that health services might require before clearance to sail can be granted. Please contact MOC Health Services with any questions regarding eligibility or completion of the NHSQ. Be sure to include proof of tuberculosis (TB) testing, sign and date the 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.

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
E-mail MOA.Health.Services@noaa.gov

Prior to departure, the Chief Scientist must provide an electronic listing of emergency contacts to the Executive Officer for all members of the scientific party, with the following information: contact name, address, relationship to member, and telephone number.

C. Shipboard Safety

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. Hard hats are required when working with suspended loads including CTD deployments and recovery. 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.

D. Communications

A progress report on operations prepared by the Chief Scientist may be relayed to the program office. Sometimes it is necessary for the Chief Scientist to communicate with another vessel, aircraft, or shore facility. Through various means of communications, the ship can usually accommodate the Chief Scientist. 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 e-mail 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 it must be arranged at least 30 days in advance.

E. IT Security

Any computer that will be hooked into the ship's network must comply with the *NMAO 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 these requirements prior to boarding the ship is required. All computers of scientific parties that are connected to the ship's network will be scanned.

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 (FRNS) 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 NMFS Deemed Exports point of contact to assist with the process.

The following are basic requirements. Full compliance with NAO 207-12 is required.

Responsibilities of the Chief Scientist:

1. Provide the Commanding Officer with the e-mail generated by the FRNS granting approval for the foreign national guest's visit. This e-mail 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 Chief Scientist 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 Regional Security Officer.
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 Chief Scientist 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 NMAO approval 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 Chief Scientist or the DSN of the FRNS e-mail 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 Chief Scientist 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 Chief Scientist of any OMAO-sponsored foreign nationals that will be onboard while program equipment is aboard so that the Chief Scientist can take steps to prevent unlicensed export of Program controlled technology. The Commanding Officer and the Chief Scientist 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 Regional Security Officer.

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, 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

APPENDICES

Appendix O

Station Operations

CTD Operations: CTD casts will include the CTD/O2 unit, a LADCP, a fluorometer, a transmissometer and a Rosette sampler and 24, 11-L bottles on the Rosette frame. Approximately 115 CTD casts will be conducted to full water column depth, maximum estimated at 6000 meters. In addition 58 trace metal casts will be performed. We will require a package tracking system and display for the CTD operations (Knudsen/Bathy2000). We request that the ship carries a back-up CTD conducting cable for this cruise with 10 km of 0.322" wire and a functioning spare winch. Approximate station locations are listed in Table 1.

Table 1. Station locations and estimated times of arrival and departure. Extra time is added to each station equivalent to about 2 weather days. The dates, speed, and steam times are approximate .

Station	Lat (S)	Long (W)	Dist (nMile)	Bott (m)	Time depart	Steam (Hr)	Speed (kn)	Trace Metal* (Hr)
Recife	8.1	34.9		5532	12/17/13 10:26	0.0	0.0	
Test	7.0	29.0	356.6	5500	12/18/13 20:17	29.7	12.0	1
1	6.0	25.0	245.9	0	12/20/13 0:36	27.3	9.0	
2	6.5	25.0	30.0	5627	12/20/13 14:58	3.3	9.0	1
3	7.0	25.0	30.0	5627	12/20/13 22:31	3.3	9.0	
4	7.5	25.0	30.0	5746	12/21/13 7:07	3.3	9.0	1
5	8.0	25.0	30.0	5705	12/21/13 14:42	3.3	9.0	
6	8.5	25.0	30.0	5733	12/21/13 23:18	3.3	9.0	1
7	9.0	25.0	30.0	5441	12/22/13 6:44	3.3	9.0	
8	9.5	25.0	30.0	5705	12/22/13 15:19	3.3	9.0	1
9	10.0	25.0	30.0	5595	12/22/13 22:50	3.3	9.0	
10	10.5	25.0	30.0	5460	12/23/13 7:17	3.3	9.0	1
11	11.0	25.0	30.0	5542	12/23/13 14:47	3.3	9.0	
12	11.5	25.0	30.0	5113	12/23/13 23:02	3.3	9.0	1
13	12.0	25.0	30.0	5609	12/24/13 6:33	3.3	9.0	
14	12.5	25.0	29.8	5389	12/24/13 14:56	3.3	9.0	1
15	13.0	25.0	30.3	5601	12/24/13 22:30	3.4	9.0	
16	13.5	25.0	29.9	5160	12/25/13 6:46	3.3	9.0	1
17	14.0	25.0	30.0	5851	12/25/13 14:26	3.3	9.0	
18	14.5	25.0	29.9	5500	12/25/13 22:54	3.3	9.0	1
19	15.0	25.0	30.1	5253	12/26/13 6:14	3.3	9.0	
20	15.5	25.0	30.0	5120	12/26/13 14:30	3.3	9.0	1
21	16.0	25.0	30.1	5678	12/26/13 22:05	3.3	9.0	
22	16.5	25.0	29.9	5143	12/27/13 6:20	3.3	9.0	1
23	17.0	25.0	30.1	5135	12/27/13 13:36	3.3	9.0	
24	17.5	25.0	30.0	5264	12/27/13 21:56	3.3	9.0	1
25	18.0	25.0	29.9	5649	12/28/13 5:29	3.3	9.0	
26	18.5	25.0	30.2	5591	12/28/13 14:01	3.4	9.0	1
27	19.0	25.0	30.2	4875	12/28/13 21:10	3.4	9.0	

28	19.5	25.0	29.7	5244	12/29/13 5:27	3.3	9.0	1
29	20.0	25.0	30.1	5405	12/29/13 12:53	3.3	9.0	
30	20.5	25.0	29.9	5286	12/29/13 21:13	3.3	9.0	1
31	21.0	25.0	30.0	5000	12/30/13 4:25	3.3	9.0	
32	21.5	25.0	30.1	5290	12/30/13 12:46	3.3	9.0	1
33	22.0	25.0	29.8	5305	12/30/13 20:06	3.3	9.0	
34	22.5	25.0	30.1	5465	12/31/13 4:34	3.3	9.0	1
35	23.0	25.0	30.0	5148	12/31/13 11:51	3.3	9.0	
36	23.5	25.0	29.9	5354	12/31/13 20:14	3.3	9.0	1
37	24.0	25.0	30.1	5547	1/1/14 3:44	3.3	9.0	
38	24.5	25.0	30.0	4956	1/1/14 11:54	3.3	9.0	1
39	25.0	25.0	30.0	5370	1/1/14 19:18	3.3	9.0	
40	25.5	25.0	30.0	4947	1/2/14 3:27	3.3	9.0	1
41	26.0	25.0	30.0	4850	1/2/14 10:34	3.3	9.0	
42	26.5	25.0	30.0	4667	1/2/14 18:34	3.3	9.0	1
43	27.0	25.0	30.0	4591	1/3/14 1:32	3.3	9.0	
44	27.5	25.0	30.0	4716	1/3/14 9:34	3.3	9.0	1
45	28.0	25.0	30.0	5318	1/3/14 16:56	3.3	9.0	
46	28.5	25.0	30.1	5072	1/4/14 1:10	3.3	9.0	1
47	29.0	25.0	30.0	5233	1/4/14 8:29	3.3	9.0	
48	29.5	25.0	29.9	5080	1/4/14 16:43	3.3	9.0	1
49	30.0	25.0	30.1	5204	1/5/14 0:02	3.3	9.0	
50	30.5	25.0	30.0	4339	1/5/14 7:51	3.3	9.0	1
51	31.0	25.0	30.0	4373	1/5/14 14:42	3.3	9.0	
52	31.5	25.0	30.0	4450	1/5/14 22:35	3.3	9.0	1
53	32.0	25.0	29.9	4171	1/6/14 5:18	3.3	9.0	
54	32.5	25.0	30.1	4169	1/6/14 13:02	3.3	9.0	1
55	33.0	25.0	30.0	4437	1/6/14 19:55	3.3	9.0	
56	33.5	25.0	30.0	4331	1/7/14 3:44	3.3	9.0	1
57	34.0	25.0	30.0	3997	1/7/14 10:22	3.3	9.0	
58	34.5	25.0	30.0	3975	1/7/14 17:59	3.3	9.0	1
59	35.0	25.0	30.0	4104	1/8/14 0:41	3.3	9.0	
60	35.5	25.0	30.0	4118	1/8/14 8:23	3.3	9.0	1
61	36.0	25.3	33.4	4058	1/8/14 15:25	3.7	9.0	
62	36.5	25.6	32.4	3995	1/8/14 23:20	3.6	9.0	1
63	37.0	25.9	34.9	4035	1/9/14 6:31	3.9	9.0	
64	37.5	26.2	33.4	4163	1/9/14 14:38	3.7	9.0	1
65	38.0	26.6	33.6	3913	1/9/14 21:37	3.7	9.0	
66	38.5	26.9	33.5	4168	1/10/14 5:44	3.7	9.0	1
67	39.0	27.2	33.1	4215	1/10/14 12:50	3.7	9.0	
68	39.5	27.5	33.5	4139	1/10/14 20:56	3.7	9.0	1
69	40.0	27.8	33.4	4356	1/11/14 4:09	3.7	9.0	
70	40.5	28.1	32.8	4151	1/11/14 12:11	3.6	9.0	1
71	41.0	28.4	33.3	4317	1/11/14 19:21	3.7	9.0	
72	41.5	28.7	32.9	4479	1/12/14 3:35	3.7	9.0	1
73	42.0	29.0	33.2	4550	1/12/14 10:53	3.7	9.0	

74	42.5	29.3	33.1	4545	1/12/14 19:10	3.7	9.0	1
75	43.0	29.6	32.8	4418	1/13/14 2:21	3.6	9.0	
76	43.5	30.0	32.8	4685	1/13/14 10:40	3.6	9.0	1
77	44.0	30.3	32.8	5200	1/13/14 18:17	3.6	9.0	
78	44.5	30.6	32.9	5128	1/14/14 2:52	3.7	9.0	1
79	45.0	30.9	32.9	5076	1/14/14 10:25	3.7	9.0	
80	45.5	31.2	32.7	5113	1/14/14 18:59	3.6	9.0	1
81	46.0	31.5	32.8	5238	1/15/14 2:37	3.6	9.0	
82	46.5	31.8	32.4	5256	1/15/14 11:12	3.6	9.0	1
83	47.0	32.1	32.8	5307	1/15/14 18:53	3.6	9.0	
84	47.5	32.5	33.2	5254	1/16/14 3:34	3.7	9.0	1
85	48.0	32.8	32.0	5312	1/16/14 11:09	3.6	9.0	
86	48.5	33.1	32.4	5071	1/16/14 19:39	3.6	9.0	1
87	49.0	33.4	32.4	4802	1/17/14 3:00	3.6	9.0	
88	49.5	33.7	32.4	5174	1/17/14 11:34	3.6	9.0	1
89	50.0	34.0	32.3	5111	1/17/14 19:04	3.6	9.0	
90	50.5	34.3	32.1	4815	1/18/14 3:24	3.6	9.0	1
91	51.0	34.6	32.4	5174	1/18/14 10:57	3.6	9.0	
92	51.5	34.9	32.2	4786	1/18/14 19:16	3.6	9.0	1
93	52.0	35.2	32.0	4493	1/19/14 2:24	3.6	9.0	
94	52.5	35.6	32.2	3699	1/19/14 10:07	3.6	9.0	1
95	53.0	35.8	31.6	3509	1/19/14 16:39	3.5	9.0	
96	53.3	36.0	16.4	3230	1/19/14 22:21	1.8	9.0	1
97	53.4	36.1	11.5	2169	1/20/14 1:55	1.3	9.0	
98	53.6	36.2	10.2	1617	1/20/14 6:02	1.1	9.0	1
99	53.7	36.2	8.9	1523	1/20/14 8:57	1.0	9.0	
100	53.9	36.4	8.2	241	1/20/14 11:54	0.9	9.0	1
101	55.2	34.7	100.7	391	1/21/14 0:12	11.2	9.0	
102	55.3	34.6	4.2	1007	1/21/14 3:19	0.5	9.0	1
103	55.3	34.5	5.3	1724	1/21/14 5:56	0.6	9.0	
104	55.6	34.2	19.9	2179	1/21/14 11:26	2.2	9.0	1
105	56.0	33.6	30.3	2816	1/21/14 17:27	3.4	9.0	
106	56.5	32.9	37.7	3555	1/22/14 1:42	4.2	9.0	1
107	57.0	32.3	37.0	3573	1/22/14 8:52	4.1	9.0	
108	57.5	31.6	37.5	3312	1/22/14 16:57	4.2	9.0	1
109	58.0	30.9	38.5	3439	1/23/14 0:13	4.3	9.0	
110	58.5	30.9	28.3	3105	1/23/14 7:10	3.1	9.0	1
111	59.0	30.9	30.0	2941	1/23/14 13:13	3.3	9.0	
112	59.5	30.9	30.0	3203	1/23/14 20:25	3.3	9.0	1
113	60.0	30.9	30.8	2746	1/24/14 2:27	3.4	9.0	1
PA	53.2	70.9	1361.2	0	1/30/14 10:41	151.2	9.0	

***** The number of trace metal casts will depend on the time required for each cast. If the trace metal casts require 1 hour to complete, then approximately 58 casts may be completed on the cruise.

Appendix A. List of Chemicals

(For full detail and links to the relevant MSDS see spreadsheet A16S_2014_Hazmat.xlsx to be provided prior to the cruise)

I. CHEMICAL REAGENTS USED FOR THE DETERMINATION OF **DISSOLVED OXYGEN** IN SEA WATER

NAME OF CHEMICAL	AMOUNT OF CHEMICAL	COMMENTS
Manganese Chloride	12 Liters, (600gr/Liter)	Solution
Alkaline Sodium Iodide	6 Liters, (320gr. Sodium Hydroxide + 600gr. Sodium Iodide, in each liter).	Solution
Sulfuric Acid	12 Liters, 280ml/liter	Dilute Solution
Sodium Thiosulfate	7 Liters, 10gr/Liter 7 vials of 10gr. Thiosulfate	Very Dilute Solution Granular Salt
Potassium Iodate	12 Liter, (0.3567gr/Liter) Std.	Very Dilute Solution Primary Standard
Triton(R) X-100	1 Liter (Polyethylene Glycol Octylphenyl Ether)	Cleaning Solution

II. CHEMICAL REAGENTS USED FOR THE DETERMINATION OF **NITRATE, NITRITE, AMMONIA PHOSHATE, AND SILICATE** IN SEAWATER

NAME OF CHEMICAL	bottles	AMOUNT OF CHEMICAL wt. Ea. (g)	total (g)	COMMENTS
Oxalic Ac.	6	500	3000	Granular
NaOH	1	400	400	Granular
Cd	2	25	50	Granular
NEDA	1	30	30	Granular
Imidazole	8	50	400	Granular
Ascorbic Ac.	14	35	500	Granular
NH4.Molybdate	10	50	500	Granular
Hydrazine	15	20	300	Granular
Sulfanilamide	12	25	300	Granular
Antimony Potassium Tartrate	3	3	9	Granular
o-phthaldialdehyde	1	4.0	4	Granular
Sodium sulfite	1	2.5	2.5	Granular
Ammonium chloride	1	5.4	5.4	Granular
Tartaric acid	1	600	600	Granular
Stannous Chloride	1	300	300	Granular

Chemical	bottles	Quantity (ml)	total (ml)	
Brij-35	3	400	1200	Liquid
Dowfax	5	300	1500	Liquid
Methanol	1	400	400	Liquid
Formaldehyde	1	2	400	Liquid

Chemical	bottles	Quantity (L)	total (L)	
HCl	8	2.5	20	Liquid

H_2SO_4	6	1	6	Liquid
Acetone	2	0.5	1	Liquid

III. CHEMICAL REAGENTS USED FOR THE
DETERMINATION OF TOTAL **DISSOLVED INORGANIC CARBO**N **(DIC)**

NAME OF CHEMICAL	AMOUNT OF CHEMICAL	COMMENTS
Magnesium Perchlorate	4 bottles, 500 g each	Granular Salt
Soda lime	4 bottle, 500 g	Granular Salt
Isopropanol	8 Liters (4 x 2 L bottle)	Solvent
Acetone	12 Liters (6 x 2L bottle)	Solvent
Coulometer solution (cathode)	52 liters (13 x 4L bottle	Liquid
Coulometer solution (anode)	10 liters (20 x 0.5L bottle	Liquid
Nitrogen, compressed	24 steel cylinders Carrier Grade	Compressed Gas
Air, compressed	6 aluminum cylinders (size a)	Compressed Gas
Pure CO2	12 0.5 Liter canisters	Compressed Gas
HgCl2	200 gr	granular for sample preservation
Phosphoric acid	6 0.5 L bottles	Liquid
Certified Reference	240 bottles (12 cases of 20, 500 mL)	Seawater standard

IV. CHEMICAL REAGENTS USED FOR TALK AND THE *SPECTROPHOTOMETRIC*
DETERMINATION OF **pH** IN SEAWATER

NAME OF CHEMICAL	AMOUNT OF CHEMICAL	COMMENTS
m-Cresol Purple	1000 mL (0.36 g/100mL)	Solution
Cresol Red	25 mL (.09 g/25 mL)	Solution
	2mM sodium bicarbonate	Dilute Solution
Hydrochloric acid	30 L (.2 Normal)	Dilute Solution
Tris buffer	7 L	
Certified reference	20 L (2 cases of 20 bottles)	Seawater Standard

V. CHEMICAL REAGENTS USED FOR THE DETERMINATION OF **CFCs** IN SEAWATER

Qty	Units	Item
14	cylinders	Nitrogen - compressed gas
2	cylinders	Air - compressed gas
2	cylinders	5% Methane in Argon - compressed gas
2	cylinders	Helium - compressed gas
1	kg	Magnesium perchlorate
1	kg	Ascarite - corrosive solid
20	pints	Ethanol

VI. CHEMICAL REAGENTS USED FOR THE DETERMINATION OF **HELIUM** IN SEAWATER

Qty	Units	Item
4	cylinders	Nitrogen - compressed gas
4	cylinders	Oxygen - compressed gas

4	cylinders	Air - compressed gas
8	liters	Acetone
8	liters	Methanol
80	liters	Isopropanol

VII. CHEMICAL REAGENTS USED FOR THE DETERMINATION OF **CDOM** IN SEAWATER

Qty	Units	Item
2.5	liters	Hydrochloric Acid
1	liters	Methanol
250	milliliters	Isopropanol

VII. CHEMICAL REAGENTS USED FOR THE DETERMINATION OF **pCO2** IN SEAWATER

Qty	Units	Item
6	cylinders	CO2 in air, compressed gas standard
1	cylinder	N2, compressed gas

Appendix B. Equipment list including Haz mats for A16S Cruise

This section provides the list of equipment as shipped followed by a descriptive list of Haz Mats and location of setup, if applicable. The description includes the disposition of the equipment and vans between the A16N and A16S cruise. The location of setup is provided in the figure 2 below

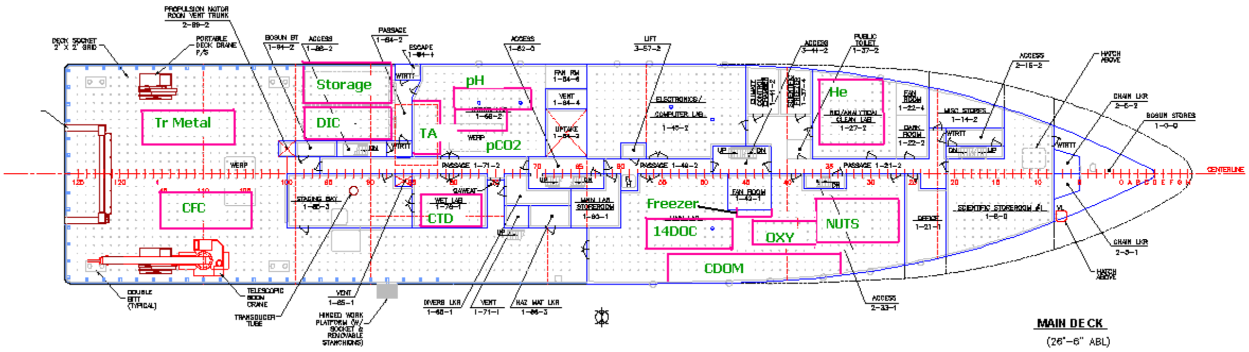

Figure 2: Layout of main deck of RHB and location of sampling and analysis groups

EQUIPMENT

AOML CTD/Oxy/Sal:
1 – 20' Storage Van containing 8 D containers (sometimes called "totes" these are 48" x 46" x 42" high collapsible plastic containers) and 2 CTD 24-bottle frames. This van is normally stored on the fantail just aft of the Hydro Lab and can hopefully stay there between A16N and A16S.
6 – D containers of equipment
2 - Rosettes

PMEL CTD:
1 CTD 24 bottle frame
12 packages (foot-locker size) containing CTD equipment
1 pallet of sea water and salinity sampling bottles
3 D containers of nutrient equipment

PMEL CFC:
1 – 20' laboratory van to be placed on the fantail, but can be moved between A16N and A16S.
6 – steel cylinders of N_2 gas. These can stay in the van between A16N and A16S. (I need to check with Dave if he will be bringing more than 6.)

AOML DIC/Discrete pCO$_2$:
1 – 20' laboratory van normally placed next to the storage van on the fantail just aft of the Hydro Lab. Laboratory vans should remain under power connected between A16N and A16S to maintain temperature-controlled environment.
24 – steel cylinders of N_2 gas. These will probably be palletized and kept in the storage van during the GO-SHIP cruises. Between cruises they can be stored almost anywhere.
6 – aluminum cylinders of CO_2 in air. Storage is same as nitrogen cylinders above.
6 – aluminum cylinders of CO_2 standard gas for the discrete pCO$_2$ system. These can be kept in the Hydro Lab.
22 – cases of Certified Reference Materials (CRMs). These are in gray cases 24" x 19" x 12" and weigh 35 pounds when the bottles are full.
2 – D containers for the discrete pCO$_2$ equipment.

AOML Nutrients:

4 – D containers will be shipped in the AOML storage van. The equipment will be set up in the Main lab and if it can remain there during the NTAS and PNE cruises without causing problems it would be helpful. Otherwise it can be packed up and placed in the AOML storage container or scientific stores.

USF/U.Hawaii/PMEL, Measures/Landing/Resing Trace Metals:
1 – 20' laboratory van to be placed on the fantail during the cruises but can be moved between A16N and A16S.
1 – FT winch, 59" x 50" x 56", 2977 pounds. This will be mounted on the fantail just aft of the staging bay during the cruises. In between A16N and A16S cruises, the winch should be kept out of the weather.
1 – polymer block and signal cable to be mounted on the A-frame with a 12-position rosette for sampling. These can be stored in the Trace Metal van between A16N and A16S.
1 – aerosol sampler, 1 – automated rainfall collector, and 1 – 10' pole.

1 – electronics/relay control box for aerosol sampler. This requires 4-5 square feet of space and can be either wall or bench mounted wherever is convenient.

UH LADCP:
8 – Boxes of LADCP equipment. They are around 25" x 25" x 20" with weights ranging from 45-140 pounds. (Based on A10 cruise, 2011)

LDEO Helium/Tritium:
4 – cylinders N_2 gas
4 – cylinders O_2 gas
4 - cylinders compressed air

The cylinders and other equipment will be shipped in a 20' container to Charleston where someone will be on hand to set it up in the Bio-Analytical Lab. The container will be kept on board for the duration. The container will be empty during the cruises and can be placed anywhere.
The Helium equipment will be set up in the Bio-Analytical lab

RSMAS Total Alkalinity/pH:
2 – D containers of equipment to be set up in the Hydro lab.
17 – gray cases of CRMs: 24" x 20" x 12", 35 lbs.

SIO Data Management:
2 – Pelican cases 3' x 2' x 2'
1 – case 2.5' x 2' x 1'

In total, their equipment requires about 18' of bench space.

RSMAS DOC/DOM:

1 – case of sample bottles are on board from A16N.

<u>HAZMAT Shipping (for details on container size and phase see Appendix A)</u>

AOML CTD/Oxy/Sal:
10 – liters Alkaline Iodide
10 – liters Manganese Chloride
10 – liters Dilute Sulfuric acid
60 – grams Sodium Thiosulfate
10 – liters Potassium Iodate

PMEL CTD:
None.

PMEL CFC:
6 – steel cylinders of N_2 gas.
6 – liters Ethanol
50 – grams Magnesium perchlorate

AOML DIC/Discrete pCO_2:
24 – steel cylinders of N_2 gas.
6 – aluminum cylinders of CO_2 in air. Storage is same as nitrogen cylinders above.
6 – aluminum cylinders of CO_2 standard gas for the discrete pCO_2 system.
11 – liters Acetone
3 – liters Phosphoric acid
2 – kg Magnesium perchlorate
200 – grams Mercuric chloride

AOML Nutrients:
500 - grams Cadmium metal granular
1.5 – liters Dowfax 2A1
300 – grams Hydrazine
500 – grams Imidazole
2 – liters Sodium Hydroxide
2.5 – liters HNO_3
3 – kg Oxalic acid
100 – grams SDS
20 – liters HCl
6 – liters H_2SO_4
3 – liters Acetone
30 – grams NEDA
500 – grams Ascorbic acid
500 – ml working standard
15 – grams NO_3 standard
5 – grams NO_2 standard
5 – grams PO_4 standard
10 – grams Silicate standard

FSU/U.Hawaii, Measures/Landing Trace Metals:
8 – liters 6M HCl

UH LADCP:
None.

LDEO Helium/Tritium:
4 – cylinders N_2 gas
4 – cylinders O_2 gas
4 - cylinders compressed air
80 – liters Isopropanol
8 – liters Acetone
8 – liters Methanol

RSMAS Total Alkalinity/pH:
40 – liters 0.24N HCl
1 – liter 2.5mM mCp indicator
7 – liters TRIS buffer

SIO Data Management:
None.

RSMAS DOC/DOM:
None.